ISSN 2085-4552

Application of Deep Learning Techniques for Enhancing Arabic Vocabulary Acquisition in Students at MTs Darun-Najah

Misbachur Rohmatul Isnaini[1], Arvita Agus Kurniasari[2], Aji Seto Arifianto[3], Pramuditha Shinta Dewi Puspitasari[4]
[1,2,3,4]Dapartment of Informatics Technology, State Polytechnic of Jember, Jember, Indonesia
[1]aninisnaini214@gmail.com, [2]arvita@polije.ac.id, [3]ajiseto@polije.ac.id, [4]pramuditha@polije.ac.id

Accepted 29 October 2024
Approved 08 January 2025

***Abstract*— Arabic vocabulary recognition is an important aspect of learning at MTs Darun - Najah, a school that emphasizes on Islamic religious education. This research proposes the application of Convolutional Neural Network (CNN) and EfficientNet B7 to create learning media for Arabic vocabulary recognition for students. This method is implemented in the form of a web-based application. The built application offers an innovative approach in learning by utilizing deep learning. The results of several trials conducted showed that the application of Convolutional Neural Network (CNN) and EfficientNet B7 achieved 90% accuracy with an average precision of 94.6%, recall 94.6%, and f1-score 94.6%. Tests using User Acceptence Testing (UAT) have a success accuracy rate of 87.2% which proves that users can accept quite well.**

***Index Terms*— *Convolutional Neural Network (CNN); EfficientNet B7; Arabic Vocabulary Recognition; Deep Learning*.**

I. INTRODUCTION

Language is a basic need for humans that enables the conveyance of ideas, thoughts, and ideas in oral and written form. Language has a very important role in human life because it facilitates effective communication between individuals. With language, humans can interact, share information, and build better social relationships [1]. In this world there are various kinds of languages, one of which is Arabic. Arabic has a special significance in Islam because it is the language of the Qur'an, the holy book of Muslims. Therefore, understanding Arabic is important for Muslims to understand and practice Islamic teachings, because much Islamic literature is written in Arabic [2].

Vocabulary is a collection of words in a language that is known and understood by humans. Vocabulary is an important part of language and communication skills, because with sufficient vocabulary, a person can more easily convey and understand messages in daily communication. In the context of foreign language learning, such as Arabic, vocabulary mastery is very influential on listening, speaking, reading and writing skills [3]. Therefore, understanding Arabic vocabulary is essential in learning this language, so that students can more easily understand the subject matter and communicate more effectively.

MTs Darun - Najah is one of the Islamic schools that includes Arabic language in its learning curriculum. In this school, in addition to providing Arabic learning materials, students are also trained to speak the language. This aims to make students not only understand the theory of Arabic, but also be able to apply it in everyday life. However, there are challenges in teaching Arabic at MTs Darun - Najah, especially related to student interest. Many students experience difficulties in learning Arabic due to monotonous teaching methods, which can make students quickly get bored and pay less attention to the teacher when teaching [4].

Teacher creativity in delivering material is a key factor in maintaining student interest. Teachers who are able to create a fun and interactive learning atmosphere will be more successful in teaching Arabic. The use of interactive learning media can help the teaching-learning process become more interesting and effective, so that students are more motivated to learn [5]. To overcome the challenges in learning Arabic at MTs Darun - Najah, technology development is a relevant solution.

A website has been developed using Deep Learning technology, specifically Convolutional Neural Network (CNN), to recognise Arabic vocabulary. This technology allows the recognition and classification of Arabic vocabulary from various objects, so that it can help students in learning and understanding Arabic better. This research aims to develop a learning media system for Arabic vocabulary recognition and implement CNN model for Arabic vocabulary classification at MTs Darun - Najah. The benefits of this research include creating Arabic vocabulary learning media for MTs Darun - Najah and knowing the Arabic vocabulary of an object using the Convolutional Neural Network method. With this technology, it is hoped that the Arabic language teaching and learning process at

MTs Darun - Najah can be more effective and fun, and can improve students' ability to understand and use Arabic.

II. THEORY

A. Arabic Language

Arabic has privileges over other languages, one of which is Arabic is an eternal language because Arabic is the language of the Qur'an which will last until the Last Day [6]. Arabic is a religious language, because Arabic is always used in various religious activities, such as prayer, sermons, weddings, and so on. In addition, Arabic is a unifying language for Muslims around the world, with the development of the times, Arabic is used as an international language. Arabic is also a pioneer of civilisation because Arabic was used internationally for 8 centuries, so many Arabic words are borrowed in Indonesian [7].

Arabic is one of the oldest and most famous languages in the world due to its large number of mufrodat (vocabulary), lafadz and their meanings and being one of the languages capable of understanding clear meanings. Arabic is also called lughotud dhot, which is a flowing language, whose scope is very broad and its explanation is clear [8]. Arabic is a Semitic language because Arabic has the same origins as other Semitic languages, such as Hebrew, Aramaic, and Akkadian. These Simitic languages are commonly found in the Middle East and North Africa.

B. Vocabulary

Vocabulary is the main component before learning foreign languages [9]. In language, vocabulary refers to all the words that can be understood and used by speakers of a language that can be understood and used by speakers of a language. Vocabulary includes nouns, verbs, adjectives, adverbs, pronouns, and so on. Vocabulary also includes vocabulary variations such as formal and informal words, colloquial words and technical language words over terms.

Vocabulary is a set that contains all the new words that a person will later use to construct a new sentence. The amount of vocabulary one has shows the level of education or learning one has mastered. One language expert named Horn said that vocabulary is a collection of words that can later form a language. A person can understand the four language skills if he has mastered vocabulary well [9]. Vocabulary is very important in language skills, because by understanding the right vocabulary, one can convey messages clearly and effectively. In addition, having a rich vocabulary can also help a person to understand readings and conversations more easily and quickly.

C. Deep Learning

Deep Learning is a branch of machine learning that adopts algorithms inspired by the structure of the human brain [10]. Deep Learning is used to solve various problems, such as face recognition, voice, and text analysis. Deep learning techniques have been applied in various fields, such as image recognition, voice, data analysis, video games, and robotics. Deep Learning, as a technique in machine learning, enables nonlinear information processing through multiple layers for pattern identification, feature extraction, and classification. This method enables computational models composed of many layers of processing that learn data from different levels of abstraction. Deep Learning algorithms include Stacked Autoencoders, Restricted Boltzmann Machine (RBM), Deep Belief Networks (DBN), and Convolutional Networks. Convolutional Neural Network (CNN) is a type of neural network in deep learning that is often used in computer applications. deep learning that is often used in computer vision applications such as image classification, object detection, and human face recognition. Compared with Artificial Neural Network (ANN) and Recurrent Neural Network (RNN), CNN is particularly used for image data processing by using kernel that extracts features through convolution operations [11].

Deep Learning is a network that consists of several layers. These layers are a collection of nodes. A node is just a place where calculations occur. A node's input is combined with its weight, after which the input and weight are summed and the sum passes through a stage called the node's activation function, to determine how far the signal proceeds further through the network, affecting the final result. The difference between Deep Learning and neural networks is that there are more hidden layers in Deep Learning. If there are more than three layers (including input and output) then it qualifies as “deep” learning. So Deep Learning can be technically defined as machine learning that has more than one hidden layer [12].

D. Convolutional Neural Network

CNN (Convolutional Neural Network) is a type of deep learning algorithm used to process data with a certain structure such as images, videos, and other spatial data. CNN works by gradually extracting features from images, starting from simple features such as lines and angles, to more complex features such as shapes, textures, and patterns. This is done by applying a series of convolution operations to the input data, followed by pooling and activation.

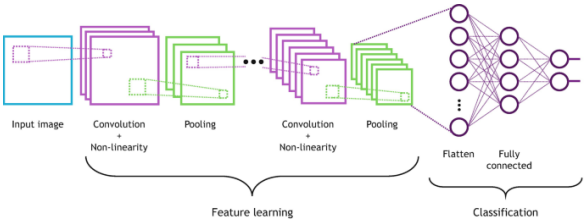

Fig. 1 CNN

CNN is simply an artificial neural network that uses a convolution multiplication matrix in its architecture. The convolution function in CNN is used for feature extraction, and this process will produce certain features that will be processed by a multilayer perceptron to produce an output from the input [13]. Convolutional Neural Networks (CNN) are deep neural network architectures that are highly effective in recognising visual patterns and are widely used in tasks such as image recognition and classification [14]. CNN has been used in various applications, such as face recognition, handwriting recognition, medical image classification, and object recognition in videos. CNNs are also used in other artificial intelligence applications, such as natural language processing and stock price prediction. CNNs became popular due to their ability to process high-dimensional and complex data, as well as the ability to automatically learn feature representations from input data. CNNs continue to be developed and used in various fields, and are one of the leading technologies in artificial intelligence.

E. Confusion Matrix

Confusion matrix testing is one method to measure the performance of a classification model. Confusion matrix is used to evaluate the extent to which the model can classify data correctly. Confusion matrix consists of four main components, namely True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN). These values are used to calculate the accuracy, precision, recall, and f1-score of a sentiment analysis model.

Accuracy, which is a value that shows the level of accuracy of the system in classifying correctly [15] :

$$Accuracy = \frac{Tn+TP}{TN+TP+FN+FP}$$

Fig. 2 Accuracy

Precision, which is the ratio of the amount of data that may be recognized with the amount of data that is recognized. The following is the precision calculation formula [15] :

$$Precision = \frac{TP}{TP+FP}$$

Fig. 3 Precision

Recall (Sensitivity), which is the ratio of the amount of data that may be recognized with the total all recognized data. Here is the formula recall calculation [15] :

$$Recall = \frac{TP}{TP+FN}$$

Fig. 4 Recall

The F1-score is a metric that assesses the overall performance of a model by computing the harmonic mean of precision and recall. It offers a balanced comparison between precision and recall [15] :

$$F1 - Score = 2 \text{ x } \frac{Precsion\ x\ Recall}{Precision+Recall}$$

Fig. 5 F1-Score

F. User Acceptence Test

User Acceptance Test (UAT) testing is carried out by asking prospective users to test the use of application programs, after conducting an assessment trial through a questionnaire that has been provided [15]. User Acceptance Test (UAT) testing aims to ensure that the application that has been designed is able to fulfill the components in business documents and is acceptable to the user. This test focuses on software functionality and other technical details that will later be used by users. This test is carried out by distributing questionnaires to MTs Darun - Najah students and also interviews with Arabic language teachers at MTs Darun - Najah, this test is carried out to find out the response of users to the system that has been built, whether the system has overcome all the problems contained in the background of this research.

III. METHOD

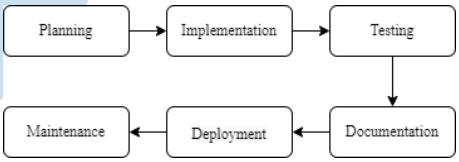

Fig. 6 Agile [16]

The research stages carried out in this study are agile methods. This agile method is designed to help developers work quickly by adjusting their needs [16]. Agile methods allow for customisation of needs and priorities throughout the development process. The team can quickly change plans and focus to adjust to the required changes [17]. Agile methods are an approach to software development that emphasises team collaboration, flexibility, continuous iteration, and rapid response to change. The approach focuses on delivering high-value products through short development cycles, often called sprints, which typically last 1-4 weeks. Key principles of Agile include interaction and collaboration between individuals, prioritisation of working software, active collaboration with customers, and the ability to respond to changing needs even in the late stages of development.

A. Planning

The first stage carried out is planning, which in this stage analyzes to find out and understand user needs for the software to be designed. Starting with conducting a

literature study to find references related to this research, namely by looking for previous journals on object recognition using the Convolutional Neural Network (CNN) method and also architectures that will later be tried. Thus, a comprehensive understanding of the framework that has been applied previously in similar studies can be obtained. Data and information collection methods in this study were also obtained by means of school surveys and interviews with Arabic language teachers at Mts Darun - Najah. This interview stage was conducted with the Arabic language teacher at Mts Darun - Najah. After conducting interviews with MTs Darun - Najah teachers, what is done at this stage is data collection. Data collection is done by taking images from various websites such as kaggle, pinterest, and google. also google.

B. Implementation

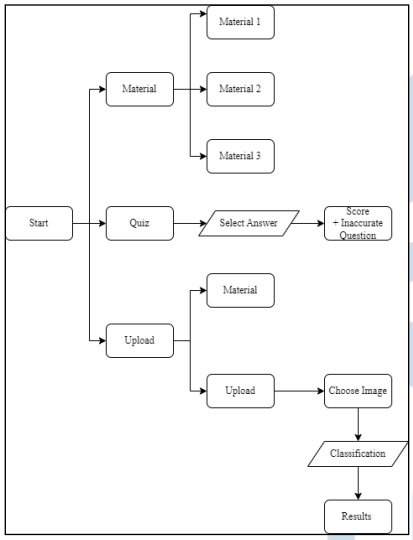

Fig. 7 Design System

First, there is the "Materi" menu which contains several pictures and their Arabic explanations. Second, there is a "Quiz" menu that allows users to work on a series of questions that have been provided. Finally, there is an "Upload" menu that allows users to enter images and find out the Arabic language of the image. The existence of the three main menus is based on the concept of this application as a learning media. It is important that there is a two-way interaction between the user and the application, so that the user can obtain information about Arabic from an object and at the same time involve themselves in the learning process through various activities that have been provided. In the implementation process, researchers also create a website mockup design that will later be applied to the website created. Here is the website development that has been made.

- Homepage

Fig. 8 Homepage

When users first access the learning website, they are greeted with a Homepage designed to provide a clear introduction to the platform.

- Menu Page

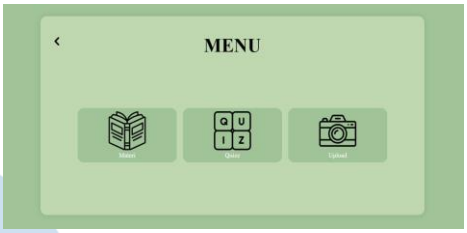

Fig. 9 Menu Page

The Menu Page displays three main options that can be accessed by users of this website.

- Select Material Page

Fig. 10 Select Material Page

The user is given the freedom to choose which chapter the user wants to explore further.

- Material Page

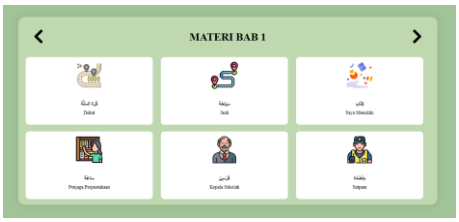

Fig. 11 Material Page

On the Material Page there is a provision of images, and bilingual text, namely Arabic and Indonesian.

• Question Page

Fig. 12 Question Page

Each question provides three answer options that can be selected by the user. The system will automatically change the question after the user selects the correct answer.

• Score Page

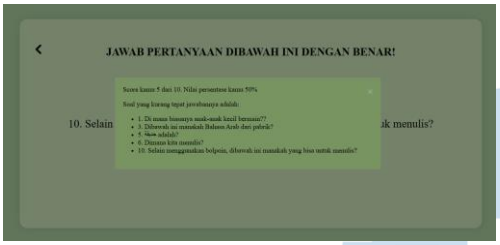

Fig. 13 Score Page

Once the user has completed the set of questions provided, the system will automatically display a Pop-Up containing the score corresponding to their work. In addition to getting a score, users can also see a list of questions that they answered incorrectly.

• Upload Menu Page

Fig. 14 Upload Menu Page

The Upload Menu view, which displays two menu options available to the user. The first is Material Upload, which serves as a repository for various materials relevant to the scanning process. The second is the Upload Menu itself, which is the main focus of using this feature.

• Upload Material

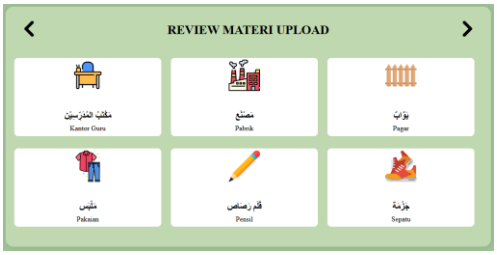

Fig. 15 Upload Material Page

In the Upload Material Menu, each object presented is accompanied by a picture describing the object, a text in Indonesian describing the object, and a translation of the text in Arabic.

• Upload Page

Fig. 16 Upload Page

Fig. 17 Upload Page

Users will upload an image to find out its Arabic equivalent. When the 'Classification' button is clicked, the website will display the Arabic translation. In this process, the CNN model with EfficientNet-B7 architecture will process the image uploaded by the user, using 70 epochs to produce optimal classification results.

C. *Testing*

At this stage, after the website is successfully designed, website testing will be carried out using two methods, namely Confusion Matrix for measuring the performance of a model, this test shows how well the model classifies data into the correct class and which errors occur, the confusion matrix consists of four cells namely True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN) and User Acceptance Test (UAT) to users to find out whether the website that has been built can be accepted or not by users.

D. Documentation

In agile methods, the documentation phase focuses on providing relevant and timely information throughout the development cycle. It starts with an application vision and roadmap that identifies the main features of this application. The main feature of the application built is the "Upload" feature which will allow users to know the Arabic language of the uploaded image. Documentation continued with the development of a product backlog containing user stories with descriptions, acceptance criteria, and priorities. Technical documentation such as code and comments are updated to support team understanding, and testing is documented to ensure quality. After the sprint, results and feedback are reviewed and recorded, and release notes and user guides are updated if there are significant changes. Continuous documentation ensures all information remains relevant and supports effective software development and maintenance.

E. Deployment

The deployment stage in agile involves a series of steps that ensure software can be released quickly and reliably after each sprint. The process starts with continuous integration, where newly developed code is routinely merged into the main repository and tested automatically. After that, automated builds produce a version of the software that is ready for further testing. Automated and manual testing is performed to ensure that the software is free of bugs and fulfils the acceptance criteria. When the build passes all tests, preparations for release are made, including compiling release notes and configuring the production environment. Finally, deployment is done automatically or semi-automatically to the production environment, followed by post-release monitoring to ensure everything is on track and address any issues that may arise.

F. Maintenance

Maintenance allows developers to fix errors that occur in the system. This includes fixing errors, improving the implementation of system units, and upgrading and customizing the system as needed.

IV. RESULT

A. Model Development

1) Resnet – 50

In the development of Resnet - 50, researchers have tried several scenarios, by playing with batch sizes of 32 and 64 with 6 epochs and with the dataset ratio of 80:20. In this experiment using 10 data for manual testing.

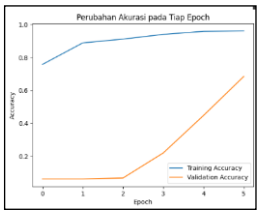

Fig. 18 Accuracy 32

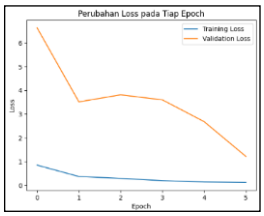

Fig. 19 Loss 32

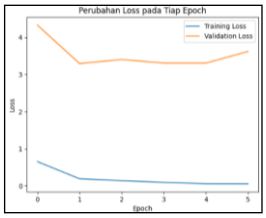

Fig. 20 Accuracy 64

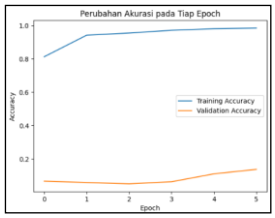

Fig. 21 Loss 64

TABLE I RESNET 50

Batch Size	Accuracy	Manual Testing
Batch Size 32	96%	9 true, 1 false
Batch Size 64	98%	7 true, 3 false

According to scikit-learn.org and medium .com that in both experiments the models experienced overfitting and underfitting, so they did not perform well.

2) Resnet – 18

In the development of Resnet - 18, researchers have tried the 10 epoch scenario with 32 batch sizes and with a dataset ratio of 80:20.

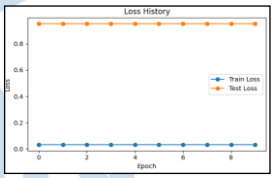

Fig. 22 Loss Resnet 18

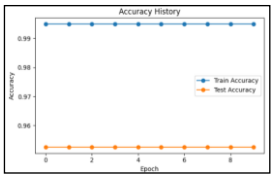

Fig. 23 Accuracy Resnet 18

At the 10th epoch using a batch size of 32, the model achieved an accuracy of 98%. Although the accuracy achieved is quite good, the visualisation results of the model development graph show an unsatisfactory graphical picture.

3) VGG – 16

In the development of VGG -16, researchers have tried several scenarios, namely by playing epochs of 15, and 20, with 32 batch sizes and with a dataset ratio of 80:20. In this experiment using 10 data for manual testing.

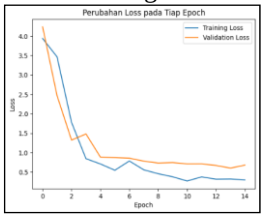

Fig.24 Loss 15

Fig. 25 Accuracy 15

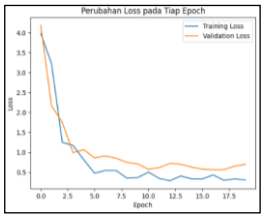

Fig. 26 Loss 20

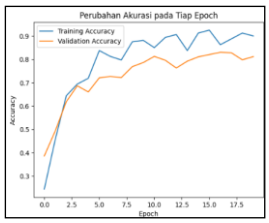

Fig. 27 Accuracy 20

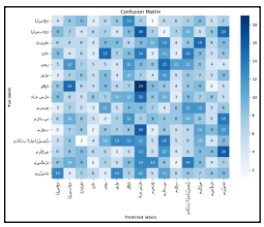

Fig. 28 Matrix 15

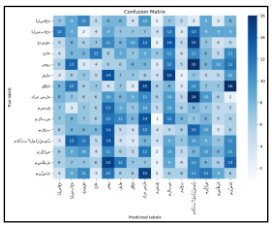

Fig. 29 Matrix 20

TABLE II VGG - 16

Epoch	Accuracy	Manual Testing
Epoch 15	89%	9 true, 1 false
Epoch 20	90%	10 true

According to the websites scikit-learn.org and medium.com both show good graphics as they display some important characteristics of an effective model training process. However, when the confusion matrix testing process is performed, both show that the model has a poor performance in classifying the data. This problem occurs because the model is not able to distinguish between different classes properly. Poor data quality, such as data that is not representative, has a lot of noise, or has wrong labels, can also lead to poor model performance.

4) EfficientNet – B7

In the development of EfficientNetB7, researchers have tried several scenarios, namely by playing epochs of 50, 60, and 70, with 32 batch sizes. In this experiment using 10 data for manual testing.

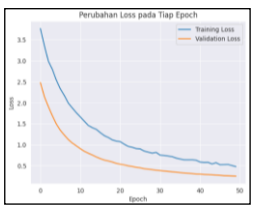

Fig. 30 Loss 50

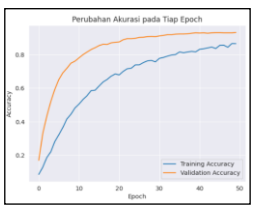

Fig. 31 Accuracy 50

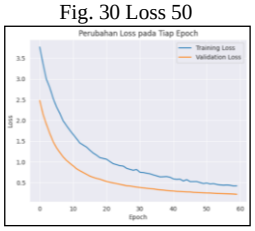

Fig. 32 Loss 60

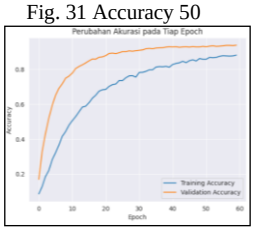

Fig. 33 Accuracy 60

Fig. 34 Accuracy 70

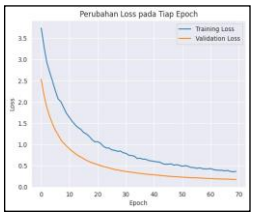

Fig. 35 Loss 70

TABLE III EFFICIENT NET - B7

Epoch	Accuracy	Manual Testing
Epoch 50	86%	10 true
Epoch 60	88%	10 true
Epoch 70	90%	10 true

In all three experiments, according to scikit-learn.org and medium.com, the graphs show a positive trend in the training process of the machine learning model, which means that they are able to provide a good enough model for this study. The consistency of improvement in both curves shows that the model does not experience overfitting, so the model has good predictive ability and is reliable for new data that has never been seen before. From the analysis that has been done, it can be concluded that EfficientNet B7 with epoch 70 and batch size 32 can be used for this study.

B. Testing

1) Confussion Matrix

After finding the optimal architecture, EfficientNet-B7, by running the training process for 70 epochs, the test results showed excellent performance through the resulting confusion matrix. The confusion matrix indicates that this model has a high level of accuracy in classifying the test data.

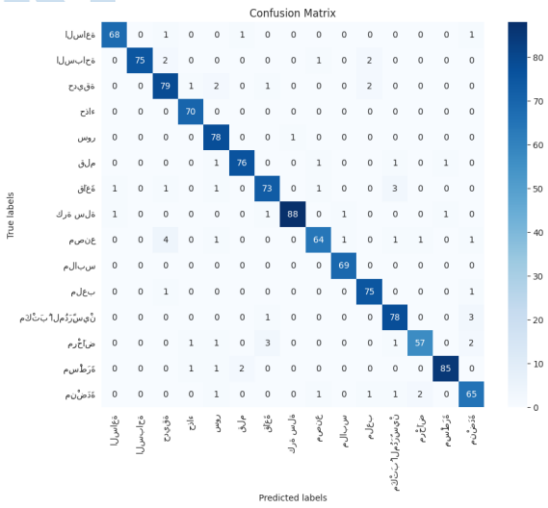

Fig. 36 Confussion Matrix

TABLE IV TP,FN,FP,TN

Class	TP	FN	FP	TN
الساعت	68	3	2	1095
اسباحت	75	5	0	1088
حديقت	79	6	9	1084
حداء	70	0	3	1093
سور	78	1	8	1085
قلم	76	4	3	1087
قعاة	73	7	6	1090
كرتسلة	88	4	1	1075
مسطرة	85	4	2	1078
مَكْتَبْ المُدَرّسيْن	78	4	7	1085
مصنع	64	9	4	1099
ملبس	69	0	2	1094
ملعب	75	2	5	1088
مرحاض	57	8	3	1106
منضدة	65	6	8	1098

In Tables the concepts of True Positive (TP), False Negative (FN), False Positive (FP), and True Negative (TN) are very important. True Positive occurs when the model correctly identifies positive examples, while False Negative occurs when the model fails to classify examples that are actually positive. Conversely, False Positive occurs when the model incorrectly identifies a negative example as positive, while True Negative occurs when the model correctly classifies a negative example as negative. In this test, the model successfully collected 1163 data from each class. One example is in class 1 which has a total of 71 data that has a TP value of 68, which means there are 3 data that fall into FN, namely data that has an actual value of positive (in class 1) but is predicted as another class or negative. Next is FP which has an actual value negative (other class) but is predicted as the class, in class 1 has 2 data from other classes that are predicted as class 1. In TN data with negative actual value or other classes other than 1 and predicted correctly according to the class is as much as 1095 which is obtained from the total overall data minus the total TP data.

TABLE V PRECISION, RECALL, F1-SCORE

Avg Precision	Avg Recall	Avg F1-Score
94.6%	94.6%	94.6%

From the calculations that have been done, the model shows good performance overall. The average precision of 94.6% indicates the model's ability to accurately predict the positive class, while the average recall of 94.6% indicates the model's ability to find all instances of the positive class. The average F1-Score value of 94.6% indicates a good balance between precision and recall.

2) UAT

UAT testing that researchers do is by distributing Google Form links to collect data from user responses. The questions on the Google Form link are about the functionality of the application that has been built.

TABLE VI UAT

P	SS x 5	S x 4	N x 3	TS x 2	SST x 1	A	%
1.	20	40	0	2	0	62/15 = 4.1	82%
2.	30	32	3	0	0	65/15 = 4.3	86%
3.	25	40	0	0	0	65/15 = 4.3	86%
4.	25	40	0	0	0	65/15 = 4.3	86%
5.	75	0	0	0	0	75/15 = 4.6	92%
6.	75	0	0	0	0	75/15 = 4.6	92%
7.	75	0	0	0	0	75/15 = 4.6	92%
8.	20	40	3	0	0	63 / 15 = 4.2	84%
9.	40	20	6	0	0	66/15 = 4.4	88%
10.	25	36	3	0	0	64/15 = 4.2	84%

In Table VI is the average result and percentage of each question, and it can be concluded that the average percentage is 87.2% which is obtained from the total percentage divided by the number of questions.

V. CONCLUSIONS

The system on the website has run well as evidenced by blackbox testing, UAT testing, testing on students, and has been validated directly by the Arabic teacher MTs Darun - Najah. The system developed by implementing CNN and EfficientNetB7 for Arabic vocabulary recognition in MTs Darun - Najah students has an accuracy of 90% with an average precision of 94.6%, an average recall of 94.6% and an average f1-score of 94.6%.

ACKNOWLEDGMENT

The authors would like to thank the Jember State Polytechnic and the supervisors who have supported this research.

REFERENCES

[1] Mailani, O., Nuraeni, I., Syakila, S. A., Lazuardi, J., & Komunikasi, P. I. (n.d.). Bahasa Sebagai Alat Komunikasi Dalam Kehidupan Manusia (Vol. 1, Issue 2). Online. www.plus62.isha.or.id/index.php/kampret.

[2] Pera Aprizal, A. (n.d.). Jurnal Pendidikan Guru. In *Jurnal Pendidikan Guru* (Vol. 2, Issue 2).

[3] Susilawaty. (2021). Prosiding Seminar Nasional Lingkungan Lahan Basah (Vol. 6).

[4] Sabaniah, S., Ramdhan, D. F., & Rohmah, S. K. (2021). Peran Guru dalam Pelaksanaan Pembelajaran Jarak Jauh di Tengah Wabah Covid - 19. *Edunesia : Jurnal Ilmiah Pendidikan*, *2*(1), 43–54. https://doi.org/10.51276/edu.v2i1.77.

[5] Jurusan, S., Sosiologi, P., Sultan, U., & Tirtayasa, A. (2019). Media Pembelajaran Dalam Proses Belajar Mengajar. 2(1), 470–477.

[6] Ratih Kusuma Ningtias. (2021). Analisis Kesulitan Belajar Maharoh Kalam Pada Mata Kuliah Bahasa Arab Mahasiswa Jurusan Pendidikan Agama Islam Institut Agama Islam Tarbiyatut Tholabah Lamongan. *Darajat: Jurnal Pendidikan Agama Islam*, *4*(1), 91–100. https://doi.org/10.58518/darajat.v4i1.1751.

[7] Urgensi Bahasa Arab; Bahasa Arab Sebagai Alat Komunikasi Agama Islam Akhiril Pane. (n.d.)..

[8] Suroiyah, E. N., & Zakiyah, D. A. (2021). Perkembangan Bahasa Arab Di Indonesia. 3. https://ejournal.iaiskjmalang.ac.id/index.php/akad/article/view/207.

[9] Mufidah, N., Izha, I., Pendidikan, R., Arab, B., Malik, U. M., & Malang, I. (2020). Pengajaran Kosa Kata Untuk Mahasiswa Kelas Intensif Bahasa Arab (*Vocabulary Teaching For Arabic Intensive Class*). In *Uniqbu Journal Of Social Sciences (UJSS)* (Vol. 1, Issue 1).

[10] Aryanto, R., Alfan Rosid, M., & Busono, S. (2023). Penerapan *Deep Learning* untuk Pengenalan Tulisan Tangan Bahasa Aksara Lota Ende dengan Menggunakan Metode *Convolutional Neural Networks*. Jurnal Informasi Dan Teknologi, 5(1), 258–264. https://doi.org/10.37034/jidt.v5i1.313.

[11] Iskandar Mulyana, D., Ainur Rofik, M., & Ohan Zoharuddin Zakaria, M. (n.d.). Klasifikasi Kendaraan pada Jalan Raya menggunakan Algoritma *Convolutional Neural Network (CNN)*.

[12] Rizki, M., Basuki, S., & Azhar, Y. (2020). Implementasi *Deep Learning* Menggunakan Arsitektur *Long Short Term Memory* Untuk Prediksi Curah Hujan Kota Malang. *REPOSITOR*, *2*(3), 331–338.

[13] Prasetyo, E., Wijaya, N. A., Armanto, H., & Zaman, L. (2020). Klasifikasi Akasara Jawa Dengan Cnn. 13(2), 2620–4770.

[14] Lusiana, Kurniasari, A. A., & Kusumawati, I. F. (2024). Enhancing Accuracy in the Detection of Pneumonia in Adult Patients: An Approach by Using Convolutional Neural Networks BT - Proceedings of the 4th International Conference on Electronics, Biomedical Engineering, and Health Informatics (T. Triwiyanto, A. Rizal, & W. Caesarendra (eds.); pp. 593–609). Springer Nature Singapore.

[15] Sholawati, M., Auliasari, K., & Ariwibisono, F. X. (2022). Pengembangan Aplikasi Pengenalan Bahasa Isyarat Abjad Sibi Menggunakan Metode *Convolutional Neural Network* (CNN). In Jurnal Mahasiswa Teknik Informatika) (Vol. 6, Issue 1).

[16] Pertiwi, T. A., Luchia, N. T., Sinta, P., Aprinastya, R., Dahlia, A., Fachrezi, I. R., & Hamzah, M. L. (2023). Perancangan Dan Implementasi Sistem Informasi Absensi Berbasis Web Menggunakan Metode Agile Software Development. *Jurnal Testing Dan Implementasi Sistem Informasi*, *1*(1), 53–66.

[17] Kurniasari, A. A., Olivia, Z., Lironika Suryana, A., Widiyawati, A., & Maria Rosiana, N. (2023). NutriTalk: Nutrition Intervention by Experts to Reduce the Impact of Stunting Through Mobile-Based Applications Using Agile Method. *Jurnal Teknokes*, *16*(3), 170–177. https://doi.org/10.35882/teknokes.v16i3.632