

SMART HOME DESIGN FOR ELECTRONIC EQUIPMENT CONTROL BASED ON INTERNET OF THINGS (IoT)

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Abstract: The advancement of technology, particularly the Internet of Things (IoT), has led to the emergence of smart home concepts that enhance comfort, efficiency, and security for residents. This study aims to design and develop an IoT-based smart home system capable of controlling household electronic devices such as lights, fans, and water pumps via a smartphone. The system employs an ESP32 microcontroller connected to a relay module as the device controller, and the Blynk application as the user interface, enabling remote control through an internet connection. The research methodology includes data collection, needs analysis, hardware and software design, implementation, and system testing. The test results indicate that all devices function properly, respond to commands in real-time, and maintain high stability when connected to the internet. This study serves as a reference for the development of simple, effective, and applicable smart home technology for daily use.

Keywords: blynk; ESP32; internet of things (IoT); smart home; remote control.

Abstract: Perkembangan teknologi, khususnya Internet of Things (IoT), mendorong lahirnya konsep smart home yang mampu meningkatkan kenyamanan, efisiensi, dan keamanan penghuni rumah. Penelitian ini bertujuan untuk merancang dan membangun sistem smart home berbasis IoT yang dapat mengendalikan perangkat elektronik rumah tangga seperti lampu, kipas, dan pompa air melalui smartphone. Sistem menggunakan mikrokontroler ESP32 yang terhubung ke modul relay sebagai pengendali perangkat, serta aplikasi Blynk sebagai antarmuka pengguna untuk kontrol jarak jauh melalui koneksi internet. Metode penelitian meliputi pengumpulan data, analisis kebutuhan, perancangan perangkat keras dan perangkat lunak, implementasi, serta pengujian sistem. Hasil pengujian menunjukkan bahwa seluruh perangkat dapat berfungsi dengan baik, merespons perintah secara real-time, dan memiliki tingkat kestabilan tinggi saat terhubung ke jaringan internet. Penelitian ini memberikan kontribusi sebagai referensi pengembangan teknologi *smart home* yang sederhana, efektif, dan aplikatif untuk kebutuhan sehari-hari.

Keywords : blynk; ESP32; internet of things (IoT); smart home; kontrol jarak jauh.

INTRODUCTION

The development of science and technology today has a big influence in completing work. Science applied to machines and electronics can be completed more effectively and efficiently. The development of science and technology also encourages humans to continue to think creatively not only to find something new, but also to maximize the performance of a technology. The increasingly rapid development of technology allows the formation of a system that is interconnected through an internet connection as its media. [1]

Humans as users of technology must be able to utilize the technology that exists today, as well as the development of the technology in the future. Human adaptation to new technology that has developed makes it easier for humans to do various things. This is done so that the next generation is not left behind in terms of new technology. That way, technology can develop together with the presence of a new generation as the successor to the old generation. Some of these adaptation methods can be realized in the form of encouraging the exploration of new discoveries, but also maximizing the performance of existing technology to lighten human work in everyday life such as controlling home lights or other electronic devices [2].

This technology can be made into a Smart Home system that can control all parts of the house using a system integrated with the internet. This aims to provide security and comfort for homeowners and the people who live in it, because it can facilitate work to be faster, more effective and efficient. Like when the homeowner has a sudden need and has to come home late at night or stay overnight, this can be overcome by controlling the headlights and the surrounding area of the house via a smartphone with the Internet of Things concept.

Based on the description above, it can be used to compile a Final Assignment with the Title " *Smart Home Design for Electronic Control Based on Internet of Things (IoT)* ". This prototype is a consideration for someone in implementing the concept of Smart Home and Internet of Things in real life.

METHOD

Method is a way or path to obtain return solution to everything problems. In the research It is known that there are several types of theories for applying one of the method criteria. relevant to certain problems.

At this research stage, the author divides the stages into: in several parts, namely:

- a. Data collection stages
- b. Analysis Stages
- c. Hardware and Software Design Stages
- d. Implementation Stages
- e. Tool Testing Stages

1. Smart Home

Smart home is a combination of technology and services designed specifically for the home environment with special features designed to improve the safety, efficiency, and comfort of residents. Smart home systems usually consist of monitoring and control devices and several automatic devices that can be accessed via a smartphone or computer connected to the internet network, smart home provides comfort, security and energy savings that are automatically controlled according to user control. [3]

2. Internet of Things (IoT)

Internet of Things is a concept that aims to connect one object to another using an internet connection. The emergence of IoT is able to bridge machines that produce data by utilizing sensors in devices such as mobile phones and other smart devices to collect information in real time.

Initially, the internet itself began to be famous in 1989. Then in 1990, a researcher named John Romkey created a device that was considered sophisticated at that time. His device was a toaster that could be turned on or off via the internet. Then in 1994, someone named Steve Mann created WearCam, and in 1997 Paul Saffo briefly explained his discovery of sensor technology and its future. It was only in 1999 that Kevin Ashton created the concept of the Internet of Things. Kevin is the Director of Auto ID Centre from MIT. In the same year, 1999, a machine was discovered whose system was based on Radio Frequency Identification (RFID) globally. Well, this discovery was the beginning

of the popularity of the IoT concept. People, especially technology experts, are competing to develop their technology according to the IoT concept. [4]

3. ESP32

ESP32 is a microcontroller module with dual mode features, namely WiFi and Bluetooth, which is used to make it easier for users to create various application systems and projects based on IoT (Internet of Things). ESP32 is a microcontroller introduced by Espressif System and is the successor to the ESP8266, ESP32 has many additional features and advantages over the previous generation. On the ESP32 there is a CPU core and faster Wi-Fi, more GPIO, and support for Bluetooth 4.2, as well as low power consumption, making it very suitable for creating several Internet of Things-based electronic projects. [5]



4. Relay

Relay is a switch that is operated electrically and is an electromechanical component that consists of 2 main parts, namely an electromagnet (coil) and mechanical (a set of switch contacts). Relay uses the electromagnetic principle to move the switch contacts so that with a small electric current (low power) it can conduct electricity with a higher voltage. [6]



5. Light Fittings

Lamp fittings are electrical components that function as lamp holders that channel electricity to the lamps. In addition, lamp fittings can also protect our hands when installing lamps. However, from the various functions that are the same, lamp fittings have different types according to the size and function of the room.



6. Light

Lamps are electronic devices that function to produce light, usually used for lighting in various purposes, both indoors and outdoors. Lamps work by converting electrical, chemical, or heat energy into light that can be used to illuminate the environment.



7. Fan

A fan is an electronic device that functions to produce air flow to help circulate air in a room. A fan works by using an electric motor that rotates the propeller, so that the surrounding air moves and creates a cooling effect.



8. Water pump

A water pump is an electronic device used to move water from one place to another by applying pressure through a certain mechanism. Water pumps are generally used in various purposes, such as domestic water supply, agricultural irrigation, industry, and cooling systems.



9. Jumper Cable

A jumper cable is an electrical cable that has connector pins at each end and allows two components to be connected without the need for soldering. [7]



10. Breadboard

Breadboard is a board or board that functions to design a simple electronic circuit. The breadboard will later be prototyped or tested without having to solder. Generally, breadboards are made of plastic which also already have various holes. The holes have been arranged in advance to form a pattern based on the network pattern inside. In addition, breadboards that can be found on the market are generally divided into 3 sizes. The first is called a mini breadboard, the second is called a medium breadboard, and the last is called a large breadboard. For a mini breadboard, it has approximately 170 points. [8]



11. Adapter

Based on the Aflah Sentosa site published in 2018, the adapter and its parts consist of an input consisting of a plug, fuse, and switch to connect to an AC source. Next is the voltage reducer in the form of a transformer that can reduce the voltage as needed. The rectifier section consists of a diode that rectifies the AC current to DC. Before entering the device, the current that is still slightly wavy is smoothed by the filter and then enters the device through the positive and negative cables at the output. [9]



12. Arduino IDE

According to the official Arduino website www.Arduino.cc which has been translated into Indonesian, it is very easy to write code and upload it to the Arduino board with the help of the open-source Arduino IDE. Any Arduino board can be used with this software. IDE itself is short for Integrated Development Environment, Arduino IDE is a software for programming on the Arduino board. The Arduino programming language (Sketch) has been modified to make it easier for beginners to program from its original language, which is similar to C. The Arduino microcontroller IC is equipped with a program called a bootloader before being sold. This program connects the microcontroller with the Arduino compiler. [10]



13. Blynk

Blynk is an Android and iOS operating system platform as a control on Arduino, Raspberry Pi, ESP8266 modules and other similar devices via the internet (Sedayu et al., 2019). This blynk application is very easy to use even if you are new to using it, to communicate with the Arduino board, blynk uses a code called an auth token. The code will be sent via email that has been registered with blynk and then paired into the program code that has been created. [11]



RESULT AND DISCUSSION

Needs Analysis

The smart home design for controlling electronic equipment based on IoT uses several tools and materials. The following are the tools and materials that will be used in the following table:

Table 1. Tools and Materials

No	Tool Name	Information
1	Esp 32	1 piece
2	Relay	4 pieces
3	Lamp Holder	2 pieces
4	Light	2 pieces
5	Fan	1 piece
6	Mini Pulp	1 piece
7	Jumper Cable	Enough
8	Breadboard	1 piece
9	Adapter	1 piece

In addition to hardware requirements, this design also uses software. The need for *software* in smart home design to control IoT-based electronic equipment includes the following .

- Arduino IDE
- Blynk

Hardware Design

In Hardware design aims to arrange and assemble components according to the existing circuit scheme. The main components used in this design include ESP32 as a microcontroller, relay modules as electronic switches, and several actuators such as lights, fans, and water pumps.

From this design, a circuit is produced where all components are interconnected into a desired tool.

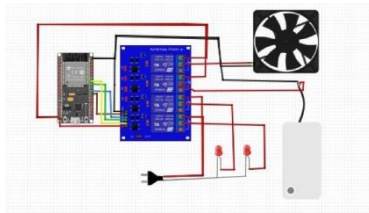


Image 1. Here is a schematic diagram of the circuit

Software Design

The design of this software aims to enable the ESP32 to receive and execute commands from a smartphone to control electronic devices such as lights, fans, and water pumps.

- Program

In software design, the program will be uploaded to Esp 32 via Arduino IDE software. The program is made according to the planned function plan of the planned project.

- Blynk Interface

The aim of designing this interface is to connect the Blynk application interface with the ESP32 microcontroller device so that it can control electronic devices wirelessly via the internet network.

Implementation

The implementation of the Smart Home Design for IoT-based Electronic Equipment Control is carried out by building an electronic device control prototype using the Blynk platform.



Image 2. The Prototype

The Blynk application is used for the user interface. This interface consists of four round buttons, each representing an electronic device that can be controlled remotely. Each button has an ON or OFF status. Each button is connected to a virtual or physical pin on the ESP 32 that controls the device.

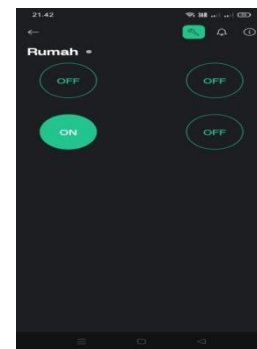


Image 3. The Application Smart Home

Testing is a process that aims to ensure that all system functions are working properly and to find errors that may occur in the system. The things tested in this design are as follows:

1. ESP32 Testing

In ESP32 testing is done to ensure that the microcontroller can function properly in controlling electronic devices on the smart home system that has been designed. This test only covers Wi-Fi connectivity. In testing the ESP 32

circuit is connected directly using USB or to a 9 volt power source.

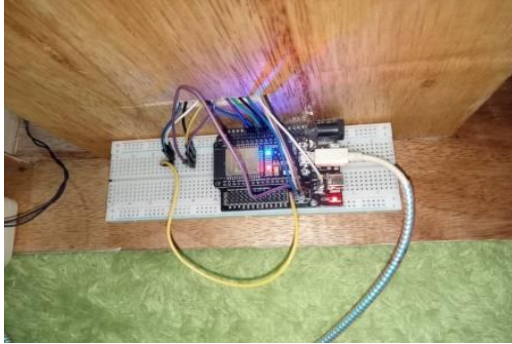


Image 3. ESP32 Testing

Relay Testing

Relay circuit testing is carried out to ensure that the relay module used can work properly in controlling electronic devices according to signals from the ESP32 microcontroller. Each relay is connected to the ESP 32 and different devices. The test results show that all relays respond to the ON/OFF command which is indicated by the LED indicator on the module turning on and the connected load being active.

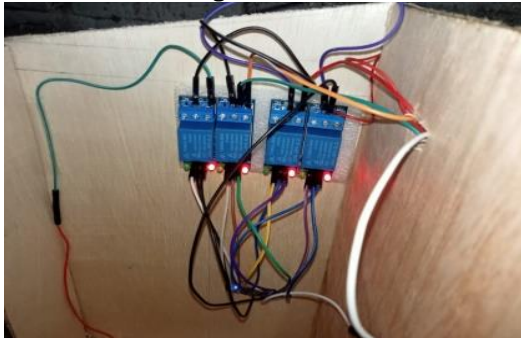


Image 4. Relay Testing

From the results of the relay circuit test in the image above, the following is a table of the results of the relay circuit test:

Table 2. Relay Circuit Test

Relay	Status ON	Status OFF	Information
Relay 1	Functioning	Functioning	Normal
Relay 2	Functioning	Functioning	Normal
Relay 3	Functioning	Functioning	Normal
Relay 4	Functioning	Functioning	Normal

Actuator Testing

The actuator circuit testing aims to ensure that all electronic devices (lights, fans, and water pumps) can be controlled properly via signals from the ESP32 and relay module. The test results show that all actuators respond to commands accurately and quickly, indicated by the device turning on and off according to instructions. The results of the actuator circuit testing can be seen in the following test results table:

Table 3. Actuator Circuit Test

Actuator	Relay	Order	Information
Lamp 1	Relay 1	ON/OFF	Functioning Normally
Lamp 2	Relay 2	ON/OFF	Functioning Normally
Fan	Relay 3	ON/OFF	Functioning Normally
Water Pump	Relay 4	ON/OFF	Functioning Normally

Overall Test Results

The overall circuit testing was conducted to ensure that all components including the ESP32, relay module, and actuators (lights, fans, and water pumps) can function in an integrated manner. The testing was conducted by sending commands through the control application to activate and deactivate each device, both individually and simultaneously.

The test results showed that all devices responded quickly. with internet connection . This proves that the integration of hardware and software is running well and ready to be applied in household use.



Image 4. Final All Testing

Table 4. Final All Testing

Actuator	Blynk	Response	Information
Lamp 1	ON	Lamp 1 is ON	Stable
Lamp 1	OFF	Lamp 1 OFF	Stable
Lamp 2	ON	Light 2 ON	Stable
Lamp 2	OFF	Light 2 Off	Stable
Fan	ON	Fan ON	Stable
Fan	OFF	Fan Dead	Stable
Water pump	ON	Water Pump ON	Stable
Water pump	OFF	Water Pump Dead	Stable

CONCLUSION

This research successfully designed and built an Internet of Things (IoT)-based smart home system using an ESP32 microcontroller, relay module, and Blynk application as a user interface. The developed system is able to control household electronic devices such as lights, fans, and water pumps remotely via a smartphone with an internet connection. Test results show that all devices can respond to ON/OFF commands in real-time, work stably, and are well integrated between hardware and software. The implementation of this system is proven to provide convenience, efficiency, and effectiveness in managing household devices, and can be a reference for the development of simple, affordable, and applicable smart home technology for everyday needs.

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