The Design of Application for Smart Home Base on LoRa

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***Abstract*— Applicated of LoRa technology itself will not separated from an interface who created to connect between humans and computers in this case a smart home device was made. This study aims to design a GUI interface for LoRa-based smart home and implement a smart home system using applications that can control LoRa-based household electronic devices. The results of this study are devices for applying LoRa-based smart homes and web-based applications as interfaces so that users can use smart home devices. LoRa Dragino is used as a client and server communication tool and the NodeMCU (ESP8266 Module) is used as a liaison between the server and the user through the GUI interface created. This web-based application is compatible with Android 6.0, 7.1.2, 9.0, 10.0, and iOS 9.3.5, and various browsers such as Internet Explorer, Mozilla Firefox, and Google Chrome. The test results of the interface design are made with a 10 times test of each feature that produces 0% error, which means that the features contained in the interface design are made to work according to plan. The average delay when controlling a household electronic device is 3.86 seconds. The furthest communication distance between the LoRa Server and the LoRa Client is 63 meters in blocked space and 183 meters in semi open space.**

Keywords— Client, Interface, LoRa, Server, Smart Home.

I. INTRODUCTION

Current technology has penetrated into human life, such as the development of smart home applications that can provide comfort, safety and efficiency for users. The comfort of a residence needs to be supported by a systematic security system that can be monitored remotely [1]. Remote control is a control that is needed considering the efficiency obtained from remote control. Control will be carried out automatically in accordance with the control exercised by the user [2].

The automation system is based on context aware which can receive data from the monitoring results of the home environment [3]. The implementation of monitoring is always based on periodic control and recording of all activities on the system continuously, with the aim that if something undesirable happens, the controller can handle it as soon as possible [4].

The development of remote controllers for smart homes has been widely carried out by researchers in various countries, but the limited cost and power required for smart homes is quite large and is a major problem in the development of this smart home. In 2012 it was acquired and introduced by Semtech IoT technology with LoRa or Long Range modulation with its characteristic low power or low power and a longer distance from WiFi technology [5].

LoRa, which means "Long Range" is one of the LPWAN (low-power wide-area network) communication systems that has long-distance transmission capabilities, supported by the development of IBM, Semtech, Actility, etc., which are members of the LoRa Alliance [6]. Even so, it won't be a problem as long as the data sent is small. Such applications are suitable for various sensors [7]. Platforms with long reach modules such as LoRa are rarely developed and published [8].

The application of LoRa technology itself will not be separated from an interface that is made to connect humans to computers, in this case the smart home device that is made. Human and computer interaction is a discipline that studies communication or interaction between users and the system. The main role of human and computer interaction is to produce a system that is easy to use, safe, effective and efficient [9]. The bridge between human and computer interaction is an interface. The interface itself is divided into two, namely the Command Line Interface (CLI) and the Graphical User Interface (GUI). CLI is a type of interface where the user interacts with the operating system via a text-terminal.

GUI is a type of interface used by users to interact with the operating system through graphics, icons, menus, and using pointing devices [10]. To connect LoRa-based smart home devices with users, this research will create a Design Interface Application For LoRa-Based Smart Home so that smart home devices can be used by users using smartphones or laptops.

II. DESIGN AND WORKFLOW

This study describes the process of designing a LoRa-based smart home system interface application by describing the parts of the system design, work principle flow, and circuit simulation design used in the interface application for LoRa-based monitoring systems and electronic device control. The design of the system interface application includes the types of hardware used by the smart home system, while the system work principle flow describes the application interface so that these parameters can display the results in a web-based application.

A. LoRa Based Smart Home System Design

The system design is done to sketch an interface application for a LoRa-based smart home, which consists of an integrated client device and server device. The system design designed is a GUI interface application design for LoRa-based smart homes, the following is a display of the LoRa-based smart home system design shown in Figure 1.

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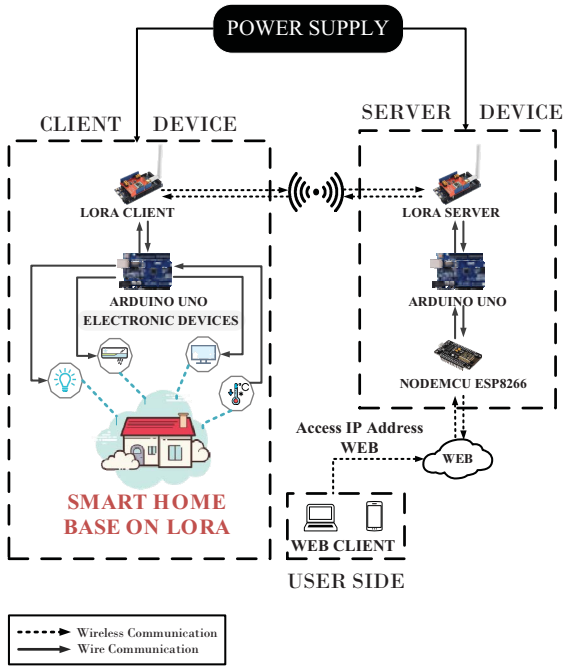

Fig. 1 LoRa Based Smart Home System Diagram

Based on the smart home system design diagram shown in Figure 1 in this study, the smart home system uses a voltage of 5V to meet the performance of the device so that it can work properly and in accordance with its function. The system that has been designed in this study is divided into two parts of system performance, namely, client device and server device.

The client device consists of an Arduino UNO Atmega328 which functions as a microcontroller to receive signals in the form of information on the condition of electronic lights, air conditioners and TVs through user instructions, and sends information on room temperature conditions via the LoRa Client to be sent to LoRa Server which is connected to a web server. via NodeMCU ESP8266.

The server device in this smart home system functions as a data transfer from the client device which contains a room temperature data signal message and is connected via a web server. Inside the server device consists of LoRa Server, NodeMCU ESP8266 and Web Server. A message containing an information signal for room temperature conditions sent by the Arduino UNO Atmega328 via the LoRa Client will be received by the LoRa Server. Then it will be forwarded to the web server and stored in the ESP8266 NodeMCU database. The stored data is then displayed on a web page to be accessed by various devices via a web browser which will later be displayed on a multiplatform so that it can be accessed by users using a smartphone or laptop.

B. Working Principles of LoRa-Based Smart Home System Application Design

The working principle of the LoRa-based smart home system interface application design explains the flowchart flow stages performed by the user in the process of controlling electronic devices and monitoring room temperature. The following is a flowchart of the working principles of the LoRa-based smart home system application design shown in Figure 2.

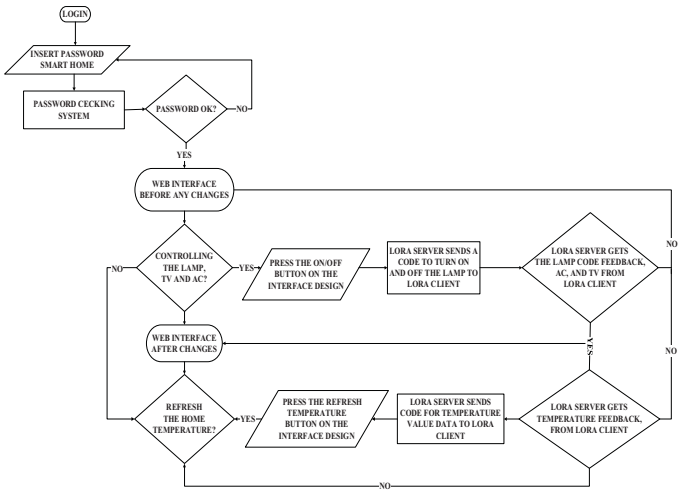

Fig. 2 Flow Chart of Smart Home Working Principles

Based on the flowchart flow in Figure 2, the first stage the user will perform a login system by entering a predetermined password. If the login system is successful by entering a password that matches the predetermined password, the user will enter the main page of the application interface and if the login system is unsuccessful by entering a password that does not match the specified password, the user will remain on the login system page until user has successfully entered the password correctly.

The main page of the application interface displays buttons for controlling electronic devices and monitoring room temperature, each button has a different function. These buttons function to turn on or turn off electronic devices and function to refresh room temperature in real-time. The button consists of buttons to control electronic devices for living room lights, living room lights, living room TV, living room air conditioning and refreshing room temperature data.

C. Designing LoRa-based Smart Home System Interface Applications

The design of a web-based interface application aims to facilitate communication between the user and the system in controlling electronic devices and monitoring room temperature by accessing a web browser page via a smartphone or laptop. The design of this interface application has a step-by-step flow scheme in the process of controlling electronic devices and monitoring room temperature which functions as a user modeling system. The following is a display of the flow of the LoRa-based smart home system interface application scheme shown in Figure 3

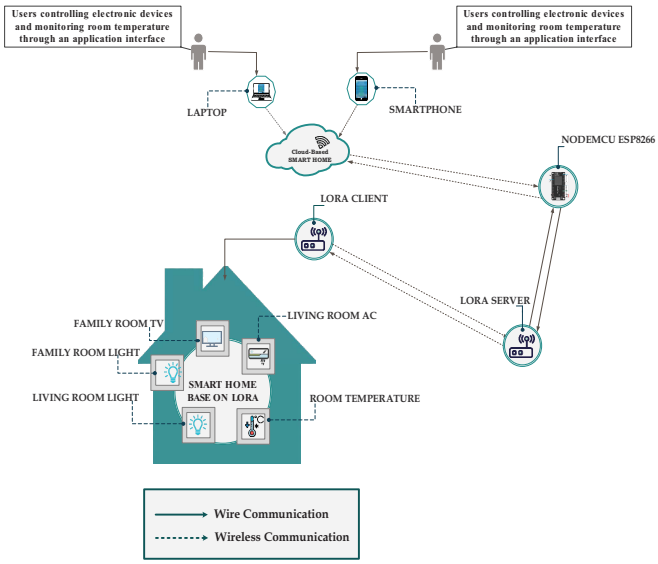

Fig. 3 The Flow Of The Smart Home System Interface Application Scheme.

Based on the schematic flow above shown in Figure 4.6, it explains the stages of a user in carrying out the process of controlling electronic devices and monitoring room temperature through an interface application on a LoRa-based smart home system. Information data on the condition of electronic devices and room temperature will be stored in NodeMCU ESP8266 which functions as a temporary data storage memory which will later be uploaded on a web server page. The following is a view of the interface application design design on a LoRa-based smart home system as shown in Figure 4.

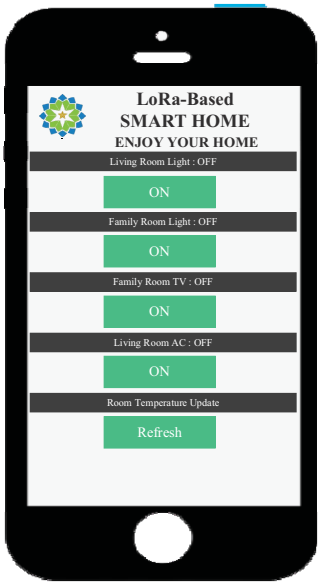

Fig. 4 The Flow of The Smart Home System Interface Application Scheme

Based on Figure 4 is a design view of the interface application design made for LoRa-based smart home systems. The design of the interface application design includes the words "LoRa Based Smart Home" and "Enjoy Your Home", then there is an ON/OFF instruction button feature for electronic device buttons for living room lights, living room lights, living room TV and living room air conditioning. And there is a refresh instruction button to update real-time temperature data.

III. TESTING AND ANALYSIS

In this study, 4 aspects were tested, namely testing the smart home system interface application, testing the delay of the smart home system, testing the functions of the smart home system interface application, and testing the satisfaction assessment of the smart home interface application using the MOS method. 5 data parameters are carried out by the sending process to monitor temperature and control electronic devices. The data sent and received serves to instruct each system to carry out the data execution process.

A. Smart Home Interface Application

The first is a test to enter the LoRa-based smart home system website page by entering a user password that has been previously set or has been previously registered.

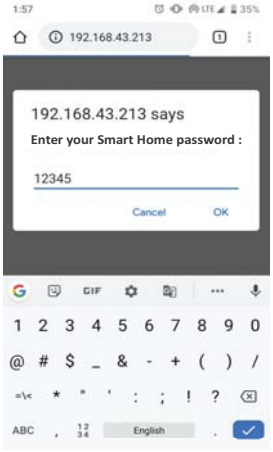

Fig. 5 Smart Home Login System

First, the user opens a web browser page, then the user accesses the website address for the LoRa-based smart home system application. Then the user will enter the first page of the login system. After the user enters the password, the user will enter the main page of the LoRa-based smart home system.

Fig. 6 The Main Page of The Lora-Based Smart Home System

Furthermore, if when the user enters the wrong password, the system will continue to display the first page of the login system until the user enters the correct password. From here it can be analyzed that the login system that is according to plan because when the user correctly the password, the system will continue to the main page and if the password is entered incorrectly, the system will display the first page of the system login until the user enters the correct password.

B. *Delay System Smart Home*

Delay testing is needed to see the delay required by a LoRa-based smart home system when sending data from the GUI interface application design on a smartphone to home electronic devices and temperature detection in the room of the house. After testing, it can be how much delay is needed for this LoRa-based smart home system when sending data from the GUI interface application design on the smartphone to electronic devices and temperature detectors in the room of the house.

The results of the overall test scenario for the LoRa-based smart home system carried out with a total of 10 tests using the Xiaomi Redmi Note 8 smartphone and the Google Chrome web browser at a distance of 10 meters.

TABLE I. CLIENT DEVICE AND SERVER DEVICE COMMUNICATION

Test	***Result***	***Planing Delay (s)***	***Trial Delay (s)***
Login	appropiate	2.5	4.3
Press ON LED Guest Room	appropiate	3	3.99
Press ON LED Living Room	appropiate	3	3.80
Press ON TV	appropiate	3	3.91
Press ON AC	appropiate	3	3.74
Press Temperature	appropiate	2.5	3.42
Press OFF LED Guest Room	appropiate	3	3.86
Press OFF LED Living Room	appropiate	3	3.97
Press OFF TV	appropiate	3	3.84
Press OFF AC	appropiate	3	3.84
Average		**2.93**	**3.86**

From the test data above, it can be analyzed that the overall smart home system functions according to the design, with an average delay of 3.86 seconds and the longest delay is when it first enters the web server page, this is because the web browser needs to first read the HTML code, CSS and Javascript on the web server page.

There is a delay difference between the delay designed in the LoRa-based smart home source code and the original delay when testing, this is due to the need for a web browser application process to read the source code that has been created in the design when accessing the web server page to carry out instructions on the smart system. home based LoRa created.

C. *The Functions of The Smart Home Application Interface*

The mechanism for testing and analyzing the features on the website is to use the features available on the website, namely the webserver login system to check whether the user knows the password so that they can enter the main web server page, a button to turn on and off the living room lights, a button for turn on and turn off the living room lights, a button to turn on and turn off the living room TV, a button to turn on and off the living room air conditioner, and finally a button to refresh the house temperature. The test results of these features are that every web browser that is compatible with a web-based application can use all the existing features.

TABLE II. TESTING THE FEATURES OF THE WEBSITE INTERFACE APPLICATION

Fitur Tested	***Result***	***Erorr (%)***
Button ON LED Guest Room	functioning	0
Button OFF LED Guest Room	functioning	0
Button ON LED Living Room	functioning	0
Button OFF LED Living Room	functioning	0
Button ON TV	functioning	0
Button OFF TV	functioning	0
Button ON AC	functioning	0
Button OFF AC	functioning	0
Button Refresh Temperature	functioning	0

It can be analyzed that all the features contained in the website interface application can function according to their function with all 0% errors. The order in which the features appear on the website is the same as the loop on the webserver. The sequence of loops on the server is as follows:

1. Login System (for first-time access)
2. Application title
3. Writing description of living room lights On or Off
4. Button to turn on and turn off the living room lights
5. Writing Description living room lights On or Off
6. Button to turn on and turn off the living room lights
7. Writing Description Living room TV On or Off
8. Button to turn on and turn off the living room TV
9. Writing Description Living room air conditioner On or Off
10. Button to turn on and off the living room air conditioner
11. Button to refresh the house temperature
12. Write a description of the house temperature

The display order is always like that, never changes, and is displayed sequentially according to design and implementation.

D. Satisfaction Assessment of The Smart Home Interface Application uses The MOS Method

The testing phase for implementing the MOS (mean opinion score) method was carried out by several respondents or users who would use the system. System testing with the MOS method is carried out which aims to determine the quality of the system from the user's side. Testing this method uses a questionnaire which has several questions that will be answered by the respondent. The purpose of this test is to determine the quality of the system that has been made.

This test was carried out by several respondents who came from students and female students from the electrical engineering department as many as 50 respondents, by explaining the system to students. Then this test explains to the respondent by providing the opportunity to see a snapshot of the system performance process that is made to provide an assessment of the system through filling out a questionnaire.

TABLE III. MEAN OPINION SCORE (MOS)

MOS	*Information*	*Value*	*Group*
SS	Strongly Agree	5	Very Good
S	Agree	4	Well
KS	Disagree Less	3	Enough
TS	Disagree	2	Bad
STS	Strongly Disagree	1	Poor

Based on these answers, the MOS (Mean Opinion Score) calculation was carried out from all the answers given by the respondents. The Mean Opinion Score can be calculated by the equation below.

$$mean\ pi = \frac{\sum pi}{n} \quad [1]$$

The $mean\ pi$ equation is used to calculate the total average score of answers given by respondents to each question attribute, while the MOS equation is used to find the mean opinion score or to find the total average score given by respondents on all question attributes.

$$\text{MOS} = \frac{\sum_{i=1}^{k} mean\ pi}{k} \quad [2]$$

The results of tests carried out by students of electrical engineering, the MOS value will be obtained with the following correlation.

TABLE IV. MOS VALUE

MOS	*Satisfaction*
4.3 – 4.4	Very Good
4.0 – 4.29	Well
3.6 – 3.9	Enough
3.1 – 3.59	Bad
2.6 – 3.09	Poor

Based on the results of MOS testing conducted by 50 students and female students, respondents have provided an assessment of each question. Details of the assessment up to MOS can be in Table V. Tests conducted on students and female students with MOS = 4.18 show that the interface application has been running well according to the results of the respondents' answers (MOS test results ⩾4.00).

TABLE V. MOS TEST RESULT

Question	*SS (5)*	*S (4)*	*KS (3)*	*TS (2)*	*STS (1)*	*Mean*
Question 1	17	28	5	0	0	4.24
Question 2	24	22	4	0	0	4.4
Question 3	15	26	9	0	0	4.12
Question 4	12	29	9	0	0	4.06
Question 5	13	28	9	0	0	4.08
Question 6	11	31	8	0	0	4.06
Question 7	20	25	5	0	0	4.3
MOS						4.18

IV. CONCLUSION

The conclusion from the research "Design Interface Application for LoRa-Based Smart Home" which has been done starting from data collection, software design, testing and analysis, it can be concluded that:

1. The web-based smart home interface application displays features that can monitor the room temperature of the house and control the state of the electronic device lighting, TV and AC to carry out instructions from the user ON / OFF.
2. The LoRa-based smart home system can be applied with an average delay when controlling household electronic devices is 3.86 seconds. The furthest distance from communication between LoRa Client and LoRa Server is 183 meters in semi-open space and 63 meters in unobstructed space.

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