IJSR International Journal of Scientific Research

p-ISSN: 1234-5678 e-ISSN: 1234-567x

Received date 28 February 2021; Revised 26 March 2021; Published 3 April 2021

DOI: 10.25299/IJSR.2023.11xxxxxx

Web Based Environmental Monitoring System Using Arduino Microcontroller

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Abstract: Environmental quality is one of the most important natural factors, air is one of the most important environmental factors in life and its quality needs to be maintained and improved so that it can support living things, especially humans. The need for data regarding environmental conditions has encouraged people to create tools that can determine the condition of an environment in real-time. The existence of this system will make it easier for researchers to see the quality of an environment, making it easier for researchers to get environmental quality data from anywhere, just by using Arduino tools or from monitoring websites. The Arduino tool that is assembled with the Ethernet Shield 5100 module makes this microcontroller able to connect to the internet. Meanwhile, for interfacing with the internet using a web server that provides a display from a browser, the parameters monitored consist of 3 parameters, namely dust, temperature, and humidity. The results of this study are an environmental monitoring system that can simplify and help ease the user in carrying out environmental monitoring in real time. Further development for the future that can integrated to the mobile platform as the data in cloud computing.

Keywords: Arduino, Temperature, Humidity, Dust, Monitoring

1. INTRODUCTION

In an era that has begun to develop rapidly, environmental quality is one of the most important natural factors, air is one of the most important environmental factors in life and its quality needs to be maintained and improved so that it can support living things, especially humans. The need for data regarding environmental conditions has encouraged people to create tools that can determine the condition of an environment in real-time. From these problems, it is certainly not easy to design a measuring instrument that can detect and monitor environmental quality with standard sensors, but we want to obtain accurate data, especially temperature monitoring which is carried out continuously.

Monitoring itself is defined as monitoring an activity carried out whether it is following the plan or not [1]. In this problem, we will monitor the environment from 3 parameters, namely temperature which is a thermodynamic quantity that indicates the magnitude of the average translational kinetic energy of molecules in a gas system, the temperature is measured using a thermometer [2] and temperature indicates the degree of heat of the object. The second parameter is humidity which is a state level caused by the presence of water vapor which causes the air environment to become wet or humid [3]. The third parameter is dust, in general dust is solid particles produced by mechanical processes such as crushing, softening, fast packing, blasting, processing, and others from organic and inorganic materials, for example, wood dust, stone, and grain. substances and so on [4].

The system built will use Arduino, where Arduino is an electronic board that contains an ATMega328 microcontroller. The ATMega328 itself is a chip that functionally acts like a computer, this board has 14 digital input/output pins (six of which can be used for PWM output) [5]. As the sensor, it will use the DHT22 sensor which is a packaging module for temperature and relative humidity sensors in one package [6], and the Sharp Optical Dust Sensor (GP2Y1010AU0F) which is very effective in detecting very fine particles, using an infrared diode and a phototransistor diagonally as a light detector. reflected from dust in the air [6].

In connection with the above, the author aims to develop a system for monitoring the state of an environment using an Arduino-based Ethernet shield. The title that will be raised for this research is "Web-Based Environmental Monitoring System Using Arduino. This work focusing how to monitor the environmental parameters automatically throughout the web base and for the future development apply on mobile platform that can monitor in anywhere as well as anytime. In the end of the work the system can help community to monitor the environments easily.

2. LITERATURE REVIEW

The difference between this research and the research being developed by the author lies in the type of microcontroller used, in this study the Arduino Uno microcontroller was used, while in this study the Atmega8 microcontroller was used. In [7] an article entitled Comparison of accuracy of temperature and humidity measurements between DHT11 and DHT22 sensors (comparative study on ATMEL AVR and Arduino platforms). This study only discusses the comparison of two sensors based on the accuracy of which sensor is better, and the results obtained are that the DHT22 sensor has better accuracy than DHT11 with a relative measurement of 4% temperature and 18% humidity. This research, only discusses comparisons between two sensors, while in the research that the author will build, it only uses one sensor by applying it to the Arduino Uno platform. In the research of numbering [8] a study entitled Arduino Uno-Based Room Temperature Control and Humidity Monitoring System Using DHT22 and Passive Infrared (PIR) Sensors. This research resulted in a temperature and humidity control system in a room, using DHT22 and Passive Infrared (PIR) sensors as detectors of human movement in a room. The difference between this research and the research that the author will build lies in the sensors used, this study uses only DHT22 sensors while this study uses DHT22 and Passive Infrared (PIR) sensors [9][10].

Research conducted by [11] as in the form of a journal entitled Prototype of Co and Hc Content Detection Tools in Vehicle Cabins Using an Arduino Microcontroller. This research, it has succeeded in making a tool for detecting CO and HC levels which produce a difference in the average error value with the Gas Analyzer for CO of 19.790% and HC of 6.82%. The application of this research uses a detection system for the presence of harmful gases in the vehicle cabin, while this research controls and monitors temperature and humidity in certain environments. Research conducted by numbering [12] in the form of a journal entitled Automatic water faucet in an Arduino uno-based Bathtub using an Ultrasonic Sensor. The system is used to prevent water from overflowing using an Ultrasonic sensor which will automatically fill when the water volume range is not within the specified range and will also automatically stop filling when it is within range. So that no more water is wasted due to user negligence. This research uses an Arduino ultrasonic sensor base while this research only uses DHT22 and Optical Dust sensors [13][14].

3. METHODOLOGY

In this system, the user gets information about room conditions through a website connected to Arduino and a 16 x 2 LCD monitor in the room. The website and LCD monitor will later display temperature, humidity, and dust information, which will be received from the DHT22 sensor and the sharp optical dust sensor connected to the Arduino Uno system as shows in Figure 1.

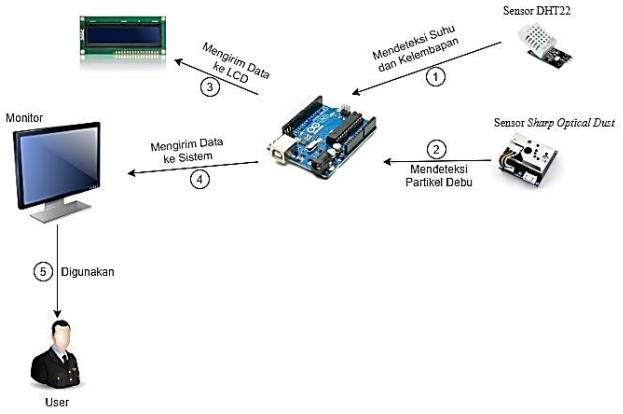


Figure 1. Design of environment monitoring used Arduino

The block diagram is a basic description of the hardware and software design of the system circuit to be designed and each block diagram has its function in terms of hardware and software. The following is a block diagram that can be seen in Figure 2.

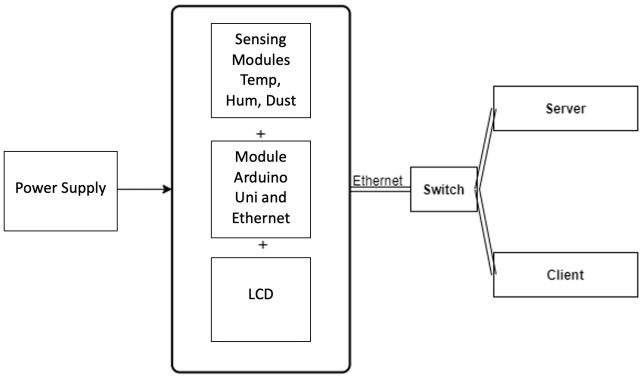


Figure 2. Function of block diagram

Refer to the block diagram design in Figure 2 it can be seen that the environmental monitoring system circuit has several blocks that have the following functions:

- The power supply is used as an input for electric current or voltage.
- Humidity and dust temperature sensor module (DHT22) is used to measure temperature, humidity, and dust.
- Main Microcontroller, which is a combination of Arduino Uno and Ethernet Shield which is used to control the entire circuit and store the program to be used.
- Liquid Crystal Display (LCD) is used to display characters in the form of temperature results on the first line, humidity results on the second line, and dust particle results on the third line.
- The switch is a link between devices that are connected with an ethernet cable. The switch functions as a signal divider and signal amplifier on a computer for a Local Area Network (LAN) network.

- The server acts as an embedded web server, which stores simple web pages used to display the results of measurements of temperature, humidity, and dust particles sent by the microcontroller.
- The client will display the results of measurements of temperature, humidity, and dust particles by asking the server.

3.1 System Design

This environmental monitoring system is made using the Arduino Uno microcontroller, programmed using Arduino software combined with various additional tools such as DHT22 sensors, and Sharp Optical Dust sensors and the results of these sensors will be displayed on the LCD and the website as an interface. Making a web-based environmental monitoring system using Arduino aims to make it easier for users to find out the level or quality of a particular environment, so that the quality of the environment can be monitored. Making this environmental monitoring system requires analysis stages that must be passed, at this stage modeling is carried out using flowcharts and circuitry on Arduino. The following are the stages of designing the tool to be built:

- Make a series of tools by making a design description as a guide.
- Assemble the sensor device with Arduino Uno using jumper cables that connect the sensor to other devices.
- Program the Arduino in the Arduino software section
- Install the system circuit to the room.

This environmental monitoring prototype was designed using Arduino Uno R3 as a microcontroller which will give commands and then be executed or carried out by other devices. In the design stage of the Arduino module in the environmental monitoring system, all components of the circuit are combined into one and will be implemented on a prototype first to test the performance of the component circuit that has been built. The following is a series of Arduino modules in the system, which can be seen in Figure 3. By connecting the microcontroller to other devices using a cable between the available pins, the devices can be connected according to their respective functions.

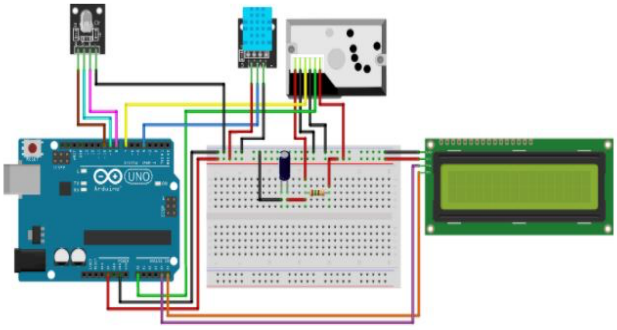


Figure 3. Arduino Uno connected to the system

3.2 Software System

A hierarchy chart is a diagram that describes complex problems described in the elements concerned. The hierarchy chart of the system to be built can be seen in Figure 4.

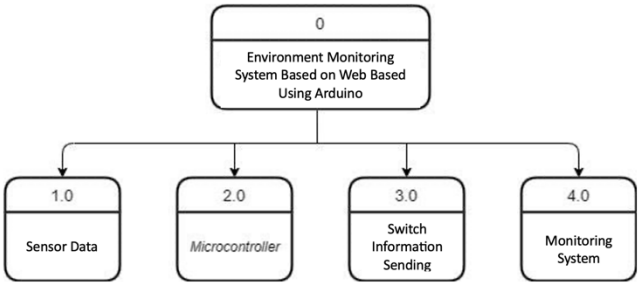


Figure 4. Hierarchy char of the monitoring system

A data flow diagram (DFD) will explain the flow of the system, this DFD will also visually describe how the data flows. The details of the process will be described in the DFD as shown in Figure 5.

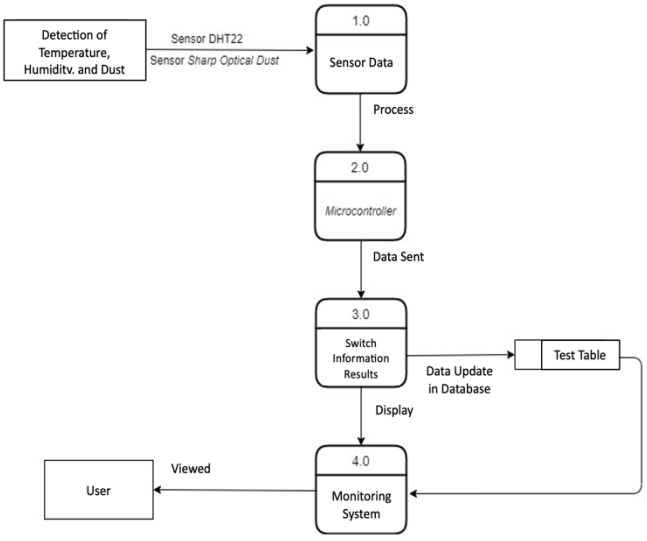


Figure 5. DFD diagram of the monitoring system

4. RESULTS AND DISCUSSION

Based on the testing have been carried out the analysis and design carried out in the previous chapter, the design of a web-based environmental monitoring system using Arduino has been made, so to find out how the Arduino device works, it is necessary to test how it works, as well as the function of the device for environmental monitoring. So that we can know the weaknesses and limitations of the system that has been made. This test aims to find out how this tool can later be used optimally.

Testing will be carried out in several stages on existing systems and tools, as follows:

- Black Box testing (black box testing)
- Testing on a series of tools and sensors.

Testing on the sharp optical dust sensor is carried out by sprinkling dust particles around the sensor so that the sensor can detect an increase in dust levels in the room from the number of particles previously detected. After the tool detects temperature, humidity, and dust in an environment, the data will be sent and displayed in the monitoring system and automatically saved to the system's database. The following is the design flow of a web-based environmental monitoring system using Arduino that will be built, which can be seen in Figure 6.

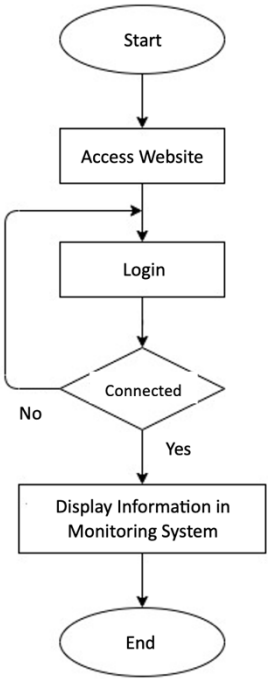


Figure 6. The process flow of the monitoring system

The measurement of the parameter of enviroemntal have done by detection of sensor reading installed in Arduino Uno Microcontroller. Figure 7 shows how the reading at the display for field and does not fill in both fields. Then the system will automatically display measurement that indicate the environemt such as temperature, humiodity dan concentration of the dust in the air. The interface develop in the web base that applicable for the future development because the database in the system can be apply for sharing in many devices.

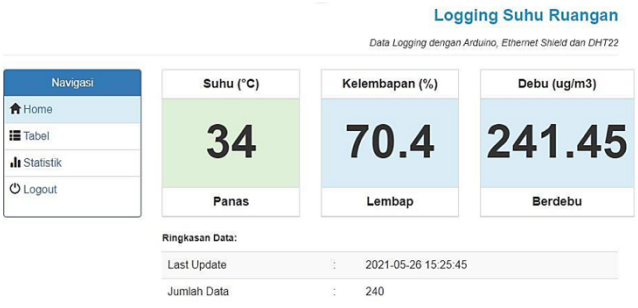
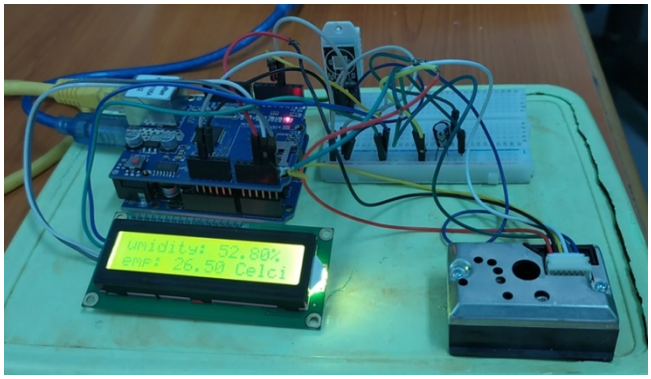
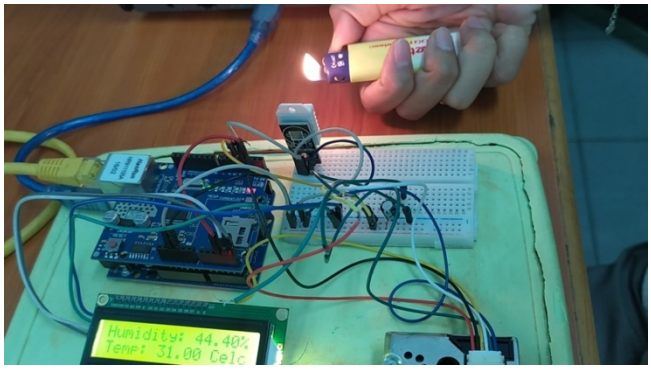


Figure 7. Reading of the measurement form microcontroller



(a)



(b)

Figure 8. Experiment for the sensor reading (a) original setup of the system and (b) testing of the temperature sensor

The author tests a room using a prototype in the room and is monitored by an environmental monitoring system. After conducting system testing, the system can monitor the state of an environment with parameters of temperature, humidity and dust particles in real time without any problems. The first test was carried out on the DHT22 sensor, when the system was turned on the DHT22 sensor was active and read the normal room temperature of 26.5 degrees C and humidity of 52.8 %. The system will read the temperature and humidity in real-time once every 1 second and the data will be displayed in the monitoring system, as shown in Figure 8.

The environmental monitoring system was built to streamline system performance which can monitor changes in temperature, humidity, and dust levels in an environment in real-time to make it easier for us to monitor environmental conditions through the system without spending more time detecting environmental conditions manually. The system in carrying out performance in monitoring the following environmental conditions is the monitoring result, which can be seen in Table 1. There is data that has been stored in the system after being detected by the device with a time span of every 1 second and sending the data will be stored in the system with a delay of 3 seconds. From this detection, the data that has been stored in the system can be displayed in tabular form as shown in Table 1.

Table 1. Sample of how to create a table

Date (2021-02-25)	Temperature (°C)	Humidity (%)	Haze (µg/m3)
22:59:09	69.2	30.7	133.54
22:59:06	69.1	30.6	149.31
22:59:04	69.1	30.7	139.35
22:59:01	69.2	30.5	145.99
22:58:59	69.0	30.7	154.29
22:58:57	69.1	30.7	145.16

Testing is carried out by taking temperature and humidity data in an environment using sensors on an Arduino machine that has been assembled. Retrieval of temperature and humidity data from the initial value is tested by increasing the room temperature value by bringing the match closer to the DHT22 sensor, which initially has a normal or low value increases and the humidity value increases from high to low due to a fire source around the sensor.

5. CONCLUSION

Based on the results of the analysis and discussion of a web-based environmental monitoring system using Arduino, the conclusion that can be drawn is that the system that the author made can simplify and help ease the user in carrying out environmental monitoring. This system can especially help users to monitor environmental conditions from parameters of temperature, humidity, and levels of dust in an environment in real-time, the feasibility of environmental monitoring applications and prototypes produced based on testing using black-box testing reaches a feasible level and there are no problems when testing the system, applications and prototypes are considered ready to be implemented in the real world.

ACKNOWLEDGMENT

This research was support by the Department of Computer Science and Information Engineering, National Dong Hwa University, Taiwan.

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