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Air Conditioner (AC) Operation Using the Internet of Things

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Abstract: Create an Internet of Things-based Air Conditioner operating system to make it easier to operate the AC. This research examines whether the system designed can transmit IR Code via IR Transmitter to AC if the device is placed at different distances. The steps to make it happen are to follow the stages of the prototyping method, which consist of gathering requirements, developing prototypes, and testing prototypes. The hardware circuit built consists of the Node MCU ESP8266, DHT 11 sensor, Infra-Red, software consisting of Arduino IDE, and blynk. By placing the NodeMCU ESP 8266 in positions with different distances, the tool can send IR Code data via the IR Transmitter to the AC, buttons on the blynk application have been made and can work according to their functions. The test was carried out with 4 different location positions, namely position 1 with a distance of 1 meter, position 2 with a distance of 3 meters, position 3 with a distance of 2 meters, and position 4 with a distance of 4 meters. From 4 test location positions with sufficient category signals to very good categories, microcontrollers can be connected to the blynk application on smartphone users. The Blynk application can function according to the commands made, the IR code can be sent through the IR transmitter to the air conditioner (AC). The DHT 11 sensor successfully measures the temperature and humidity of the air. Hopefully, in the future, the development of this tool into a multi-controller capable control not only AC but also other electronic devices.

Keywords: Air Conditioner; Blynk; Internet of Things; Infra-red; NodeMCU ESP8266.

Introduction

The development of technology is increasingly rapid but there are still many electronic equipment, one of which is AC (Air Conditioner) which is a machine made to stabilize the temperature and humidity of the air in a room by cooling or heating the room (Andriulo et al., 2024; Davis et al., 2021), whose operation is still done locally using a switch or using a remote control. So it requires someone in the room to operate the air conditioner so that when someone from outside the room arrives in the room the new air conditioner is turned on so that they have to wait a while for the room to cool, and someone can forget to turn off the air conditioner when leaving the room (Jasim et al., 2021; Sung & Hsiao, 2020).

So by utilizing the concept of IoT (internet of things) technology, namely to be able to connect humans with devices or devices with devices to obtain or share data (Mukhsin & Yulianti, 2021; Yuan et al., 2021), and an infrared receiver to capture infra code from the remote control, as well an infrared transmitter which functions to send infrared code to AC (Aldiansyah et al., 2022; Diori et al., 2019), so it can replace the remote control. By using the NodeMCU ESP8266 microcontroller as a control system and using BLYNK to connect smartphones with microcontrollers, as long as the microcontroller and smartphone are connected to the internet, they can operate the air conditioner from anywhere. Signal quality is a barometer of wifi signal quality to find out whether wifi is good or bad. The better the wifi network analyzer signal produced, the faster the connectivity (Efendi, 2018). The amount of wifi signal is indicated by dBm units which is an absolute value of the power unit, calculated as 10log power value / 1mW. If the value shown is greater then the signal

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strength will be smaller, for example (-90 dBm is smaller than - 75 dBm), the signal -75 dBm is stronger or can be called better than -90 dBm. The quality standards for the Signal to Noise Ratio (SNR) quality variable on the Signal Level indicator are as follows (Alwi, 2019).

This research was conducted to find out how IoT-based air conditioning control systems can interact and coordinate with other smart devices in the home or building (e.g., window/door sensors, lighting, and security systems). This can result in a more intelligent response to changes in the environment or user activity. And also develop systems that can respond to signals from the power grid, such as dynamic energy prices or response requests (Rachman et al., 2020). Air conditioners can automatically adjust their energy consumption during peak load periods or when electricity prices are high. For commercial applications, research can focus on more seamless integration between IoT-based air conditioning control systems with a wider range of BMS, enabling more holistic energy and facility management (Ekayana, 2019; Faiazuddin et al., 2020).

The purpose of this study is to find out the implementation of Internet of Things-based Air Conditioner operating tools, to determine the quality of sending IR Code signals through IR Transmitters to AC if placed in different places, and to determine the strong influence of wifi signals and internet networks on AC operation (Atlam et al., 2017; Pribadi, 2020; Singh et al., 2020).

Method

Research Flowchart

When research is more focused, it is necessary to have steps in the research procedure can be seen in the flowchart Figure 1 research steps start from reading a journal or thesis to determine what you want to make for the thesis, after determining what you want to make, then an understanding of this thesis, after that buy tools and materials and then assemble according to what has been planned, Programming on the microcontroller after that is checked on the performance of the tool whether it is in accordance with the desired expectations.

Table 1. Comparison of signal quality levels

Signal quality	Signal strength value (dBm)
Very good	<-60dBm
Good	-60 to -70dBm
Simply	-71 to -80dBm
Bad	-81 to -90dBm
Very Bad	<-90dBm

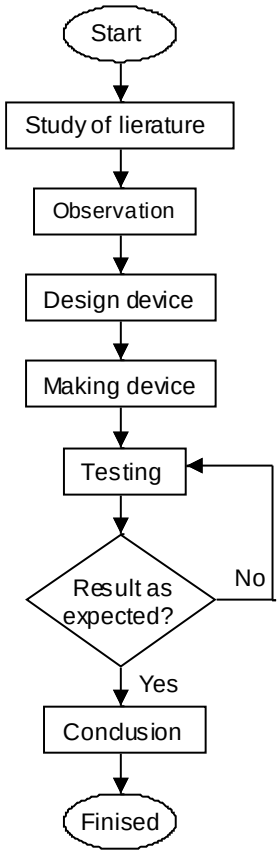
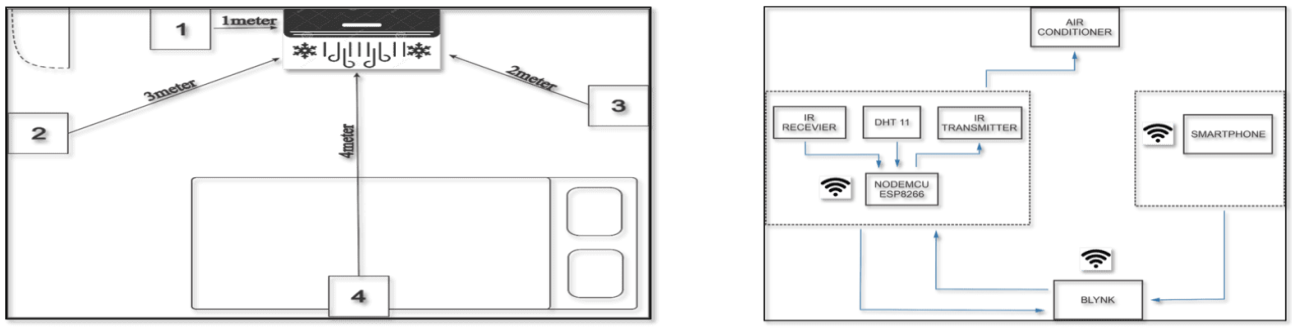


Figure 1. Research Flowchart



(a) (b)

Figure 2. Research design: (a) tool testing equipment floor plan; and (b) block diagram equipment.

Briefly how this system works can be explained as follows. First, *the smartphone* and NodeMCU ESP8266 are connected to a *wifi* or internet network (Kemala et al., 2022), ESP8266 serves as a controller (Cameron, 2020). Blynk is used to display the *user interface* of the air conditioning control system and monitor the temperature and humidity of the room that has been made previously in the Blynk application (Kamarudin et al., 2022). The initial step of creating an account on the *Blynk application then making the interface* display according to the design you want to make, then connected between Blynk and ESP8266 through the code entered in the code, after that if it is connected there are menu options that have been made to control the air conditioner. Then ESP8266 sends an IR Code signal to AC via IR Transmitter. In addition, a feature is added to monitor the current temperature status of the air conditioner, and there is a feature to monitor temperature conditions and air humidity in the room.

Hardware Design

By using the NodeMCU ESP 8266 microcontroller as a data processor on the AC operating device connected to sensors, first the DHT 11 sensor has 4 (four) legs, namely ground, VCC, NC (unused) and data, for data connected to pin D2, after that for IR Transmitter has 3 (three) legs, namely, data, VCC, and grounding, for data connected to pin D5, after that for IR *recevier* has 3 (three) legs, namely VCC, data, and grounding, for data connected to pin D6 (Shamsudeen, 2021).

NodeMCU's programming methods ESP8266 generally use the C++ programming language through the Arduino IDE platform. In addition, NodeMCU also supports programming using the Lua language.

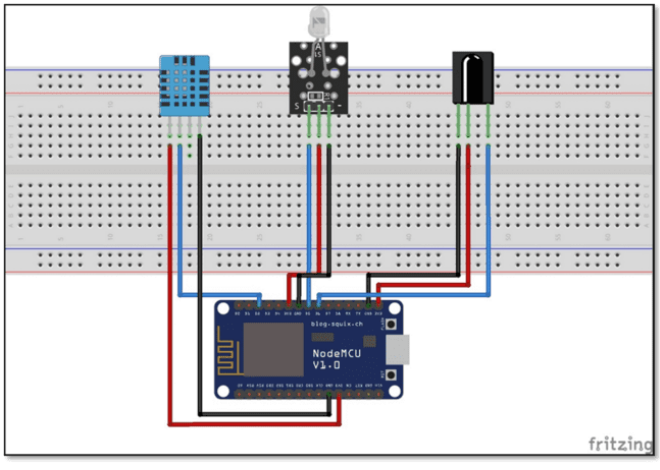


Figure 3. Hardware Design

Software Design

Figure 4 shows the display design on the blynk. There are several features and control buttons, there are features to display the results captured by the DHT 11 sensor in the form of temperature and humidity, besides that there are AC ON and OFF buttons, there are also buttons that can adjust to add and reduce the temperature of the air conditioner, and there is a button to adjust the swing so that it can move or be stationary. Blynk will send you an authentication code via email, which must be inserted into the microcontroller program in order to connect.

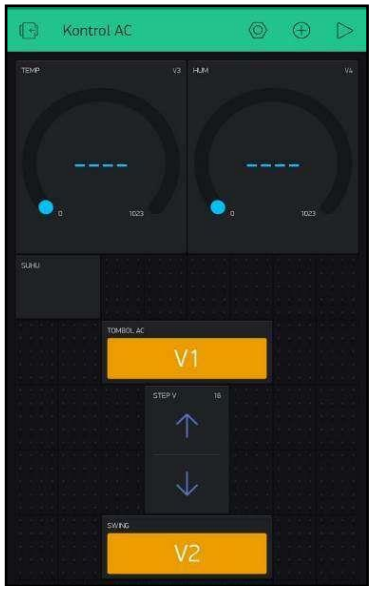


Figure 4. Blynk View

Result and Discussion

School Production Unit

In this section, testing the effect of distance on sending IR Code through IR Transmitter to AC will be carried out, by placing microcontrollers at different distances ranging from 1-4 meters in the room and for testing buttons and features in the application so that users control from inside the house and test from outside the house while still placing the microcontroller in the room with a distance of 1 meter to the air conditioner, This test is done to find out whether it can control the air conditioner from outside and indoors and also to determine the temperature and humidity in the room. Figure 5 is the result of the *Hardware implementation* and Figure 6 is the blynk display.

Position 1. The signal obtained with *a range* ranging from -29 dBm to -37 dBm, has a signal quality that can be categorized as Excellent, the microcontroller can be connected to the blynk application on *smartphone users*. So that during testing the buttons on the blynk application can function and according to the commands that have been made. When the button on the blynk is pressed, the IR Code can be sent well through the IR Transmitter with a distance of 1 meter to the air conditioner, in addition to the DHT 11 sensor manages

to capture the temperature and humidity in the room, which is 26°C / 46% and can be displayed on the blynk application. In position 1 the air conditioner operating device can run and function properly.

Position 2. The signal obtained with *a range* ranging from -40 dBm to -50 dBm, this signal has a signal quality that can be categorized as Excellent, the microcontroller can be connected to the blynk application on *smartphone users.* When testing the buttons on the blynk application can work and according to the commands that have been made. And when the button on the blynk is pressed, the IR Code can be sent properly through the IR Transmitter with a distance of 3 meters to the air conditioner. The DHT 11 sensor successfully captures the temperature and humidity in the room which is 27°C / 45% and can be displayed on blynk applications. So that in position 2 the air conditioner operating device can run and function properly.

Position 3. Signals obtained with *a range* ranging from -72 dBm to -82 dBm, this signal has a signal quality that can be categorized as Enough even though it can touch the Bad category in the Swing On Button experiment, the microcontroller can be connected to the blynk application on *smartphone users*, so that during the test the buttons on the blynk application can function and are in accordance with the commands that have been made. And when the button on the blynk is pressed, the IR Code can be sent properly through the IR Transmitter to the air conditioner, in addition to the DHT 11 sensor successfully captures the temperature and humidity in the room which is 28°C / 42% and can be displayed on the blynk application. So that in position 3 the air conditioner operating device can run and function properly.

Position 4 gets the results with the data contained in table 5, from the data it can be seen that if you look at table 1 of the signal quality scale, if the signal strength obtained with *a range* ranging from -58 dBm to -68 dBm is strong, this signal has a signal quality that can be categorized as Good, the microcontroller can be connected to the blynk application on smartphone users, so that during testing the buttons on the blynk application can function and are in accordance with the commands that have been made. And when the button on the blynk is pressed, the IR Code can be sent properly through the IR Transmitter to the air conditioner, in addition to the DHT 11 sensor successfully captures the temperature and humidity in the room, which is 27°C / 45% and can be displayed on the blynk application. So that in position 4 the AC operating tool can run and function properly.

Teaching factory models will be able to integrate school learning and industrial practice with the help of professional school management and effective collaboration with industrial companies. Such a model will be extremely beneficial in producing qualified and competent workers for the modern era. Educational policymakers and stakeholders might take the implementation of the teaching factory model into more serious consideration in an attempt to get students ready for jobs and contribute to social work. Further and more detailed investigation of the teaching factory's effect on each Industry 4.0 competency is worth researching.

The test was carried out with 4 different location positions, namely position 1 with a distance of 1 meter, position 2 with a distance of 3 meters, position 3 with a distance of 2 meters, and position 4 with a distance of 4 meters. From 4 test location positions with sufficient category signals to very good categories, microcontrollers can be connected to the blynk application on smartphone users. The Blynk application can function according to the commands made, the IR code can be sent through the IR transmitter to the air conditioner (AC). The DHT 11 sensor successfully measures the temperature and humidity of the air.

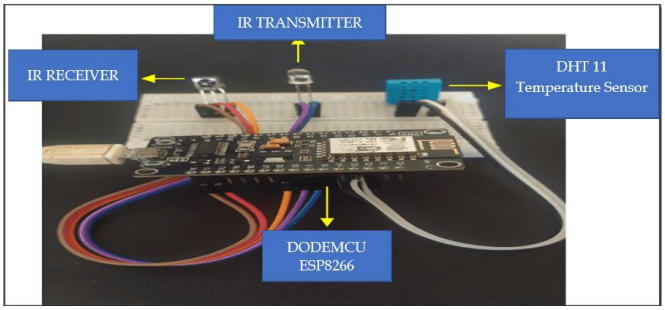


Figure 5. Results of device Implementation

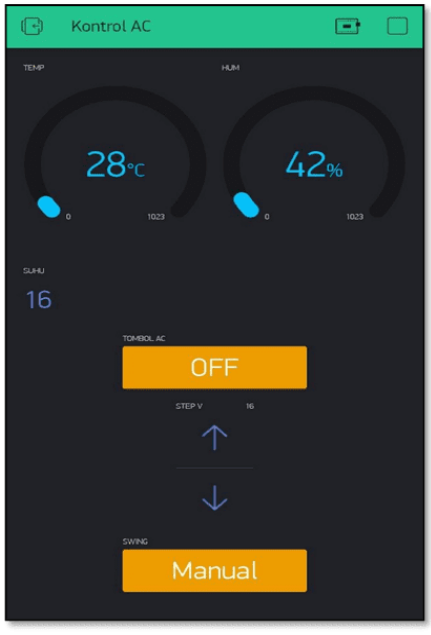


Figure 6. Blynk View

In-House Testing 1 meter distance

Testing at position 1 gets results with data contained in Table 2, from these data it can be seen that when viewed from table 1 of the signal quality scale, if the signal strength obtained with a *range* ranging from -29 dBm to -37 dBm this signal strength has a signal quality that can be categorized as Very Good, the microcontroller can be connected to the blynk application on *smartphone users* , so that when testing the buttons in the blynk application can function and are in accordance with the commands that have been made. And when the button on the blynk is pressed the IR Code can be sent properly through the IR Transmitter with a distance of 1 meter to the air conditioner, besides that the DHT 11 sensor successfully captures the temperature and humidity in the room which is 26 ° C / 46% and can be displayed in the blynk application. So that in position 1 the AC operation tool can run and function properly as represented by Table 2.

Table 2. Position 1 test results from inside house

Distance (meter)	Temperature (°C) and Humadity (%)	Button	Result
1	26°C / 46%	ON button	Successfully
		OFF button	Successfully
		Temperature up button	Successfully
		Temperature down button	Successfully
		Swing On button	Successfully
		Swing Off button	Successfully

In-house Testing 3 meters distance

Testing at position 2 gets results with data contained in table 3, from these data it can be seen that when viewed from table 1 signal quality scale, if the signal strength obtained with a *range* ranging from -40 dBm to -50 dBm this signal strength has a signal quality that can be categorized as Very Good, s microcontroller can be connected to the blynk application on *smartphone users* , so that when testing the buttons in the blynk application can function and are in accordance with the commands that have been made (Isyanto et al., 2019). And when the button on the blynk is pressed the IR Code can be sent properly through the IR Transmitter with a distance of 3 meters to the air conditioner, besides that the DHT 11 sensor successfully captures the temperature and humidity in the room which is 27 ° C / 45% and can be displayed in the blynk application. So that in position 2 the AC operation tool can run and function properly as represented by Table 3.

Table 3. Position 2 Test Results from Inside the House

Distance (meter)	Temperatutre (°C) and Humadity (%)	Button	Result
3	27°C / 45%	ON button	Successfully
		OFF button	Successfully
		Temperature up button	Successfully
		Temperature down button	Successfully
		Swing On button	Successfully
		Swing Off button	Successfully
		Swing Off button	Successfully

Table 4. Position 3 Test Results from Inside the House

Distance (meter)	Temperature (°C) and Humadity (%)	Button	Result
2	28°C / 42%	ON button	Successfully
		OFF button	Successfully
		Temperature up button	Successfully
		Temperature down button	Successfully
		Swing On button	Successfully
		Swing Off button	Successfully

In Home Testing 2 meters distance

Testing at position 3 gets results with data contained in Table 4, from these data it can be seen that when viewed from table 1 of the signal quality scale, if the signal strength obtained with a *range* ranging from -72 dBm to -82 dBm this signal strength has a signal quality that can be categorized as Sufficient even though it can touch the Bad category in the Swing On Button experiment, Microcontrollers can be connected to the Blynk application on *smartphone users*, so that when

testing the buttons on the Blynk application can function and are in accordance with the commands that have been made. And when the button on the blynk is pressed the IR Code can be sent properly via the IR Transmitter to the air conditioner (Cardillo et al., 2021), besides that the DHT 11 sensor successfully captures the temperature and humidity in the room which is 28 ° C / 42% and can be displayed on the blynk application. So that in position 3 the AC operation device can run and function properly.

In Home Testing 4 meters distance

Testing at position 4 gets results with data contained in Table 5, from these data it can be seen that when viewed from table 1 of the signal quality scale, if the signal strength obtained with a *range* ranging from -58 dBm to -68 dBm this signal strength has a signal quality that can be categorized as Good, the microcontroller can be connected to the blynk application on *smartphone* users , so that when testing the buttons in the blynk application can function and are in accordance with the commands that have been made (Durani et al., 2018; Pramana et al., 2025). When the button on the blynk is pressed the IR Code can be sent properly through the IR Transmitter to the air conditioner, besides that the DHT 11 sensor successfully captures the temperature and humidity in the room which is 27 ° C / 45% and can be displayed in the blynk application. So that in position 4 the AC operation tool can run and function properly.

Table 5. Position 4 Test Results from Inside the House

Distance (meter)	Temperature (°C) and Humadity (%)	Button	Result
4	27°C / 45%	ON button	Successfully
		OFF button	Successfully
		Temperature up button	Successfully
		Temperature down button	Successfully
		Swing On button	Successfully
		Swing Off button	Successfully

Table 6. Position 1 Test Results from Outside the Home

Distance (meter)	Temperature and Humadity	Button	Result
1	27°C / 45%	ON button	Successfully
		OFF button	Successfully
		Temperature up button	Successfully
		Temperature down button	Successfully
		Swing On button	Successfully
		Swing Off button	Successfully

Outdoor Testing distance of 1meter

The test results in Table 6 by placing the AC operating device in position 1 with a distance of 1 meter, and the *user* testing from outside the home, with reference from table 1 Signal Quality Scale, with a signal strength ranging from -73 dBm to -80 dBm the quality of the signal strength obtained by the *user's smartphone* can be categorized as Sufficient and microcontroller with Very Good signal strength quality with *range* The signal strength obtained starts from -28dBm to -35dBm, the microcontroller can be connected to the blynk application on *smartphone users* (Wei et al., 2021), so that when testing the buttons in the blynk application can give instructions to the microcontroller in accordance with the functions that have been made. And when the button on the blynk is pressed the IR Code can be sent properly through the IR Transmitter to the air conditioner (Afandi et al., 2021), besides that the DHT 11 sensor successfully captures the temperature and humidity in the room which is 27 ° C / 45% and can be displayed in the blynk application. So that tests carried out from outside the house of AC operating equipment can run and function properly (El Anshori et al., 2025).

Conclusion

Based on the test data, it can be concluded that the AC operating device if placed at different distances, namely at a distance of 1 meter, a distance of 2 meters, a distance of 3 meters, and a distance of 4 meters, when sending the IR Code through the IR Transmitter to *the Air Conditioner* (AC) does not experience obstacles or problems, while for control using the blynk application, the ON, OFF, the temperature rises, temperature drops, swing ON, Swing OFF can function as expected, and also this AC operation tool can be controlled both when indoors or outdoors, as long as it has good internet or wifi. The author hopes that in the future this tool can be developed into a *multi-controller to* be able to control not only air conditioning but also other electronic devices

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Conflicts of Interest
The authors declare no conflict of interest.

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