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DESIGN AND BUILD SMART REMOTE FOR IOT BASED AIR CONDITIONER

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Keywords
ESP Microcontroller, Internet of Things, Infrared, AC.

Abstract
Progress Internet of Things (IoT) technology has open opportunity new in development device smart and capable increase efficiency energy and provide comfort more for user. One of the potential device For automated is cooler air conditioning (AC), considering its intensive use in consumption energy at home ladder and also building offices. However, traditional AC Still own limitations in matter accessibility distance distance and efficiency energy, which is often result in waste energy consequence lack of arrangement automatically. Therefore that, research This aiming For design and develop smart air conditioner remote prototype IoT based which can controlled from distance Far as well as set up in a way automatic based on temperature data environment.
Quantitative methods used in study This covering preparation tools, observation, consultation expert, testing tools, evaluation, and withdrawal conclusion. Testing done For evaluate functionality tools, stability IoT connections, as well as effectiveness arrangement automatic in control temperature. Research results show that IoT based remote AC system developed capable arrange temperature room in a way automatic in accordance with condition environment and reduce consumption energy compared to with manual operation . System this also works increase accessibility user through control distance far as can be accessed through application mobile.
Implications from study This is development more carry on from IoT technology in management device House ladder smart and economical energy. Prototype This can become base for innovation other devices in automation House as well as contribute to global efforts in subtraction consumption energy. With more implementation wide, expected system This can support sustainability environment through efficiency energy in various sector.

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INTRODUCTION

Progress The rapid growth of the Internet of Things (IoT) has revolutionize various sector, especially automation home and devices smart, including system cooler air conditioning (AC). Traditional AC system generally not enough own accessibility distance distance and adaptability time real, which limits efficiency in respond change condition environment and optimize consumption energy. In this digital era, there is increasing demand increase to device intelligent capable give control and feed come back in real-time. As the world faces challenge environment consequence consumption excessive energy, researchers and engineers the more focus on development solution IoT based that enables control distance remote, monitoring, and management efficient energy.

One of problem main in traditional AC systems is his inability For integrated with device clever For efficient use and control. Users often No can adapt arrangement from distance Far or set response automatic based on temperature data time real. Limitations this is very significant Because part big building donate portion big in consumption global energy,

especially For need heating and cooling (Ali, 2019)). For overcome problem This, IoT- based AC remote control system has been appear as solution potential to improve comfort, optimize energy use, and enable users control their AC unit Where have you been through application mobile or web interface.

A number of study has explore integration IoT technology with system AC control for reach solution more cooling smart and responsive. For example, in research conducted by Anwari (2020), a prototype IoT based AC remote control system using infrared sensors designed For manage AC operation from distance far. This study at the State University of Jakarta highlights efficiency use of IoT for real-time control, which improves comfort user through accessibility distance Far.

Desai (2019) develop system automation homes that utilize IoT for integrate control fans and air conditioners for efficiency energy, with NodeMCU as controller main. This integration show how IoT can simplify control device House stairs, reduce need will manual adjustment, and offers response automatic to change temperature. Similarly, Isyanto et al. (2020) designed a portable AC clever IoT based which shows its potential in facilitate arrangement higher temperature easy through interface mobile.

In a study conducted by Totade (2022), a system automation House based on Arduino and NodeMCU is proposed, where the user can manage various device House stairs , including AC system, in distance far. Focus the main thing is on the rise comfort users and reduction consumption energy with adapt AC settings based on preference users and conditions environment. Alam (2023) step more Far with develop system IoT based special For heating and cooling, which aims to increase efficiency energy throughout system building.

Thongkaew (2022) works on smart AC system IoT- based capable control temperature in room in a way automatic. Research This is part from more trends broad focus on development system intelligent responsive change environment in a way autonomous. Research This show that IoT based AC control offers a viable solution For reduce consumption energy at home stairs and buildings while maintain comfort thermal.

Foundation theoretical from system IoT based AC control is based on the principle system embedded, communication wireless, and automation smart. IoT technology utilizes connectivity network For transmit data between device, allowing monitoring and control time real. NodeMCU and Arduino, which are common IoT microcontroller, facilitating interaction between the AC unit and the cloud, where data is processed and stored.

In the study as done by, Rocha (2020)the role of IoT in increase efficiency energy in buildings smart is emphasized, providing framework solid work for system IoT based AC control. With integrating sensors such as detector temperature and humidity, IoT devices can make decision based on data. This is important For smart AC system, which adapts its operation based on reading temperature, preference user, or the schedule that has been determined (Hariadi, 2019).

Researches This in line with theory that IoT technology can allow device economical energy with make it more smart and more autonomous. Combination sensor network, connectivity wireless, and computing cloud allow AC system for respond condition environment in a way dynamic, reduce use energy that is not need, and improve comfort user (Afandi, 2021).

Study This aiming For develop and implement smart air conditioner remote control prototype IoT- based that enhances comfort users and efficiency energy. Its main purpose includes : Building an IoT- based AC remote control that utilizes sensors and microcontrollers For allow operation distance Far and real-time monitoring. Developing optimizing algorithm AC usage based on temperature data room For reduce consumption energy that is not need. Make friendly interface users who allow user control their AC unit from application mobile or web, regardless from location they. Increase Comfort in Room : Ensure system can maintain temperature in comfortable room with adapt AC settings automatically automatic based on bait back sensor.

Implications from study This is diverse, impacting progress technology and efforts conservation environment. Implementation system IoT based AC control can produce

savings significant energy with minimize wasted energy .Alam (2023) emphasize IoT potential in reduce footsteps environment building, with system control clever like This become key For style life more urban sustainable.

In addition, research This provide print blue For innovation in the future in automation home. Along with development IoT technology, system This can expanded For integrate device House ladder others , creating a completely environment automatic and mutual connected. Vinola (2020) :Widodo (2021)) explore system similar, shows eligibility integrating IoT with device daily For more control and monitoring Good.

More further research This can contribute in reduce cost operational For House stairs and buildings commercial. With automate AC unit control and adjust timetable For use optimal energy, users can lower bill electricity in a way significant (Al-Ghasem, 2020). Economic benefits This is very valuable in areas with price high electricity or where conservation energy become priority consequence policy environment.

RESEARCH METHOD

Types of research used in studies This is study development technology (development research) which focuses on designing and developing system or tool new. Research This try create IoT based AC remote control prototype designed For increase efficiency energy and provide convenience control for user.

The approach used in study This is approach quantitative. This is Because study involving collection and analysis of numerical data from results testing tools, such as effectiveness control temperature, level efficiency energy , as well as stability connection network on IoT devices. Quantitative data This analyzed For know how far the tools have been developed fulfil indicator the success that has been determined.

With approach this , research focus on evaluation based on data regarding performance tools and how system can give optimal results according to with objective study.

In research This is the method used covers a number of stages , namely technique preparation, observation, consultation, testing tools, evaluation, and withdrawal conclusion. Here is explanation from every stages the :

Preparation

Stage preparation is step beginning in the research process, which includes planning and determination tool as well as necessary materials. At stage this, researcher identify specification tools, components that will be used, and design the system that will developed. Preparation This includes :

1. Selection and assembly device hard such as temperature sensors, NodeMCU modules, and devices infrared .
2. Development device soft For control the AC through the IoT platform, using Language appropriate programming.
3. Block diagram creation and design channel Work system as guide in stage implementation.

Observation

After preparation finished, stage observation done For understand more in about conditions and variables to be tested in study this. Observation This done to :

1. Condition environment the room where the AC will be used, including variation temperature and humidity.
2. Characteristics response from AC when connected with IoT devices and changes temperature.
3. Behavior device in various condition like temperature high and low, and change sudden For test response system.
4. Observation This aiming For understand dynamics the environment that will made into base in design arrangement automatically on IoT- based AC remote.

Consultation

Stage consultation done For get input from competent experts in the field of IoT, systems control, and techniques electro . Consultation This done in a way periodic For ensure design and implementation tool in accordance with required standards. Consultation done For :

1. Validating design device hardware and devices software that has been made.
2. Ensure that programming on the system walk with good and following standard relevant technical.
3. Discuss potential possible problems arise during testing, as well as look for the right solution.

Consultation This help ensure that design and operation tool walk in accordance with objective study.

Tool Testing

Stage This is part important in method research, where the tools that have been designed and assembled tested in a way deep For ensure its functionality. Testing tool done in a number of step :

1. Testing Basic Function : Ensure every component functioning with well, like a temperature sensor that detects temperature room in a way accurate, NodeMCU that sends data to the cloud, and the module infrared that transmits order to AC.
2. Testing Connectivity : Testing the connection device to the internet and ensure the data can be sent and received in a way stable.
3. Testing Control Automatic : Testing settings automatic on AC based on detected temperature, as well as ensure AC response to order in accordance with what is desired .
4. Durability Test : Performing testing in term time certain For ensure that tool still functioning with good below condition normal use or intensive.

Testing This aiming For see whether tool can functioning with good, and ensure that results obtained in accordance with specifications that have been planned.

Evaluation

Stage evaluation done with analyze results testing tools that have been conducted. Evaluation includes :

1. Test Data Evaluation : Data from testing collected and analyzed For know whether system fulfil indicator the success that has been set.
2. Identification Weaknesses and Strengths : Review parts from functioning system with good and in need repair.
3. Analysis Energy Efficiency : Evaluating extent of use of smart AC IoT based can reduce consumption energy If compared to with manual settings.

Evaluation This aiming For to obtain information about performance tools and validate whether tool the has reach desired goal.

Drawing Conclusions

Stage end in method study This is withdrawal conclusion based on the data obtained from results testing and evaluation. This conclusion will includes :

1. Effectiveness and efficiency IoT based remote AC system in control temperature and save energy.
2. Reliability system in respond change environment and fulfill need user.
3. Recommendation For development more carry on or improvement feature For research and application furthermore.

Through this process, it is hoped that study can give contribution to development IoT technology in AC control as well give outlook new about effectiveness device clever in help management energy.

RESULTS AND DISCUSSION

In this chapter, the author will explain and explain how to create and test the results of this Final Project product research. The tests carried out include testing the performance of the entire system, as well as analyzing data transmission from *input* to *output,* so that this tool can be applied to AC (AC) at home that already has an internet network.

Tool Making

Hardware Manufacturing

Tools and materials

To make a tool, several components are needed and assembled into one unit, here are the components and tools that have been assembled:

1. ESP32 Microcontroller
2. Smartphone with Telegram application installed
3. USB Type C Cable
4. BC547 Transistor
5. 1k resistor
6. IR Receiver
7. Led by IR
8. DHT11 Temperature Sensor
9. Cable Jumper
10. 2m hole PCB board
11. 40W Soldering Iron
12. Solder Tin

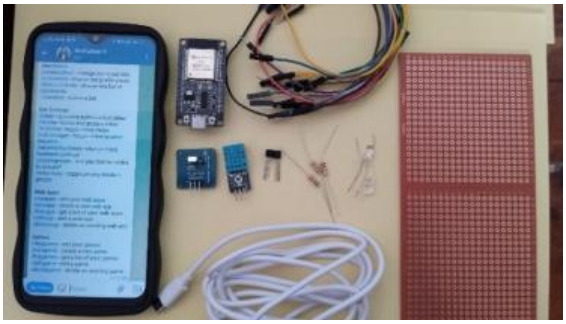

Figure 1. Tools and Materials
Source (Personal Document)

Network Scheme

a. IR Receiver Signal Receiver Network Schematic.

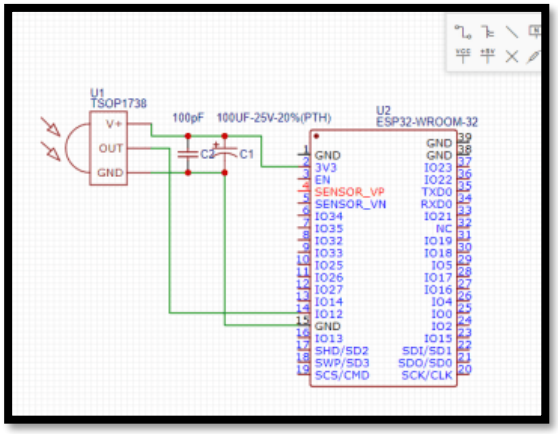

Figure 2. IR Receiver Circuit Schematic on ESP32

Source (Personal Document)

b. Smart Remote IoT For AC Network Scheme

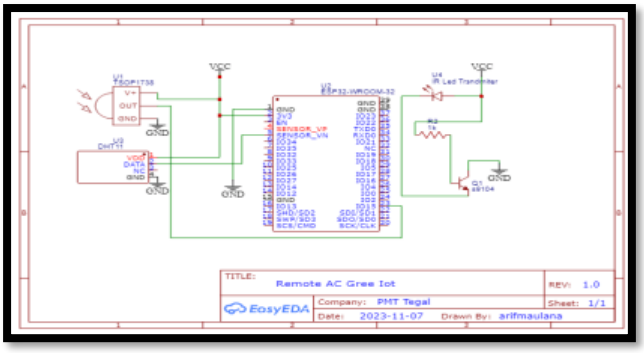

Figure 3. Smart Remote IoT Network Schematic For Gree AC
Source (Personal Document)

c. Mounting Components to PCB Board Points

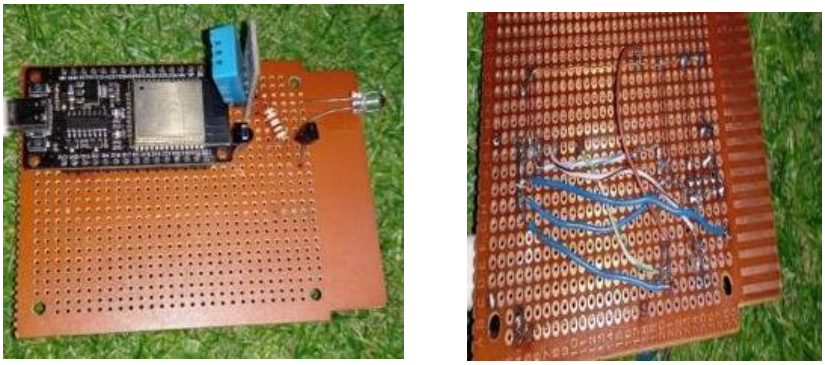

Figure 4. Installation Component

d. Catch signal Gree AC IR

a. Signal capture

Figure 5. Recording IR code from AC Remote

b. IR Receiver Signal Capture Results

Gree AC Remote Code

Save and use the IR Receiver code retrieval results in programming the Gree Smart Remote AC in the Arduino Ide application .

Software Design

Make Botable in Telegram app

In this case, the author uses the Telegram application to communicate and send messages to *ESP32 board,* here the steps :

a. Type in the column search with the word " *BotFather* " , select box tick blue .

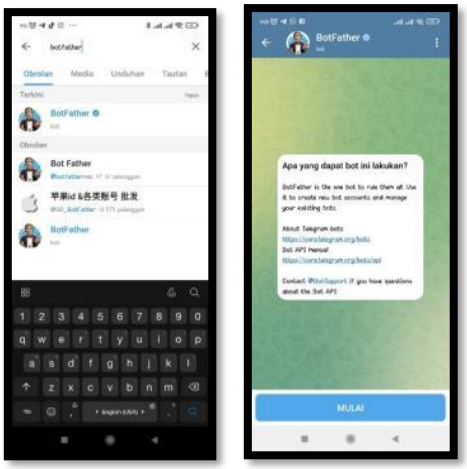

Figure 7. " Botfather " column

b. Then click **Start.**
c. Then select or type ***"/newbot"*** and type the name of the Bot we want without spaces. Make sure the Bot name is unique and has never been used by another bot. For this time, the author is registered with the name *@RemoteAcIot_bot*.

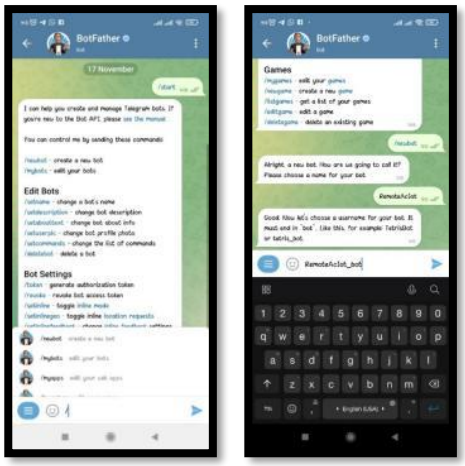

Figure 8. Column " Newbot "

d. Then, if the bot father replies by sending a token, it means that the Bot name we registered was accepted.
e. Type in the search field with the name of the Bot that we have successfully registered. If it appears, it means that the telegram bot is ready to communicate automatically with *the ESP32 Board*.

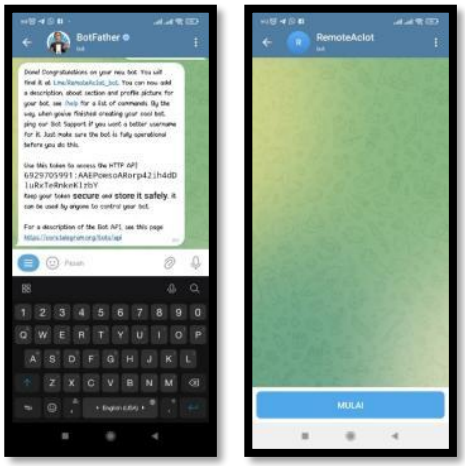

Figure 9. Successfully registered Branda Telegram Bot Column

Install the ESP32 Board in the Arduino IDE application

Because the author uses the ESP32 microprocessor. To start programming the ESP32 using the Arduino Ide, the Board must first be configured so that the Arduino Ide is connected to the ESP32 microprocessor module.

Here are the steps:

a. **Open Arduino IDE** >> Select **File >> Preferences menu**

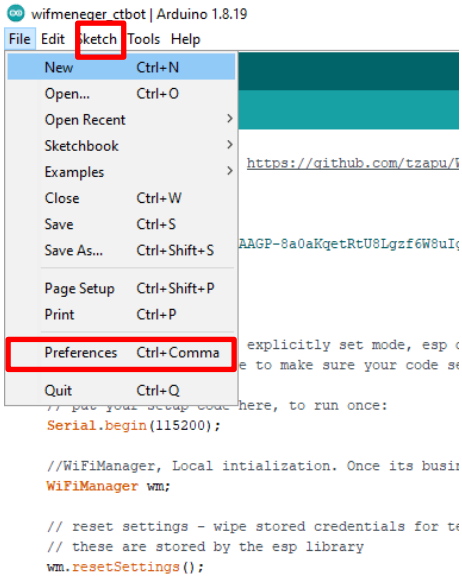

Figure 10. Arduino Idea

b. Preferences column, enter this link *https://dl.espressif.com/dl/package_esp32_index.json* in the field that . Then click OK.

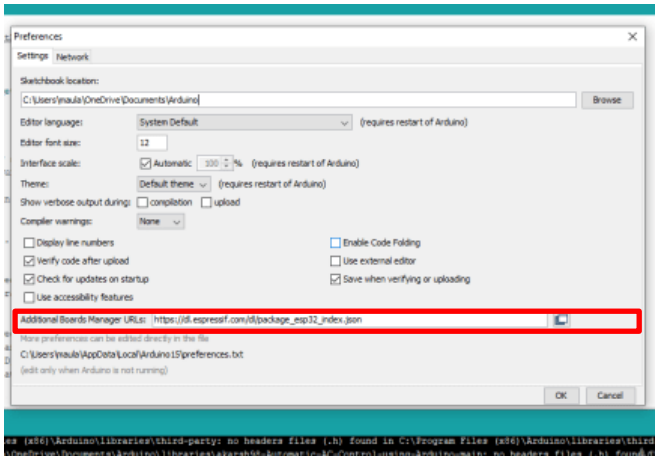

Figure 11. Arduino Idea Reference Column

c. Close the **Preferences Window** , go to **Tools >> Board >> Boards Manager**

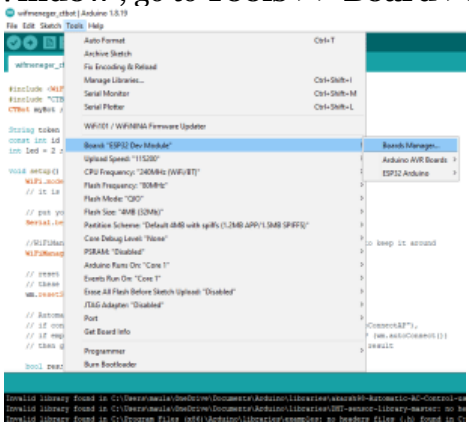

Figure 12. Tools, Board, Board Manager

d. Boards Manager window , type **ESP** >> select the highest version from >> then click **Install**

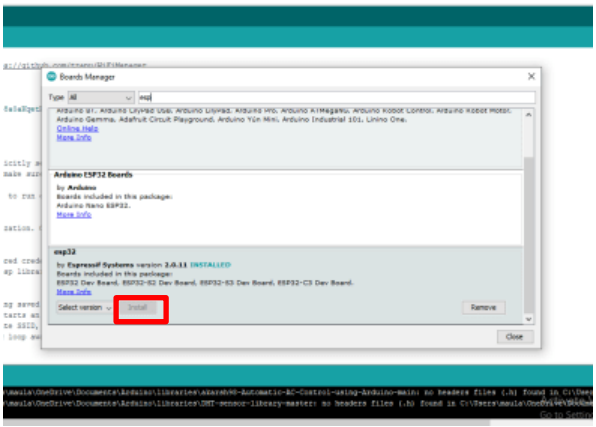

Figure 13. Windows Board Manager, ESP

e. Next, select **the Tools** >> **Board Menu** > >Select **the ESP32 Dev Module**

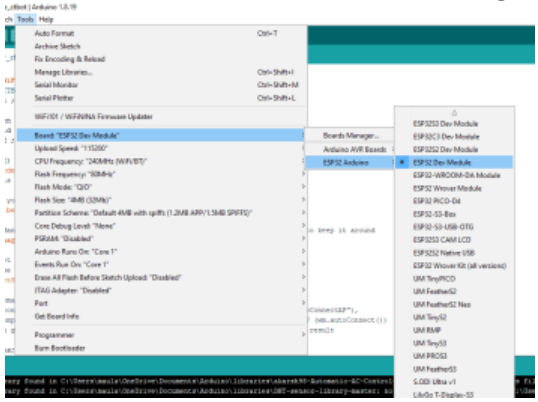

Figure 14. Menu Tools, Board, ESP32 Developer Module

f. Connect the ESP32 Module to your Laptop as shown in the image below.

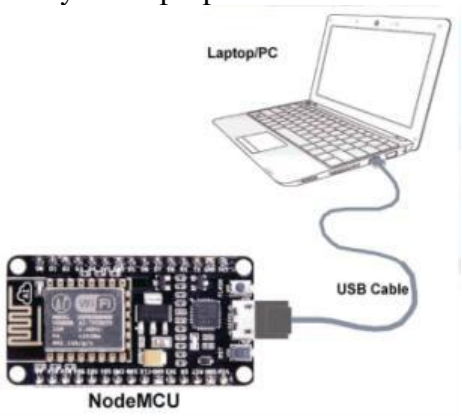

Figure 15. Connecting the ESP32 Module to a Laptop

g. Make sure **the USB PORT** is connected as shown in the image below .

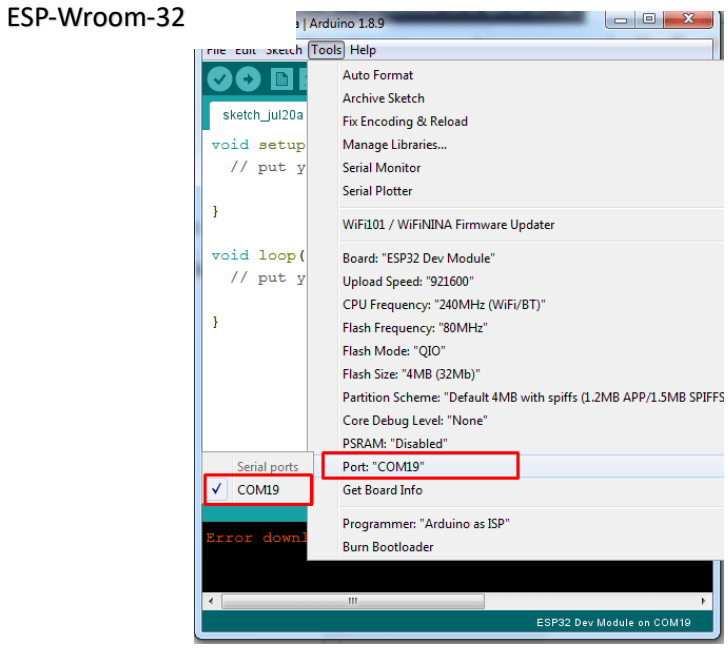

Figure 16. Connected USB Port

Type the Program Code below for Test and make sure the ESP32 Serial Port is working properly.

Table 1. Program Code ESP32 Serial

ESP32SerialTest//
cancel setup( )
{
serial.begin (115200);
}
loop ( )
{
Serial.println (" ESP32 Serial Test ");
delay(1000);
}

h. **Upload** the program code to the ESP32 Module just like you would to an Arduino Uno or anything else.
i. When the following text appears as **connecting……_____……_____**, press the key **BOOT** on the ESP32 Module board .

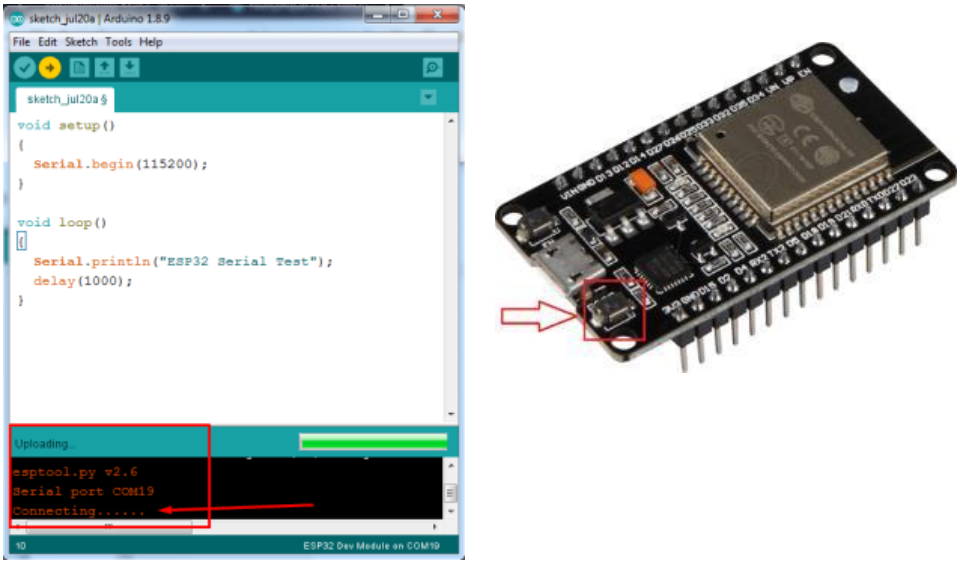

Figure 17. Connecting on the ESP32 Module Board

j. Then select **Tools** >> **Serial Monitor** . If successful, it will appear as follows in the Serial Monitor. And make sure the Baudrate uses **115200.**

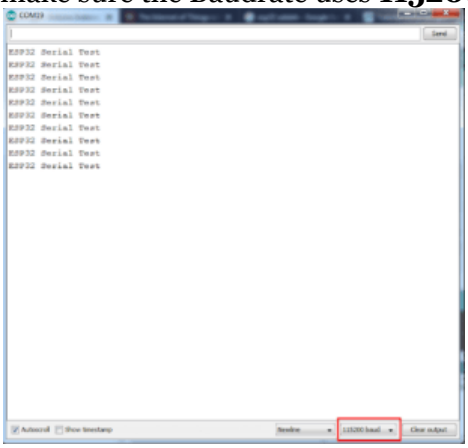

Figure 18. Serial Monitor Tool

k. The ESP32 module is ready to use and can be programmed according to commands.

Programming on Arduino Software *idea*

Programming is done after *the hardware* is complete. All hardware is tested whether it can run and according to desire or not. Then enter the C++ language program to the *ESP32 Board* using *the Arduino IDE software*. In it there are include, *define, setup* and *loop*.

1. The first process is # *include*. which functions to call libraries from each set used. This program can be seen in figure 19 below.

Figure 19. Hardware library calling code

2. The next process is *#define,* which functions to determine *the pin out* used on *the*

esp32 board so that the program sent is as desired. This program can seen in figure 20 below.

Figure 20. Pinout definition code used

3. The next process is to write the device variables used, such as *telegram bot, ir led, ir recv, DHT11*. This program can seen in figure 21 below .

Figure 21. Device variables used

4. Next is *void setup();* used to initialize the initial settings required by the hardware and software. This program can seen in figure 22 below .

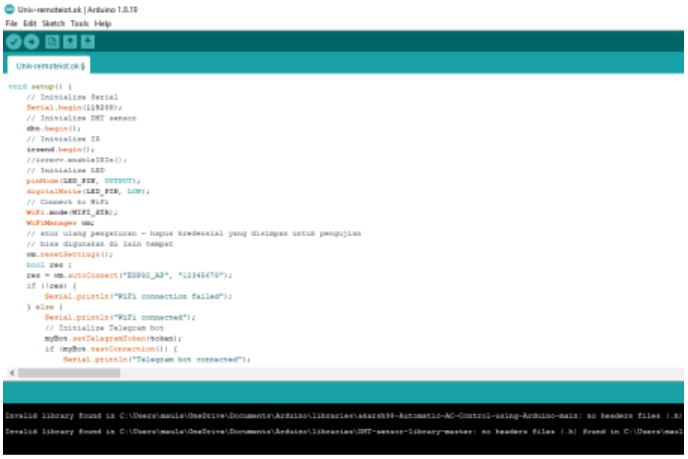

Figure 22. Cancel setup process

5. Then the last one, namely *the loop,* for *the loop the author* uses the command *void handleMassage( );* which is a special function used to process and respond to messages received from the source. certain (e.g. Telegram, MQTT, etc.). This program can seen in figure 23 below .

Figure 23. Void handles the massage process

Testing Tools on Air Conditioning Units

In the Arduino Nano test, it is done by writing a program on the Arduino IDE sketch and then *compiling it* on the ESP32 board, until the process is complete.

Preparation of Tools and Place

- Place the appliance in a position parallel to the indoor AC unit with no obstructions between the two.
- Make sure the USB Type-C cable is connected as a 5V power source. to tools and indicators light up .
- This means the tool is ready to use.

Connect to Wifi

- Connect your phone to the device by linking using the ESP32 Access Point Board. Password customized with coding on Arduino IDE
- Tap ESP32_AP to continue to *menu Wifi Manager* For configuration wifi House .
- Select the home wifi with the strongest signal. Then click the (√) sign
- The Wifi Manager window will close automatically, meaning the device is connected. to wifi home and ready used .
- Marked by the indicator light on the device turning blue.

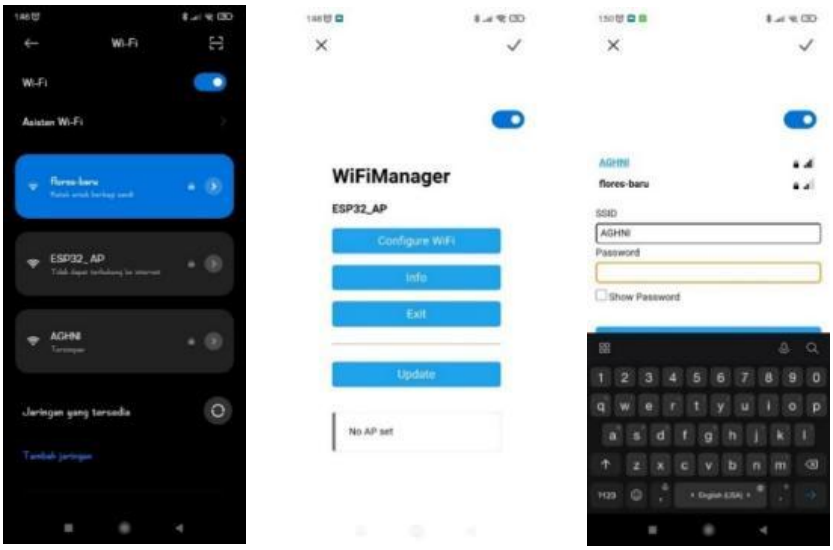

Figure 24. Configuration Wi-Fi

Telegram Connection Test

- If the blue indicator LED lights up, it means the device connection with the telegram bot is connected.
- And the telegram is ready to send messages
- This corresponds to the coding command as shown in the image below.

```
// Initialize Telegram bot
myBot.setTelegramToken(token);
if (myBot.testConnection()) {
    Serial.println("Telegram bot connected");
    digitalWrite(LED_PIN, HIGH);
} else {
    Serial.println("Telegram bot connection failed");
    digitalWrite(LED_PIN, LOW);
    //while (true); // Stop here if Telegram bot fails to connect
}
```

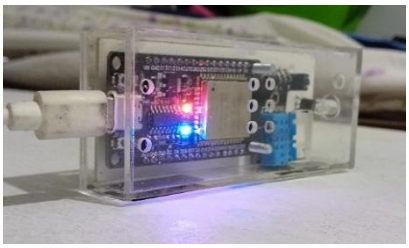

Figure 25. Telegram bot connectivity process

AC On, Off, Temperature Check Test

- Send the command "/on" via Telegram.
- Wait a few seconds, until the telegram gets a reply message from the device "AC is turned on" and the blue LED lights up, meaning the device has sent a signal to the AC unit.
- Send the command "/off" via Telegram.
- Wait a few seconds, until the telegram gets a reply message from the device "ac turned off" and the blue led lights up, meaning the device has sent a signal to the AC unit.
- Send the command "/temperature" via Telegram.
- Wait a few seconds, until Telegram gets a reply message from the tool "current temperature: " according to the room conditions.
  The process can be seen in figure 25 below.

Telegram Message Sending Process

Equipment Condition When AC is Off

Equipment Condition When is On

Figure 26. Tool Testing

CONCLUSION

Development smart air conditioner remote control system IoT based is step significant progress in automation home and management energy. The literature that has been reviewed show that system kind of This offer benefit substantial, starting from efficiency more energy height and comfort user until sustainability a more environment good. With integrating IoT with AC system, it is possible For create solution smart to overcome limitations of traditional AC units and contribute to the goal savings global energy.

Proposed prototype aiming For give benefit This with insert temperature sensor, accessibility distance far, and algorithm intelligent to in system AC control. Research This No only fill in lack in understanding moment This about IoT potential in management energy but also provides solution practical for users who search control more big on device House ladder them. Along with accessibility IoT technology is increasingly wide, adoption smart air conditioning system This possibility will increase, in the end contribute to a better future sustainable.

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