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Human Tracking Methods Comparison for Smart House

Method Comparison in Human Tracking for Smart House Purpose

Gustave Lyman
Program Studi Teknik Informatika, Universitas Multimedia Nusantara, Tangerang, Indonesia
Gustave.lyman@gmail.com

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***Abstract*—Smarthouse systems require some information of human locations in the system environment, different smart house system offers different human tracking method. The idea of this paper is to determine which method is better in which condition. This paper discusses amongst RFID, voice recognizer and temperature-sensor. As a result, each method have its own advantages and disadvantages.**

***Index Terms*—smart house, human tracking, voice recognition, RFID, Sensor.**

I. INTRODUCTION

There are many problems in our lives that can be solved much easier if smarthouses exists. There are many smarthouse concepts, that can be used to solve many different problems. All of the concepts show many different thoughts in problem solving. Different methods and algorithms are emerged.

Different concept has different functionality. They are many entities that the co-existence is questionable. Some project can be co-exist with another, but some project can't.

Out of those many ideas, they have one thing in common, human-tracking. The root of the problem in smarthouse concept is the human. The existence of the human, location of the human, and number of humans exist are the main problems. To track this main problems, different smarthouse concept has different human tracking method. Which one is the best? Which one is most efficcient? It will be discussed in this paper.

The focus of this paper is to compare some methods of human tracking. Voice recognizer, RFID and temperature-sensor. These three methods are most used in common, but in different way.

II. RELATED WORKS

RFID was used in Juhi-Ranjan's paper [1] about using RFID for location based activity recognition. They discuss the RFID's efficiency in human tracking. Thus we can know RFID's efficiency accurately.

Juhi-Ranjan, et al. then develop their paper about RFID into different paper about implementing RFID in a doormat.

Voice Recognizer was used in david liu's smarthouse system to assist the disabled. This method of human tracking was chosen considering the target of assistance was the disabled.

Temperature-sensor was used in David Bregman's paper about smarthome. This sensor was the most common method used in smarthome systems. Not only human, this sensor can also detect fire and smokes.

Temperature-sensor was also used in Kurdina Iulian Benta's smarthome agent. It is necessary to detect human activities.

III. METHOD

In this section we will discuss about some methods in human tracking that are used in the smarthouse concepts. We have three methods to be discussed: RFID, Voice Recognizer and temperature-sensor.

A. RFID

Radio-frequency identification (RFID[1]) is the wireless non-contact use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. In this context, we used RFID to identify human-existence in some rooms/places.

RFID is commonly used as an identifier. Mostly used in cards such as ID cards, fund cards, Passports, etc. RFID was applied because it's small in size, simplicity, and accuracy. Unlike the bar code, RFID doesn't need to be within line of sight of the reader. And RFIDs can be embedded in the tracked object.

The idea of using RFID to track human-existence is to embed the RFID to an object that humans commonly bring, and to embed the RF-scanner to the part of the room that will be passed (such as door).

B. Voice Recognition

Voice recognition[9] is the process of taking spoken words as an input to a computer device's program. In computer science and Electrical Engineering, this process is related to speech recognition, translating spoken word into text. Using voice recognition, humans can give input to the computer other than the usual input devices (eg.: mouse, kyeboard). Voice that spoken is translated into specific command that can do specific function/job.

The idea to use voice recognition in the smarthouse system is to make the user easier to control the system. The user don't have to input the command through keyboard and mouses, just speak the command and the system will do it. Especially for the disabled, this feature would help them so much.

As it ability to detect the presence of human from the voices, we can say that the voice recognizer can also detect the presence of living object from sound. The existence of the sound itself indicates the presence of someone in the room.

C. Temperature-Sensor

Temperature-sensor[4] is a sensor that can detect heat difference between objects. It can distinguish between living object and non-living object from body temperature. Thermal differences indicates the presence of living objects in the room.

Body thermal is uneasy to be manipulated, the temperature-sensor most likely could see the thermal differences, making it a reliable sensor to detect the presence of someone. Unlike regular eye-sight visual, temperature-sensor is independent to the light. There is no differences between detecting someone at somewhere bright and detecting someone at darkplace.

The idea using temperature-sensor is to detect the presence of someone, from the body thermal to lead the system for making decision. The temperature sensor can be placed room-per-room so they can detect whether the room was occupied or not, and which rooms are occupied.

IV. METHODS ANALYSIS AND COMPARISON

In this section we are going to discuss each method's advantages and weaknesses. It is necessary to understand what each method can do, so we can decide whether that method is compatible with our system or not. We would like to see which method has more advantages and which method has fewer advantages, and the reason why this method was used within these advantages.

A. RFID

As a human tracking method, RFID is reliable enough because it has many advantages. Those advantages are:

Size	Small and easy to be embedded to objects.
Accuracy	Can distinguish between people through IDs
Power	Easy to power, can be powered by batteries.
Data	Have detailed record when is the RFID scanned.
Tracking	Easy to track

RFID is small and easy to be embedded to objects, making it very portable. The ID stored in the RFID could be used as a method to distinguish people. This RFID's ability is very reliable and accurate assuming the ID was not exchanged. RFIDs even could have detailed information about time when the ID was scanned.

Having this many advantages, RFID also have some disadvantages that can mislead RFID to wrong information and history logs. Those disadvantages are:

- Need some time to be scanned(about 1-3s).
- Need two entities to operate (RFID and scanner)
- Need more RFID for more peoples.
- Can't detect intruder who doesn't have any RFIDs

These disadvantages make developers think twice when they want to use RFIDs. Especially when RFID can't detect intruder who doesn't bring any RFIDs. Everyone should be registered before the system ran. The system should register again if there is another people came in, and RFID cannot be embedded with such short time. Thus, these RFID considered cannot be used in small houses. But, this RFID should be worked well in big company that have many people and workers registered.

The first weakness, solved in Juhi-Ranjan et al.'s research. They embed the RFID scanner into a doormat and the ID was embedded into an indoor sandals. As people walk through the doormat, the RFID was scanned. Their research solved this problem with approximately 98% accuracy out of 580 doorways through 11 different doors.

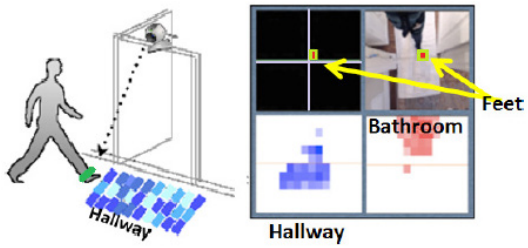

Figure 1. Juhi-Ranjan et al.'s RFID doormat System

B. Voice Recognizer

Voice recognizer has a feature that other method doesn't have, sound oriented. This feature as identity of this method give this method much advantages and disadvantages simultaneously. Much advantages that the voice recognizer can do, but at the same time, that advantages can become disadvantages if not used and handled correctly.

The advantages of voice recognizer are:

Size	Doesn't need other input devices. (Very small)
Accuracy	Could distinguish people with their voice frequency (Need more complicated system)
Power	Easy to power, embedded with the system.
Data	Have detailed record when is the voice recognized (Not always accurate)
Tracking	Could track peoples using voice inputted
Easiness	Commands can be operated immediately if needed (On Emergency)

Having that many advantages could be a reason to use voice recognizer as the input for human tracking device. But this many advantages could be disadvantageous if doesn't handled correctly. The disadvantages will be:

- High error rate in speech recognition
- Need a silent room to operate accurately.
- Often misrecognized other sound as human.
- Difficult to be implemented.

Voice recognizer are hard to implement, and having error rate making the voice recognizer hard to be handled correctly. These factors are the main problem to the system developer to consider whether they implement voice recognizer or not.

C. Temperature-Sensor

Temperature-Sensor is one of the old ways to detect presence of living objects. Using body temperature as main parameter, it can bring many advantages and some disadvantages.

The advantages of temperature-sensor are:

Size	Small, the size is same with webcam
Accuracy	High accuracy of detecting presence of living object (Not easy to be manipulated, but could not distinguish between people)
Power	Powered by the system.
Data	Have thermal-vision video record
Functionality	Could be used as fire-detector (extreme heat detection).

Implementing temperature-sensor to make sure about existence is one good idea. But having this high accuracy, this method also have some disadvantages. Those disadvantages are:

- Not easy to implement.
- Cannot distinguish between humans and other living-object.
- Hard to determine how much living-object exist in one room, especially if the objects are near one to another.
- Cannot detect presence in room with higher temperature than human body.

Disadvantages above make the temperature-sensor's data hard to be processed. Cannot determine how much existence in one room often mislead the system to give wrong information. This factor make the temperature-sensor almost useless to be implemented in a room that consist of many people such as classrooms, canteen, etc. But in a way it could be the best option to prevent intruder remembering its ability to detect presence is near-absolute.

V. CONCLUSION

Neither one of them is perfect to detect the presence of someone in a room. Each method have its own advantages and disadvantages. Some method are compatible one with another, but some other not. Considering those advantages on each method leading the way for the smarthouse system developer to decide which method(s) is/are better.

RFID has high accuracy and detailed history in detecting presence, but can be easily manipulated and disguised. Worst at security sensor, but very reliable in detecting presence and distinguish people with the IDs.

Voice recognizer are hard to handle, and often mislead system to wrong input. But it is very helping because can do other commands immediately especially for the disabled one. Consider that if we could handle it correctly, it has great potensial.

Temperature-Sensor is very reliable at detecting presence of living objects, but unreliable if the place is too crowded, because it cannot count how many living objects exist in one room. But this method is one of the best method to prevent intruder come in for security purpose.

Combination of methods above would lead the human-tracking system into a perfection. For example, if RFID combined with temperature-sensor, it can track how many people exist in one room, and it can track presence of someone in empty room. But the implementation may be more complicated and harder to develop.

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