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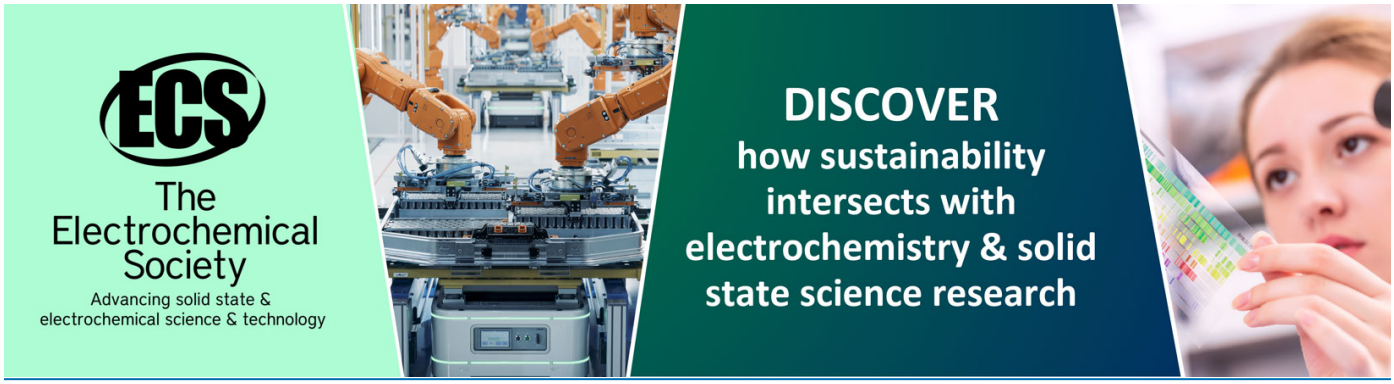

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Detection object application at mirror for smart home with fuzzy logic method using Raspberry PI Microcontroller

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Abstract.During this time, the mirror is used to view objects that are not visible to the eye, but can be used as a supporting tool in providing information, which is to detect the distance of objects that are around it. By using Raspberry PI Mini PC which is equipped with Raspberry Pi camera module, speaker and ping sensor. In displaying information the application is designed using python, PHP, css that runs on a single board operating system, the output is a display of a camera or PHP display. Therefore, the mirror can have different functions by applying the Fuzzy Logic method as a decision making process on the micro. This algorithm is used to translate a quantity expressed using linguistic language. In the application of intelligent systems on smart mirrors, there are three fuzzy logic processes, namely fuzzification, evaluation of rules and defuzzification. From each of these processes will affect the response of the system that is controlled. But there is a shortage, in the ping sensor delay process with Raspberry pi cameras because the ultrasonic wave reflection process is rather slow.

1. Introduction

The Smarthome system is more focused and prioritizes control of system equipment compared to controlling the needs of routine and family planning [1]. One of the main goals of Smarthome is to facilitate the life of household use by utilizing communication and automation technology to create a smart environment [2]. Automation at home can be built at a low cost utilizing a single board Raspbery Pi computer [3]. Raspberry Pi is used as a control board between connected home appliances [4]. The system is built using humidity sensors, proximity sensors and cameras and utilizes Wi-Fi as a communication medium between the tools used. The system built is open source, low cost, and easy to use by lay users [3]. The system runs on Raspbery Pi OS, taking pictures using OpenCV using python programming. Ultrasonic sensor (ping) can recognize objects at varying distances using ARTMAP's fuzzy neural network classification system [5]. Low-cost control and monitoring systems for smart home can be built by utilizing Raspberry Pi and Arduino microcontrollers through sensors in interconnected networks [6].

Along with the development of technology, many things can be developed from technology such as the application of a smarthome in a mirror. Where the mirror is used to see objects that are not visible to the eye, but can be used as a supporting tool in providing information, which is detecting the distance of objects that are around it. One image processing is to detect objects (object recognition) in recognizing

objects to be processed further in order to get an information [7]. Fuzzy algorithm is used for automatic control of lights on a smart home. The system uses the principle of continuous learning, so the system can run on its own without the need for data training and user intervention [8]. From the comparison of the three logic fuzzy logic Mamdani, Sugeno and Tsukamoto, that Mamdani is more precise and accurate in the case of predicting the number of new student registrants, because it has a smaller error rate [9]. So in this study in designing applications that are able to detect objects through mirrors on homesmart using Fuzzy Logic Mamdani.

2. Research Methodology

2.1. Analysis

Algorithms on intelligent systems use the Fuzzy Logic Mamdani method. The basics of fuzzy theory discuss the basic concepts of fuzzy association. Which includes discussion of fuzzy sets. Logic operations on fuzzy and laws on fuzzy sets. In the Crisp set theory a variable has only two possibilities, being a member of a set. In this set of crisp theories has boundaries between members and non-members [10]. The distance to activate the sensor is 1.5 meters. If the user is away from the sensor as far as 1.6 meters, then the member exceeds the maximum. Whereas if the user approaches the sensor with a distance of 0.7 meters then it is minimal. In this case the set of crips only has 2 possibilities that occur that the user approaches or moves away from the sensor. So if the distance is only 1.39 meters then it is not included in the maximum. In the fuzzy set there are differences with the set of crips. The fuzzy set can have several possibilities not just 2 possibilities as in the classic set.

For the fuzzy set distinguishes the maximum and minimum distance by using the membership value, that is from the membership value 0 to 1. The value or degree of membership can be expressed as a membership function. The set of fuzzy logic uses 3 parameters to form membership in the set [10]. The parameters used to form the fuzzy logic set are:

a. Variable linguistic
   Variables used in fuzzy logic to replace quantitative variables used in crips logic. Linguistic variables have values expressed by words, for example values in the form of lingsuistic values such as: Maximum (Max), Medium (Med), Minimum (Min), High (T), Medium (M), Short (P).
b. Membership degree
   Membership degrees are the values found in the linguistic variables that are mapped to the interval [0,1]. This mapping value is referred to as membership value or membership degree.
c. Membership function
   Mapping relationships on linguistic values and membership values (from 0 to 1) this function is referred to as the membership function in the fuzzy set.

2.2. Design of a Fuzzy Logic Control system

Fuzzy logic control has four main parts in making the basic structure of fuzzy control systems, namely: Fuzzification, Knowledge Base and Inference and defuzzication [10] [11].

a. Fuzzification

In this intelligent system there are two input inputs that will be fuzzified to the fuzzy set and become fuzzy membership functions. Fuzzification from input inputs issued by the distance sensor circuit which selected 3 linguistic pieces for the proximity sensor output are minimum distance (MIN), Center, maximum (MAX). Minimum = 40 cm - 70 cm; Center = 70 cm - 100 cm; Maximum> = 100 cm.

b. Knowledge Base

For automatic screen activation systems, several rules are most likely to occur on the screen to be controlled. In making this rule or statement, it actually does not have a limit in the number, the more rules that are made the more precise and detailed the work tools that are designed.

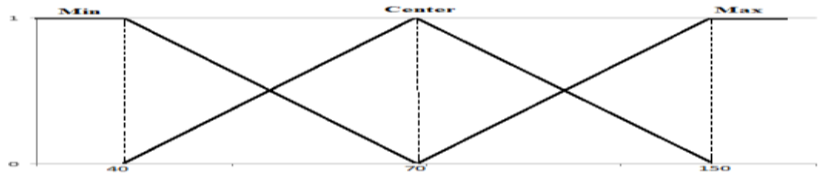

Figure 1. Membership function distance

$$\mu \min(jarak) = \begin{cases} \frac{70-min}{70}, 0 \leq \text{jarak} \leq 70 & , 40 \leq \text{jarak} \leq \\ 0 \end{cases}$$

$$\mu\, center(jarak) = \begin{cases} \frac{j}{} & , 70 \leq \text{jarak} \leq 150 \\ \frac{7}{} & , 70 \leq \text{jarak} \leq 150 \end{cases}$$

$$\mu \max(jarak) = \begin{cases} \frac{jarak - 70}{40} \end{cases}$$

c. Mamdani Method Inference

The stage of the next Fuzzy calculation process is the stage of reasoning (inference). This process serves to find a Fuzzy output value from Fuzzy input. The process is as follows: a value of Fuzzy input derived from the fuzzification process is then entered into a rule that has been made to be used as a Fuzzy output. In the reasoning process there are three things that will be done, namely: applying Fuzzy operators (aggregation), applying the implication method, and the composition of all outputs. The method that will be used in doing this Fuzzy system inference is MAX - MIN or commonly called MAMDANI.

d. Defuzzication

In this process there is a graph of membership functions to determine the limits of the desired fuzzy output. Fuzzy rules can be from the previous data which consists of 3 rules, namely: IF melee then the camera responds to display images; IF distance center then alpha camera is half and; IF remotely then alpha camera 0 and provides information.

2.3. Process Analysis

The process of web server and smart mirror is: (1) at the initial stage the user enters the localhost address; (2) there is a branching statement: whether the address is cached (temporary storage that contains the previous request); (3) If so, it will be directly linked to the web server; (4) If not, root DNS will be sought; (5) If the address is in the root DNS, it will connect to the web server; (6) However, if there is no such thing as a client, only the web information; (7) after connecting with the web server, the client will get a web display page; (8) If the user chooses exit, then the web display will be closed. And for the process of how the mirror works are: (1) when the user enters the bwoser the user enters the webserver; (2) after entering the web server, the PHP script will be scripped; (3) PHP script that is run requires internet data to access RSS news from the news website; (4) the final result will appear on the LCD as an interface. Can be described with a flowchart as in Figure 2.and Figure 3.

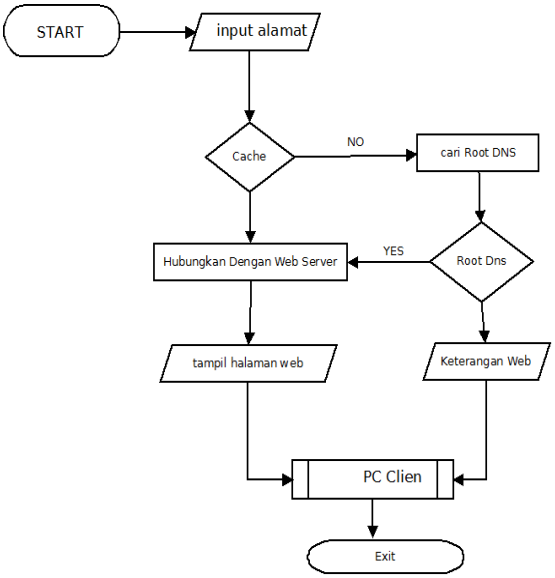

Figure2. Flowchart web Server [15]

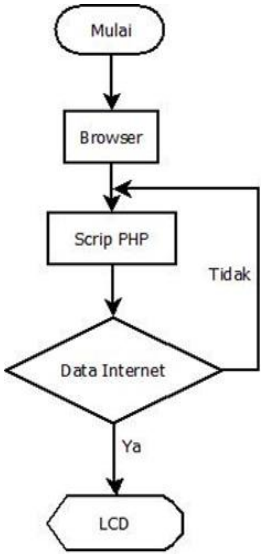

Figure 3. Flowchart interface.

2.4. Diagram

The designed application is modeled using use case diagrams and activity diagrams. In usecase diagram, it starts when the mirror is on and the user is in front of it. When the user is in front of the mirror, the sensor detects the user and the LCD provides information. In the activity diagram, it is explained that (1) Initial Node, as an object that begins; (2) Action states of systems that reflect the execution of an action including: process, object detection, output appear; (3) 1 Decision Node, which functions to determine the decisions taken. In this case, when the ping sensor detects an object it will be displayed to the LCD / mirror and vice versa; (4) 1 Final State, as the object to be terminated. like pictures 4 and 5 below.

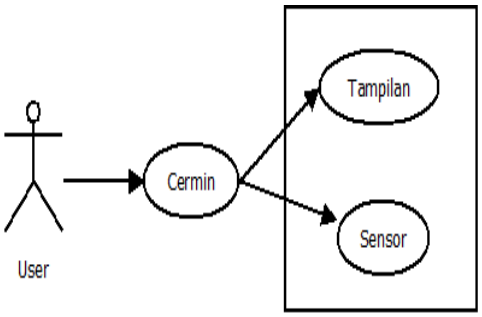

Figure 4. Use Case Diagram**.**

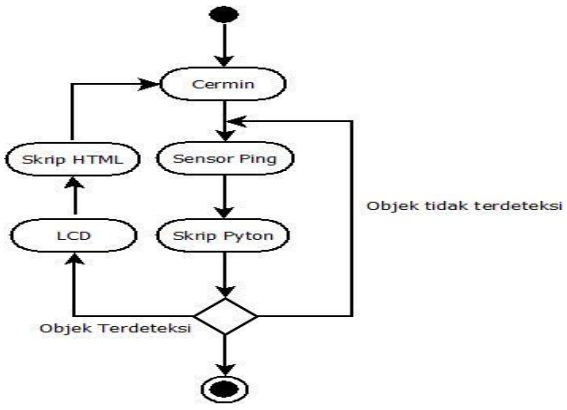

Figure 5. Activity Diagram

Application design is made using python language [13] [14], PHP, css running on a single board operating system. This application includes the detection of object distance from the ping sensor, the processing of data from the ping sensor is processed by fuzzy logic method, the output in the form of a camera or in the form of php display.

2.5. Architecture

The workings of the Cemin work system architecture are: The system architecture above is divided into 4 parts, namely 21 "LCD, Raspberry Pi3 [16], ping (ultra sonic) sensor [17], Power Supply. Broadly

speaking, this system uses a mini computer as an integration andcontinuity of this system. This mini computer uses the Debian OS to operate it. And the use of the camera module to display images. This system uses webserver as display using PHP (Hypertext Preprocessor) to display time and news taken from RSS Feed seconds.

The ping sensor used is the HC-SR04 ping sensor presented in Figure 6, with the function of shooting ultrasonic waves towards an area or a target, the target will re-establish the shock wave and will be captured by the sensor, then the sensor will calculate the gap between the wave delivery time and time reflected waves are received [17]. While the way it works is: (1) The signal is transmitted by an ultrasonic transmitter with a certain frequency and with a certain duration of time. The signal has a frequency above 20 kHZ. To measure the distance of objects, the commonly used frequency is 40 Khz; (2) The transmitted signal will propagate as a sound wave with a speed of about 340m / s. when pounding an object, the signal will be reflected by the object; (3) After the reflection wave reaches the receiver, the signal will be processed to calculate the distance of the object. The distance of the object is calculated according to the formula: S = 340.t / 2, where: 340 m / s = the speed of sound, s = distance, and t = time.

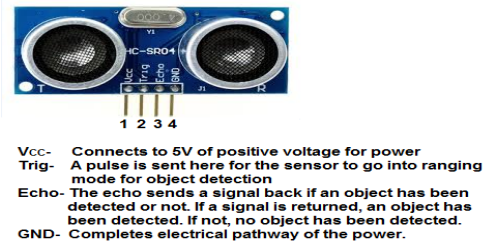

Figure6.HC-SR04 Ping Censor[17]

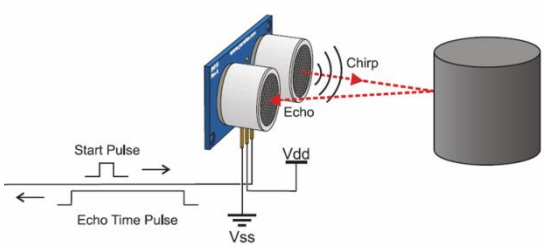

Figure7. Ping Censor Performance [17]

If the ping sensor is active (stand by), ping sensors emit ultrasonic waves. When the sensor captures the object at a distance of ≤ 70cm and ≥ 40cm the sensor will activate the camera so that the user can mirror, if it is within 70-150cm then the mirror will display half mirror and the news in the mirror, when it is outside the distance 150 then the mirror is dark / sleep. As shown in fig.8 below:

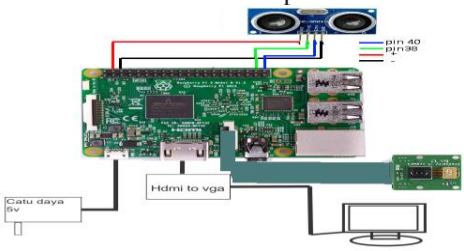

Figure 8. Work System Architecture on the mirror

3. Implementation

The appearance of the application is shown in fig.9 below:

Figure9. Application Appearance

To run the designed application, several supporting factors are needed, namely; (1) Hardware (hardware) used to build applications, with specifications: Raspberry PI 3 Model 1.2GHz 64-bit BA quad-core ARMv8 CPU, 16gb Memory card, Monitor Screen, Mirror Case, Mifi M2S Router, Ping Sensor HC -SR401 [17] is presented in fig.9, the Raspberry Pi v1.3 camera module and Speaker; (2) Software needed is: Debian Linux Operating System [12], Web Server [15], Midori and Python Web Browser

3.1. Sensor Testing

Testing the motion sensor using distance, the test is done with a mirror height of 1 meter from the floor.

1. The first test is carried out at a distance of 1.5 meters, the camera stops and displays information, show at fig. 10.
2. Testing 2 using a distance of 0.8 meters is a medium distance so the camera responds with alpha 170, show at fig. 11.
3. Testing at a distance of 0.5 meter alpha camera full with display, show at fig. 12

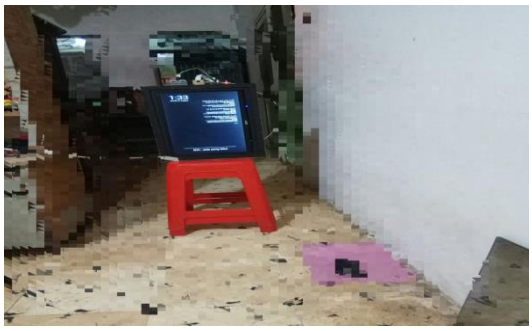

Figure 10. Testing of 1.5 meters.

Figure 11. Testing 0.8 meters

Figure 12.testing at a distance of <0.5 meters.

The closer the distance between the object and the camera, the camera will function better in detecting objects. But if the distance of the camera to the object is farther away> = 1.32r meters, the camera cannot detect objects, only displays information in the form of news that is connected with the active internet, automatic date and time and news messages that are adjusted to the current clock conditions, such as: clock 2:00 p.m. to 5:00 p.m., news message "Time is empty", like the display in Figure 7 application display. Fuzzy logic algorithms affect the level of clarity of objects detected.

4. Conclusion

From several application tests, the conclusions obtained are smart mirrors utilizing intelligent systems using proximity sensors to detect objects. Delay of the ping sensor process with the camera still has drawbacks because the ultrasonic wave reflection process is rather slow. Suggestions that can be implemented for the development of smart mirrors are better to use other methods besides fuzzy logic

methods and to combine several other methods to get more specific detection results. Addition of sound sensors, Pir sensors, relay modules for controlling lights or other home appliances. Add a touch screen to interact.

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