IoT-Based Smart And Healthy Wardrobe System

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***Abstract*— Having favorite clothes to last long is the desire of everyone to be able to perform optimally in public with these clothes. This is inseparable from how to store clothes and the surrounding factors can affect the quality of clothing. Air quality, especially humidity and temperature are factors that can affect the quality of clothing stored in a wardrobe. High humidity can affect clothes, it can make mold grow in clothes. The air quality needs to be considered and maintained so that conditions become optimal. This is easier to do automatically and can be monitored regularly using a mobile device. Therefore, this paper will make a system model using the IoT concept. The method used is combining 6 Arduino sensors. Those sensors will trigger dehumidifier, humidifier, and air purifier to maintain air quality. Another function that can help users choose their clothing is to use color recognition, which uses the color sensor to detect clothing colors. With the on-going research of these systems, it is expected that clothes can be more durable and healthy because they are free from mold, also it makes easier for users to choose their clothes.**

Keywords*— *IoT, air quality, sensor, smart system, wardrobe

I. Introduction

Technological developments in the IT field are growing rapidly. One of the effects of these developments can be seen from the emergence of the concept of the Internet of Things (IoT). The IoT concept emerged after the discovery of Radio Frequency Identification (RFID) and the discovery of Wireless Sensor Networks (WSN) technology in 1999 [1]. This concept comes from a pioneer in the field of information technology [2] named Kevin Ashton [3]. The use of IoT began to be developed so that it can be used in various aspects of daily life. Research conducted by D. Yacchirema [4] focuses on the construction of a detection system and system to help sufferers of Obstructive Sleep Apnea (OSA) using the concept of IoT and big data. There is also IoT-based research to manage energy and Congestion-Aware Routing Metrics in Smart City [5]. Gonzalez-Amarillo also conducts IoT-based research to create a greenhouse model that can monitor the nursery process, germination and growth of agricultural products [6].

Based on these examples it can be concluded that IoT development is very diverse and can be developed in various fields. This research also uses the IoT concept in it to create a smart wardrobe model, which monitors the air quality in the wardrobe so that clothes can be maintained more and the quality of the clothes will last longer. Another function of the smart wardrobe model developed is being able to choose the clothes that the user wants by reading colors on the shirt using the color sensor. This is based on the needs of this era which are completely automated [7] and the need for systems that can make decisions. Users can also monitor the situation in the closet via a smartphone using the Blynk application.

This paper have 5 section 1 is an introduction and the rest is as follows: Section 2 discusses IoT and Air Quality from another literature review, section 3 about how system work. Section 4, describe system design architecture and result. The last section 5 is a conclusion about this system and future work.

II. Related Work

IoT can be applied to various fields, one of which is in the field of environmental care. This can be seen from the many studies that discuss air quality, air pollution, and research on ozone pollution[8]. The research conducted by F.Corno has the purpose of monitoring the air condition in the city named SmartBike [9]. In this study, a smart bicycle was developed which has several sensors needed to detect air quality, namely ST X-Nucleo-IKS01A1. There are also studies to detect air quality using the Air Monitoring Sensor (AMS), by Mehta [10]. The use of sensors in a closed environment has several needs, namely the sensor must have a small size, high sensitivity [11][12], can operate for a long time [13], and not cause excessive noise.

Given the IoT device must be connected to the network, the security factor in IoT should also be taken into consideration in building it. There is research that examines the security of IoT A. Riahi argues that there are several important factors in security on IoT, namely privacy, trust, identification, and access control [14].

Based on the literature above, air quality can be detected, controlled, and monitored by using sensors. So this research will use some of the sensor to make a system for a wardrobe that can maintain air quality and make clothes more durable and healthier.

III. Proposed Method

This study uses a variety of sensors, specifical sensors for the Arduino microcontroller. The Arduino microcontroller is an architecture board consisting of 14 digital input and output pins, a USB port, a reset button and power [15]. The use of the Arduino microcontroller and sensors is done to reduce product costs. Product costs are very important considering the cabinets are goods that are needed by humans, so the cost of the product must be as minimal as possible so that they can be mass produced [3].

A. Sensor

The model of this smart wardrobe has six sensors and one linear actuator. There are three sensors needed to detect air quality, one sensor for detecting the color of clothing, one sensor for detecting light and one sensor for detecting sound. Table 1 shows any sensors in the smart wardrobe. The air quality function is regulated by temperature, humidity and dust sensors. Color sensors and light sensors are used in the color searching function, while the voice command uses a sound sensor. While the microcontroller needed is the Arduino Uno and Arduino WiFi module.

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TABLE 1. ARDUINO SENSOR NEEDED

Wardrobe Function	Sensor
Air Quality	Temperature
	Humidity
	Dust Sensor
Color Searching	Color Sensor
	Light Sensor
Voice Command	Sound Sensor

1) Temperature Sensor

Temperature sensors generally have three terminals that need to be connected to a microcontroller. The three terminals are Vs, Vout and Ground. Terminal Vs terminal requires 5v power from the Arduino board.

2) Humidity Sensor

Humidity sensor according to D. Hernandez-Rivera [16], has begun to be used widely in various sectors as in the medical sector, agriculture and environmental conservation. This sensor has also been developed in research in industrial areas, universities [17] and civil engineering [18].

3) Dust Sensor

There are six terminals on this sensor. There are V-LED, LED-Ground, LED, S-Ground, VO, and VCC.

4) Light Sensor

Light sensors work by detecting the intensity of light, which is received. In this system, the light sensor is used to help the process of color searching by providing sufficient light during the process.

5) Sound Sensor

The sound sensor has four terminals to operate. There are analog output, ground, VCC with 3.3V voltage, digital output.

6) Color Sensor

Color sensors used in this system are color sensors based on RGB (red, green, blue) colors that generally detect colors based on tristimulus value[19]. This value can be obtained from at least three photodiodes and there must be three appropriate image filters.

B. How it works

1) Air Quality

One of the functions of this smart wardrobe is air quality. This function aims to maintain the air quality in the wardrobe, especially humidity conditions and the intensity of dust. Wireless air quality sensors are unlimited used to measure airborne particles in the environment and have become progressively important in various remote health monitoring application [20]. The working process of this function can be seen in Fig. 1.

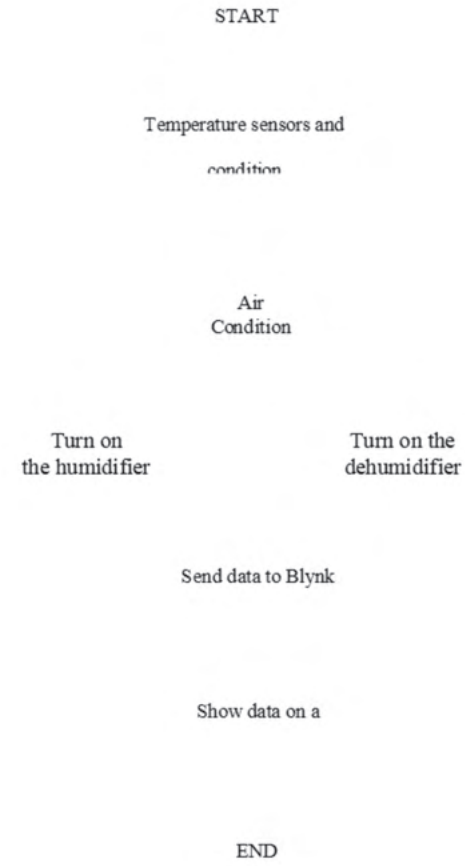

Fig. 1. Flowchart of air quality

The process of the flowchart in Fig. 1 can be described as follows:

- Temperature sensor & humidity sensor will check temperature & humidity in wardrobe, to maintain an optimal level of humidity (water vapor)
- If water vapor amounts too high, the system will turn on the dehumidifier.
- If water vapor amounts too low, the system will turn on the humidifier.

2) Dust Monitoring

Using a dust sensor, it is possible to monitor the intensity of dust. According to A.Proietti et al. [21], there are several biological materials that can be carried by dust, such as pollen, epidermal cells, insect fragments, and other organic materials. Therefore it is important to maintain air cleanliness. The working process of this function can be seen in Fig. 2.

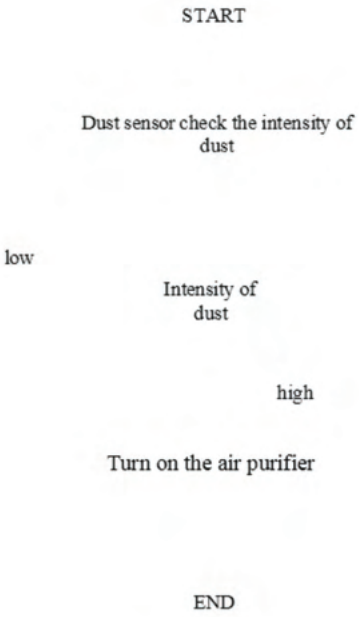

Fig. 2. Flowchart of the dust sensor

The process of the flowchart in Fig. 2 can be simplified as follows:

- Dust sensor will check the intensity of dust.
- If the intensity of dust too high, the system will turn on the air purifier.

Input and output system from the function of the air quality system can be seen in Fig. 3.

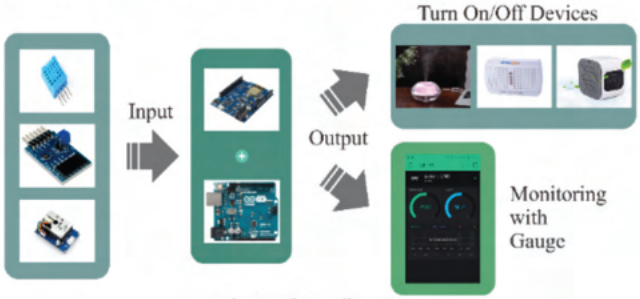

Fig. 3. Air Quality I/O

Fig. 3 describes the system input and output. There are 3 inputs obtained from the controller, which will then be processed and forwarded by the Arduino Uno microcontroller and WiFi module. The results of the process are 2, namely turning on/off the device to maintain air quality and output in the form of temperature and humidity gauge.

3) Color Searching

The working process of the function of color searching can be seen in Fig. 4

Fig. 4. Flowchart of color searching

The process of the color searching function in Fig. 4 can be simplified as follows :

- Sound sensor, detect sound and using voice recognition to process the request.
- Color sensor, the sensor will check clothes color with some actuator device to scan all clothes in the wardrobe.
- Light Sensor, to help color sensor detect color with more light intensity in wardrobe or to help the user search manually clothes if the light intensity too low at the outside wardrobe.

Light sensors also play a role in the process of color searching by providing sufficient light, so that color sensors can scan colors better. The light sensor process flowchart can be seen in the following Fig. 5.

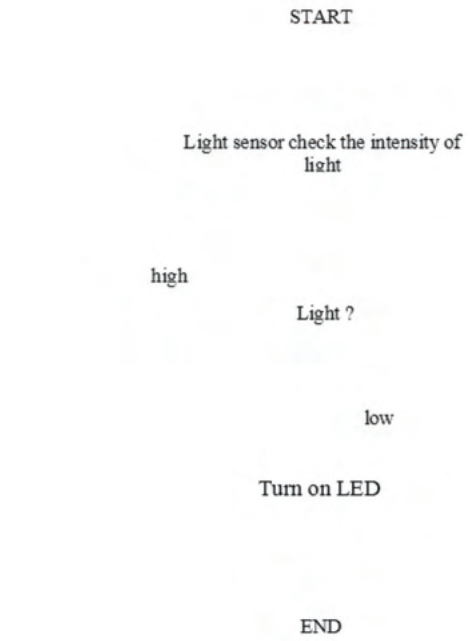

Fig. 5. Flowchart of the light sensor

The explanation of the flowchart in Fig. 5 is as follows:

- The sensor detects the intensity of light in the wardrobe.
- If the sensor detects a low light intensity, the LED light will turn on.
- If the LED light is not fixed it will be turned off.

Input and output of the color searching function can be seen in Fig. 6.

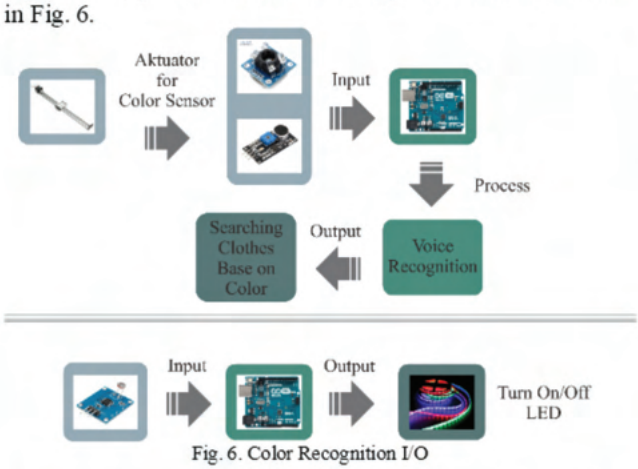

Fig. 6. Color Recognition I/O

Figure 6 describes the system input and output. The color sensor aided by a linear actuator will scan the clothes, then it will be processed by the Arduino Uno microcontroller and the color search process will be executed. While the light sensor will help illuminate the closet to make it easier to scan colors.

IV. Result

The design and layout of the sensors in the wardrobe can be seen in Fig. 7 below:

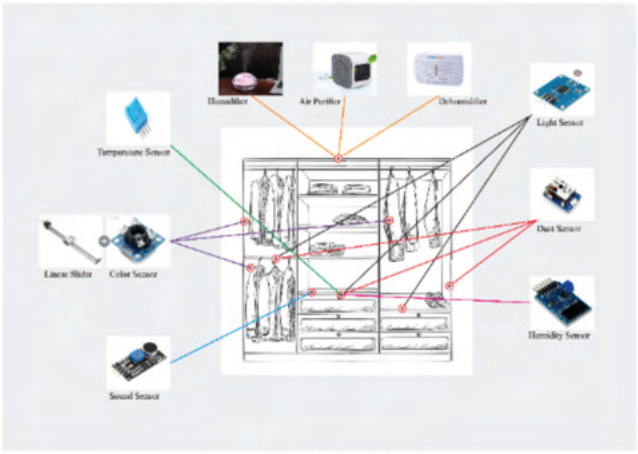

Fig. 7. Wardrobe design

In Fig. 7, you can see the installation location of each sensor. Temperature and humidity sensors, the sound sensor is placed in the middle of the wardrobe, while for dust sensors and light sensors are placed on each cabinet screen. The color sensor is placed on the part of the wardrobe that has the clothes stored by using a hanger. The color sensor is assisted by a linear slider so that the sensor can see the overall color of the clothes that are hung from the top to the bottom. This system has an application architecture as shown in Fig. 8

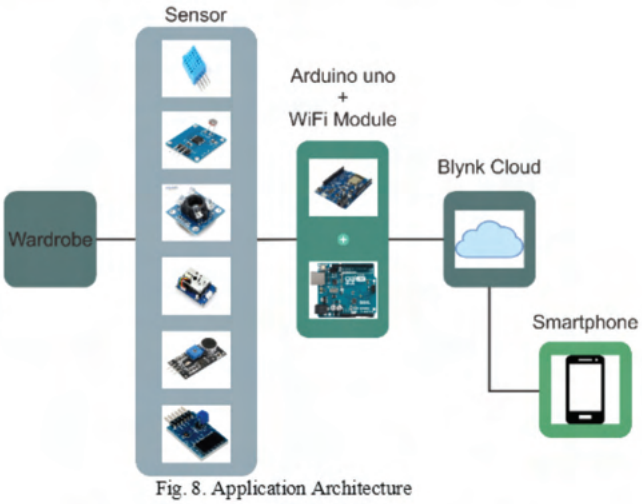

Fig. 8. Application Architecture

Fig. 8 above explains how the system is connected to the network so that it can be connected and controlled via a smartphone. The wardrobe is provided with the necessary sensors, namely temperature sensors, humidity sensors, dust sensors, color sensors, sound sensors, and light sensors. The sensors are connected to the Arduino Uno microcontroller and are connected with a Wi-Fi module to be able to connect to the internet network. After that, the system code will be

uploaded to the Blynk Cloud. Smartphones can retrieve sensor output data from Blynk Cloud and are displayed on Blynk's mobile application.

The result from this on-going research is the design of a smart and healthy wardrobe system. The system is expected to maintain air quality and can search clothes based on color. The output of the air quality sensor can be monitored through a smartphone so that the user still gets information on the condition of the wardrobe.

V. Conclusion

With the combination of several sensor functions, it is possible to be able to create a smart healthy wardrobe that can maintain air quality by using temperature sensors, humidity sensors, and dust sensors. It also can provide clothing recommendations according to the desired color using the color sensor and can maintain clothes quality. Air quality can also be monitored directly through the Blynk application on the smartphone. With combination from those sensors, it expected can make clothes more durable and healthier from mold. It also expected can searching clothing base on cloth color, so user can easily find it. Because this is still on-going research, then the future work of this research is to implement the system and improve the clothes selection function, not only based on choice but the system also has a knowledge-base to be able to provide different clothing choices/ according to certain parameters.

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