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Food Ordering Application in Restaurant Using Loyalty Program Based on Android

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***Abstract*—The purpose of this research is to make an application that give an information to the waiter or waitress about the table that want to ask for help and to chef or drink maker about the order sequentially, to easily make the restaurant management to renew the menu list without pay for more surcharge, ease the customer to save their point and for increase customer's loyalty, help the customer to count their individual payment including the tax, and to ease the restaurant to analyze the revenue, product, and customer satisfaction. The method of this research is collecting data (interview), analysis method, system design method (use case diagram, activity diagram, class diagram, sequence diagram, application interface, and incremental SDLC), and also literature review. The result is mobile application based on Android for food ordering and web application for restaurant management. The conclusion of this application is this application "TMS Cafe" help restaurant to increase the customer loyalty using membership system, ease customer to store their point, simplify the restaurant to manage the menu and promo list with digital system, facilitate the restaurant to give information to customer about the active promo, ease customer to order food, increase the customer satisfaction with song request feature, facilitate customer to count their individual payment including taxes and also to see the transaction and point usage history.**

***Index Terms*—Android, Food Ordering Introduction, Loyalty, Mobile, Restaurant**

I. INTRODUCTION

Restaurant business is still having a good chance to develop that there are many people who cultivate this business. Nevertheless, not a few businessmen who have gone bankrupt. This business has a good prospect because this business has a close relation with the fulfillment of human's basic needs; the need for food. Unfortunately, many businessmen still don't know about what things that they have to watch, like to keep the quality of the food they serve and also service quality. To keep the service and food quality is the most important things in the way to start restaurant business. However, there still a lot of businessmen don't care about this. They don't know how to keep customer's loyalty through give a best food and service quality of the restaurant.

In this modern era, technology becomes an important thing in human life, and it expected to answer the problem that faced by restaurant. Therefore, businessman see there is a chance to develop an application that can increase customer's loyalty and to ease business process in the restaurant and answer the problems that arising from manual business process of restaurant as well.

The application that want to be develop is a mobile application based on Android. Seeing Android is open source operating system makes the businessman choose Android to replace manual way in restaurant.

Different from the previous application, developer also add some function in this application like customer's reward to increase customer's loyalty, notification to show the order status (waiting or cooking), and tax calculator feature to ease customer to count each payment including restaurant tax if they come in group.

The problem that are often encountered is a problem about updating a menu or promo list. As the knowledge of researchers, menu in restaurant change constantly, this change make restaurant must pay more to print that menu again. The other problem is restaurant always get a constraint in case that restaurant is crowd; The waiter/waitress have to list all of the customer; this may take a long time and also can't be given to chef/drink maker in the correct order. The other problem is to keep customer's loyalty.

A. Similar Application

There were several similar applications before that can help them to solve their problem; Application in *Genki Sushi* Restaurant and *Mujigae* Restaurant. *Genki Sushi* Restaurant have some features in their application: Menu digital, promo, and call waiter. As well, *Mujigae* Restaurant has several features like Menu digital, add/redeem point, request song, game, and call waiter. There was some feature that each other restaurant applications do not have, therefore we develop an application that combine their feature to solve the problem in restaurant. The comparison of these three applications is shown in Figure 1. There were several similar applications before that can help

them to solve their problem; Application in *Genki Sushi* Restaurant and *Mujigae* Restaurant. *Genki Sushi* Restaurant have some features in their application: Menu digital, promo, and call waiter. As well, *Mujigae* Restaurant have several features like Menu digital, add/redeem point, request song, game, and call waiter. There was some feature that each other restaurant application don't have, therefore we develop an application that combine their feature to solve the problem in restaurant. The comparison of these three-application is shown in Figure 1.

Feature	Application Name		
	Genki Sushi	Mujigae	TMS Cafe
Digital Menu	v	v	v
Promo	v	x	v
Add and Redeem Point	x	v	v
Request Song	x	v	v
Game	x	v	x
Membership System	x	x	v
Call Waiter	v	v	v
Tax Calculator	x	x	v
Digital Customer Rating	x	x	v

Fig. 1. Application Comparison

II. Literature Review

Android is a mobile operating system that is based in a modified version of Linux. It was originally developed by a startup of the same name, Android, Inc. In 2005, as part of its strategy to enter the mobile space, Google purchased Android over its development work [2]. Android is an open source project that develop in purpose to provide an open platform for develop user experience in mobile. Android was the first mobile platform that complete, open, and free [1].

The most important software to develop Android application is Android SDK. Android SDK contains debugger, libraries, emulator, documentation, example code, and tutorial. Besides Android SDK, for developing an Android Application, we also need the integrated development environment (IDE). In the case of Android, the recommended IDE is Eclipse, a multi-language software development environment featuring an extensible plug-in system. It can be used to develop various types of application, using languages such as Java, Ada, C, C++, COBOL, Phyton, and others [2]. And the additional tools to support development and debug of Android application is android development tools (ADT). So, to develop Android application, we need Android SDK, IDE (Eclipse), and ADT.

III. Research Methodology

Methodology that used in this project consists of two processes. First, estimate cost using Activity Based Costing (ABC). Second, controlling cost using Earned Value Analysis (EVA).

Methodology used in this research is:

- *Data Collection Method*

  In collecting data, researcher used interview method. Conduct interview with client and the company as the bridge between us and client.

- *Analysis Method*

  Researchers analyze the result of collecting data that got by interviewing related parties.

- *System Design Method*

  System design method that used in this research is:

  – *Unified Modelling Language* (*UML*): Researchers design use case diagram, activity diagram, class diagram, and sequence diagram.

  – *Software Development Life Cycle* (*SDLC*): Application development using incremental SDLC model as shown in Figure. We use this model because at the first meeting, client just give the outline of the application that they want.

  – *Designing Application Interface*: Before we develop the interface, we build a mockup of the application.

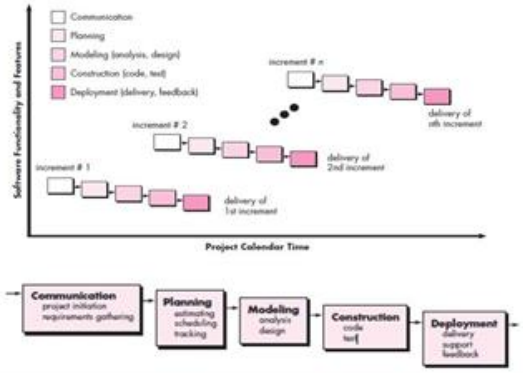

Fig. 2. Incremental Model

IV. Results and Analysis

Here is the result of this application. This application has some features, in following:

- *Digital Menu*

  Digital Menu shown in this application is equipped with discount info from promo menu.

- *Promo Feature*

  This feature shown the active promo in the restaurant.

- *Add and Redeem Point*

This application has Add Point feature that gave to member as the reward for their loyalty. Point that has been collected can be redeem with the selected product in restaurant.

- *Song Request*

  In order to increase customer satisfaction, this application have song request feature, as well, so customer can request the song they want to play.

- *Membership System*

  This application has membership system to increase customer loyalty

- *Call Waiter*

  This application has call waiter feature to ease restaurant in fulfill customer's needs.

- *Tax Calculator*

  This application has tax calculator feature to help customer while count each payment including the tax if they come in group.

- *Customer Rating Digital*

  This application has customer rating digital feature to ease restaurant to measure customer's satisfaction to service and product quality

Figure 3 shows the first page of this application that only appear once a day. The table number is input by waiter/waitress. The table number is used for marking the device.

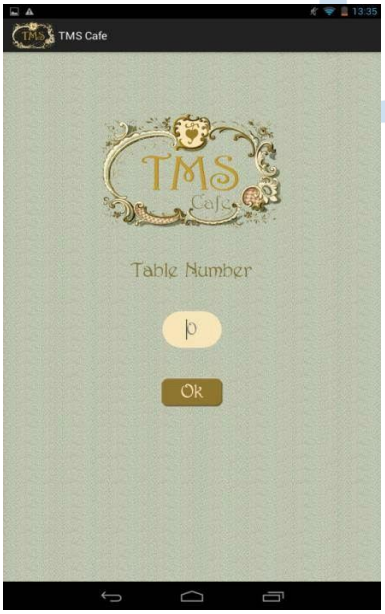

Fig. 3. First Page Interface

The home interface of this application contains main menu (features) of this application. The features of this application are shown in menu icon in the center of page and tabs in the bottom of page. The home interface of this application is shown in Figure 4.

Fig. 4. Home Interface

Digital menu as the solution of one of the restaurant problem is shown in Figure 5.

Fig. 5. Menu Interface

Customer's satisfaction is needed to know to help restaurant in analyze their products and services. We give the solution by make a page in this application to let customer give a feedback to the restaurant. It is shown in Figure 6.

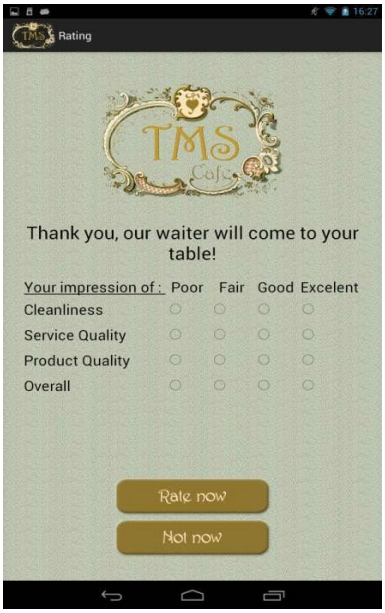

Fig. 6. Customer Rating Interface

V. CONCLUSION

This paper presents a food ordering application for Android based devices. The application deploys to help restaurant in manage their business process (including to renew the menu and promo list and manage customer order), to increase customer's loyalty, and to facilitate restaurant to analyze the revenue, product, and customer satisfaction. This application is quite good and useful, and also can solve the main problem of the restaurant in renew the menu and promo list, manage customer order, increase customer's loyalty, and to analyze.

In the further development of this application, it will be developed to iOS or windows operating system and researchers also will add some additional features in this application like entertainment feature like games, search feature, and feature to provide delivery order of the restaurant.

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Designing Mobile Application Interaction for School Internal Communication Using User-centered Design

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***Abstract*—In order to fastened up the process, the school internal communication system has been changed from its conventional way using linking book and announcement letter, to messaging groups or mobile applications. This was done to create a good communication between teachers and parents for their children. But parent capability on using mobile application has been causing problems. In this paper, we present the result of our observation for the current school internal communication system problem and made the better solution. To make sure the application design matches with parent's capability, the user-centered design method is applied. The final result of this study is a high-fidelity prototype of the application for parent side built using Sketch tools. The usability testing has been done to student parents. Based on the test result, this prototype has a good interaction, user-friendly interface for parents, and also already fulfills the usability goal and the user experience.**

***Index Terms*—Interaction, Parents, Prototype, User-Centered Design**

I. INTRODUCTION

The growth of technology and its innovations have contributed to improve communication in any fields, including education. In education field, the good communication between parents and teacher is needed to contribute on student success [1]. According to Ramirez, integrating technology can help schools more quickly communicate information to parents [7]. No wonder every school tries to find the best internal communication system, including trying to use technology which is mobile application. Several school use group feature in mobile messaging apps or google classroom apps. For group mobile messaging they usually use WhatsApp, the common text messaging application to spread the information. Google classroom is a classroom management apps that developed by Google. This application is actually only can access by teacher and student. Parent can access it by sign in with their child account. That its causing a several problem and limitation for parents.

User-centered design (UCD) is a method that used to develop product and make sure the product meets the user needs [2]. UCD focusing user in their development from observation, analyzing, designing, testing, and evaluating and iteration usually occurs. Because of this method involving user in every step, there is the big chance that the design is right solution for user problems and user will use it in daily basis.

Observation has been done and shows that there are problems faced by parents. The major problem is they had difficulty to get their children school information easily and quickly in detail. Either parents can't access the application cause of their ability, parents just missed the information cause of their own job, or parents lost the information resources. Another problem is parents find it's hard to talk to teacher and parents it's hard to differentiate their children activity. As a result of this problem, parents will not be able to supervise and accompany their children learning process at home.

Based on the problem that found from parents, in particular when trying to get information from school, we will make a mobile application prototype as a solution by using user-centered design method. This method is chosen because from the previous research the proposed design result from user-centered design method have been accepted and rated well by their users [8,9]. The process and the design results with the evaluation are described in the next section of this paper.

II. THEORIES

A. *Usability Goals*

Usability goals are quality attribute that can measure how easy the apps are to use for their user [3]. There are six usability goals; effective, efficient, safe to use, having good utility, easy to use, and easy to learn.

B. User Experience

User experience is how the product behave to the user or how the product being used by their user [4]. User experience also can define as user feeling and reaction while using the apps.

C. User-centered Design

User-centered Design (UCD) is a method that used in product development that makes the product based in user needs [2]. Includes 5 stages, which was used in this study: (1) Defining the scope, (2) Analyzing the problem, (3) Design content solution, (4) Design and implementation, (5) Testing and evaluation.

Iteration in UCD is occurs in step number four and five. While the result from the evaluation shows the prototype not good enough, the prototype must be revised. The iteration stopped when the test result shown that the prototype already fulfilled usability and user experience goals.

III. Proposed Method

In this study, user-centered design approach was used. This approach chosen because we want to make suitable solution for the user which are parents who has various problems, needs, behaviors, and goals. By using this approach, we can focus on users and involve user in every step on the development.

A. Defined Scope

In this step, we define the users of the application. Users for this study quite diverse, but the users must have at least one child that go to school. Realizing the target user from this study is parent, so we only make the design of application for parent side not for teacher side.

B. User Research

User research is done to gain information and insight from user. Two methods being used in this research which are questionnaire and interview. By questionnaire method, we get the quantitative data. Not only that, some of the question collect profile, preferences, needs, and user insights. This questionnaire got 96 respondents. Interview method also done to get qualitative data. By this method, we get the answer more detail and can dig deeper from user answers. The interview has been done to 9 respondents. After obtaining users data through questionnaire and interview, we did an in-depth analysis from the results.

C. User Problem and Goals

Based on the user research, we analyze and conclude user problems. There are 9 problems which are parents can't meet their child to get school information, child didn't tell complete information from school to teacher, parents hesitate to speak at online messaging group, there is no communication room between parent and specific subject teacher, parent found lot of difficulties using Google Classroom, often forget school information, miss important school information because of parent busy life, lost information resource provided by school, and it's hard for parent to differentiate several child school information.

From the user problems, we can construct and define the user goals as the basis for designing solution in this study. There are 6 user goals; (1) knowing detailed task information, (2) knowing detailed test information, (3) knowing detailed school event information, (4) aware of each info when it comes to deadline, (5) have conversation with homeroom and subject teacher, and (6) distinguish school information for every child.

D. Persona

Persona is user models that represented as specific, individual human beings. They are not actual people but the fictional data derived from the observation facts. Persona, like any models, must be based on real-world observation [5]. There are two types of persona in this study. The first one is a 36-year old workaholic woman named Nurul who has 2 children who wants to get school information without seeing her children and get notify when it comes to deadline. Because of their daily activity at work, she is familiar with using mobile application. The second one is a 53-year old man named Yanto who has 1 child in junior high school. He only use mobile phone if it is really needed and usually left or delete an application if it is too complicated for him to use. The first persona was defined as the main persona as this persona represented the largest percentage of target users.

E. Usability Goals and User Experience Goals

To develop prototype that solve the user problem, we must define suited usability goals and user experience goals for school internal communication apps. The prototype design will be made based on this goal. The usability goals that chosen are: (1) Effective, the school internal communication apps able to give all information from school, (2) Easy to learn, the school internal communication apps should be easily learned by every parent, (3) Easy to use, the school internal communication apps should be easily used every time user want to use.

The user experience goal that chosen are: (1) Helpful, users should feel helped when using the school internal communication apps, (2) Satisfying, users should feel satisfied by the information shown and all the features given by the school internal communication apps.

F. *Feature Analysis*

The feature that designed for the school internal communication apps must support and help user to achieve their goals. There are several features proposed that will help user achieve their goals. Each feature is a proposed solution to support each user goals and the feature is grouped into three feature group. After the feature group defined, we choose the usability goals and user experience goal for each group. Mapping of the user goal to proposed solution is on Table I.

TABLE I. PROPOSED SOLUTION AND FEATURE

User Goal	Proposed Solution	Feature Group	Usability Goal & User Experience
1	List of school task, Detail information for each task	Child School Activity List	Effective, Easy to use, Helpful, Satisfying
2	List of school test/remedial, Detail information for each test/remedial		
3	List of school event, Detail information that need to be prepared for school event		
4	Reminder or push notification when the deadline come		
5	Provide communication line with homeclass teacher, provide communication line with all subject teachers.	Teacher Conversation Room	Effective, Helpful, Satisfying
6	Separate each child profile, Display school information for each child seperately	Split Children Activity List	Effective, Easy to learn, Helpful

IV. PROTOTYPE DESIGN AND IMPLEMENTATION

Prototype is the initial model that describing and visualizing a product. Prototype is used to show product concept before they are built by developer. User-centered design process emphasizes the use of prototype so we can take users feedback before implementing the product. This study uses two type of prototypes which are low-fidelity and high-fidelity prototype. Prototype design will be done repeatedly until it fulfilled all defined goals. Before designing prototype, we designed the concept of the prototype first including, information architecture, navigation design, and visual design.

A. *Low-fidelity Prototype*

Low-fidelity prototype is uncompleted prototype that not have all interaction with black-and-white colors but already can visualize the content and the interaction of the application to users [10]. The low-fidelity prototype was developed using Sketch. We designed the interface of prototype based on several design principles such as visual hierarchy, consistency, direct manipulation, metaphors, and feedback [6]. The design is also made by considering several things which are usability strength and weaknesses of existing application that have been analyzed previously. Figure 1, 2, and 3 show the initial idea of the design for every feature that will be implemented in the high-fidelity prototype.

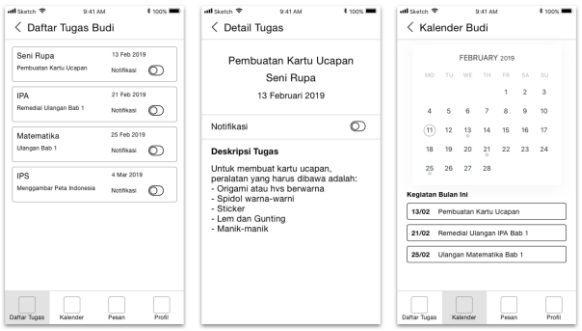

Fig. 1. Child School Activity List on Low-fidelity Prototype

Consistency was tried to be applied when designing this prototype. With consistency, we help users to easily learning every page. To maintain the consistency, every main page has a title at the top and navigation bar at the bottom. At the middle is the main information that will show base on the chosen menu at navigation bar. This consistency thing supported by the chosen navigation model, hub and spoke that shown by navigation bar. Hub and spoke with navigation bar is commonly used by mobile application.

Fig. 2. Teacher Conv. Room on Low-fidelity Prototype

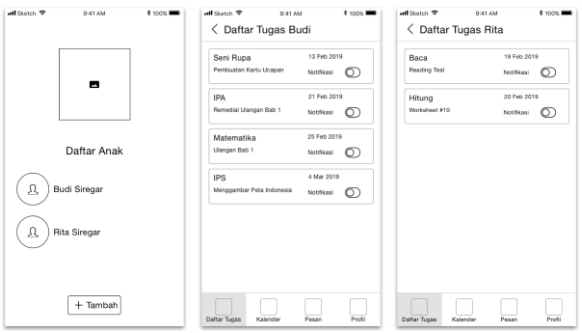

Fig. 3. Split Children Activity List on Low-fidelity Prototype

B. *High-fidelity Prototype*

High-fidelity prototype is complete version of this design which include color, image, and interaction [10]. High-fidelity prototype for school internal communication is the main result of this study. The high-fidelity prototype was developed using Sketch and can be access from Sketch Cloud.

The element of color, image, and other basic design element has been added in this prototype. In this study, we have two version of high-fidelity prototype. First one is high-fidelity prototype based on the improvement of the low-fidelity prototype. Second one is high-fidelity prototype based on the improvement from the iteration and has been declared as the final prototype.

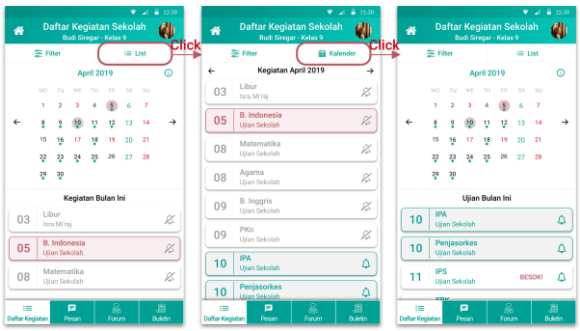

Fig. 4. Teacher Conv. Room on Low-fidelity Prototype

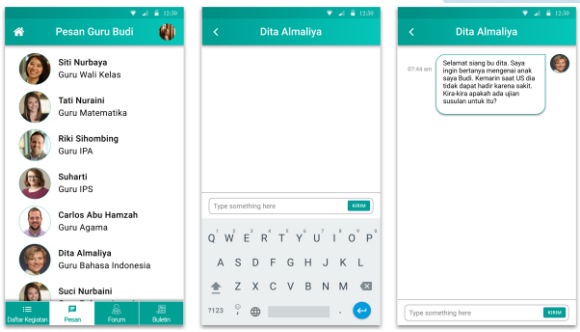

Fig. 5. Teacher Conv. Room on High-fidelity Prototype

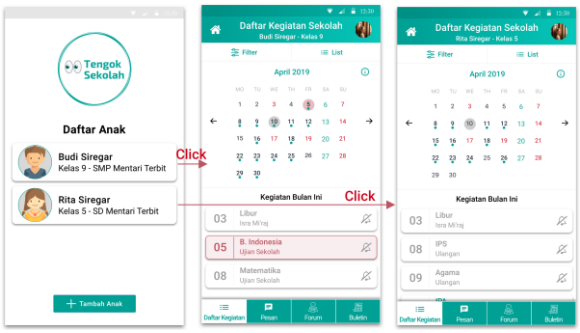

Fig. 6. Split Child Activity Task on High-fidelity Prototype

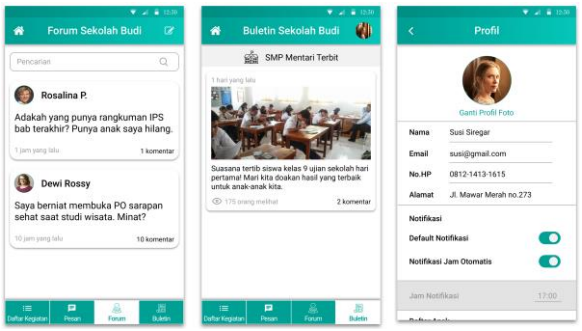

Fig. 7. High-fidelity Prototype (a) Discussion Forum, (b) School Bulletin, (c) Profile

Figure 4 until 7 shows the final high-fidelity prototype of school internal communication apps. This prototype was an improvement from the last iteration. Usability testing has been done for this final prototype.

Figure 4 shows the child school list feature. This feature contains the main page that shows child activity for one month with calendar. If users only want to see the list, they can hide the calendar. This feature offering a filter for user so they can see some categorize activity easily; task, test, school event, etc. By clicking the activity card users can open activity detail page that show activity name, description, deadline, subject, and teacher of the subject.

Figure 5 shows the teacher conversation room feature. This feature contains two main page which are the teacher list page and chatroom page. By clicking the teacher name card, user will open the chatroom for that teacher.

Figure 6 shows the split child activity feature. This feature contains child list page and add more child page. Child list page is the first page that will user see after sign in. They must choose one child that they want to see the activity. After clicking the child name card, the child school activity will show based on the name their chosen.

Figure 7 shows the addition feature from the last iteration which are discussion forum and school bulletin. The profile page is the additional page for parent to manage their account and information.

V. TESTING AND EVALUATION

For test and evaluate the prototype, we used usability testing method. Usability had been done several times and iteratively. Figure 8 shows the flow of the testing and evaluation process. We did usability testing three times, one time for evaluating the low-fidelity prototype and two times for evaluating the high-fidelity prototype. At that time, the prototype already fulfilled all the defined usability goals and user experience goals.

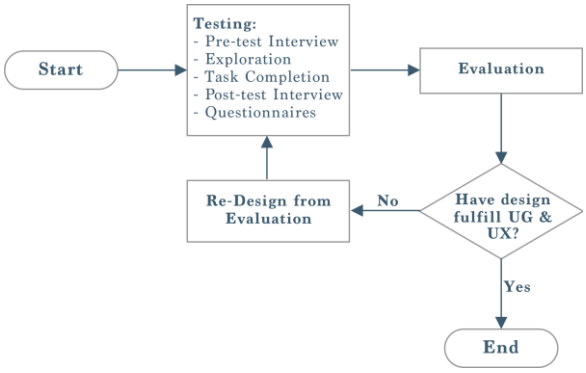

Fig. 8. Testing and Evaluation Flowchart

Respondent for the usability testing were chosen to suit the characteristics of the personas. The first and second iteration were tested on 10 respondents: 5 persona 1 and persona 2 for first iteration and 7 persona 1 and 3 persona 2 respondents for second iteration. The final iteration was tested on 12 respondents: 8 persona 1 and 4 persona 2 respondents. For further observation, every usability testing conducted was recorded. The usability testing phase was divided into 5 stages.

A. *Pre-test Interview*

The test begins by introducing and informing respondent about the research and purpose of this usability testing. Then followed by start to asking the pre-test question which explores about respondent demography, habits, and abilities related to mobile application. The interview also consists of question related to current school internal communication and problem they faced, and what they think of existing school internal communication system.

B. *Exploration*

After the pre-test interview, respondent was give the prototype to be explored. Respondent is given around three minutes to perform any activity with the prototype. This exploration is done to give respondent knowledge about prototype without given instructions.

C. *Task completion*

After the exploration, respondent are given several tasks to be finished. The purpose of the task is given at this test is to evaluate whether the users understand the flow, the objective of every element, and also the information given on prototype. The tasks were made based on feature and the user goals that want to be achieved. There are nine tasks defined for this phase, the tasks are:

1) See list of activity

2) Use filter to see activity

3) See detail of a task

4) Sent a subject teacher a message

5) Add topic at discussion forum

6) See school bulletin

7) Turn reminder/notification off

8) Change child activity list

9) Add another child

The result show that majority of the respondents perform all of the tasks successfully without any difficulty. The respondent also understands all of the elements implemented in the prototype except for several respondents that categorize in persona 2 who are novice users.

D. *Post-test Interview*

After the task completion, there is post-test interview. The questions were made to gain respondent feedback after using the prototype. Each question is designed to explore the respondent overall insight through the use of prototype. The question that been asked include how respondent views the prototype, what user likes and dislikes, what respondent need for further feature, and what improvement can be done.

E. *Questionnaires*

Questionnaire is given to respondent in order to get the quantitative data from respondents. The questionnaire used a 5-scale Likert scale technique. Rate 5 represent the best value and rate 1 represent the worst value. The questions of the questionnaire being asked to gather information whether the usability goals and user experience goals have been reached. Table II shows the results of the questionnaire from the final iteration.

TABLE II. QUESTIONNAIRE RESULTS

Parameters	Achievements		Response				
	Usability Goals	User Experience	5	4	3	2	1
General opinion	Easy to use		10	2			
User interface	Easy to use	Satisfying	11	1			
User experience	Easy to use	Satisfying	6	6			
Usability of activity list	Easy to use	Helpful	12				
Usability of teacher conv. room	Easy to use	Helpful	9	3			
Usability of split child task	Easy to learn	Helpful	9	3			
Easy to use	Easy to use		5	4	3		
Easy to learn	Easy to learn		5	4	3		
Information utility	Effective		10	2			
User satisfaction		Satisfying	9	3			

From the results we calculate the average score for every usability goals and user experience. The average score for usability goal easy to use is 94%, easy to learn is 89%, effective is 96% and user experience helpful is 96%, satisfying is 94%. That percentage all above 80% and all users agree that the prototype fulfills usability goals and user experience goals. The prototype also solved all of the problems observed in the school internal communication as well.

VI. CONCLUSION AND FUTURE WORK

The suitable usability goals for parents in school internal communication apps are easy to use, easy to learn, effective. In addition, the suitable user experience for parent is helpful and satisfying. The proposed design for school internal communication apps based on those goal had been achieved and accepted by users. All users agree that the is easy to use, easy to learn, effective, helpful, and satisfying.

For future work and development, the prototype can be implemented as a software and teacher side application for school internal communication should be designed and implemented too. The user-centered approach proofed to be great for making good application and should to be used for future development.

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DynaBot: Dynamic Dota 2 Bot

Implementation of Dynamic Scripting on AI for Three Dota 2 Characters

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***Abstract*—This research was conducted to find out whether the Dynamic Scripting method that has been used before only on zeus characters can be generalized to be used on other characters on the Dota 2 game. Dynamic scripting works by using the rulebase where the rulebase contains actions that determine the actions performed by Artificial Intelligence (AI). In addition, some adjustments have been made to existing methods. To find out whether the performance of a generalized and adjusted model is better than the previous model, a test has been conducted where AI is made with dynamic scripting against AI provided by the valve in the Dota 2 game. In addition, AI has also been tested against humans. Then the performance of AI will be analyzed by comparing the winning ratio and several other supporting variables. The results of this study are that AI got a low winning percentage against standard AI and cannot win at all and give poor performance against humans. It can be concluded that the Dynamic Scripting method cannot be generalized to other characters in the Dota 2 game.**

***Index Terms*—AI, Dota 2, Dynamic Scripting, Video Games**

I. INTRODUCTION

In 2017 64% of US households own a device that they use to play video games [1]. With these high numbers, it is not a surprise that the development of video games happened at amazing speed. Therefore, when considering how games should evolve in the future, it is wise to take into account AI that learns and directly reacts specifically to each player [2].

OpenAI, a non-profit organization has also succeeded in creating an adaptive AI for the Dota 2 game. OpenAI developed an AI consisting of 5 Neural Networks which have the name OpenAI Five that capable of defeating human amateur teams with certain Dota 2 characters [3].

To implement a Neural Network, it required hardware with high specifications because the calculation process is very complicated and constantly changes according to the action that occurs. For the game against Bot or AI, that is done offline, computation and calculation processes will be carried out on home personal computer which do not have very high specifications so that the implementation of OpenAI cannot be run by home personal computers. The alternative solution is still needed so the AI can be implemented on most computers. Other method that is simpler and has been applied for the development of AI in games is the Dynamic Scripting method.

Previous studies that have been done to create adaptive AI are "Adaptive game AI with dynamic scripting" by Pieter Spronck, Marc Ponsen, Ida Sprinkhuizen-Kuyper, and Eric Postma who applied the Dynamic Scripting method to the Neverwinter Nights game.

Dynamic Scripting is an online machine learning that uses the rulebase to produce the script. The Rulebase contains actions that can be selected, where elections will be conducted randomly with weight adjustments registered for each action [5].

Dynamic Scripting is a simpler method because with the rulebase that will regulate the actions that AI will take. The calculation process that occurs will be simpler so that computers with low specifications can still run AI without any obstacles. The Dynamic Scripting method was also applied in the Dota 2 game to create an adaptive AI in “Implementation of Dynamic Scripting on Dota 2 AI” research.

In the previous research [5], the application of Dynamic Scripting on AI Dota 2, resulted in AI for the character "Zeus" that can adapt to tactics and games from the default AI Dota 2 created by Valve. From the 50 times of learning, AI that uses the Dynamic Scripting method is able to achive a 72%-win percentage in the face of the AI Valve with unfair difficulty. Whereas to fight humans the results of previous studies have not been able to defeat humans [5].

From the research conducted by Evan Asher the problem is that in previous studies AI was made only to be used on one character and cannot be used with other characters. This research will generalize the existing models in the previous research to be used

for other characters and how the performance of other characters using the same model, whether the performance will be better or worse than the characters used in the previous research [5].

The rest of this article will be presented as follow. Next section provides a brief introduction about Dota 2 game. Section 3 and 4 describe the method and AI design proposes by this study and its evaluations. Finally, 5 and 6 explain the work of the model and conclude this study.

II. DOTA 2

Dota 2 is a multiplayer online game played by 2 teams, called Radiant and Dire, each of which consists of five players. Both teams have Ancient which must be protected from enemy attacks that came from 3 directions or called lane, namely Top, Middle and Bottom which each is protected by three towers or defenses and forces or creeps that appear on each lane. Each player chooses one from a total of 117 different heroes. Each hero has attributes that are strength, agility, and intelligence, and has 4 or more unique abilities that have many functions such as healing and strengthening friends or dealing damage, paralyzing and slowing down opponents. In addition, there are also many items that can be used to strengthen the hero [7].

Abilities and Items give each hero a role in a team, like an attacker or called a carry, which focuses on giving injuries to enemies, healers who focus on healing friends and strengthening friends, and spellcaster who focuses on deal damage to enemies with their active abilities. Carry is responsible for killing the opponent hero but requires items to reach their maximum potential. Offlaner that focuses on playing against your opponent's carry at the beginning of the game, and Supports are helping other heroes.

Each player or hero can increase the power of their hero by gaining experience points to raise his level, his unique abilities and strengthen his attributes. Experience points are obtained by killing opponent creeps or own creeps and opponent's hero. Beside experience points, players can also strengthen the power of their hero by gaining gold that can be used to buy items that help them winning the game. Gold is obtained in the same way as experience points.

There are several game modes in Dota 2, such as All Pick which is a traditional mode where playing five versus five between Radiant and Dire. There is also 1 vs 1 Solo Mid which is used in this research, which is a mode where there is only one on one battle between two heroes in the Middle lane and the winner will be determined from the first time to kill the opponent 2 times or destroy 1 opponent tower in Lane Middle.

Dota 2 also provides bots that can be played offline, which have various levels of difficulty: passive, easy, medium, and unfair.

In order to measure the level of skills of Dota 2 players, MMR system is implemented. MMR are Matchmaking Rating system where player skill defined by number. The higher MMR player has meaning they are more skillful, contrarily if the player are bad then the MMR will be low.

III. RESEARCH METHOD

In this research, the first thing to do is selecting the heroes that will be used as the object of research. The next thing that will be done is training on AI and the last one is evaluating the performance of the AI that has been tested.

A. Selected Heroes

The selected characters are the 3 most used carry heroes in the The Chongqing Major tournament, which is an official tournament organized by the Dota 2 game developer. These characters are Juggernaut used 33 times with a 45%-win ratio, Terrorblade used 31 times with a 52%-ratio, and Sven which is used 30 times with a 43%-win ratio [8].

1) Sven

Sven is a character with a melee attack and has a Strength attribute. Sven is categorized as hero category that focuses on attacking opponents with Auto Attack in combat. Juggernaut has 4 unique abilities where 3 of them are active abilities that need to be activated and consume Mana. These abilities are Storm hammer, Great Cleave, Warcry, and God's Strength [8].

2) Juggernaut

Juggernaut is a character with a melee attack and has an Agility attribute. Juggernaut is categorized as hero that focuses on attacking opponents with Auto Attack in combat. Juggernaut has 4 unique abilities where 3 of them are active abilities that need to be activated and consume Mana. These abilities are Blade Fury, Healing Ward, Blade Dance, and Omnislash [9].

3) Terrorblade

Terrorblade is a character with a melee attack and has an Agility attribute. Terrorblade is categorized as hero that focuses on attacking opponents with Auto Attack in combat. Terrorblade has 4 unique abilities where 3 of them are active abilities that need to be activated and consume Mana. These abilities are Refraction, Conjure Image, Metamorphosis, and Sunder [10].

B. Bot Structure

Based on the model from previous research, in this research AI will be divided into 7 Modes which each mode will contain actions based on the available modes. The 7 modes are Laning, Evasive, Retreat, Rune, Tower, Farming, and Attacking. Each mode will have a chance to appear based on a probability value, where the probability value is influenced by the reward and punishment received by the mode or action.

This research will be conducted on 3 heroes which each hero has a unique ability that is different from each other. AI mode will be divided into into two type, namely the general mode, which is the mode that can be used in many hero and specific modes where in that mode the action will be adjusted to the unique abilities of the hero. The actions for general mode are as follows:

1) Laning

The action in this mode are when the game starts, AI will walk towards the middle lane where the fight will take place and wait for the creep to appear and will block the creep. Blocking is an action where AI slows down the creep rate to get a more profitable battle position.

2) Evasive

The action that is in this mode is that the AI will move away from the enemy so that it is out of enemy attack range which is 500 units so AI will not receive damage or attacks from the enemy.

3) Retreat

The action in this mode are AI will return to the base to regenerate health points and mana points if AI health and mana points going down to 25%. From this mode AI will switch to laning mode when regeneration is complete

4) Rune

This mode contains an action where AI will go to the location of the appearance of the rune, which is a power up that will strengthen the AI for a certain time. After the runes are taken AI will return to the lane where the battle takes place to move to other modes.

5) Tower

Action in this mode are AI will attack the opponent's tower with a normal attack, AI will only attack the tower if there are creeps or comrades who also attack the opponent's tower, if the creep stops or no one attacks the opponent's tower AI will switch to laning mode.

For farming and attacking mode will be a specific mode. The action on each hero is as follows:

1) Sven

a. Attacking

First action is AI will use Storm Hammer's ability to finish off enemies whose health points are lower than 20%. The second action is when enemy health points are lower than 50%, AI will use Storm Hammer to immobilize the enemy, then AI will use the Gods Strength ability that will strengthen AI attack damage and strength, then AI will finish off the enemy using normal attacks.

b. Farming

First action is AI will attack creep that health points are lower than AI's attack damage and the second action is AI will use storm hammer to kill the enemy creep that health are lower than 30%.

2) Juggernaut

a. Attacking

The first action is AI will use Blade Fury's abilities and then move towards the enemy to continuously damage the opponent whose health point is lower than 25% and then continue with a normal attack. The second Action is when the opponent's health point is lower than 50%, the AI will use Blade Fury to deal damage the enemy, then the AI will use Omnislash ability to finish off opponents who still have the remaining health points.

b. Farming

First action is AI will attack creep that health points are lower than AI's attack damage and the second action is AI will use Blade Fury to kill opponent's creep by giving damage continuously to the opponent's creeps around him.

3) Terrorblade

a. Attacking

For attacking mode, there are four types of actions for Terrorblade. The first is where AI will use Reflection's ability to summon enemy shadows and attack enemies. The second AI will use the ability of Conjure Image to call its own shadow to attack the enemy. For the third, AI uses the ability of Metamorphosis to strengthen itself then AI will use Conjure Image to call its shadow and then attack the enemy along with its shadow. Last, when AI's health points become lower than 25% AI will use Sunder's ability to exchange its health

points with the opponent's health points and then attack the enemy with normal attacks.

b. Farming

First action is AI will attack creep that health points are lower than AI's attack damage and the second action is AI will use Metamorphosis to increase its attack damage and attack range which will make it easier for AI to kill the creep.

C. Bot Structure

All actions that AI has will be registered to the rulebase. Each action will have a value variable that can be reduced or increased according to the results of the action. The reward and punishment for weight will be calculated by this formula where W is Weight of each actions.

$$\Delta W = W + \text{Reward}$$
$$\Delta W = W - \text{Punishment}$$

Reward and punishment assessment will only be applied to farming, attacking, rune, and retreat modes. All action in the mode will have a variable value as well. Where the chance of the action to be selected will be higher if the value have high number. For laning, evasive, and tower modes, AI will only have one type of action because of the limited object of the research, which is 1 vs 1 mid solo which only uses the middle lane and more limited winning conditions.

Testing will be done in 2 phases. First phase AI will play against Dota 2 default bot with a difficulty level of insane in 50 matches for each character and for the second phase AI will play against humans. The subjects collected were 2 people who were Dota 2 players with an MMR of around 2500.

In the first test each AI will fight random characters controlled by the default Dota 2 AI. As for the second test each AI will fight each subject 2 times per subject using random heroes. This test is done in 1 vs 1 solo mid mode.

The action will be evaluated every 2 minutes and the weight value of the action will be adjusted based on existing parameters. The evaluation parameters for each action in each mode will be different, adjusting to the characteristics of the mode. The parameters for each mode are as follows:

1) Farming

The assessment will be considered successful if the AI manages to kill the opponent's creep in a certain amount within the time set. If AI do not succeed in reaching the specified amount, the reward obtained will not be as high as if AI succeed in reaching the set amount.

2) Attacking

When AI takes action and reduces opponent's health points, it will be compared to the number of AI own health points, if the opponents lose more health point than the AI health points then the assessment is considered successful. On the other hand, they will be considered to be failing. The number of AI health points decreases more than the opponent's health points.

3) Rune

Assessment will be conducted based on whether the runes can be taken first before the opponent is taken, if the AI succeeds in taking it first then the action is considered successful, if the opponent takes the rune first then the action is considered a failure.

4) Retreat

Assessment will be made based on whether AI managed to avoid death and return to the base to regenerate. If the AI survives, the action will be considered successful, and if the AI character dies, the action will be considered a failure.

D. Evaluation Method

Because this study uses a model from the previous study [6], then the method for evaluating results will be the same as that research. Analysis on training against default bot will be carried out based on data taken from the game, namely:

- The percentage of wins from the AI against Dota 2 default bot game.
- Gold per Minute. The amount of gold obtained in one minute.
- Experience Points per Minute. The number of Experience Points obtained in one minute.
- Total Last Hit. The number of enemy units killed in one match.

The evaluation against human will be the same as previous research. It will be done with a Likert scale with the same statement as previous research [5].

IV. EVALUATION

A. AI Test Results Analysis Against Default Bot Based on Winning Percentage

Fig. 1. AI Winning Percetage

Based on the results obtained Sven can only get 6 wins from a total of 50 matches against default bot. Juggernaut and Terrorblade can only get 3 wins from a total of 50 matches against default bot. From the test results, the value of victory is very low. And victory can only be obtained if Default Bot is a character that does not focus on fighting in the lane and leaving the lane so that AI can destroy tower or opponent's Tower easily.

B. AI Test Results Analysis Against Default Bot Based on Gold per Minute, Experience Points per Minute, and Total Last Hit

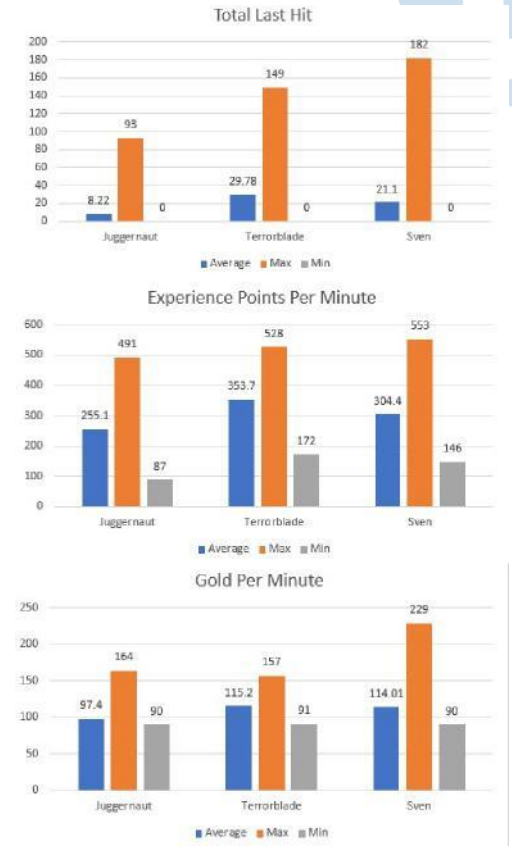


Fig. 2. AI Gold per Minute, Experience Points per Minute, and Total Last Hit

From the testing result it can be seen that Terrorblade has the highest last hit average, but Sven has the highest potential in getting last hit, it's maximum last hit is the highest among the three. AI on all characters has experienced a failure where AI cannot get any last hit at all in one game.

Whereas for Experience Points per Minute all three get maximum values that are not too much different from each other. For the average Experience Points per Minute obtained, the Terrorblade gets the highest value with a fairly significant difference with the other two characters.

For gold per minute, Sven got the highest maximum value with a significant difference with the other two characters but the average gold per minute obtained remained lower than Terrorblade. Terrorblade gets the highest average gold per minute but the maximum gold per minute obtained is the lowest, lower than Juggernaut who has the lowest average gold per minute among the three.

C. AI Test Results Analysis Against Human

In the second phase of testing, AI that has been trained against default bot will be tested against humans. The result of testing on all characters is that AI cannot defeat players at all against Dota 2 players with intermediate level player.

After testing, the players who were the subject of the test gave an evaluation of the performance of the AI in the game. The maximum points that can be earned from one subject are 25 points with the minimum number of points that can be earned is 5. The points earned by AI is 18 from the maximum points of 50.

Based on the survey conducted, it was found that the ability of AI to do last hit was so poor. Besides that, AI's ability to be aggressive and kill enemies is bad. AI isn't too bad at keeping the lane. What is good about AI performance is only in selecting items.

V. DISCUSSION

Based on the results of the testing it was found that AI was unable to obtain a high winning percentage, this is because the characters controlled by AI are characters with melee attacks. Characters with melee attacks have difficulty being able to keep a distance so that they are not attacked by enemies while having to stay within the optimal distance to provide a final attack or kill the opponent's creep.

The inability of AI to kill the opponent's creep causes AI unable to gain the experience points and gold needed to strengthen the AI character. Meanwhile, the default bot is able to get the optimal experience points and gold so that it can strengthen its character well. The character of AI cannot keep up

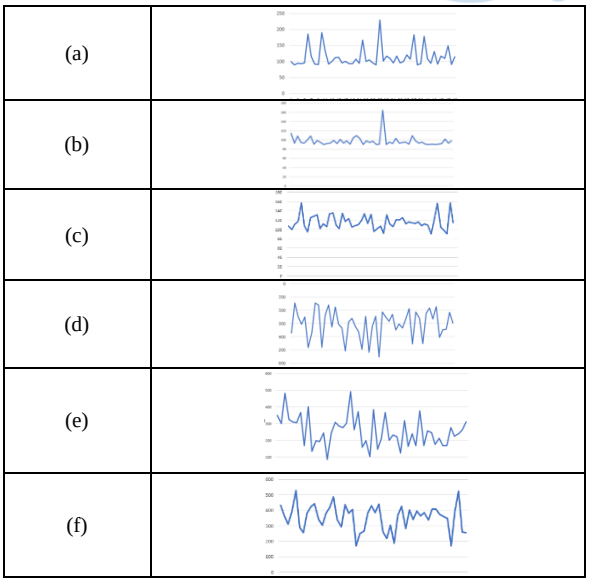
with the growth of standard AI strength, so it is difficult to achieve victory.

The parameter used by AI to maintain distance in the game is only the distance between AI and the opponent's character. To do a final attack or kill the opponent's creep, AI must enter an unsafe area. AI will back down because it feels insecure so that the AI cannot gain enough experience points and gold to strengthen itself.

A short experiment was carried out where one parameter was added, namely the number of health points from AI. If the health points of AI are still high, then the unsafe area of AI will be smaller, so that AI will get an opportunity to gain experience points and more gold that can be used to strengthen AI. The results obtained from the short experiments are not much different from using only one parameter, AI still has difficulty in carrying out the final attack or killing the opposing forces which causes the AI difficulty to strengthen itself.

Unlike the Zeus character used in the research "Implementation of Dynamic Scripting on Dota 2 AI" [5] which is a character with long range attacks so it can be easier to give a final attack or kill the opponent's creep so that it can gain experience points and optimal gold that can strengthen itself so that can get victory more easily.

The three characters used in this research also have different characteristics from the characters used in previous studies. The characters in this study are characters with power peak at the end of the game that require a lot of experience points and gold to reach the peak of their power, whereas in previous research the characters used are characters with peak strength in the beginning to mid-game. It has unique abilities that can deal big damage on opponents without lot of experience points and lots of gold.



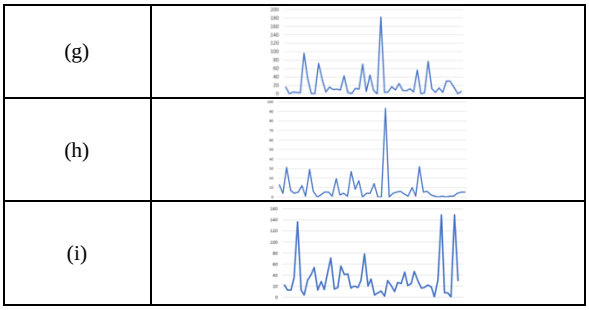


Fig. 3. (a) Sven gold per minute, (b) Juggernaut gold per minute, (c) Terrorblade, (d) Sven experience points per minute, (e) Juggernaut experience points per minute, (f) Terrorblade experience points per minute, (g) Sven last hit, (h) Juggernaut last hit, (i) Terrorbalde last hit. Blue lines indicate variable values for 50 games

Based on the graph shown in the picture, it can be seen that all variables have patterns that are very random. There is no trend line that can be seen. This shows that AI cannot learn from every game.

AI cannot learn because all opponents faced by AI have different characteristics. Things that learned by AI in a game cannot be used in the next game because the opponent in the next game has characteristics that are far different from the previous opponent. AI can only learn to play against one hero continuously, so AI can learn how to play against that hero. the solution to this problem is that AI must be specifically trained for facing one hero.

VI. CONCLUSION AND FUTURE WORKS

In this study AI defeated by default bot in most matches. The percentage of wins obtained by AI is 12% for Sven characters and 6% for Juggernaut and Terrorblade. In facing players with MMR 2500 or intermediate level, AI cannot win at all.

From this study it can be concluded that in generalizing the method used in the previous research [6] was unsuccessful. AI cannot learn anything from each game that AI played because opponent that AI faced have very different characteristics. For future works thing that can be tried is to give AI a different "brain" to deal with each character in the Dota 2 game.

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Leveling Up Difficulty Model Based on User Experience in Education Games Mobile-based for Student Kindergartens

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***Abstract*—The purpose of this study was to identify how to build an educational game model with numerical recognition, numerical ordering and simple counting for kindergarten students with an age range of 3-6 years, where the method used is leveling up difficulty automatically based on user experience, where the level of difficulty will increase based on the success of the user completing the game, the more often the user plays the game, the difficulty level will continue to increase, so hopefully with this model education games mobile-based can develop education games model that can help students recognize numbers and improve their ability to sort and count numbers with more easy and fun way.**

***Index Terms*—Education Game Model, Game Modelling, Kindergarten, Leveling Up, Mobile-Based**

I. INTRODUCTION

In the present era, in the life of modern society, smartphone technology cannot be separated from its users, where almost all people, from all ages use smartphones, including teenagers even early childhood also use smartphone technology, where smartphones can have an impact negative or positive in the life of modern society, where one of the positive effects that can be obtained is to use a smartphone to get information or knowledge through media information or also through applications, such as educational games. According to Ponticorvo in his research, educational digital games can be used as attractive media learning for kindergarten children [6].

This study aims to facilitate student's understanding the concept of numbers, about how the numbers shape, sequence, counting and compare numbers with building interactive and interesting learning models mobile-based, so with interactive and interesting learning is expected can develop soft-skills and competencies behaviors that affect interpersonal interactions [7].

According from De Basterrechea and Salvador, the game is a methodology where the children will learn and internalize learning concept, games for children are another experiences that can make them change, create another world, live other lives, have the role of being someone else without losing their identity , through games, children can build their own learning methods to support the knowledge that had given by their teachers at school [10]. According to Lucas, a child sees the world as a game and all his actions are imagine as a part of a game that can be enjoyed by children [1].

Based on Gabos Kiss's research, a student is more motivated to be able to complete the assignment when the assignment is in game-based form, where they will get better grades rather then when they work assignment manually [2]. According to Harvey, making education game models must be concerned with the following things, such as adjusting the game model to player target and thinking about how to keep the player's interest to still continue playing our games [9].

Also according to Esper, using games as a media learning can increase children's learning productivity, because children can get understanding from different teaching methods [8].

Based on some opinions from previous studies, with various educational game making it can be concluded, the game can provide a view of new learning methods, which are fun and easy to understand for children, to realize an interesting and interactive educational game that is easily accepted by children, in this study a education game model with leveling up difficulty based on user experience, which aims to improve children's ability to recognize and organized numbers, because according to (Moore 2000), that when a student learns something in a fun way, it can increase the enthusiasm for learning children and can also improve children's learning outcomes, in addition to having an impact on children, learning in a fun way can also have a good impact on teachers [3]. And to prove the benefits and user acceptance of this education games application, also to prove the success of the method of leveling up on user experience based on game education, a survey will be conducted using a user acceptance test.

II. METHODOLOGY

In developing education models this game will built with colorful colors that because early childhood really likes coloful colors, because with that can improve mood, spirit and comfort for children [5].

This game model will be built using leveling up difficulty based on user experience, to maintain player interest and to reduce stress on children [5], so it is expected to have a positive impact for children.

In "Fig. 1" show a basic flowchart leveling up based on user experience diagram in this mobile-based game education game. This leveling up step will execute when player finished playing the game and gets a star.

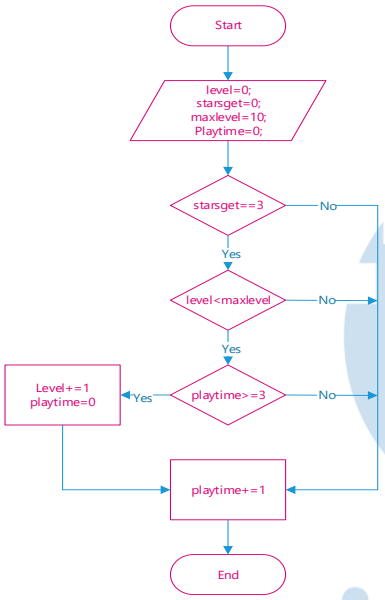

Fig. 1. Flowchart Diagram Leveling Up Method

Leveling up difficult process has 3 parameters, namely starsget parameter to accommodate the number of stars obtained by players, maxlevel to limit the maximum level and playtime to count the number of players playing. And the next step is proceed with checking, where the first check is when the player gets a star, if the player gets a three star, it will be checked for maxlevel, if it has not passed the levelmax yet, then the player need played the game at least three times, and if all conditions are met the level game will increase. Playtime parameters will always increase when player finished the games.

Main menu model in this education game develop by making several menu choices, such as starting the game, setting game options, and closing the application, as shown in "Fig. 2".

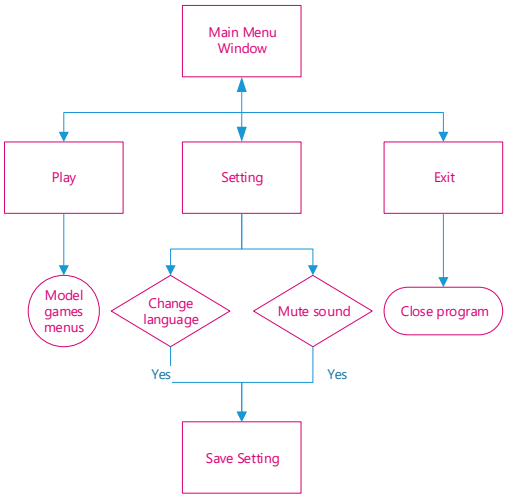

Fig. 2. Main Menu Flow

In the selection games, menus model was designed with many selection menus, where the user can choose many various types of numbers games, as shown in "Fig. 3".

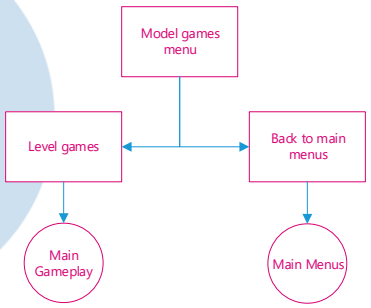

Fig. 3. Model Games Selection Menu Flow

In the gameplay menu, first step will show how to play window as a guide for user, After that the main game will show, where users will get stars based on certain criteria in each game, as shown in "Fig. 4".

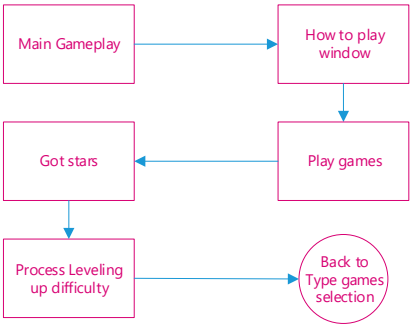

Fig. 4. Main Gameplay Flow

III. DISCUSSION

In the development model of a mobile-based educational game, the development will be divided into three sections of development, namely the section of making the main menu model, the menu selection game model section and the gameplay menu section

which are the main scenes of this education game. This game will applied portrait display orientation, to facilitate early age users can control the games more easily [4].

In the main menu display is given a colorful color as an attraction for early age users, and in there has 3 simple buttons on the main menu that can be selected by the user, such as the start button to begin playing game, setting button or option button and exit button, as shown in “Fig. 5”.

Fig. 5. Main Menu Model

The play button will be used to start the game, where after that model selection menu will be displayed as shown in **Error! Reference source not found.**. For the options menu will contain game settings, which will affect the main gameplay, the options menu will appear as shown in ”Fig. 6”. And for the Exit button, it will be used to exit the game.

Fig. 6. Option Menu and Selection Model Games Menu

In this learning educational game there are several types of game choices, which are made as an interactive and fun learning model, including Learn Numbers “Fig. 7”, where the gameplay in this game has not been applied to the leveling up difficult method, because at this early stage the user is introduced about the shape of numbers and pronunciation. In addition there is a choice of sorting game numbers, where the leveling up method is applied in this gameplay, where when user success completing the game, it would have an impact on the level difficulty.

Fig. 7. Gameplay Learn Numbers Model

In “Fig. 8”. shows changes in the level of difficulty of the gameplay, after the user successfully completes the sorting game several times and then user tries again with same game, then the level of difficulty sorting will increase, where difference lies in the random numbers that appear, if at the beginning of play, the numbers will only bring up numbers from one to ten, after a number of times the user successfully completes the game with good results, new problems will be raised which increase the difficulty level, where the numbers appear above ten.

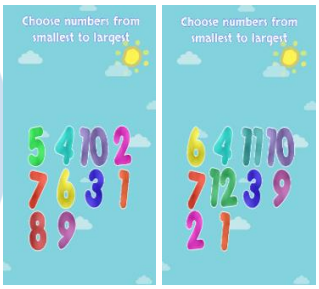

Fig. 8. Before and After Numbers Issue Model

Every time a user solves a problem, the user will get a star “Fig. 9”, which will appear at the end of each game, where the number of stars indicates the user's success level in completing the game, the star is used as a trigger to increase the level of difficulty of the questions.

Fig. 9. Stars Report in The End of Games Model

The gameplay model comparing numbers is another type of game that is expected to help users understand the value of a number, where players will be asked to answer larger, smaller or equal from the 2 numbers being compared. In comparing the game

model also applied a leveling up based on user experience model, where the number level is higher, the numbers in question that will appear more diverse. In “Fig. 10” shown an increase the levels with increasingly large numbers.

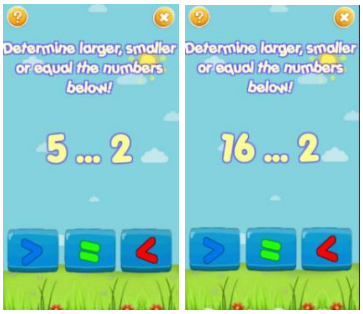

Fig. 10. Before and After Leveling Up Matching Games Model

Another type of number learning game model is counting items or objects, where multiple choices will be provided to help answer the question, in this type of game will counts the user’s speed calculating, where the more user plays, will affect higher criteria for user to getting a perfect score, at “Fig. 11” attached display of gameplay counting items or objects.

Fig. 11. Counting items model

To find out user acceptance of game education application leveling up difficult models on user experience in mobile-based educational games will be tested using the User Acceptance Test (UAT), where the target respondents who are preschool children are represented by their parents in filling out the survey this. On the User Acceptance Test form, a number of questions are presented as follows to the respondent:

1. The appearance of this mobile-based education games application is interesting.
2. Presentation of learning information recognizes numbers easily understood by children.
3. Presentation of mobile-based education training questions can help children recognize numbers?
4. With this education games application, children are more interested or happy in learning to recognize and organized numbers.
5. This education games application can run well on your mobile device.

IV. RESULT

Testing in this application, carried out at a private school located in the location of Tangerang - Indonesia, and the following are the results of user acceptance tests conducted with respondent parents or guardians of kindergarten school students where children of parents or guardians of these students had played or experimented with education games applications.

TABLE I. USER ACCEPTANCE TEST RESULT

No	Question	Grade					Sum	Anl	Prc
		5	4	3	2	1			
1	Q1	**30**	**12**	**3**	**0**	**0**	**45**	7,50	150
2	Q2	**10**	**32**	**0**	**0**	**0**	**42**	7,00	140
3	Q3	**10**	**28**	**3**	**0**	**0**	**41**	6,83	137
4	Q4	**20**	**24**	**0**	**0**	**0**	**44**	7,33	147
5	Q5	**40**	**8**	**0**	**0**	**0**	**48**	8,00	160

Based on the table above, it can be explained that in the Anl column (Anlysis) can be calculated from the total value (sum) / number of responded, and to get Prc (Percentage) obtained by Analysis / number of questions * 100.

By doing the above calculations, it can be concluded that there are 88% of respondents who agreed that the application of leveling up based on user experience in education games can help and can improve children's ability to recognize and organized numbers.

V. CONCLUSION

The development model with leveling up method based on user experience has been proven that as many as 88% of respondents agree that with the leveling up based method on user experience in mobile-based educational games, can increase

children's interest in learning and increase children's ability to recognize and organized numbers.

In the next research, it is expected that more educational game models for number processing can be built, such as adding, reducing numbers and so on. In addition, it is expected that this education game can be developed to be played on various types of operating systems, which can be played not only on mobile-based but also can be played on desktop-based, and leveling up based on user experience method can be applied to many types of educational games to increase user ability.

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Simple Computer Vision Algorithm Production Using OpenCV for "Virtual Ecosystem" Project

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***Abstract*—The main purposes of this research is to produce a Computer Vision (CV) algorithm using various library in python programming language (mainly OpenCV, Numpy, and ZBar) to automate extraction and process information from an analog drawing into a digital image to be used in the "Virtual Ecosystem" project. The Computer Vision step will include detecting data within the analog drawing using QR-code, determine drawing area, replace white background with certain threshold with transparency, and finally save the digital image following required ratio.**

***Index Terms*—Computer Vision, Numpy, OpenCV, Python**

I. INTRODUCTION

Computer vision technology has been implemented in various industries nowadays. Starting from simply logging you in to your smartphone [1], detecting disease through your eyes [2], to autonomous driving. It has been an exciting technology since its inception in 1970 [3] that helps automate tasks that the human visual system can do through high level understanding from digital images. However, the implementation of computer vision in new media art is still in its nascent stage.

Computer vision techniques in arts commonly used to detect motion, detecting presences, detection through brightness thresholding, simple object tracking, and basic interactions such as the one used by suicide box (object tracking), Videoplace (basic interaction), and cheese (detecting presences) [4].

Therefore, in this research, the authors will discuss the implementation of elementary computer vision technology in new media art installation within "Virtual Ecosystem" project using python as main programming language with additional OpenCV, Zbar, and Numpy library. The author will focus mainly on detecting presence technique to find certain attributes within a given raw image to extract an analog drawing.

II. RESESARCH PURPOSES

The aim of this research is to produce a simple computer vision algorithm that is able to gain an analog creature drawing, extract information contained within the analog data, and process the image data to be used by the game AI within the "Virtual Ecosystem" project.

The author also wishes this paper to encourage more implementation of computer vision in practical art by artists alike either by art students, academicians, or general artists from various backgrounds.

III. GAME REQUIREMENT

The CV algorithm produced in this research is one of many algorithms written for the "Virtual Ecosystem" project. Therefore, the image data output processed by the algorithm will have to meet certain requirements of the next algorithm (next referred to as the game) of the project in order to work.

First, the game has various creature types with its own animation and AI behaviour where each image data sent to the game has to contain a creature information code. This information has to be passed from the analog drawing template through the CV algorithm to the game without any human intervention to minimize human error.

Next, the image data sent to the game has to contain only the colored part of the drawing area without the border and the white background. The white background with a certain threshold has to be replaced with an alpha background to give a cut-out illusion in the game.

Finally, the image alignment and direction produced by the CV algorithm has to be consistent on every image data. Any deviation or error won't be able to be fixed by the game itself.

IV. System Flowchart

The following flowchart shows the general idea on how the system works and how data is processed on each stage.

First, the analog drawing using the specialized drawing sheet discussed on section 6 will be scanned using Fujitsu SV600 scanner which then creates a digital image representation of the analog drawing in the system.

Next, the computer vision algorithm discussed on this paper will process the digital image and extract the creature data and creature drawing within the drawing.

Finally, if the CV algorithm able to detect both creature data type and drawing area, it will extract the creature image and send the resulting image to the game networked drive to be used by the game.

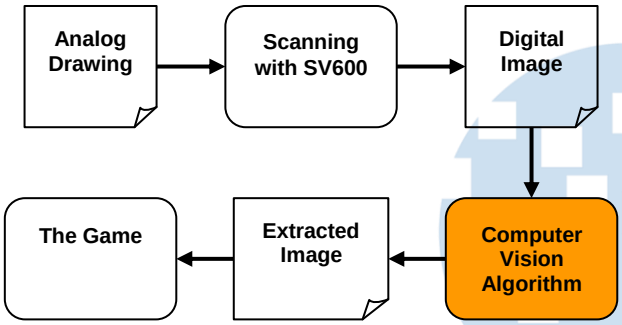

Fig. 1. System Flowchart

V. Image Data Acquisition

Various ways of image data acquisition (scanning) have been tested to find the most efficient technique with minimal human intervention possible in this research.

Initial technique involves using a webcam and a tower platform where a webcam is installed on top of custom-made simple tower structure made of aluminium with a large wooden platform as the base.

Fig. 2. Image Scanner Using Tower Platform and Webcam Installed on The Top

Using this technique, the system is able to capture analog drawing. However, the setup produces inconsistent lighting on image data due to its reliance on the surrounding light environment where the same image scanned in different places will yield different readability results.

In order to achieve stable consistent images but maintain a rapid scanning process, the authors utilize Fujitsu SV600 scanner. Its non-cover and self-lighting method provides high quality image data with consistent readability result and rapid scanning process. Additionally, the system provides an automatic skew correction algorithm which helps prepare the image data before processed by the CV algorithm.

Fig. 3. Fujitsu SV600 Scanner Produce Consistent Raw Image Regardless of The Ambient Light

VI. Analog Drawing Template (Controlled Environment)

Due to its simplistic approach, the CV algorithm requires a certain number of controlled environments to ensure smooth operation, easy image readability analysis and minimize human intervention. This is predominantly done using a rectangular shape [5] template which act as a certain marker in the analog drawing.

Initially, using a webcam shown on the previous chapter, the authors utilized no template on scanning process and only a red bracket marker on the computer viewfinder and this method relied on the operator to fit the image inside the bracket.

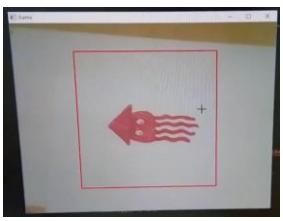

Fig. 4. Red Bracket Viewfinder with Non-Template Drawing Being Scanned

This method, although very simple to use, requires lots of human intervention which make scanning time longer due to image fitting and adjustment. This method also didn't provide creature type information as per the game requirement.

Therefore, the authors decided to use an easily recognizable template using basic shape to frame a

certain area of interest as shown below where the drawing area has been framed using basic rectangle following quad detection found commonly in ARTag [6].

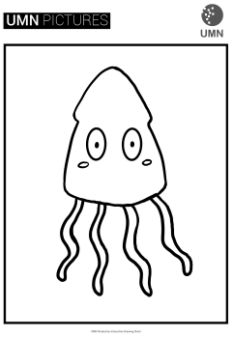

Fig. 5. Basic Shape Frame The Drawing Area with Creature Outline Inside

The quad frame creates a controlled environment for the CV algorithm to identify the drawing area. Human intervention has also been limited to scanning only as the detection of the drawing area and the skew correction will be done by the CV algorithm which in turn accelerates the entire scanning process.

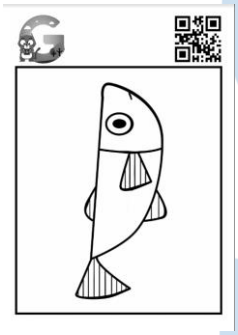

Fig. 6. Drawing Template with QR-code Embedded Top Right

The template final requirement will need the template to carry information for the game to process their creature type. This has been done using QR-code embedded on the top right of the drawing template [7]. The QR-code contains a numeric information where each number represents a type recognized by the game.

Fig. 7. Analog Drawing Sample Retrieved Using SV600 Scanner

VII. IMAGE CORRECTION

Image scanned using various methods mentioned in this research often still possess imperfections in it such as unaligned image with small rotation, defective printing, warped image, etc. These imperfections need to be corrected before proceeding to the next step to prevent error or misreading from the image data.

The first image scanning method (using a webcam but no template) requires little to no image correction due to its simplistic scanning mechanism. However, the second method (using a webcam with a template) requires rotation correction since the traditional webcam has no automatic rotation correction algorithm. Using threshold and minAreaRect function in open CV [8], the author is able to determine image rotation deviation and make corrections before proceeding to the next step.

Fig. 8. Slanted Scanned Image

Another common imperfection from the scanned image data is the printing imperfection due to using non-specialized QR-code printers. QR-code itself is characterized with a finder pattern on three or four corners of QR-code [9] which if not printed properly like in this case a fading barcode, it will make the barcode harder to read and make QR-code detection inconsistent. In order to address this issue, the author crops the QR-code area (located on top right) then

apply gaussian blur [10] to fill in the fading barcode. This method increases the QR-code readability greatly by filling the faded QR-code.

Fig. 9. Fading QR-Code on Analog Drawing and Blurred QR-code

In the previous chapter, the drawing area needs to be characterized with the largest rectangular frame within the drawing template. However, the said rectangular frame has a thickness which we need to clear. Therefore, the CV algorithm will reduce the image size cropping the thickness of the rectangular frame.

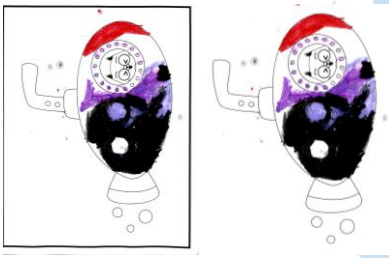

Fig. 10. Scanned Image with Rectangular Frame and Processed Image with Rectangular Frame Cropped

VIII. Template Detection and Image Processing

In the previous chapter, the author discusses a controlled environment using a drawing template to simplify the image detection process. In this chapter, image scanned and corrected will be processed further to meet the game requirements.

First, the CV algorithm has to detect the creature type contained in the template. This can be done by reading the QR-code located on the top right of the drawing template. The author uses z-bar library to read the encoded type using numerical value where each value represents the creature type where the game will assign it to each respective creature behavior.

Next, to detect the drawing area the CV algorithm will list all contours found in the image data using findContours function to detect area of interest. By calculating each contour area and poly count, the author is able to determine the drawing area which characterized by possessing 4 poly count (hence the rectangular frame) and with the largest area of any contour.

Fig. 11. Contours Found in The Image (Visualized by Red Enclosure)

Finally, in order to meet with the game requirement where the image white background has to be replaced to alpha (transparent), the CV algorithm extract white area from the original image using threshold function then using its alpha mapping, the author merge it back to replace the white background with transparent background leaving the non-white pixel to be intact while the white background (with certain threshold) to be replaced with alpha.

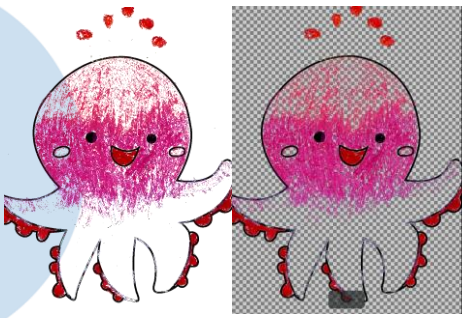

Fig. 12. Original Processed Image, White Map Extracted, and Final Image with Alpha Merged (Alpha Represented with Checkerboard)

The image data then will be saved to a network drive with a name syntax <entry number>_<type>.png. The .png used to carry the alpha information to the game.

IX. Conclusion

Producing a simple offline computer vision algorithm without employing machine learning technology requires a combination of mathematical solution with lots of controlled environment to work with. Starting from the paper has to be designed to be easily processed (controlled environment), QR-code to carry creature type information, and some manual configuration adjustment.

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A Comparison of Traditional Machine Learning Approaches for Supervised Feedback Classification in Bahasa Indonesia

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***Abstract*—The advancement of machine learning and natural language processing techniques hold essential opportunities to improve the existing software engineering activities, including the requirements engineering activity. Instead of manually reading all submitted user feedback to understand the evolving requirements of their product, developers could use the help of an automatic text classification program to reduce the required effort. Many supervised machine learning approaches have already been used in many fields of text classification and show promising results in terms of performance. This paper aims to implement NLP techniques for the basic text preprocessing, which then are followed by traditional (non-deep learning) machine learning classification algorithms, which are the Logistics Regression, Decision Tree, Multinomial Naïve Bayes, K-Nearest Neighbors, Linear SVC, and Random Forest classifier. Finally, the performance of each algorithm to classify the feedback in our dataset into several categories is evaluated using three F1 Score metrics, the macro-, micro-, and weighted-average F1 Score. Results show that generally, Logistics Regression is the most suitable classifier in most cases, followed by Linear SVC. However, the performance gap is not large, and with different configurations and requirements, other classifiers could perform equally or even better.**

***Index Terms*—Bahasa Indonesia, F1 Score, Feedback Classification, Requirements Engineering, Supervised Machine Learning**

I. INTRODUCTION

Feedback from users is an essential source of information for software engineers, especially requirements engineers. As time goes, software and their requirements also evolve. To get a grip on which direction a software product must be going to, a lot of developers rely on user feedback. There are several reasons which could cause software requirements to change or evolve, including defects to be fixed, project fluctuations in terms of priorities and constraints, better customer understanding of the system's actual features, and so on [1]. Furthermore, merely knowing users' opinions and sentiments regarding a specific feature in a software product could be very useful for developers and business owners. User involvement in software requirements engineering is crucial in delivering the right product, even after the product is released [2]. However, the amount of information the users provide can quickly become too abundant to be analyzed manually [3], causing various scalability problems. Especially for software products with lots of users, it becomes more challenging to put in the effort required to assess all user feedback; thus, the idea of building an automatic tool for processing user review seems promising.

Interests in classifying user feedback into several categories have grown in recent years. Several related works of research [4, 5, 6] use traditional machine learning classification approaches, such as Naïve Bayes classifier and Decision Tree classifier (C4.5 or J48), Support Vector Machines, and Logistics Regression, combined with NLP methods, and the result displays the enormous potential of those methods in classifying feedback written in English. Our research focuses more on supporting requirements engineers in processing Bahasa Indonesia, which has different structures and poses various challenges compared to English. Previous publications [7, 8] have already shown the possibility of doing text classification in Bahasa Indonesia for news articles and also to classify user sentiments in product review written in Bahasa Indonesia. Our previous work [9, 10] had tried to implement Naïve Bayes classifier to process user feedback to classify them into several categories, as well as categorizing them into positive and negative sentiments, showing promising results but could still be improved. Furthermore, the classification results and performance of the previous works could be re-evaluated by performing similar

NLP preprocessing techniques on the same dataset using different classification algorithms.

This paper aims to implement natural language processing techniques for text preprocessing, which then are followed by traditional (non-deep learning) machine learning classification algorithms and finally evaluate the performance of each algorithm in the same dataset that we use. Traditional machine learning approaches are chosen as there are some constraints for deep learning approaches which are, amongst other things [11], data-hungry and thus is not suitable for data with small size and has a high computational cost of learning, both of which is not readily available in every situation, including ours. Based on their performance in previous studies, we experimented with Logistics Regression, Decision Tree, Multinomial Naïve Bayes, K-Nearest Neighbors, Linear SVC, and Random Forest classifiers using the Scikit-Learn library [12] in Python. The performance of the various algorithms to classify the feedback in our dataset into several categories is then evaluated by looking into the confusion matrix results.

II. Resesarch Methods

A. Dataset

Our research uses a dataset of user feedback from a university e-learning web application used by staff, students, and faculty officers of the institution. At the moment of our experiment, the dataset consists of 345 user feedback, labelled manually by the head of the Learning Center Department that is in charge of the system. The texts are classified into several categories, which are Content, Technical, Strategic, and Others. Here are examples for each group in the dataset:

- "*Tolong dibuat fitur notifikasi untuk deadline terdekat*" = Technical (in English: "please build a notification feature for the nearest deadline")
- "*Dosen harus bisa diajak untuk mengupload materi di elearning*" = Strategic (in English: "Lecturer must be encouraged to upload course materials to the e-learning")
- "*Kalau bisa di perbanyak lagi materi - materi atau kisi -kisi*" = Content (in English: "If possible, add more materials and course summaries")
- "*semoga e-learning semakin baik dan menarik :)*" = Other (in English: "I hope for e-learning to be better and more interesting")

Fig. 1 shows the distribution of feedback in the imbalanced dataset that is used in our current experiment. As can be seen, the number of feedbacks in the technical category far outweighs the number of feedbacks in the content category. This kind of dataset possesses various challenges that could be addressed in multiple ways. However, this paper focus on evaluating the classifiers with minimum text preprocessing techniques. The next sub-sections describe the step by step explanation of our current experiments.

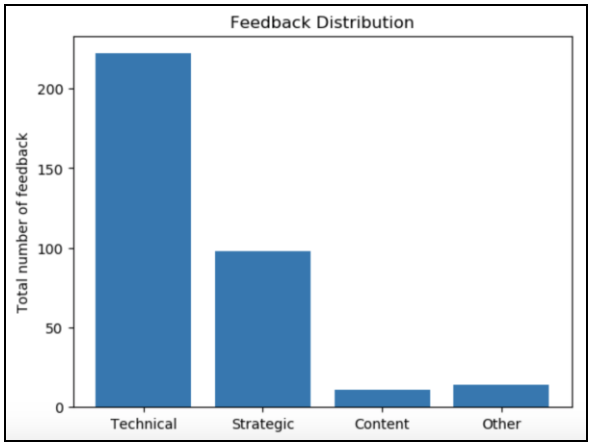

Fig. 1. Feedback Distribution in the Dataset

B. Text Preprocessing

In order to prepare our feedback to be classified using various traditional machine learning techniques, the feedback texts are preprocessed first. In this preprocessing phase, here are the steps that were done in our experiment:

1. Remove any character except alphabets using Regular Expression,
2. Lowercase all characters,
3. Stemming to remove suffixes, and
4. Stop-words removal.

After the text preprocessing phase is done, feedback texts became simpler to be passed on to the next steps. For example, feedback such as "Tolong dibuat fitur notifikasi untuk deadline terdekat" is processed to "fitur notifikasi deadline dekat".

C. Bag of Words Model

After every word in the dataset is preprocessed, we move on to the feature extraction phase. Our research uses the bag of words model using the CountVectorizer library from Scikit-Learn to convert a collection of text documents to a matrix of token counts [12]. In this phase, we experimented with various parameters in CountVectorizer regarding the word and character n-grams as the tokens converted from the text documents of our feedback dataset. Some of the settings that we experimented with are word unigram, word bigram, word trigram, word uni+bi+trigram, character unigram, character bigram, character 5-gram, and character 1- until 9-gram. Not all results will be described in this paper as many results are similar to each other; thus, only some of the findings that are considered to provide enough comparison between the various classification techniques are displayed.

D. *Feedback Classification*

Finally, after every feedback is preprocessed and fitted into the bag of words model, the dataset is split into training and testing sets with a 70:30 ratio. Furthermore, we experimented with six classification methods, which are Logistics Regression (LR), Decision Tree (DT), Multinomial Naïve Bayes (MNB), K-Nearest Neighbors (KNN), Linear Support Vector Classification (LSVC), Random Forest (RF). For the K-Nearest Neighbors, we experimented with k={1,3,5,7,9}, however only show the results of n=7 as it is the value with the overall best performance so far in the dataset and for the Linear SVC, we experimented with tolerance for stopping criteria (tol) equals to 1e-5.

III. Results and Discussion

The result of our experiments is generally divided into two groups, the first group uses the word n-gram, and the results are shown in Fig. 2 – Fig. 4, while the second group uses the character n-gram, and the results are shown in Fig. 5 – Fig. 7. Furthermore, the resulting figures depict the bar charts showing the comparison of the six classifiers in predicting the class of feedback from the testing set with different evaluation metrics, which are the macro-F1, micro F-1, and the weighted F-1 average score. We use different f1 score average metrics, using functions from the Scikit-learn library because each is used in different situations.

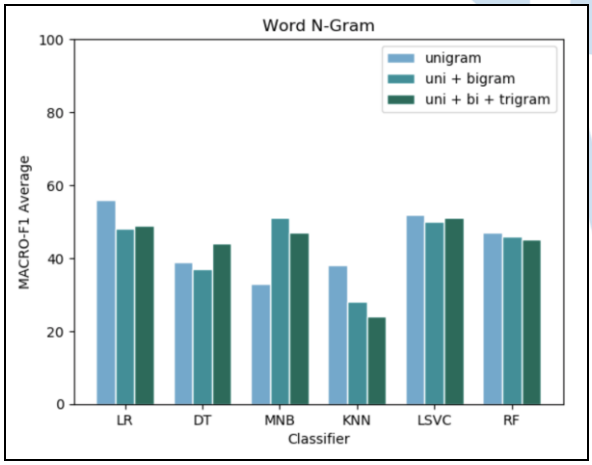

Fig. 2. Macro-average F1 Score with Word N-Gram

Macro-average F1 score calculates metrics for each label, and find their unweighted mean. This does not take label imbalance into account. The second metric, the micro-average F1 score, calculates metrics globally by counting the total true positives, false negatives, and false positives. And finally, weighted-average F1 score calculates metrics for each label, and find their average weighted by support (the number of true instances for each label). This alters 'macro' to account for label imbalance; it can result in an F-score that is not between precision and recall [12]. However, a higher f1-score does not always mean or translate to a better classifier, it depends on the condition of the dataset and the purpose of the classifier. Three types of f1-score metrics are used in this paper to provide a general comparison between the six classification methods in the dataset.

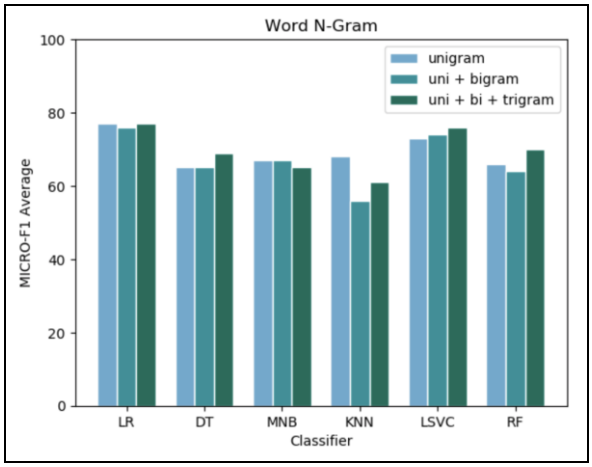

Fig. 3. Micro-average F1 Score with Word N-Gram

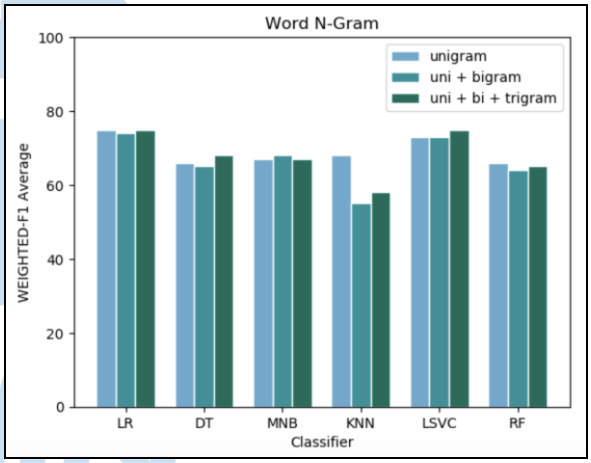

Fig. 4. Weighted-average F1 Score with Word N-Gram

As can be seen in the previous figures from Fig. 2 – Fig. 4, we use word N-Gram to evaluate each classifier using unigram, uni+bigram, and uni+bi+trigram. Other values of N in the N-gram were also assessed but showed similar results. Using the macro-average f1 score, by not taking into consideration the imbalanced dataset and calculating the harmonic mean of precision and recall of each class, Logistics Regression performs the best with word unigram, reaching a score of 0.56. However, it can also be seen that Linear SVC also performs good and showing similar result, whether using the different word n-grams, where Logistics Regression only performs best using the unigram.

Furthermore, by taking the imbalanced condition of the dataset, we calculate the micro- and weighted-average f1 score. By calculating the results globally (micro) and giving weights to each class based on their occurrences, the average f1 scores increase. The

highest score is attained again by the Logistics Regression scoring 0.77, followed tightly by the Linear SVC with 0.76 by combining the word uni+bi+trigram. Furthermore, it can also be seen more clearly that when the micro-average f1 score is the suitable metric, combining uni+bi+trigram could increase the classifiers' performance, except for KNN and Multinomial Naïve Bayes.

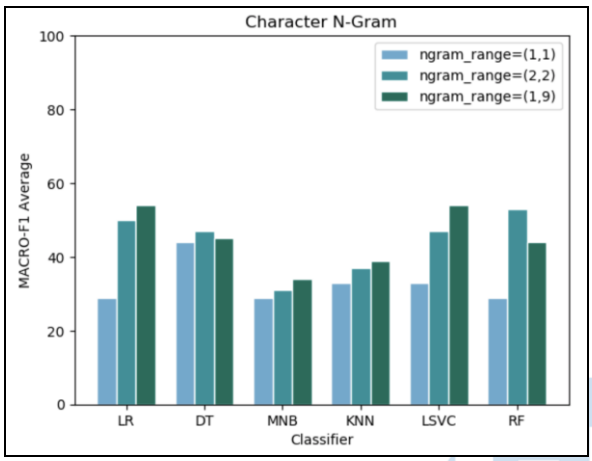

Fig. 5. F1 Score with Character N-Gram

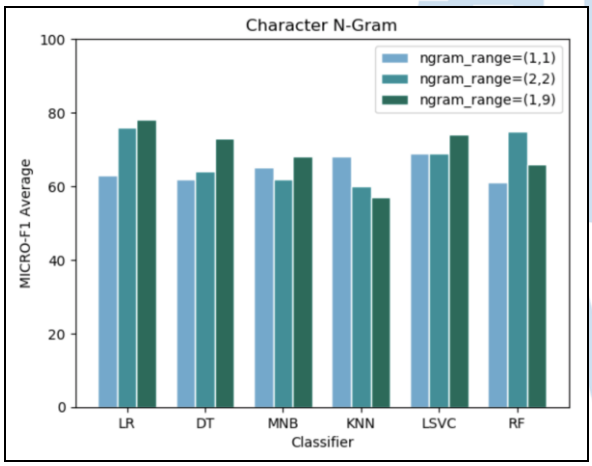

Fig. 6. Micro-average F1 Score with Character N-Gram

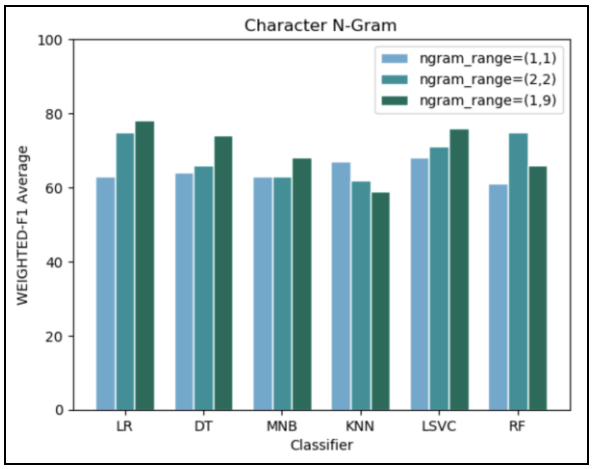

Fig. 7. Weighted-average F1 Score with Character N-Gram

Fig. 5 – Fig. 7 shows the result of using Character N-Gram as the feature extraction technique for the six classifiers. Generally, the combination of 1- until 9-gram shows better results for almost all classifiers, calculated using the macro-, micro-, and weighted average f1 score. The best score is achieved by Logistics Regression with 0.78 with character 1- until 9-gram calculated both by the micro- and weighted-average f1 score and for calculation using macro-average f1-score, Logistics Regression and Linear SVC both perform equally by achieving 0.54 score.

This research conducted experiments with many other n-gram combinations, which are not shown in the previous figures but show exciting results nonetheless. For example, when the weighted-average f1 score is essential, the following five classifiers (Logistics Regression, Decision Tree, Multinomial Naïve Bayes, Linear SVC, and Random Forest) perform almost equally using character 5-gram, as can be seen in Fig. 8. Decision Tree even outperforms all the other classifiers when the micro-average F1 score is essential, using the combination of word uni+bigram, as shown in Fig. 9.

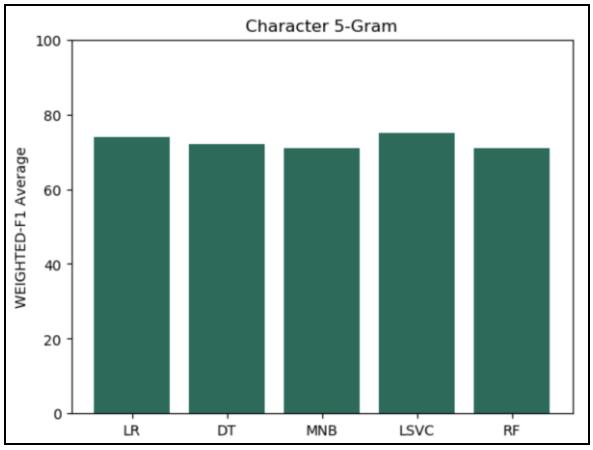

Fig. 8. Weighted-average F1 Score with Character 5-Gram

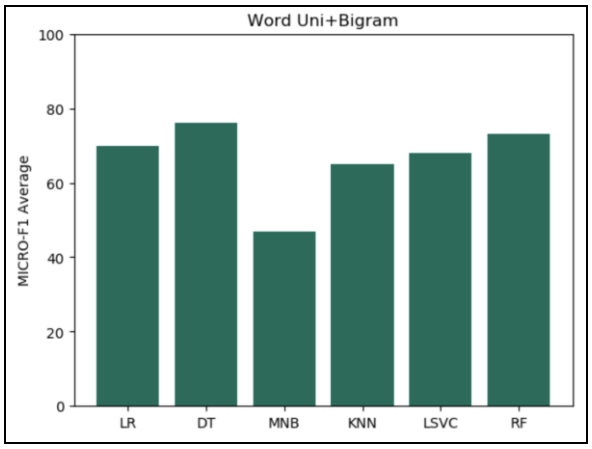

Fig. 9. Micro-average F1 Score with Word Uni+BiGram

These comparison results between each classifier using various n-gram configurations for our dataset shows that Logistics Regression is the most suitable classifier in most cases, followed by Linear SVC. However, many other tools and techniques could be integrated into the system to enhance performances such as feature extraction using word embedding, using various up-sampling and down-sampling techniques to deal with the imbalanced dataset, and many more. By further implementing different NLP techniques, the performance of the classifiers evaluated in this paper could vary greatly. In other cases, some classifiers that do not perform as well in our experiments could beat the others, and vice versa.

IV. Conclusion

This paper presented the result of our study, which provides a general comparison using three different metrics on six classifiers for classifying user feedback according to their categories. In our feedback dataset, each feedback is classified into one category from the existing four categories, which are Technical, Strategic, Content, and Other. We use three metrics for calculating the harmonic mean of precision and recall of the resulting confusion matrix in each scenario, the macro-, micro-, and weighted-average f1 score, as each function differently and might be useful in different requirements.

Generally, Logistics Regression is the most suitable classifier in most cases, followed by Linear SVC. Other classifiers also perform quite similarly based on the resulting confusion matrix, though not as good. For example, Random Forest with character bigram performs excellent compared to the others when the micro-average f1 score metric is essential, as it scores 0.75, only 0.01 less than the Logistics Regression. Another case shows that when the weighted-average f1 score matters most, Logistics Regression, Decision Tree, Multinomial Naïve Bayes, Linear SVC, and Random Forest perform almost equally.

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Logistic Regression Prediction Model for Cardiovascular Disease

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***Abstract*—It is undeniable that cardiovascular disease is the number one cause of death in the world. Various factors such as age, cholesterol level, and unhealthy lifestyle can trigger cardiovascular disease. The symptoms of cardiovascular disease are also challenging to identify. It takes careful understanding and analysis related to patient medical record data and identification of the parameters that cause this disease. This study was conducted to predict the main factors causing cardiovascular disease. In this study, a dataset consisting of 14 attributes with class labels was used as the basis for identification as a link between factors that cause cardiovascular disease. The research area used is the area of analysis data where the analyzed data are on factors that influence the presence of cardiovascular disease in the State of Cleveland. In predicting cardiovascular disease, a logistic regression algorithm will be used to see the interrelation between the dependent variable and the independent variables involved. With this research, it is expected to be able to increase readers' knowledge and insight related to how to analyze cardiovascular disease using logistic regression algorithms and the main factors that cause cardiovascular disease.**

***Index Terms*—Decision Tree, K-Means Algorithm, Logistic Regression, Naïve Bayes**

I. INTRODUCTION

The number of cardiovascular disease sufferers is also increasing yearly. This disease occurs due to several factors, such as age, blood pressure, cholesterol levels, diabetes, hypertension, genes, obesity, and unhealthy lifestyles. Various symptoms can be identified through physical signs such as chest pain, shortness of breath, dizziness, and easy feeling of fatigue [1].

Cardiovascular disease identification techniques are complicated to do. It is essential to know the existence of this disease as early as possible because the complication of cardiovascular disease can give an impact on one's life as a whole. The diagnosis and treatment of cardiovascular disease are very complex. While still using invasive-based techniques through analysis of the patient's medical history, reports of physical examinations performed by the medical tend to be less accurate and require a relatively long time. For this reason, a support system is implemented to predict cardiovascular disease through a machine learning model.

Palaniappan and Awang [2] uses classification modelling techniques by digging up the information contained in cardiovascular disease data. The model is created using training data and tested with data testing as a form of evaluation of results. Sellappan Palaniappan, Rafiah Awang uses the lift chart and matrix method to evaluate the effectiveness of the model. Based on the research that has been done, they concluded that the most effective model for prediction of heart disease is Naive Bayes which found that the use of the Naive Bayes algorithm produces a better level of accuracy than the Decision Tree.

Mai Showman, Tim Turner, Rob Stocker [3] applied the K-Means method and decision tree to predict cardiovascular disease. In the research, they implemented Initial centroid selection techniques to improve the accuracy of the model. Meanwhile, to diagnose cardiovascular disease, they use the decision tree classification. To produce the initial centroids based on the actual number of samples in the data set, random rows, random attributes, inliers, outliers and range methods are used. The result, researchers can compare the performance of the decision tree that was applied previously with the K-Means method applied using the same data with the data used in the decision tree. As a result, the K-Means technique used produces better accuracy. The process shows an accuracy of around 83.9%.

II. LOGISTIC REGRESSION

Logistic regression is a predictive model used to evaluate the relationship between the dependent variable (target) which is categorical data with nominal or ordinal scale and the independent variable (predictor) which is categorical data with interval or ratio scale. This algorithm can also be used for time series modelling to find the relationship between the variables involved. Logistic regression is an algorithm used to predict the probability of categorical dependent variables. In logistic regression, the

dependent variable is shown as a binary variable that is valued at 1 (yes) Or 0 (no). The logistic regression model predicts as a function of X. The assumptions used in Logistic regression are as follows: binary logistic regression requires binary dependent variables, for binary regression, the factor 1 level of the dependent variable must represent the desired result, independent variables must be independent of each other. In this case, the model must have little or no multicollinearity and be linearly related to log opportunities [4].

Logistic regression used appropriate regression analysis to be performed when the dependent variable is dichotomous (binary). Logistic regression acts as a predictive analytical model. Logistic regression is applied to describe data and explain the relationship between one dependent binary variable with one or more independent variables at the nominal, ordinal, interval or ratio level. Logistic regression has several advantages and disadvantages. The benefits of logistic regression include the following. First, logistic regression can show a significant relationship between the dependent variable and the independent variable. Second, logistic regression analysis can also be used to compare the effect of variables measured at different scales includings the effect of price changes and the number of promotional activities. This benefit helps market researchers or data analysts to eliminate and evaluate the best set of variables that will be used to build predictive models. Third, the logistic regression model is not only a classification model, but also provides information related to probability. To achieve a better result using Logistic Regression, first all independent variable must contain their valid value. Secondly, logistic regression works well for predicting categorical results and multinomial results. Third, there is no multicollinearity between variables in the dataset [5].

III. METHODOLOGY

Human cardiovascular system is examined in this study using some variables that affect its performance. As shown on Fig. 1, the process is started from retrieve data, analyze the correlation between variables, split data, prediction with logistic regression algorithm, and finished with data validation.

A. Data Retrieval

The first process is Data Retrieval. In this process, Heart Disease UCI Dataset -published by Ronit in Kaggle website (https://www.kaggle.com/ronitf/heart-disease-uci)- will be used. It will be imported into the Rstudio software. The data obtained are categorical data and numerical data. The data in this study contain 14 variables with 76 attributes and 304 responses as the basis for analysis. First variable is age with units in years (age). Second, the gender with value one means male and value 0 means female (sex). Third, the variable type of chest pain (cp). Fourth, the variable trestbps-resting blood pressure in mm Hg at admission to hospital (tresbps). Fifth, chol-serum cholesterol variable in mg/dl (chol). Sixth, the fbs variable, which is blood sugar when fasting with a value of 1, means true, and 0 means false (fbs). The seventh variable is resting electrocardiographic outcome variables (restecg). Eighth, the maximum thalach heart rate variable is reached (thalac). Ninth, the exacting-exercise variable induced angina with value 1 means yes, and value 0 means no (exang). Tenth, oldpeak-ST variable depression caused by exercise relative to rest (oldpeak). Eleventh, the slope variables of the peak training segment ST (slope). Twelfth, ca-number of main vessels with values 0 to 3, colored by fluoroscopy (ca). Thirteenth, thal-3 variable means normal; 6 means permanent disability; 7 means reversible defects (thal). Fourteenth, the target variable with a value of 1 or 0 (target).

B. The Correlation between Variables Analysis

Besides, to facilitate data analysis, all variables in the imported dataset will be visualized in the form of a histogram to facilitate the reading of the data in general. In the process, Analyze the Correlation between Variables; the correlation between variables is examined to prove that the method to be used is the logistic regression model is the right model. Relationships between variables in the available dataset will be plotted in the form of a matrix. This is also done to check whether there is multicollinearity between variables in the dataset.

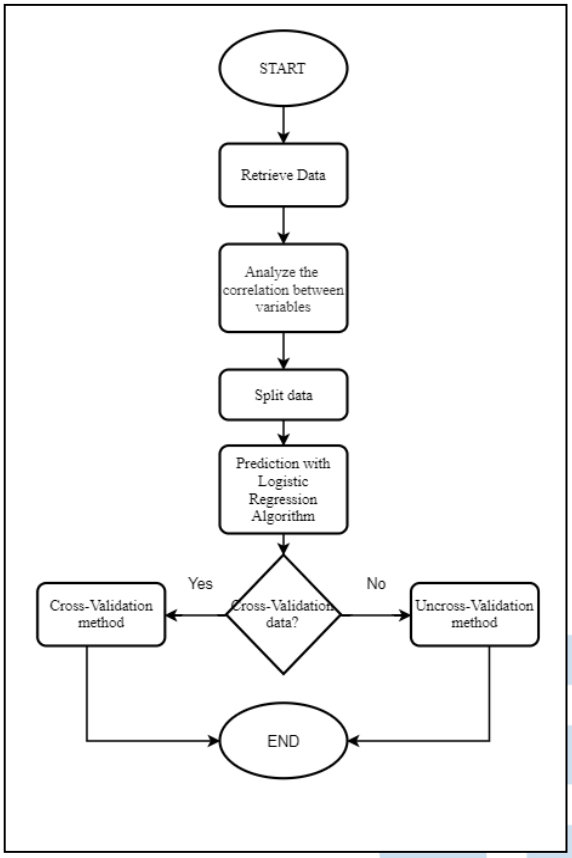

Fig. 1. Framework

C. *Data Preparation*

The dataset imported in Rstudio will be divided into two parts, namely training data and testing data. Training data is used as a basis for building models. Meanwhile, testing data is used as a basis for testing or validating the model. In this data preparation process, 293 data will be sampled. Then the data will be partitioned into train data and test data.

D. *Prediction with Logistic Regression Algorithm*

In this process, the data that has been partitioned in the previous process will be used. Prediction using the logistic regression method will produce several data that can be used as a basis for concluding to make predictions.

E. *Data Validation*

The technique used to validate the results is the method of the confusion matrix and K-fold cross-validation with 10-fold. By using a confusion matrix, the accuracy of the use of the logistic regression model can be known. Besides, the use of the K-fold cross-validation method, produces values of errors that may occur when using a logistic regression model.

IV. Data Analysis and Discussion

A. *Data Analysis*

The dataset obtained by the researcher as a basis for analysis is imported into RStudio. The output of this process can be seen on Fig. 2 and Fig. 3. The data retrieval process is also performed in the data visualization to see the value of each variable involved in the overall research analysis.

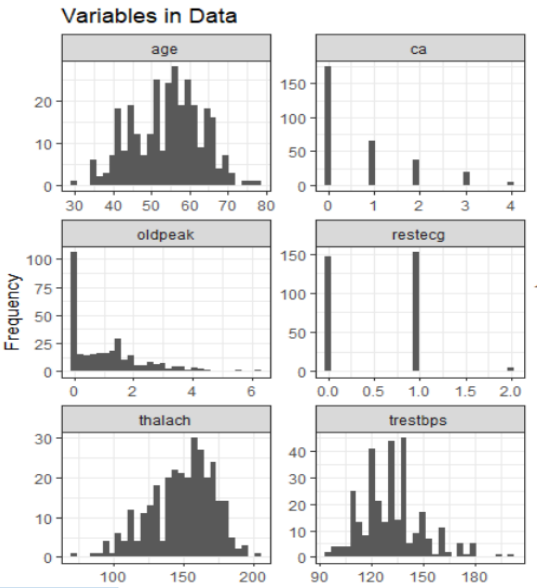

Fig. 2. Plot Variable 1

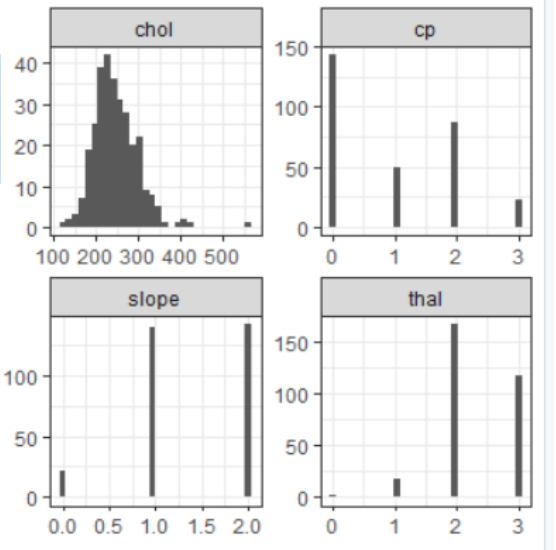

Fig. 3. Plot Variable 2

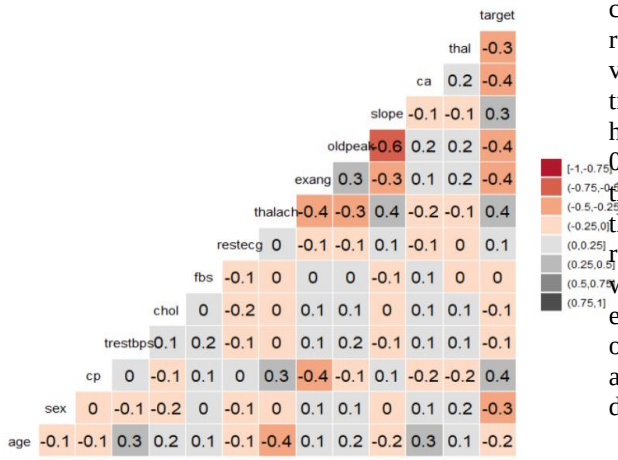

Fig. 4. Correlation Plot

In this process, the correlation between variables will be examined, which will be used as a basis for analysis to predict cardiovascular disease. Based on the matrix in Fig. 4, it was found that the variables induced angia (exang), chest pain type (cp), ST depression induced by exercise relative to rest (oldpeak), maximal heart rate (thalac) had a strong correlation with the target variable. Meanwhile, blood sugar (fbs) and cholesterol (chol) levels do not correlate with the target variable. Meanwhile, among the independent variables, there is a strong correlation between the slope and oldpeak variables. Besides, thalac, exhang, oldpeak, and slope variables are also strongly correlated. Strong correlation also applies to variables Exang, cp, and thalac. It proves that there is no multicollinearity in the relationship between variables where each independent variable does not correlate with each other.

Data that has been imported will be taken as many as 293 random data as a basis for analysis. The data is divided into train data and test data. The data shown in Fig. 5 on the next page is data from train_data and test_data that will be used in this study. The training data is used to build a logistic regression model using the glm () function because logistic regression is included in the generalized linear model with binomial type families. Based on the results of using the logistic regression method, it is predicted that the sex, cp, trestbps, restecg, ca and that variables influence the target variable at an alpha value of 5% significantly. The selected variables are the variables that significantly affect the target variable. In logistic regression, the effect of each variable on the target variable can be seen from the odds ratio value. For example, for the sex variable having a coefficient value of -1.547601 with a reference category with a male value, the odds ratio value is 4.2655 which means that for male patients, the odds of getting heart disease are 4.2655 times the female odds or it can be said the tendency of men to heart disease is higher than women. For the trestbps variable with a coefficient value of -0.029713, it is found that the odds ratio value is 0.0822 which means that for the trestbps variable there will be a significant increase when trestbps enters the value 0.0822 mmHg. On the other hand, the thalach variable with a coefficient of 0.032028 will have an odds of 0.08856 which means that at that value there will be a significant change in the performance of the heart rate or cardiovascular rate. The exang1 variable is exercise-induced angina with an estimated coefficient of -1.05855 so that the exang variable with a reference value of 1 will have an odds of 2.92710 which means that if the value is achieved then cardiovascular performance will decrease.

Next is the variable ca with reference ca values 1, 2, and 3. Ca1 with an estimated coefficient of -1.430110 will have odds of 3.955, while ca2 with an estimated ratio of -3.329874 will have odds of 9.1777 and ca3 with an estimated factor of -0.553711 will have odds in the amount of 1.5261. It proves that when the number of fluoroscopy vessels reaches its value odds, this will have an impact on decreasing cardiac performance which will affect the increased potential for cardiovascular disease.

```
Call:
glm(formula = target ~ age + sex + trestbps + chol + fbs + restecg +

    thalach + exang + oldpeak + slope + ca + thal, family = binomial
(link = "logit"),
    data = train_data)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.7562  -0.3933   0.1859   0.5167   2.6218

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -0.647872   3.103802  -0.209  0.83466
age          0.017395   0.029489   0.590  0.55528
sex1        -1.547601   0.612277  -2.528  0.01148 *
trestbps    -0.029713   0.012591  -2.360  0.01828 *
chol        -0.004401   0.004313  -1.020  0.30760
fbs1         0.690600   0.584336   1.182  0.23726
restecg1     0.454490   0.445116   1.021  0.30723
restecg2     0.029025   1.924828   0.015  0.98797
thalach      0.032028   0.012098   2.647  0.00811 **
exang1      -1.058555   0.472189  -2.242  0.02497 *
oldpeak     -0.400718   0.262301  -1.528  0.12659
slope        0.702040   0.418460   1.678  0.09341 .
ca1         -1.430110   0.545908  -2.620  0.00880 **
ca2         -3.329874   0.854150  -3.898 9.68e-05 ***
ca3         -1.972362   0.912773  -2.161  0.03071 *
ca4         -0.553711   1.822086  -0.304  0.76121
thal1        2.136555   1.847010   1.157  0.24737
thal2        1.860416   1.572538   1.183  0.23678
thal3        0.688015   1.611155   0.427  0.66936
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 293.58  on 212  degrees of freedom
Residual deviance: 149.90  on 194  degrees of freedom
AIC: 187.9

Number of Fisher Scoring iterations: 6
```

Fig. 5. Output Logistic Regression

The method used to validate the logistic regression model used in this study is the k-fold cross-validation method with k-fold value of 10. Following is the syntax of the k-fold cross-validation method. Based on the k-fold cross-validation data method, it was found that the prediction data using the logistic regression method had an error rate that tended to be lower at 0.1406565. It proves that referring to the two validation methods that have been done, and it can be concluded that the logistic regression model is an appropriate and effective model for this research.

Besides, the composition of value 0 and value 1 on variable target is 97:116, which is still fairly balance, so the result will be reliable and free from any imbalanced dataset problems.

B. Discussion

This study involved fourteen factors that affect cardiovascular performance as variables to build a logistic regression model. Among the variables, it is not found that there is no significant relationship between variables. Therefore, the potential for multicollinearity in this study tends to be smaller. This study uses a logistic regression algorithm as a solution to the problem. With the use of the algorithm, it was found that the logistic regression algorithm was classified as an effective and efficient algorithm in predicting the main factors causing cardiovascular disease as the problem raised in this study. Confusion matrix is shown on Fig. 6. With an accuracy of 85.45% and an error rate that tends to be small at 0.1406565, the logistic regression algorithm can be said to be successful in predicting factors that affect cardiovascular performance significantly. Especially with calculations using specific estimated values, it can be obtained the probability of the potential for cardiovascular disease in a person.

By modelling data and predicting data using a logistic regression algorithm, it was found that not all factors had a significant influence on the performance of the cardiovascular system. The factors that affect cardiovascular performance are gender, trestbps - blood pressure level, thalach - heart rate, and ca- number of vessels affected by fluorosophy. By obtaining an estimated value of these factors, probabilities can be obtained related to the potential for cardiovascular disease in a person.

```
Confusion Matrix and Statistics


LogisticPred   0   1
           0  78  12
           1  19 104

               Accuracy : 0.8545
                 95% CI : (0.7998, 0.8989)
    No Information Rate : 0.5446
    P-Value [Acc > NIR] : <2e-16

                  Kappa : 0.7048

 Mcnemar's Test P-Value : 0.2812

            Sensitivity : 0.8041
            Specificity : 0.8966
         Pos Pred Value : 0.8667
         Neg Pred Value : 0.8455
             Prevalence : 0.4554
         Detection Rate : 0.3662
   Detection Prevalence : 0.4225
      Balanced Accuracy : 0.8503

       'Positive' Class : 0
```

Fig. 6. Model Performance

V. Conclusions

A. Conclusion

By using the Heart Disease UCI dataset consisting of fourteen variables, including age, sex, cp, fbs, restecg, thalac, exang, oldpeak, slope, ca, thal, and target, it was found that the use of the logistic regression algorithm is effective and efficient in predicting cardiovascular disease where based on the results of data validation it is found that the accuracy of the prediction results with the algorithm reaches 85% with an error rate that tends to be small at 0.1406565. It proves that this algorithm is suitable for use as a prediction algorithm in this study.

Based on the results of cardiovascular disease predictions, it can be concluded that cardiovascular disease is significantly affected by gender, trestbps - blood pressure level, thalach - heart rate, and ca- number of vessels affected by fluoroscopy. An increase in the value of these variables will have an impact on overall cardiovascular performance where the cardiovascular performance will decrease, while the potential for cardiovascular disease is predicted to increase. The use of the logistic regression algorithm is successful in predicting the main factors causing cardiovascular disease where the main elements of the disease are gender factors, blood pressure level factors, heart rate level factors, and blood vessel colour factors (vessels).

B. Future Work

For similar studies, it is better to use two or more algorithms. More algorithms create more results, and the best result can be chosen as the decision. In addition, Logistic regression itself is an algorithm that is quite effective in providing predictions related to cardiovascular disease. In analysing using logistic regression, binary data is needed to simplify the development of an algorithm model. Besides, in implementing the logistic regression algorithm, further validation is also required. We recommend that you validate the data and the results of using the algorithm, more than twice. It is suggested that a better level of accuracy is obtained so that the analysis and evaluation of the effects of implementing the logistic regression model can be.

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Ethnicity Classification Based on Facial Features Using Viola-Jones Algorithm

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***Abstract*—Ethnicity information is an aspect of human identity. Ethnicity holds the same importance in human identity as gender or age. In this paper, we will propose a new approach to classify Indonesian Races, especially Western Indonesian (Java and Sumatra) and Eastern Indonesian (Papua and Nusa Tenggara). We implement two major steps for this research, the first step is face detection using the Viola-Jones Algorithm and the second step is the classification process using Support Vector Machine and K-Nearest Neighbour. Our proposed approaches give good results, with the best result is 81% using YCbCr color space.**

***Index Terms*—Ethnicity Classification, K-Nearest Neighbour, SVM, Viola-Jones Algorithm**

I. INTRODUCTION

The human has many properties such as ocular, periocular, gait, voice, and fingerprint—a Biometric system used for personal recognition, gender classification, and ethnicity classification/ ethnicity detection [1]. Three crucial aspects of soft biometric, especially in face regions, are ethnicity, gender, and age.

Ethnicity plays a significant role in biometric recognition. Classification of ethnicity has a great impact on surveillance, advertisement, and social media profiling. Even though many challenges in ethnicity classification, we cannot forget the importance of ethnicity classification for health care, educational, and socioeconomic status study [2].

In the current year, the use of demographic data such as ethnicity for a facial image has increased, especially in automatic detection using machine learning and computer vision approaches. The practical applications range from law enforcement and disaster victim identification [3].

Several works have tried to propose a new framework for ethnicity classification. Heng et al., implement a hybrid supervised learning using Convolutional Neural Network and Image ranking engine algorithm. The proposed method gives a significant improvement in overall accuracy [2].

Mohammad et al. proposed the Fusion of Local Binary Pattern and Histogram of Gradient (HOG). In this research, there are three crucial steps. The first step is preprocessing using the CLAHE filter before applying the dlib landmark to solved the difficulty of the light condition. The second step is extracting features using fusion LBP and HOG. Furthermore, the last step is the classification process using Support Vector Machine (SVM) and Multilayer Perceptron (MLP) [1].

Jilani et al. proposed geometric feature extraction with SVM as the classification process. They are also implementing dimensional reduction using Principal Component Analysis (PCA) and Partial Least Square Regression (PLR). This result of this research shows a promising result [3].

Achkar et al. proposed a different approach; they segment the face area using the Viola-Jones algorithm. This step was done to focus on the face. Furthermore, the next step is extracting features using the facial-geometric area. The last step is the classification process using Multi-Layer Perceptron [4].

According to previous research, especially Achkar et al., we proposed the same approaches as Achkar et al. The differences between our approach with Achkar et al. are in the feature extraction process, we used maximum likelihood estimation (MLE) of the images rather than using geometric facial features. Another difference is that our classification process was done using SVM because, according to the previous research, most of the research using SVM as the classifier process compared to MLP.

We are also using color images compared to grayscale images to our approach, and Based on Dhivakar [5] research on skin color recognition, the best color space for human color skin is YCbCr.

This paper separated into four sections. Section I is the introduction of the research statement and the background of the research. Section II will explain the proposed method more thoroughly. Section III will

explain the result of the paper, and the last section will explain our conclusion toward our proposed method.

II. METHODOLOGY

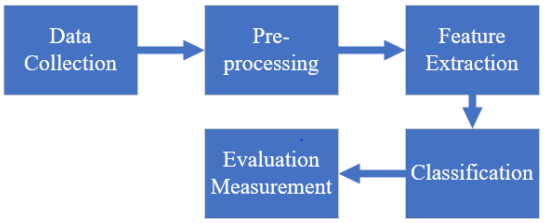

Fig. 1. Our Research Methodology

A. Data Collection

First, confirm that you have the correct template for your paper size. This template is for International Journal of New Media Technology (IJNMT). It has been tailored for output on the A4 paper size. Data was taken using a mobile phone camera with 8 Megapixels resolution. We did not use any camera filter, and we took the data in the same place to minimize any different images. We took 48 total images, which consists of 24 people from Java, and Sumatra region, and the other 24 people from the Nusa Tenggara and Papua region. The sample consists of three different angles: front face, side-left angle, and side-right angle.

TABLE I. DATASET

Class	Total
Western Indonesian (Java, and Sumatra region)	24
Eastern Indonesian (Nusa Tenggara and Papua region)	24
Total	48

B. Preprocessing

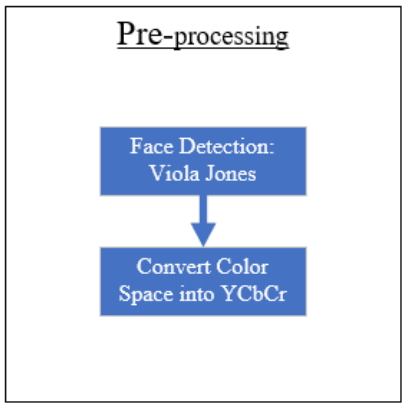

Fig. 2. Our Research Methodology

The first stage of the preprocessing is finding the face area using the Viola-Jones algorithm. The Viola-Jones algorithm consists of four-stage: The first stage is the Haar Feature, creating an integral image, AdaBoost and cascading classifiers. The Viola-Jones algorithm utilizes a Haar feature to represent the images. In the next part, after getting the Haar feature images, the Viola-Jones algorithm finds the integral image at location x, y, which contains the sum of the pixels.

$$I' = \sum_{x' \le x, y \le y'} I(x', y') \quad (1)$$

This phase was resulting in enormous rectangle features that can be computed in sub-windows. The next step is finding the set of features using Adaboost. After finding several weak features and then the Viola-Jones cascades the complex model into one classifier. The purpose of cascading is to reject non-face and face images [6]. Figure 2 represents the images after cropping using the Viola-Jones algorithm.

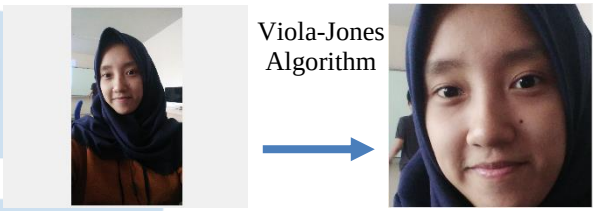

Fig. 3. Face Detection Using Viola-Jones Algorithm

The next phase is converting the RGB images into YCbCr color spaces. The converting images color images RGB is vital because the RGB is not suitable to perform any face detection or color detection type. We did not use RGB color space because of the character RGB colorspace. The character of RGB color space is merging between luminance and chrominance. Handling this issue, we implemented the YCbCr color space, which consists of Xerox YES color space [7].

$$Y = 0.253R + 0.684G + 0.063B \quad (2)$$

$$E = 0.5R - 0.5G \quad (3)$$

$$S = 0.25R + 0.25G - 0.5B \quad (4)$$

Where Y represents the luminance component and E, S represents chrominance components. R, G, B represent Red Green Blue color.

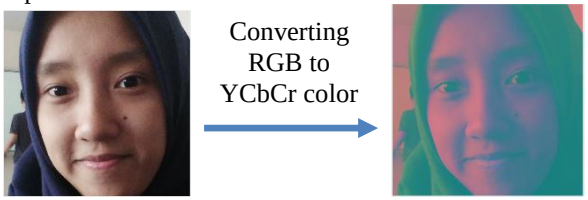

Fig. 4. Converting RGB into YCbCr Color Space

C. Feature Extraction

In the feature extraction, we used the Maximum Likelihood Estimation (MLE) to extract the features of the images according to the likelihood function. The MLE selects the set of values of the images and maximizes the likelihood.

D. Classification Process

In the classification process, we implemented the Support Vector Machine (SVM) as a binary linear classifier. The algorithm classifies data based on the optimum hyperplane, which linearly separated the class. Given the training set:

$$\{(X_i, y_i)\}_{1 \le i \le n}, X_i \epsilon \mathbb{R}^s, y_i \epsilon \{+1, -1\} \quad (5)$$

SVM finds the hyperplane by solving this equation:

$$\begin{cases} \min_{w_b} \frac{1}{2} ||W||^2 \\ y_i (w.x + b) \end{cases} \quad (6)$$

For $i = 1,..n$ are the observation, w is the weight, and b is the bias. The {+1} represent Western ethnic Indonesia and {-1} represent Eastern ethnic Indonesia [3].

E. Evaluation Measurement

Finding our proposed method is good compared to other classifiers; we evaluated our result in accuracy, precision, and recall [8].

$$accuracy = \frac{tp + tn}{tp + tn + fp + fn} * 100\% \quad (7)$$

$$precision = \frac{tp}{tp + fp} * 100\% \quad (8)$$

$$recall = \frac{tp}{tp + fn} * 100\% \quad (9)$$

Where tp is true positive, fn is false negative, tn is true negative and fp is false positive. To understand the tp, fp, fn and tn, Figure 5 will explain more thoroughly.

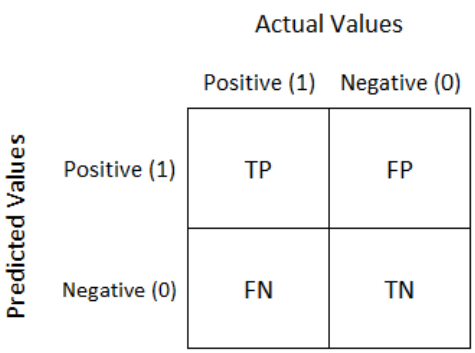

Fig. 5. Confusion Matrix [9]

III. Experiment Result

In this experiment, we compared two things our proposed method on RGB color spaces and YCbCr color spaces. We also compared three different Kernel in Support Vector Machine to find our dataset is linear, Gaussian, or radial using Linear Kernel, Gaussian Kernel, and Radial Basis Function (RBF Kernel). Another comparison is using K-Nearest Neighbour. We are also separate our dataset into a 70% training set and 30% for the test set. We separated the images manually.

Table 2 and Table 3 show the evaluation between RGB color spaces and YCbCr color space.

TABLE II. The evaluation of RGB color space

Classifier	Accuracy	Precision	Recall
Svm-Gaussian Kernel	50%	50%	100%
Svm -Linear Kernel	**75%**	**75%**	**75%**
Svm – RBF Kernel	50%	50%	100%

TABLE III. The evaluation of YCbCr color space

Classifier	Accuracy	Precision	Recall
Svm-Gaussian Kernel	50%	0%	0%
Svm -Linear Kernel	**81%**	**86%**	**75%**
Svm – RBF Kernel	50%	0%	0%

According to Table 2 and Table 3 results using YCbCr color space significantly improve our result, which proves that the RGB color space is not good enough to handle chrominance and luminance of the images. The result also shows that our dataset is linearly separable.

Table 4 and Table 5 show the comparison of SVM with KNN in each color space.

TABLE IV. The comparison classifier in RGB color space

Classifier	Accuracy	Precision	Recall
Svm – Linear Kernel	**75%**	**75%**	**75%**

KNN	63%	63%	63%

TABLE V. THE COMPARISON CLASSIFIER IN YCBCR COLOR SPACE

Classifier	Accuracy	Precision	Recall
Svm-Linear Kernel	**81%**	**86%**	**75%**
KNN	75%	83%	63%

Table 4 and Table 5 shows that the proposed classifier, which is SVM with Linear Kernel, has better accuracy, precision, and recall measure compared KNN.

IV. CONCLUSION

In this paper, we want to classify Indonesia's ethnicity into two different ethnicities (Western and Eastern Indonesia). We implement the Viola-Jones algorithm to separate between face and non-face from images, and we convert the colorspace from RGB into YCbCr color space. The next step is to extract the images into Maximum Likelihood Estimation (MLE) and creating a model using the SVM algorithm. The result shows that the YCbCr gives better results compared to RGB color spaces, and SVM gives better results compared to the KNN classifier. We also know our dataset is linear data, which is a good measure for the next experiment to improve the accuracy based on the linear approach.

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Wi-Fi-based Indoor Localization for Location-based Smart Notification

An Initial Study and Deployment

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***Abstract*—Indoor localization has been researched widely in the recent two decades due to its wide range of applications such as navigation, elder care, advertising. This work presents a utilization of indoor positioning for a location-based smart notification purposed, deployed in a meeting room booking application. Our localization method is based on Wi-Fi fingerprint, tailored to our application needs to alleviate the drawback of its tedious offline phase. The initial implementation is done with limited number of recorded locations. The testing shows that the meeting room booking application works well, with the localization detecting user's location correctly aside from when poor signal condition occurs.**

***Index Terms*—Context-aware System, Fingerprint, Indoor Positioning/Localization, Smart Notification, Wi-Fi**

I. INTRODUCTION

The concept of localization or positioning for indoor environment has been gaining traction in the recent two decades. Wide range of works on indoor positioning tackle various aspects such as the physical technology, the position tracking methodology [1], [2]. While there are wide range of applications that can take advantage of indoor positioning, its implementation was mainly hindered by the lack of infrastructure. On the other hand, outdoor positioning system has been implemented and widely used for decades, covering areas globally using satellite as their positioning infrastructure. Such systems are classified under the term Global Navigation Satellite System (GNSS). There are only limited number of GNSS deployments as it requires huge amount of investment for its satellite infrastructure, namely GPS, GLONASS, Galileo, and BeiDou [3]. However, the same satellite infrastructure is not applicable to the indoor positioning as it lacks the accuracy required in indoor environment [4].

To track in an indoor environment with adequate accuracy, the system needs to rely on wireless technology whose signal characteristics are designed for indoor or urban environment [2, 3]. With the development of multitudes short / medium range wireless standards (that is of WPAN, WLAN), indoor positioning system has the choice of leveraging those standards along with their existing infrastructure. For example, Wi-Fi network with decent coverage can be found almost anywhere in an urban area or a building [5]. Such ubiquitous indoor network could not be found easily a couple decades ago. Cellular network infrastructure has also evolved, deploying smaller nano and picocells to extend reach and service quality inside public places such as shopping malls, office buildings [6]. Bluetooth beacons infrastructure, while not readily deployed as widely as Wi-Fi and Cellular, can be implemented with reasonable cost. Furthermore, these wireless technologies can be leveraged to track objects and people due to the omnipresence of modern smartphones which include those wireless modules, hence allowing the tracked entities to interact with the positioning system.

Methods of localization in general can be classified into static (pre-recorded location signatures / fingerprints) [7]–[10] and dynamic (calculating distances to several anchor points based on received signals) [11]–[13] approaches. There are wide variety of methods on either approach, each with their pros and cons which can be tailored to the application. As with outdoor positioning, indoor positioning can be leveraged for various purposes such as indoor navigation [14]–[16], surveillance of sick and elderly people [17], [18], and location-aware advertising [19], [20].

Smart campus is one example of suitable environment to integrate the indoor positioning technology into. Within a campus, large number of students, staffs, and lecturers move around the campus in different hours for classes, labs, or meetings. Depending on the period, those individuals' schedules or appointments could be packed. With smartphones, reminders and emails can be conveniently used to keep track of those schedules. However, they also generate lots of notifications that may lead to interruption overload [21]. By utilizing indoor positioning, notifications around the scheduled activities can be

filtered, and presented to the user only if necessary, such as when the appointment time is close, and the user is not around the appointed vicinity [22].

In this work we present an application of indoor positioning in an application with location-aware push notification requirement, deployed in our campus at Universitas Multimedia Nusantara, Indonesia. The system itself is still at an early stage, with its initial deployment covering limited area and users. This work serves to display how we benefit from tailoring certain indoor localization method to fit our use case. Testing of the application use case will be discussed, while the in-depth accuracy test of the positioning itself is yet to be performed and shall be done as this work progress. The rest of this paper is organized as follows. Section Two discusses various indoor localization approaches. Section Three discusses about location-based smart notification and its implications on the localization technology we use. The initial implementation and testing of the system are described in Section Four. Lastly, Section Five concludes this paper.

II. INDOOR LOCALIZATION APPROACHES

In the last two decades, interests towards indoor localization application have sparked numerous works on developing robust and scalable indoor localization system. Those works range widely in terms of the physical / wireless technology being used and the localization / tracking algorithm.

A. *Localization Technology*

As more wireless standards emerge, researchers have been proposing the utilization of those standards for locating objects / people in indoor environment. A single or multiple wireless standard(s) may be utilized by the localization system. Evaluation of those wireless standards are usually based on these several parameters [1], [2]:

1) *Signal Quality and Precision*: As the available wireless standards are designed for different purposes, their signals may have different propagation characteristics which affects range, penetration, and received signal quality. This will affect the required infrastructure particularly the number of transmitters, e.g. access points in Wi-Fi infrastructure. The longer the signal travels and be detected reliably, the less transmitters needed throughout the indoor environment. This however does not directly yield lower deployment cost as the cost of individual transmitter may be greater. Precision of the tracking, i.e. minimum range that can be detected is also affected by the signal characterics of the wireless standards. For example, UWB transmission allows precision up to 15 cm indoor, Wi-Fi at 2-5 m, Bluetooth at 2-3m, etc.

2) *Operating Frequency*: Choosing the existing wireless standards also requires proper consideration of their operating frequency. In general, like many wireless applications, we want the less crowded frequency to reduce the interference. Standards operating at free ISM bands such as Bluetooth, Wi-Fi may have disadvantage on this aspect.

3) *Existing Infrastructure & End-device Support*: As the indoor positioning relies greatly on the anchors, i.e. the transmitters, having the transmitters deployed throughout the indoor environment is crucial. Generally, having more transmitters or anchor points results in better localization, but there is also a possibility that these additional anchor points provide unreliable signal quality hence resulting in worse localization [23]. Availability of end devices also plays an important part in deciding which wireless standards to use, as these devices serve as identifier to the object or people being tracked. For example, while both Wi-Fi Bluetooth enjoy the benefit of ubiquitously embedded in almost all mobile devices, Wi-Fi access points are more commonly found throughout indoor environment compared to the Bluetooth counterpart, i.e. beacons. Likewise, cellular system also enjoys both the wide deployment in infrastructure and mobile devices. However, cellular system in average is less performing compared to Wi-Fi in indoor environment, albeit the limited implementation of indoor cellular transmitter stations (picocells & femtocells).

4) *Power Consumption*: While this aspect applies to both the infrastructure and end-devices, we will keep the discussion to the end-devices part as the infrastructure part is more related to operational cost. During the localization, end device are required to communicate with the anchors periodically. This, depending on the period, frequency of communication, and the baseband signal processing, may affect the power consumption of the end-devices which commonly run on battery. Some wireless standards are inherently low-power, such as Bluetooth Low Energy (BLE), or LoRa [24]. Passive-RFID requires no battery at all on end-devices / tags, but drawn back by the very limited detection range and rather costly readers [1].

B. *Localization Algorithm*

Regardless of the wireless standards or technologies, algorithms being proposed to provide the tracking functionality can be broadly classified into static and dynamic approaches [1], [2].

With static approach, the algorithm is composed of two phases [7], the offline phase (recording) and the online phase (location tracking). The offline phase is where signatures (fingerprint) of the location of interests (which could vary depending on the application) are being recorded and stored in the system database. The signatures being recorded also varies widely depending on the wireless technology being used. One commonly used signature is the received signal strength (RSS) of Wi-Fi access points. Once the offline phase is done, i.e. recorded signatures for every location, the system can be deployed to online phase. Continuing the example of Wi-Fi RSS signature, in online phase the location tracking is performed by having the user end-device reads the RSS it is receiving and compares it to the signatures database. The comparison then may determine whether the user is in any of the recorded location, or in between. The simplest comparison function is Euclidean Distance function [7]. This approach provides good accuracy if the offline process is performed properly. However, it is disadvantaged since the offline process is tedious to perform both initially and during maintenance. For example, Wi-Fi infrastructure may change due to broken down access points, or just topology changes. Such approach may require additional cooperation with the network manager to avoid tracking malfunction.

With dynamic approach, the system determines user's location directly by estimating distance to the known anchor points based on the received signals. The estimation is commonly performed with triangulation, which is very similar to outdoor positioning system such as GPS. Metrics being used in the triangulation may vary from time-of-arrival (ToA), time-difference-of-arrival (TDoA), signal strength (RSS), time-of-arrival (ToF), etc [1], [4]. This approach is similar to the static approach in terms of its reliance on the anchor points, that is requiring them to be non-changing over extended period of time else re-adjustment is needed. However, there is no initial work involved as in creating the signatures (fingerprints).

Both methods however do not define where to implement the calculation, i.e. on the server side or client side. In the case of server-side calculation, user end-devices will have longer battery life, but there will be delay as the signal measurements need to be sent over to server and back to the end-device after calculation. Moreover, that process may need additional internet connection to the server. On the contrary, putting the computation on the client side will increase the end-devices power consumption (depending on the computation complexity).

III. Notification and The Indoor Localization Requirements

A. Smart Notification System

As described in [21], interruption overload generated by push notifications from computer system, e.g. smartphones may lead to decline of user's productivity. Take for an example a campus with mobile application where students and lecturers can be notified of the upcoming classes, or where lecturers and staffs are notified of their meeting appointments. Such notification system would only serve its positive purposes up to a certain point in which people can still handle the amount of information presented. A more context-aware system does not notify users if they are already in the designated class or meeting room. This work assumes the use case of a mobile application with location-based smart notification [22], in which user can schedule meetings, book the available meeting rooms, and get notified accordingly (based on current time and user's location). The indoor localization requirement for this use case will be detailed in the next subsection.

B. Location-based Notification Localization Requirements

Considering the use case assumed in this work, the positioning system has no necessity to track people's exact location all the time. First, the positioning system is only necessary near the appointed time (it is set to T-15 minutes in this work). Second, in its most basic form, the position tracking only needs to determine whether user's location is in the vicinity of interest or not. Hence, the fingerprinting method would fit this scenario well. We benefit from the accuracy of offline fingerprint recording while reducing the number of fingerprinted locations or rooms to a manageable number.

Tracking people's exact location throughout the building indeed provides additional functionalities such as calculating user distance to the vicinity and informing when should the user leave for the meeting. However, this approach comes with trade-offs in immense offline fingerprinting work (and its maintenance) and possibly larger power consumption in user's mobile devices due to the extra computations required. To limit the scope of the trade-offs however, we shall keep the power consumption factor out of this work.

The wireless infrastructure used in this work is Wi-Fi as it is already deployed campus wide. With the limited amount of locations or rooms to be recorded, deploying Bluetooth beacons to those places would be feasible too with little cost for the beacon devices. However, should the system be expanded to cover wider area and possibly the whole campus, the additional cost of Bluetooth beacons could add up to a hefty sum.

C. *Localization Technique Design*

In general, our Wi-Fi indoor localization system is comprised of two parts, the offline fingerprint recording and the online user location tracking. An Android mobile application is developed for the offline fingerprint recording purpose. Result of the fingerprinting process is saved in a JSON-formatted file and passed to the user-side mobile application. The user application is a meeting room booking system [22] with location-based push notification, which uses the recorded fingerprints to determine whether the user is in the appointed room or not.

Fingerprint recording with the utility application is performed in these several steps below. The application's front page is show in Figure 1.

1) Pressing the '**Scan Wi-Fi**' button will scan the surrounding Wi-Fi for the campus wide deployed Wi-Fi SSID, which in this case is 'UMN'. This should return list of access points (AP) along with their MAC address and received signal strength (RSS). The MAC address is greyed out in this paper for security reason.

2) The APs list is automatically sorted by RSS. The application increments the '**Scans saved**' counter by one, informing how many scans performed that yet to be saved.

3) Process one and two may be repeated for multiple times. The application automatically records each scan and averages the RSS of each APs accordingly.

4) Pressing the '**Save FP**' button will lead to the fingerprint creation page, shown in Figure 2. Here, the application displays the top four APs by RSS. We can specify the virtual coordinate and name for the location being fingerprinted and save it to a JSON file. Here, both the virtual coordinate and name field may represent the location index in the system. By default, the newly fingerprinted location will be appended to the existing list in the JSON file, if any. Checking the '**Clear existing Fingerprint database'** box will clear the JSON file and remove all existing fingerprints. **Error! Reference source not found.** shows the JSON file format.

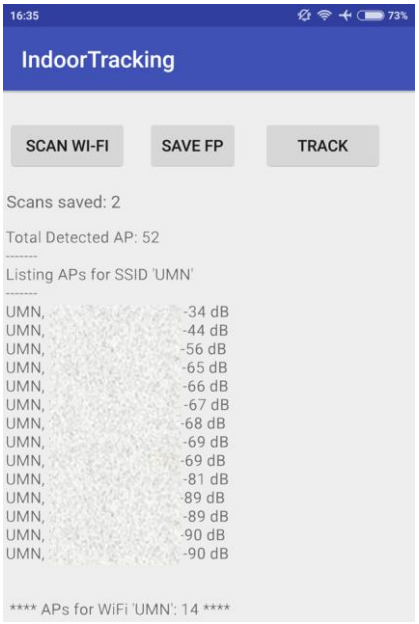

Fig. 1. Fingerprint Application Front Page

In this work, the name field is used instead of virtual coordinate for indexing different locations. Since the indoor localization is used in a meeting room booking application, the location of interest would be meeting rooms. The fingerprint collection for each room is performed in the middle of the room, by scanning APs for five successive times before saving it to the JSON file. The resulting JSON file is stored locally in the device storage and used by the user-side meeting room application.

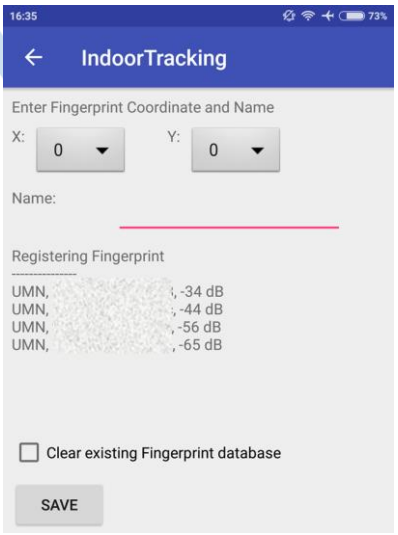

Fig. 2. Fingerprint Application Creation Page

```
[
  {
    "x": 0,
    "y": 0,
    "name": "Meeting5",
    "AP": [
      { "bssid": "                ", "rss": -34 },
      { "bssid": "                ", "rss": -44 },
      { "bssid": "                ", "rss": -56 },
      { "bssid": "                ", "rss": -65 }
    ]
  }
]
```


Fig. 3. JSON File for Fingerprint Database

The user-side application contains a background logic for push notification that will start 15 minutes before the appointed time. Once the logic starts, the application scans the surrounding for Wi-Fi networks broadcasted with SSID of 'UMN' along with the APs MAC address and RSS. Note that the user-side application only requires the Wi-Fi to be on, it does not require the device to be connected to the 'UMN' Wi-Fi network. Like the fingerprint recording application, the scan result will be sorted by RSS. The top four APs will then be compared with the previously recorded fingerprints (in JSON file) using Euclidean Distance [7] to determine whether the user is in the room of interest.

That is, we calculate the Euclidean Distance D of the recorded fingerprint (list of Aps and their signal strengths) Rk and the user-side application received signal strengths at certain instance, P. We define R as a vector of fingerprints for each room of interest, with each fingerprint being a vector whose element is an object composed of AP's MAC address and RSS. These are shown in equation (1) and (2), respectively. Similarly, P is a vector of APs and their respective RSS.

$$R = \{Rk\}, k = 1,2, \dots n\ rooms \quad (1)$$

$$Rk = \{\{APj_{mac}, APj_{rss}\}\}, j = 1, \dots, 4 \quad (2)$$

$$D = \sqrt{\sum_{j=1}^{4} (Rk_j - P_j)^2} \quad (3)$$

$$inside(Rk, P) = \begin{cases} 1 \ if \ D(Rk, P) \leq t \\ 0 \qquad otherwise \end{cases} \quad (4)$$

Room index k will be selected based on the upcoming meeting appointment, assuming a one to one mapping from index k to the room name. User will be deemed to be inside the room if the resulting Euclidean Distance is less than certain threshold value, described in equation (3) and (4), respectively. As this initial implementation is limited to a single meeting room, we took the leverage of hardcoding the threshold value into the application. However, the method that yields the threshold value is reproduceable for any room in future work, i.e. we record the fingerprint values at multiple points around the edge of the room and calculate the average distance from those points to the fingerprint at the room center. The next section details the integration of the indoor positioning into the user-side application.

IV. Initial Implementation and Testing

A. Meeting Room Booking Application

In our previous work [22], based on the initial user requirements, we developed a hybrid mobile application using Ionic Framework in which the location-based smart notification system works. User acceptance test shows promising results. Several main findings are that the hybrid application is perceived to be useful and easy to use due to its fast development pace to be deployed into multiple platforms, giving the user more time to experiment with the app and make necessary changes along the way. However, there are still some things to consider when choosing the approach to develop a mobile application, such as performance and user experience [25]. In this paper, we developed a native version of the same application for Android, using its native language, Java. The new native application serves to be a comparison to the previous hybrid application.

As seen in Figure 4, user must have an account to use the application, in this application, we use a free version of Google Firebase's [26] authentication feature for user registration and sign-in method. We then get the ID of each user from Firebase then save the remaining data into our own backend server using PHP and MySQL. After signing in to the application, user will be able to see all the bookings made to the meeting room, including bookings from other users. For bookings which are created by the current user, the user can edit and/or delete them, however, a user cannot edit nor delete bookings made by other users.

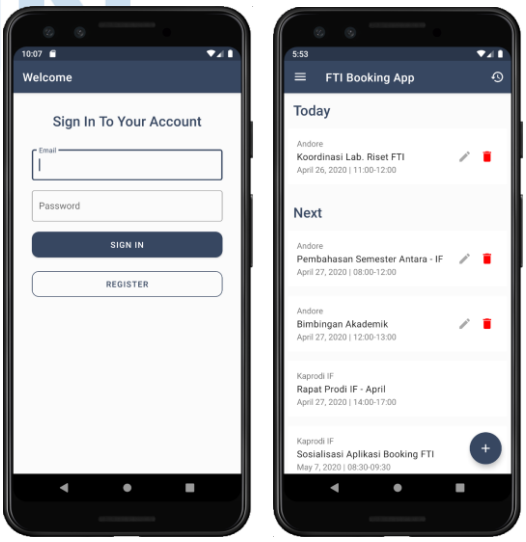

Fig. 4. Sign-in and Main Page User Interface

Our location-based smart notification system will notify users 15 minutes before a booked-meeting starts only if the user is detected as not in the meeting room,

as can be seen in the left-side picture on Figure 5. Furthermore, to add a new booking, users can simply click on the floating action button on the bottom right of the main page UI (picture on the right in Figure 4), and the UI as shown in the right-side screen on Figure 5 will be displayed.

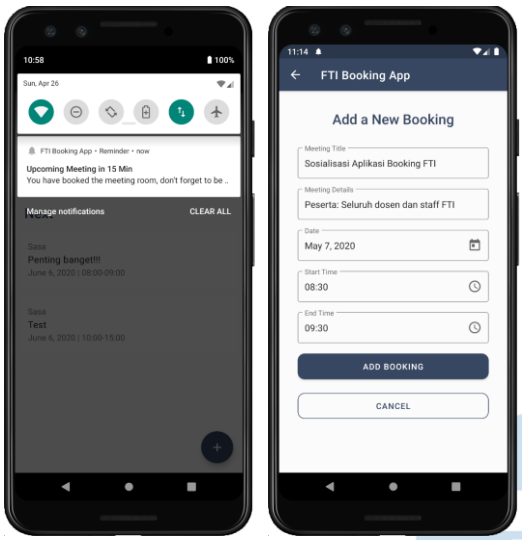

Fig. 5. Meeting Notification and Add New Booking User Interface

B. *Application Testing*

The functionality of the developed native application explained in the previous section has been tested in various scenarios. The detailed scenarios and results can be seen in Table I below.

TABLE I. BLACK BOX TESTING RESULT

Scenario	Result		
	Expected Output	***Actual Output***	***Status***
Register using an existing email account	Invalid email: already existed	Invalid email: already existed	OK
Sign in with invalid data	Can't sign in, invalid email or password	Username or password incorrect	Need fix, not username but email.
Sign in with valid data	All current and future booking data are shown	All current and future booking data are shown, with delete button on user's own bookings	OK
Button click: Floating action buttton (+)	Add new booking page is shown	Add new booking page is shown	OK
Button click: Add New Booking (Start time is after end time)	Invalid start time	Invalid start time	OK
Button click:	Booking	Confirmation	OK
Delete booking	deleted	pop up -> if YES -> Booking deleted	
Button click: History Icon	All past bookings are shown	All past bookings are shown	OK
15 minutes before any user's booking time AND user is detected not anywhere near the meeting room	Meeting notification is shown	Meeting notification is shown, however if user's device time is not correct, then it will follow the incorrect time	Need fix
15 minutes before any user's booking time AND user is detected to be in the meeting room	Meeting notification is not shown	Meeting notification is now shown, however, in some occasions the detected location is not precise and the notification is shown	Need improve ment
Button click: Logout	Sign in page is shown	Sign in page is shown	OK

As shown in Table I, most of the functional requirements are met by the newly built native application. However, there are some improvements need to be made, especially concerning the location-based notification. In most cases, in which the device time is correct, and the received Wi-Fi signal is good, there are no problem. However, there are some cases where the location detection is not accurate, and device's time is not showing actual time. We suspect that the intermittent misdetection problem stems from unstable Wi-Fi signals due to interference and/or the device's Wi-Fi receiver quality, and that a more robust fingerprinting method is required. Further testing and evaluation are needed to first measure the accuracy of the indoor positioning system in detecting the users' location. The rigorous evaluation also requires multiple devices involved as wireless receiver embedded in the devices could vary.

On the other hand, based on several quick interviews with the application's potential users, so far, the performance and user experience of both the previous hybrid application and the current native application are nearly identical. However, we considered that in terms of scalability, it still needs more rigorous testing where the number of users accessing the server is increasing rapidly, or tested in various operating system version (various devices with different API level in Android) to be able to be confident that in our case, the hybrid and native application are both nearly identical in terms of performance and user experience.

V. CONCLUSION

In this work, we presented a Wi-Fi fingerprint-based indoor positioning, applied in a location-aware meeting room booking application. In this initial implementation stage, the native Android application's booking and notification functions properly. Tailored to the application needs, our localization approach reduces the number of fingerprints needed while still functioning well under good Wi-Fi signal condition. Incorrect location detection happens intermittently due to poor Wi-Fi signal condition and/or the quality of the device's wireless receiver.

FUTURE WORKS

As this work only evaluate the indoor localization functionality in the application, future works should include improving the localization in poor signal condition and conducting thorough testing and evaluation of the localization system performance. Additional features such as punctuality record and Google Calendar integration can also be added to the meeting application.

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- The abbreviation "i.e." means "that is," and the abbreviation "e.g." means "for example."

IV. Using the Template

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention as below

IJNMT_firstAuthorName_paperTitle.

In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper. Please take note on the following items.

A. Authors and Affiliations

The template is designed so that author affiliations are not repeated each time for multiple authors of the same affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization).

B. Identify the Headings

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include ACKNOWLEDGMENTS and REFERENCES, and for these, the correct style to use is "Heading 5."

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced. Styles, named "Heading 1," "Heading 2," "Heading 3," and "Heading 4", are prescribed.

C. Figures and Tables

Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation "Fig. 1," even at the beginning of a sentence.

TABLE I. TABLE STYLES

Table Head	**Table Column Head**		
	Table column subhead	***Subhead***	***Subhead***
copy	More table copy		

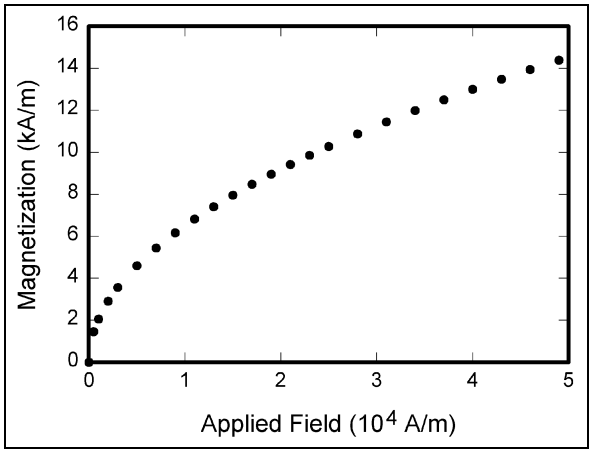

Fig. 1. JSON File for Fingerprint Database

V. Conclusion

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

Appendix

Appendixes, if needed, appear before the acknowledgment.

ACKNOWLEDGMENT

The preferred spelling of the word "acknowledgment" in American English is without an "e" after the "g." Use the singular heading even if you have many acknowledgments. Avoid expressions such as "One of us (S.B.A.) would like to thank ... ." Instead, write "F. A. Author thanks ... ." You could also state the sponsor and financial support acknowledgments here.

References

The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use "Ref. [3]" or "reference [3]" except at the beginning of a sentence: "Reference [3] was the first ..."

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors' names; do not use "et al.". Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [4]. Papers that have been accepted for publication should be cited as "in press" [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

[1] G. Eason, B. Noble, and I.N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529-551, April 1955. (*references*)

[2] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.

[3] I.S. Jacobs and C.P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.

[4] K. Elissa, "Title of paper if known," unpublished.

[5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740-741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

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