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Room Monitoring Uses ESP-12E Based DHT22 and BH1750 Sensors

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***Abstract*—Comfortable room is one of the services that must be provided by STMIK STIKOM Indonesia campus to students. This research designed a room monitoring tool based on ESP-12E in STMIK STIKOM Indonesia. The room monitor is designed using a DHT22 sensor to measure temperature and humidity and the BH1750 sensor to measure light intensity. The tool also includes features a 16x2 I2C LCD to display measurement results. Testing is done by testing the layout circuit on the PCB and observing the measurement of temperature, humidity, and light intensity on the LCD. The test results of all layout circuits are functioning properly, and the measurement results can appear on the 16x2 I2C LCD.**

***Keywords*—Room Monitoring; ESP-12E; DHT22; BH1750**

I. INTRODUCTION

The comfort of the classroom can affect the concentration and productivity of students and teachers in learning activities. The convenience factor is a service that schools and high schools must provide to their students. So that students are able to understand, understand and apply what the teacher says. The things that need to be considered in providing room comfort are the right temperature and humidity, adequate lighting, and supporting facilities for other teaching and learning activities [1][2][3][4][5].

STMIK STIKOM Indonesia is a high school of management informatics and computer science located on Jl. Tukad Pakerisan No. 97 Denpasar, Bali. STMIK STIKOM Indonesia has a teaching system with a theory that is also supported by practicum activities. So that teaching and learning activities are carried out in classrooms and laboratories. In supporting these activities, STMIK STIKOM Indonesia has 20 classrooms and 7 laboratories.

At STMIK STIKOM Indonesia, the infrastructure maintenance system is the responsibility of Assistant Chairman II, who is assisted by Office Boy (OB) officers. The limited number of OB officers often has problems monitoring the room. The problem that often occurs is that the class has been used, but the lights are still on, so it wastes electrical energy. The air conditioner was not working properly, causing the classroom to be hot and uncomfortable. Thus it is necessary to have a tool that can monitor and provide information about the state of the room [6][7][8][9][10].

The room monitoring tool was implemented using the ESP-12E microcontroller [11][12][13][14]. The microcontroller is an IC chip that can be programmed according to user needs [15][16][17]. The ESP-12E microcontroller is a microcontroller that has a wifi module embedded. So that the ESP-12E microcontroller can perform processing and has connectivity features using a wifi network [18][19][20][21]. Besides, the ESP microcontroller has a compact size and a large memory of 4MB. ESP-12E is a microcontroller developed by the AI-Thinker company [22][23][24][25][26]. The development of ESP-12E is intended to build a tool based on the Internet of Things or IoT. Fig. 1 is ESP-12E microcontroller [27][28][29][30][31][32].

Fig. 1. ESP-12E Microcontroller [33]

The information about the pins that are generally available on the ESP-12E microcontroller is as follows:

1. Pin Vcc is used as a pin to provide a positive voltage of 3.3V to the ESP-12E.
2. The GND pin is used as a pin to provide ground or negative voltage to the ESP-12E.
3. Pin Rest is used as a pin to reset, which is usually in a circuit containing a push button or switch.
4. ADC pin is, as the name implies, an Analog to Digital Converter where this pin is used to convert analog values to digital values at the input or output connected to the ADC pin.
5. GPIO pins or General Purpose Input Output are pins that are used as pins that can be connected to the input or

output devices used. On the ESP-12E microcontroller, there are 11 GPIO pins.

6. The Rx and Tx pins can be used for serial communication with other devices such as USB drivers and so on. Apart from these pins, there are also pins CH_PD, MISO, MOSI, SCLK, and CS0 [33][34][35].

As a processor, the ESP-12E processes measurement data from the sensor and displays the measurement results on a 16x2 I2C LCD screen [36][37][38]. The sensors used in the room monitor are DHT22 and BH1750 sensors. The DHT22 sensor is used for temperature and humidity measurements. DHT22 is a temperature and humidity sensor which is also known as the AM2302 sensor. This sensor is almost the same as the DHT11, which also has four legs [39][40][41][42][43]. The DHT22 legs are as shown in Fig. 2.

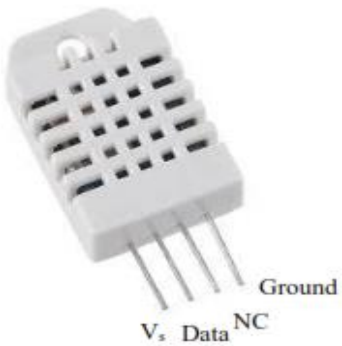

Fig. 2. DHT22 Sensor Configuration [44]

Fig. 2 shows the four legs of the DHT22 sensor, namely the Vs., Data, NC, and GND legs. Where the Vs. leg is the leg to provide a positive voltage to DHT22, which is generally a 5V voltage. Then the data leg is the leg that is connected to the microcontroller. NC or Not Connected feet are feet that are not connected anywhere or are not used. At the same time, the GND leg is a leg that is connected to the ground [45][46].

Meanwhile, to measure light intensity using the BH1750 sensor. The BH1750 sensor is a light sensor that has a digital signal output, so it doesn't require complicated calculations to display the results of light intensity measurements. This BH1750 digital light sensor can take measurements with output lux (lx) without the need to do calculations first [47].

The BH1750 light sensor has several advantages over other light sensors. The advantages of the BH1750 sensor are as follows:

1. Using I2C interface or SCL and SDA pins.
2. The output of light measurement is digital data.
3. The wide measurement range is 0 to 65535lx
4. Measurements can be measurements with sunlight sources, incandescent lamps, fluorescent lamps, and LEDs.
5. The effect of infrared rays is very small.

The results of temperature, humidity, and light intensity measurements can then be displayed on the 16x2 I2C LCD screen. A liquid Crystal Display (LCD 16x2) is a display of liquid crystal material which is operated using a dot matrix system. Liquid Crystal Display (LCD 16x2) can display 32 characters consisting of two lines, and each line can display 16 characters. This LCD also supports communication with I2C.

In addition to monitoring, the ability of this room monitoring device is to control the lights in the room. Research on room monitoring tools begins with analyzing data collection, while the data used as references are the results of interviews with Assistant Chair II and OB officer coordinators and direct observation at STMIK STIKOM Indonesia related to room monitoring tools. In addition, there are also many literature studies that are used to gather sources related to the topics raised in this study. As obtained from various sources of journals, documentation books, the internet, and libraries [48][49]. The next stage is analysis and design, implementation, and system testing.

Fig. 3. Light Intensity Sensor BH1750 [50]

II. DESIGN AND METHODS

Based on the results of the interviews with the two informants, it can be concluded that there is a need for a system that can monitor the room, which can be integrated with one another so that STMIK STIKOM Indonesia to facilitate room monitoring work and be able to provide good service to students.

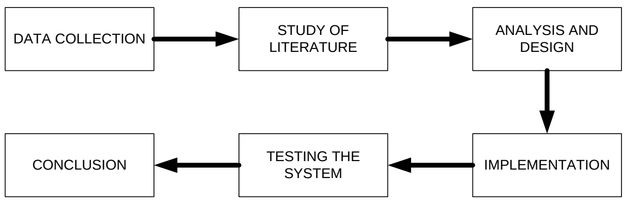

Fig. 4. Research Flow

Based on the results of the interviews with the two informants, it can be concluded that there is a need for a system that can monitor the room, which can be integrated with one another so that STMIK STIKOM Indonesia to facilitate room monitoring work and be able to provide good service to students.

Based on the data obtained, a room monitoring device can be designed, such as PCB board design tools and program code design for testing the room monitoring device.

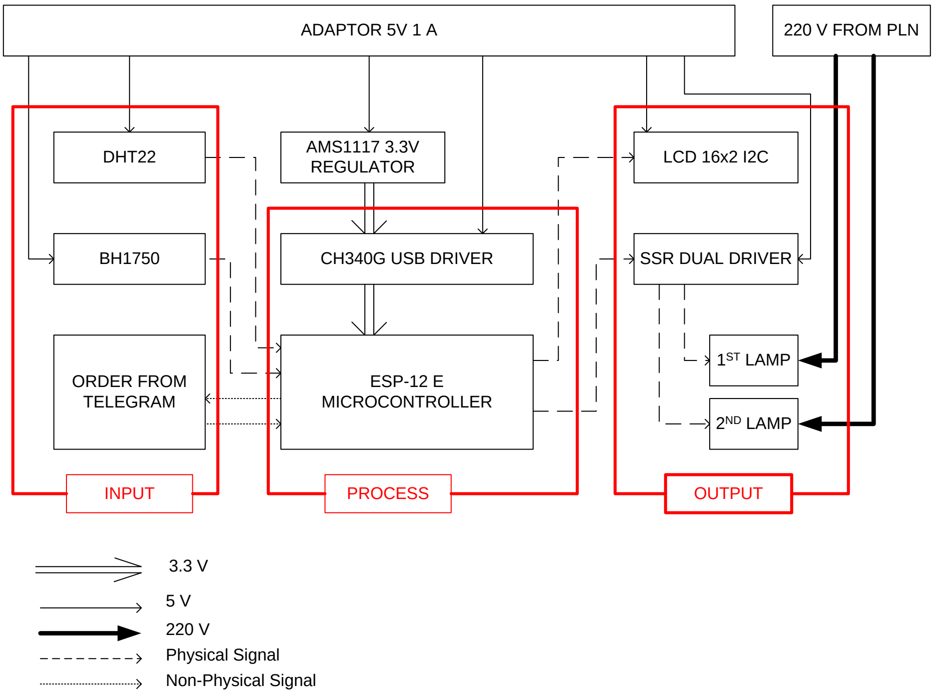

Fig. 5. Block Diagram of Room Monitor

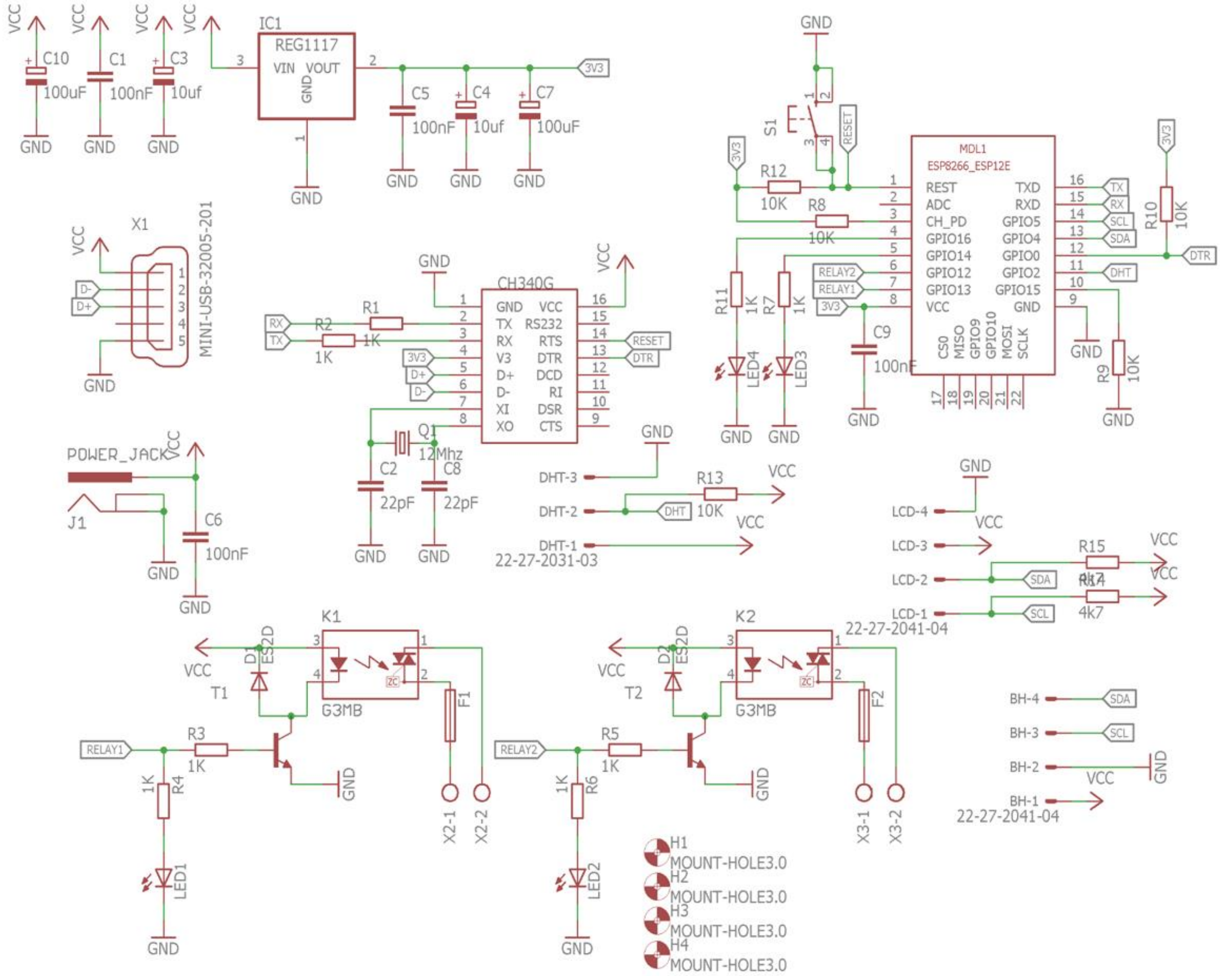

Fig. 6. Schematic of The Whole Room Monitor Circuit

The diagram block consists of an input device in the form of a DHT22 sensor and a BH1750 sensor. To process the input device, an ESP-12E microcontroller is used. On the processor, there is an IC CH340G as a USB driver. This USB driver is used so that the room monitor can be programmed using a laptop device with a USB cable. After being processed on the microcontroller, the measurement results are displayed on the 16x2 I2C LCD. the information displayed is SSR state, temperature, humidity, and light intensity. The output device which is also used is the dual-driver SSR to switch the lights in the room and, of course, the lights. After the block diagram, the design that is no less important is the schematic and PCB layout.

The schematic design of the room monitor was made using the EAGLE application. A schematic consists of several schematic parts. The schematic parts are the power circuit, the sensor circuit, the LCD circuit, the USB driver circuit, and the ESP-12E. This schematic is the basis for the PCB layout.

At the design stage, the PCB board display in three dimensions is also designed. This design can be used to obtain an overview of the shape of the PCB board and the components that will be used later on the room monitoring device PCB.

III. IMPLEMENTATION OF RESULTS

3.1 Implementation of The System

The results of the making of the room monitoring device, including the PCB board and casing, went well and in accordance with the design that had been made. From these results, the information on each component that was successfully installed on the PCB board is as follows:

1. The component in No. 1 is where the SMD-type mini USB installation is successful.
2. The component in No. 2 where the dip-type power connector is installed successfully.
3. The component in number 3 where the push-button installation for the dip type reset button was successfully carried out.
4. The component in number 4 where the dip types 12,000 crystal oscillator was successfully installed.
5. The component in number 5 where the SMD type mini USB installation is successful.
6. The component in No.6 where the SMD type ESP-12E microcontroller was installed successfully.
7. The component in No.7 where the Molex connector for dip-type DHT22 sensor is successfully installed.
8. The component in No. 8 where the Molex connector for dip-type BH1750 sensor is successfully installed.
9. The component in No. 9 where the installation of screw terminals for lamp output is successful. There are two component Terminal Screws for two different outputs.
10. The component in No. 10 where the SMD type pico fuse is installed successfully. Pico fuse is used as a safety circuit
11. The component in No. 11 where the SSR (Solid State Relay) for input in the form of an electrical signal is successfully installed. There are two SSR components for two different inputs that will be forwarded to the output of each SSR.
12. The component in No.7 where the Molex connector for dip-type 16x2 LCD sensor is successfully installed.

The implementation for the PCB was successfully printed and according to the design that had been made. For fixing components on a PCB using, two soldering methods, namely using a blower or steam solder and the usual soldering method.

3.*2 Result of The System*

Even though the tool has been implemented successfully, it is also necessary to test the entire series that has been made. There are several circuit tests, such as testing the LED circuit, the SSR circuit, the DT22 circuit, the BH1750 circuit, and the 16x2 I2C LCD circuit.

LED circuit testing is carried out to determine whether the LED circuit can be used properly. So that the LED circuit can be used according to its function, namely, serial communication indicators with laptops, room temperature threshold indicators, and SSR indicators. After finishing uploading the program code that has been made, the room monitoring device is paired with a 5V voltage source from the adapter. Next, do a test for each LED condition, both given a LOW and HIGH signal to find out whether the four LEDs can turn on or off according to the program code that is being run. The LED circuit test table is shown in Table 1.

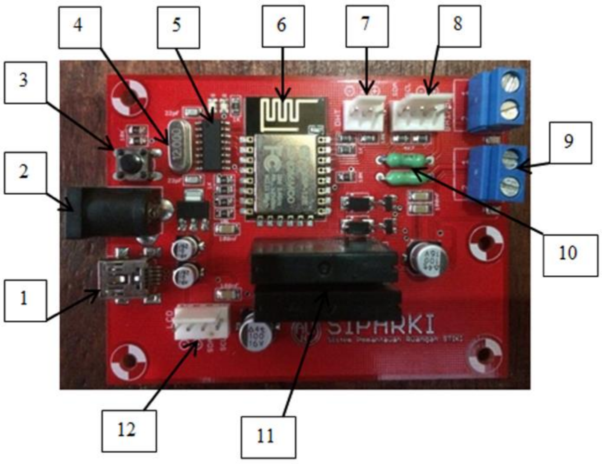

Fig. 7. Implementation of System

TABLE 1. LED CONDITION TEST TABLE

Test to-	Signal condition				Results
	LED 1 Pin 16	LED 2 Pin 14	LED 3 pin 13	LED4 pin 12	
1	LOW	LOW	LOW	LOW	Succeed
2	HIGH	LOW	LOW	LOW	Succeed
3	HIGH	HIGH	LOW	LOW	Succeed
4	HIGH	HIGH	HIGH	LOW	Succeed
5	HIGH	HIGH	HIGH	HIGH	Succeed

From the test results, it was found that the four LEDs managed to turn on and off according to the programmed conditions. It can be ensured that the LED circuit is functioning properly. So, for development to become an indicator, it can be done by programming the tool according to the overall program of the room monitoring tool. The example of an LED circuit test image is shown in Fig. 8.

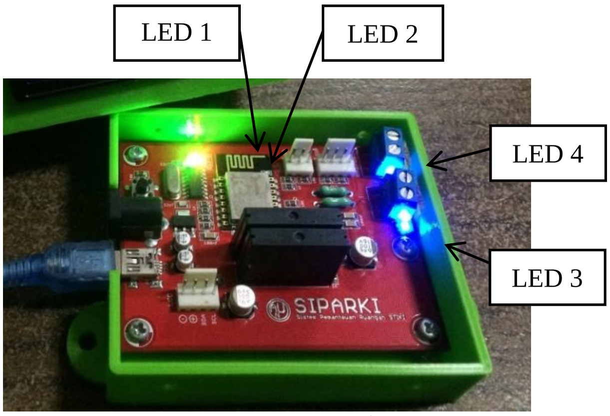

Fig. 8. Testing the LED circuit on the condition of all LED's HIGH

It is furthermore testing the SSR series. Testing the SSR circuit is done by checking the pin on the screw terminal. The test results of the SSR circuit are successfully carried out by marking with the AVO Meter, showing that the pin is connected. The connected pins will connect the load cable that is attached to the voltage source. This is because if a lamp is installed, the light will turn on.

Fig. 9. SSR Testing

Know the SSR circuit can work properly. So that the SSR circuit can be used in the entire program code, the use of SSR here is to perform digital switching at a voltage of 220V using a low voltage of 5V. Tests were carried out under HIGH and LOW conditions on the SSR1 and SSR2 circuits. The table of tests carried out on SSR testing can be seen in Table 2.

TABLE 2. TEST CONDITIONS FOR THE SSR CIRCUIT

Test to-	Signal condition		Results
	SSR1 pin 13	SSR2 pin 12	
1	LOW	LOW	Succeed
2	LOW	HIGH	Succeed
3	HIGH	LOW	Succeed
5	HIGH	HIGH	Succeed

Please note that the LED indicator and the SSR input pin are on the same pin, namely pin 13 and pin 12. So, only one variable is used for its application. Based on the results of the tests carried out on all signal conditions as in table 2, the results of the SSR1 and SSR2 circuits are successful and can be used. For condition testing, results are also obtained by the program code that has been uploaded to the room monitoring tool. While the direct test is carried out using an energy-saving light bulb that is connected to a voltage of 220V PLN electricity. The examples of tests carried out are shown in Fig. 10.

Fig. 10. Testing the SSR circuit on SSR2 in HIGH. Conditions

LCD testing is done by displaying the characters on the LCD. The results of the LCD circuit testing have been successfully carried out by having the characters appear on the LCD screen.

Fig. 11. LCD Testing

LCD testing is done to find out whether the LCD circuit can work properly. The test is done by displaying the characters on the LCD screen. As is well known, the LCD communicates using the SCL and SDA pins or pins 5 and 4. The results of the tests carried out on the LCD circuit are as shown in Fig. 11. LCD testing is also an important test because communication uses SCL and SDA pins or pins 5 and 4 where these pins are also used by the BH1750 sensor. So in this LCD circuit, a 4K7 pull-up resistor is given to avoid floating or floating values to become a high signal. So that the LCD and the BH1750 sensor can later be used in conjunction with this 16x2 I2C LCD, based on the tests carried out as shown in Fig. 11, it can be concluded that the LCD circuit can work well. This is indicated by the appearance of letters on the LCD.

Testing of tools to connect to wifi networks is also carried out, considering that the ESP-12E can work using the internet network. The result is the ESP-12E is successfully connected to the wifi network.

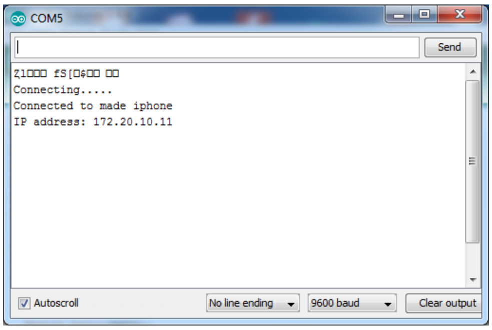

Fig. 11. ESP-12E Testing Connected to Wifi

Testing of the LED circuit, DHT22 sensor and BH1750 sensor circuit were also carried out. The test results obtained that the tool can measure temperature and light intensity according to the program code made.

IV. Conclusion

The results of the research show that all electronic circuits on the PCB are working well and in accordance with the design that has been made. The DHT22 sensor and BH1750 sensor can also take measurements and display the results of temperature, humidity, and light intensity measurements on the 16x2 I2C LCD. For lamp switching, using SSR was also successful.

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