SMART ROOM DESIGN BASED ON MICROCONTROLLER AND INTERNET OF THINGS

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Abstract

The Smart Room prototype uses a Microcontroller that will facilitate a person's daily work with a control system via a smartphone, this control system can be accessed anywhere and anytime. This research method is carried out by developing an automated tool or circuit. The purpose of this research is to provide an overview of the Internet of Things system sophistication which the IoT system can control a device in the room more effectively and efficiently. The content of the research shows a flowchart form and its system design through Software and Hardware. The results of the study can be concluded with the existence of a Smart Room Prototype based on a microcontroller and the Internet of Things control system, in every door lock system, temperature and humidity control systems in the room, and smart lighting systems become easier.

Keywords: Internet of Things, Prototype Smart Room System, Door Locking System, Smart Lighting System and Temperature Control System, Humidity.

Introduction

Smart home is a promising concept, offering several benefits such as providing convenience, increasing safety and security, and saving energy usage. There are several factors that need to be considered before designing a Smart home system. Devices must be easily accessible, easily expandable so that new devices can easily be added, and must be easily controllable. The goal of implementing the Prototype Smart Room is to be able to control a system in the form of lights, electricity and door locking so that users can see and adjust it easily so that it fits the desired conditions. The intended users for this Smart Room application are a family, a busy individual, the elderly and persons with disabilities.

The internet also has weaknesses in security factors which are still often a threat to its users. However, these factors are challenges that must be resolved. But the advantages of IoT are one of the many networks that have been chosen. In addition, IoT provides a smart system, convenience, and improves the quality of life. Thus, the system controlled in this project includes controllable door locking, lighting, and remote control of electricity using IoT as the network. With the existence of the smart home system, it is hoped that it will increase the safety and efficiency of users in their daily lives.

Theoretical Basis

1. Types Of Arduino

Currently the Arduino development team is Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino, David Mellis, and Nicholas Zambetti. They strive for 4 things in this Arduino, namely:

1. Affordable price
2. Can be run on various operating systems, Windows, Linux, Max, and so on.
3. Simple in terms of Software and Hardware so that it is easy to learn even by ordinary people.
4. Open Source, hardware and software.

Image 1. Arduino Uno R3 328P SMD

2. Arduino DUE

Unlike its siblings, Arduino Due does not use ATMEGA, but uses a higher ARM Cortex CPU chip. It has 54 digital I/O pins and 12 analog input pins. For programming it uses Micro USB, available on several cellphones.

Image 2. Arduino DUE

3. Arduino Mega

Similar to Arduino Uno, both use USB type A to B for programming. But Arduino Mega, uses a higher chip ATMEGA2560. And of course there are more Digital I/O Pins and Analog input pins than Uno.

Image 3. Arduino Mega

4. Arduino Leonardo

You could say Leonardo is Uno's twin brother. From the start, the number of digital I/O pins and analog input pins are the same. Only the Leonardo uses Micro USB for programming.

Image 4. Arduino Leonardo

5. Arduino Fio

The shape is more unique, especially for the socket. Even though the number of digital I/O pins and analog inputs is the same as Uno and Leonardo, Fio has a Socket XBee. XBee makes Fio usable for projects related to wireless.

Image 5. Arduino Fio

6. Arduino Lilypad

It's circular shape allows Lilypad to be used to create unique projects. Like making amor iron man for example. Only the old version uses ATMEGA168, but it's still enough to make a cool project. With 14 digital I/O pins, and 6 analog input pins.

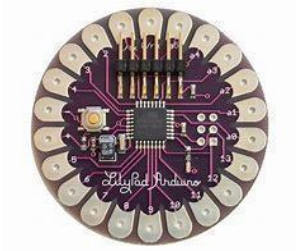


Image 6. Arduino Lilypad

7. Arduino Nano

As the name suggests, this small and very simple Nano has many facilities. It is equipped with FTDI for programming via Micro USB. 14 Digital I/O Pins, and 8 Analog input Pins (more than Uno). And some use ATMEGA168, or ATMEGA328.

Image 7. Arduino Nano

8. Arduino Mini

The facilities are the same as that of the Nano. Only not equipped with a Micro USB for programming. And the size is only 30 mm x 18 mm.

Image 8. Arduino Mini

9. Arduino Micro

The size is longer than the Nano and Mini. Because there are more facilities, namely; It has 20 digital I/O pins and 12 analog input pins.

Image 9. Arduino Micro

10. Arduino Ethernet

This arduino is equipped with ethernet facilities. Make your Arduino connected via a LAN network on a computer. The facilities for the Digital I/O Pin and Analog Input are the same as the Uno.

Image 10. Arduino Ethernet

11. Arduino Esplora

Recommendations for those of you who want to make gadgets like smartphones, because they are equipped with joysticks, buttons, and so on. You only need to add an LCD, to beautify Esplora even more.

Image 11. Arduino Esplora

12. Arduino Robot

This is a complete package of Arduino in the form of a robot. It is equipped with LCD, speakers, wheels, infrared sensors, and everything you need for robots is already in this arduino.

Image 12. Arduino Robot

Tools for assembling Smart Room consist of :

1. RFID stands for Radio Frequency Identification. RFID is a technology used to identify and retrieve data using a barcode or magnetic card.

Image 13. RFID

2. The relay module is a device that operates based on electromagnetic principles to drive the contactor to move the ON position to OFF or vice versa by utilizing electricity.

Image 14. Relay 4 Channel

3. *Node MCU* is an open source IoT platform. It consists of hardware in the form of a System On Chip ESP8266 from ESP8266 made by Express if System.

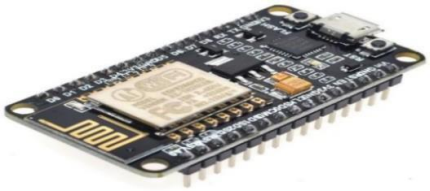


Image 15. *Node MCU*

5. Lolin V3 Sensor DHT11 is a sensor module that functions to sense temperature and humidity objects that have an analog voltage output that can be further processed using a microcontroller.

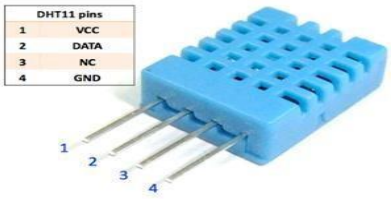
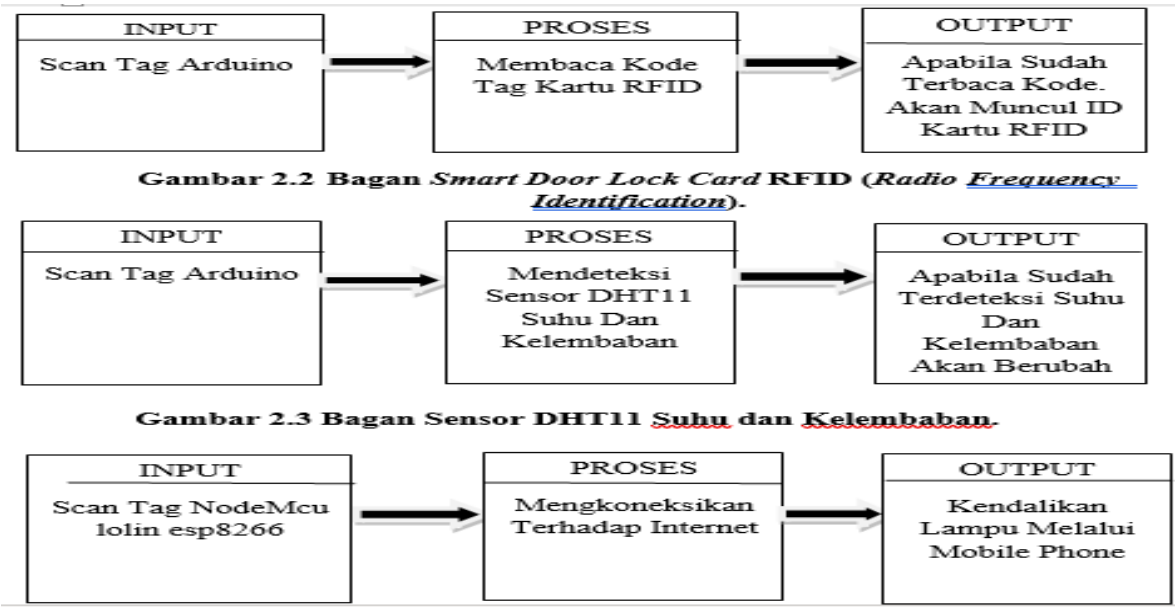


Image 16. Sensors DHT11

In the Figure, the Arduino IDE has IDE toolbars that provide instant access to important functions, namely:

1. Verify button, to compile the program currently being worked on
2. Upload button, to compile the program and upload it to the Arduino board
3. News button, creates a new worksheet
4. Open button, to open the program in the file system
5. Save button, to save the program being worked on.
6. Stop button, to stop the serial number that is being executed.

The Research Framework of the Smart Room:



Gambar 2.2 Bagan *Smart Door Lock Card* RFID (*Radio Freguency Identification*).

Gambar 2.3 Bagan Sensor DHT11 Suhu dan Kelembaban.

Image 18. The Research Framework

Research Method

1. **Technology Architecture**

The architecture on the Arduino Rev 3 DIP board has the following new features:

First is the pinout: there is the addition of SDA and SCL pins close to the AREF pin and another two new pins placed close to the RESET pin, IOREF which allow the shield to adapt to the voltage supplied from the board. In the future, the shield will be compatible with both boards using AVR, which operate on 5V.
Second Both are unconnected pins, which are reserved for future purposes.

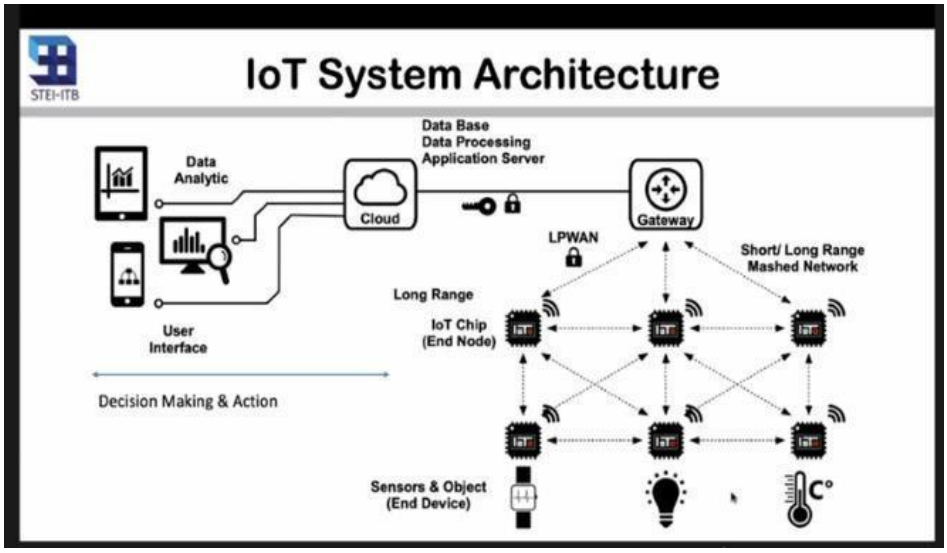
Third Reset very powerful circuit. The four Atmega16U2 replaced the Atmega 8U2 which was used as a usb-to-serial converter.

Architecture Arduino Uno R3 Arduino Uno can be powered via a USB connection or with an external power supply, the power source is selected automatically. External non-USB power can be either an ac-dc adapter or a battery. This adapter can be connected by connecting a 2.1mm positive center plug into the power jack board. As for the battery, it can be connected to the gnd and vin header pins from the power connector. The board can operate on power supplies from 6 – 20 volts. If you use a voltage of less than 6 volts, it may not be stable. If using more than 12V, the voltage regulator can overheat and damage the board. The recommended range is 7 to 12 volts. The available electrical pins are as follows:

1. Vin. Input voltage to Arduino board when using internal power source. You can supply voltage through this pin, or, if you want to supply voltage through a power jack, use this pin.
2. 5V This pin is the 5V output that has been set by the Arduino board regulator. The board can be powered by either a 12V DC 7 power jack, a 5V USB connector, or the board's 7-12V VIN pins. If you input voltage via the 5V or 3.3V pin directly without going through the regulator it could damage the Arduino board.
3. The voltage at pin 3.3V,3.3Volt is generated by the on-board regulator. Provides a maximum current of 50 mA.
4. GND. Ground Pins. Abbreviation of 'Ground'. There are several GND pins on the Arduino, any of which can be used to connect to your circuit.
5. IOREF. This pin on the Arduino board provides the reference voltage when the microcontroller is operating. A properly configured shield can read the IOREF pin voltage so it can choose the right power source to work with 5V or 3.3V.

Arduino Uno R3 has 6 analog inputs labeled A0 to A5, each providing 10-bit resolution i.e. 1024 different values. By default the system measures from ground to 5 volts, although it is possible to change the upper end of the range using the AREF pin and the analog Reference function. In addition, some pins have special functions, namely:

1. TWI A4 or SDA pin and A5 or SCL pin, supports TWI communication.
2. AREF Voltage reference for analog inputs, used with analog Reference.
3. RESET Used Some buttons turn on again.



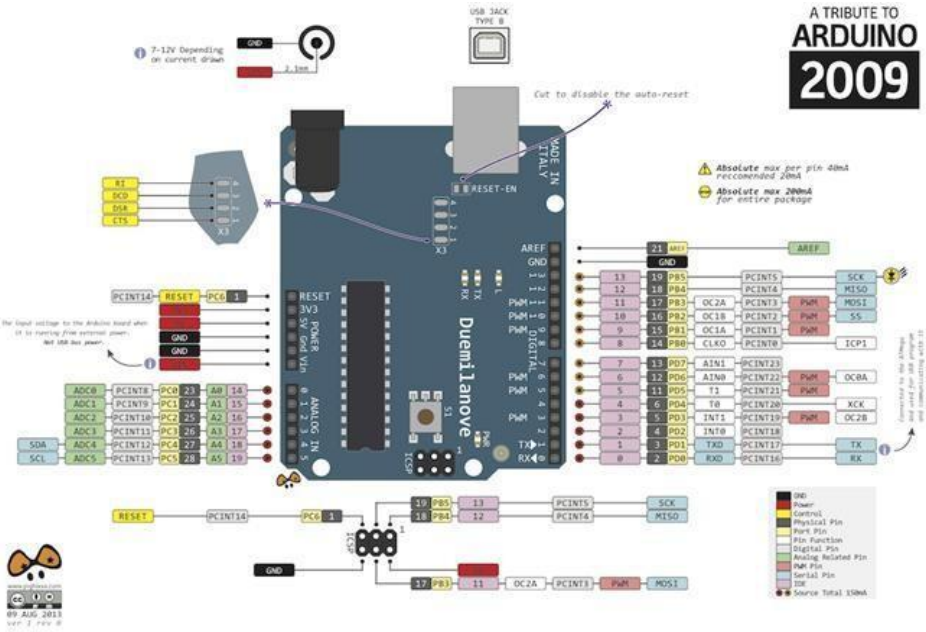


Image 19. Architectural Drawings on Arduino Uno R3 DIP

Image 20. Architectural Drawings on the Internet of Things

4. Only refers to the three main elements of the IoT architecture, namely physical goods equipped with IoT modules, internet connection devices such as modems and wireless routers, and cloud data centers as applications and database storage areas.
5. Rapid developments in the field of mobile communications have introduced a technological leap in home automation. Wireless networks (3G, 4G, WiFi) and smart devices have become ubiquitous that allow users to control the home. Home automation ultimately has an impact on comfort, safety and energy conservation in residential and industrial buildings. This impact occurs because home automation provides access to control appliances in the home from smart devices and from anywhere.
6. Describe what devices can be used as smart devices, for example we can adjust the room temperature or deactivate the temperature control device remotely using a remote which is a smartphone or tablet. Some of

the main aspects of a smart home/smart room are the capabilities of the home infrastructure and controlled devices, the use of user interfaces with mobile devices, and the motivation to invest in control and automation technologies.

2. Technology Architecture Needs Analysis :

NO	Nama Komponen	Jumlah	Satuan
1	Mikrokontroler Node MCU Esp8266	1	Unit
2	Relay 4 channel	1	Unit
3	DHT11 Sensor	1	Unit
4	Arduino Uno	2	Unit
5	Lcd 16x2	2	Unit
6	RFID	1	Unit
7	Kabel Jumper	1	Unit
8	Adaptor 9 Volt	1	Unit
9	Adaptor 12 Volt	1	Unit
10	Kabel USB	1	Unit
11	Lampu 5 Watt	4	Unit

3. Technology Tools Testing

Devices such as the smart room that the author uses include temperature detection, turning on the lights via telegram, and a door lock card system on the prototype.

Telegram Bot Creation

In the process of making Bots for the Smart Room system, there are several commands that are not used because the Bots that are created are only to receive commands and then call each specified function when the command is received. Following are the steps for creating a Bot for Smart Room.

Step 1 : Initially asking the user for BotFather and Then type /newbot to create the bot user we want.

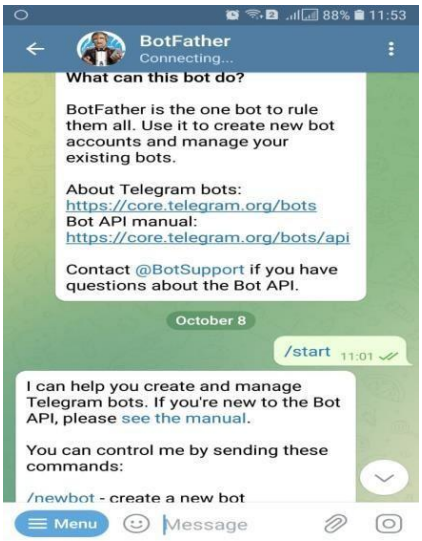


Image 21. Starting With The Step To Create A Userbot

Step 2: Initiate communication to BotFather. as the Telegram Bot service provider with the /start command.

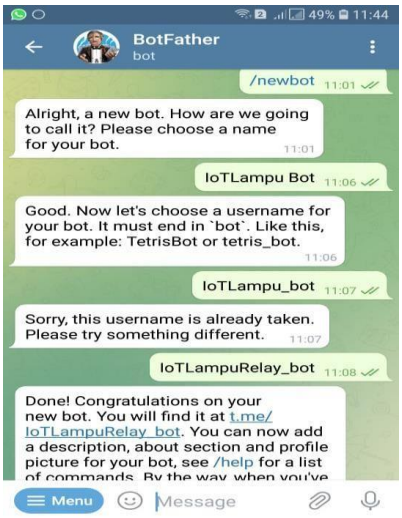


Image 22. Making Commands On Bots

Tahap 3: Give the command /mybots to check whether the bot has been created successfully. BotFather will provide options for actions to be taken against bots such as changing the name, description, bot profile photo, and additional commands to be given.

Image 23. Receiving List of Sent Commands

4.1 Technology Design

Understanding System design is the determination of processes and data required by the new system. The purpose of system design is to meet the needs of system users and to provide a clear picture and complete design according to Mulyani (2017; 80). The tools and materials for building a Prototype Smart Room are as follows:

A. Order

In general, the Smart Room miniature frame uses several components, namely plywood boards, bolts and washers as reinforcement so that the frame is firmly attached. The plywood used is plywood which has a width of 50x50 cm and has 2 floors. Because plywood boards are easier to form than other frames.

Image 24. House Prototype Frame

B. Cable

Electrical cable which in English is called Electrical Cable is a medium for conducting electric current consisting of Conductors and Insulators. The cable will be connected to the 4 channel relay and reconnected to the 4 lights.

Image 25. Power Cable

C. 5 Watt Lamp

The 5 Watt lamp is made for the light source of each room because the room has 4 of them, there are 2 floors. 2 rooms for downstairs and 2 rooms for upstairs.

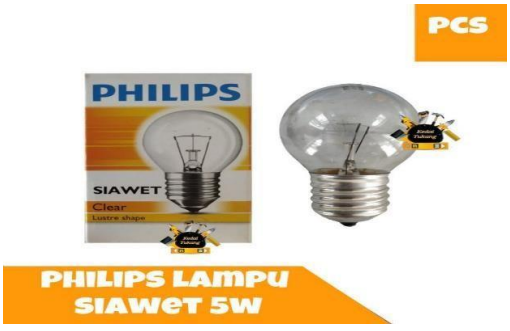


Image 26. 5 Watt Lamp

D. LCD (Liquid Crystal Display) 16x2

LCD is a type of display media or display made of liquid crystal material as the main viewer. The 16x2 LCD can display up to 32 characters consisting of 2 lines with each line displaying 16 characters.

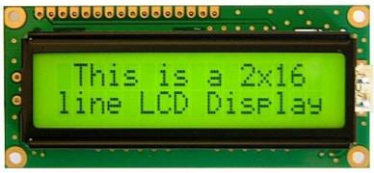


Image 27. LCD 16x2

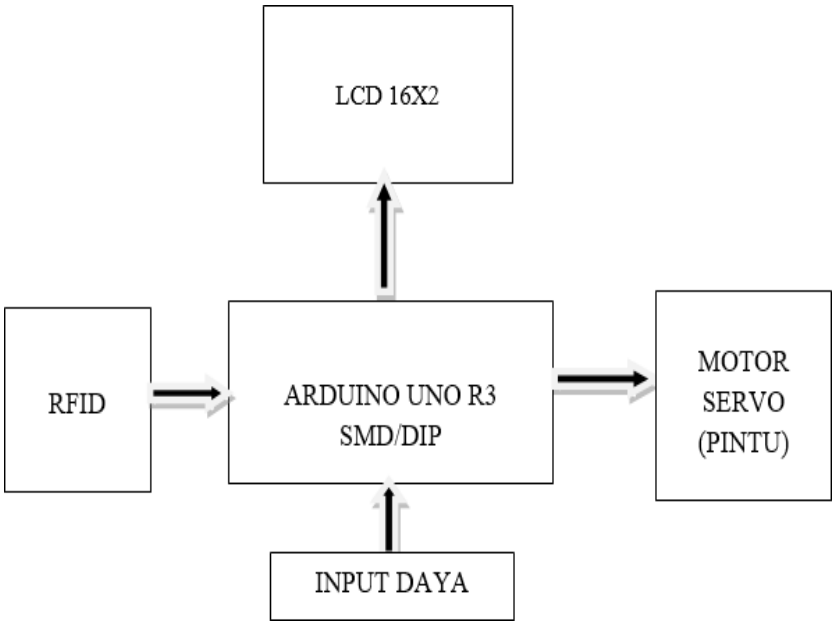
E. Jumper Cable

Jumper wires are electrical cables that have connector pins at each end and allow you to connect two components involving an Arduino without the need for solder.

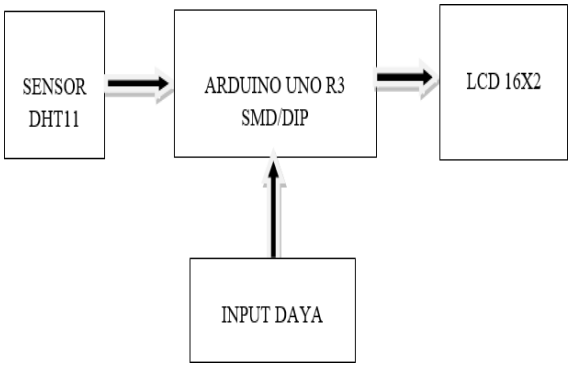
Image 28. Jumper Cable

5. Hardware Design

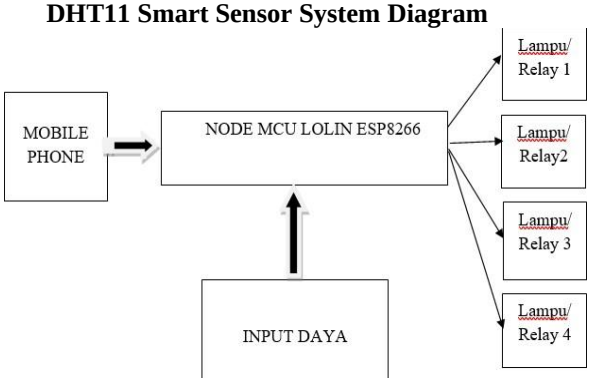
The hardware design of the Arduino Uno Microcontroller-Based Smart Room and NodeMCU is shown in the following diagram:



Smart Lock Door Card (RFID) System Diagram



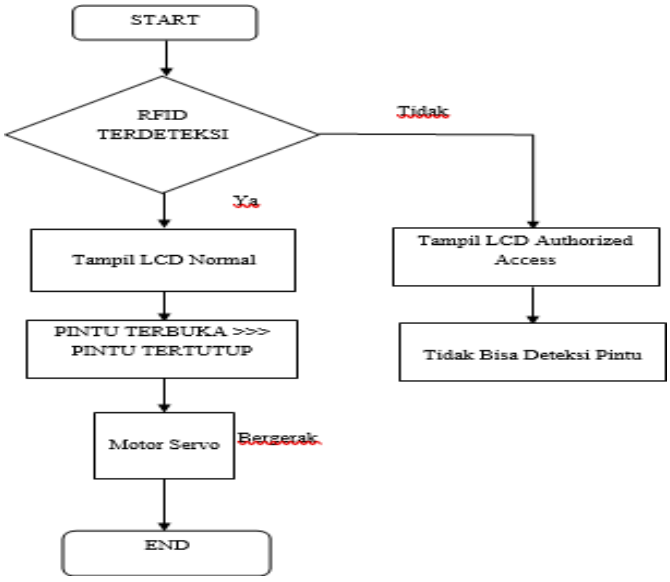
DHT11 Smart Sensor System Diagram



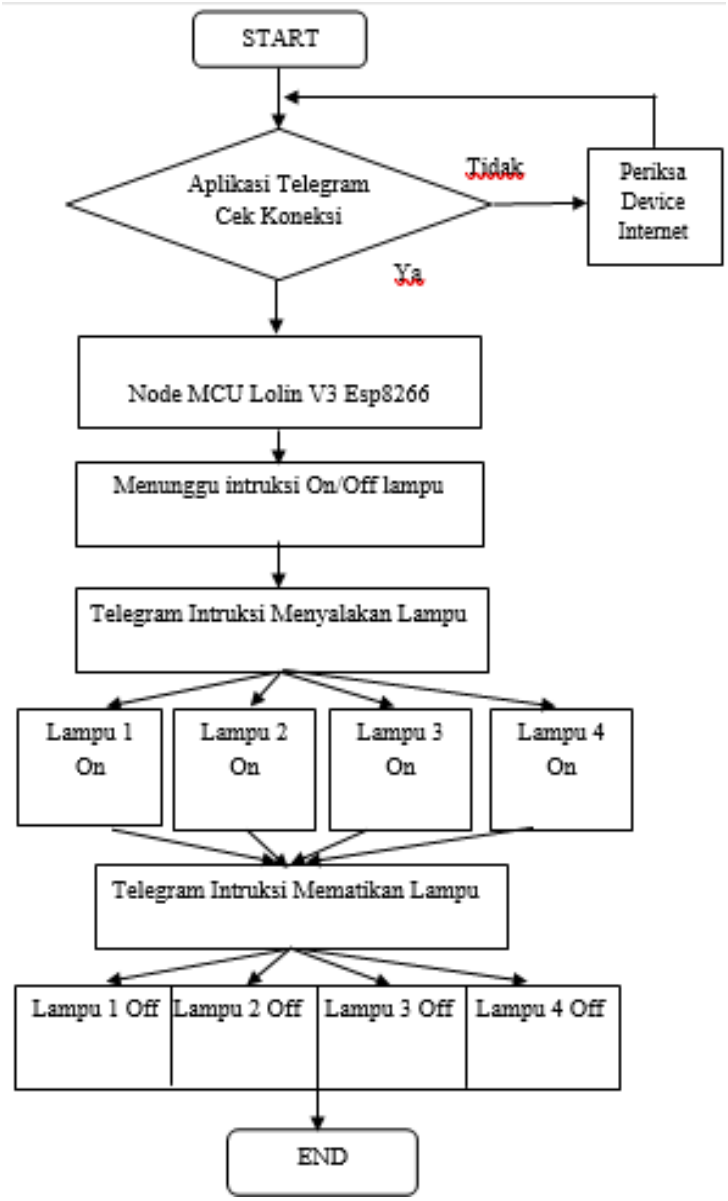
***Internet Of Things* System Diagram**

6. Software Design

The software from the Arduino Uno Microcontroller-Based Smart Room and NodeMCU is shown in the following flowchart:



Smart Lock Door Card (RFID) System Flowchart



Flowchart of the Smart Lamp *Internet of Things* System

The main objective of this research is a remote control and monitoring system for electrical devices. The electrical device used as the object of light research, and for close range, is the door key card and temperature. The light control uses a 4 channel relay, the door lock card controls using RFID and the temperature uses the DHT11 sensor which has been integrated into Arduino Uno and NodeMCU. The programming uses the Arduino IDE Software as a programming interface. The tool is designed to illustrate that opening the door uses a card, to find out the temperature and humidity in the room using the DHT 11 sensor, and the Lolin MCU Node is designed to control four 5 watt lamps, a 12V transformer as a relay and microcontroller power supply, this light control uses Telegram application.

2. Discussion Of Technology Test Result

Testing of the microcontroller-based door lock card tool is carried out by using the RFID card to be held close to the reader, the information on the 16x2 LCD "DOOR OPEN" and automatically when the door is closed will appear the information "DOOR CLOSED".

Testing the temperature and humidity of the microcontroller-based room is carried out by using the DHT11 sensor. When the room is lit by a light and the heat conductor is from the lamp, the DHT11 sensor will automatically detect the temperature and humidity will rise.

Testing of microcontroller and Internet of Things-based lamps is carried out by using the NodeMCU lolin esp8266 tool and its electric power transformer, namely a 4 channel relay for 4 lamps. 2 rooms downstairs, 2 rooms upstairs. Turning on the 4 lights is through the internet and using an application on a smartphone called Telegram. Make sure or check that the NodeMCU lolin esp 8266 tool is connected to the Smartphone hotspot or wifi, because if it is not connected to wifi or the internet, the light will not turn on.

3. Weaknesses And Advantages Of Technology

The advantages of the Prototype include:

1. Easy to shape and install anywhere because of its flexible, light, and easy to recycle texture.
2. Available in various thicknesses and sizes making it easier for us to apply it at home.
3. Its size will not change like iron because it will not expand or shrink.

Weaknesses of the Prototype include:

1. Prototype finishing takes a long time because it requires a very high level of accuracy so that the plywood is installed correctly.
2. The prototype is vulnerable if exposed to water because of the potential for brittleness.
3. The level of thickness precision of the prototype is not good when it is corrugated, making it not sturdy and vulnerable to heavy loads.

Conclusion

Based on the results of the discussion of analysis, implementation, and testing of devices and tools, the following conclusions can be drawn:

1. The smart room prototype has been successfully assembled with a manual locking system, while the lighting system is functioning and controlled via the internet which can be done anywhere and anytime.
2. Testing the fixed angle on the servo has 180 degrees, when the condition of opening and closing the door is 90 degrees.
3. This IoT (Internet Of Things) based smart room system was built using a programming language for Hardware programming and for Software programming controller applications.
4. The system is running well according to design, but a little long or delayed when executing control commands by the Android device, this is because the Wifi module used on the device is not a good category module, so the process of sending commands takes a little time.

References

Najmurrokhman, A., Kusnandar, K., & Amrulloh, A. (2018). Prototipe Pengendali Suhu Dan Kelembaban Untuk Cold Storage Menggunakan Mikrokontroler Arduino Atmega328 Dan Sensor DHT11. *Jurnal Teknologi*, *10*(1), 73-82.

Syahputri, A. (2018). Rancang Bangun Palang Pintu Otomatis Berbasis Mikrokontroler Menggunakan Kartu RFID dan Photodioda.

Agung, P., Iftikhor, A. Z., Damayanti, D., Bakri, M., & Alfarizi, M. (2020). Sistem Rumah Cerdas Berbasis Internet of Things Dengan Mikrokontroler Nodemcu Dan Aplikasi Telegram. *Jurnal Teknik dan Sistem Komputer*, *1*(1), 8-14.

Desnanjaya, I. G. M. N., & Iswara, I. B. A. I. (2018). Trainer Atmega32 Sebagai Media Pelatihan Mikrokontroler Dan Arduino. *Jurnal RESISTOR (Rekayasa Sistem Komputer)*, *1*(1), 55-64.

Prastianto, G. S., Saputra, R. E., & Setianingsih, C. (2021). Perancangan Alat Pengontrol Lampu Pintar Berdasarkan Kebiasaan Ruangan Berbasis Android. *eProceedings of Engineering*, *8*(2).

Prasetya, P. T. (2019, November). *Laporan Tugas Besar Mikrokontroler (Smart Room)*. (Z. Trada,Editor)