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Design and Build an IoT-Based Shoe Dryer Monitoring and Control System

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Abstract

Wet shoes that are not dried immediately can lead to the growth of bacteria and fungi that can potentially damage the shoes and cause health problems in the user. Therefore, an effective and efficient shoe dryer is needed. This research aims to design and develop a monitoring and control system for shoe dryers based on the Internet of Things (IoT) that can be operated remotely through a web-based application or mobile device. The system consists of several main components, namely humidity and temperature sensors, microcontrollers, wireless communication modules, and heating elements. Humidity and temperature sensors are used to detect the condition of the shoe and the surrounding environment, while the microcontroller is in charge of processing the data and regulating the operation of the heating element as needed. With the wireless communication module, users can monitor and control the drying process in real-time through an application connected to the internet.

Keywords: *IoT, shoe dryers, monitoring systems, remote control, humidity sensors, temperature sensors*

1. Introduction

Nowadays, telecommunication technology is developing rapidly. One of the telecommunication technologies is the Internet of Things (IOT). The Internet of Things is used as a system on an automatic tool that can be controlled with the help of the internet. One of the automatic technology products that can be applied is in drying shoes. Shoes are a footwear that protects the feet from impact and for the daily use of humans who travel so that their use becomes a daily necessity. Regular use of shoes makes shoe hygiene need to be considered. Shoe hygiene is done by washing shoes and drying shoes.

Weather changes are one of the important factors that affect how we care for our clothes and shoes throughout the year. Especially, the rainy season and summer pose its own challenges related to drying clothes and shoes. For example, in the rainy season, clothes and shoes are often difficult to dry naturally in the open air due to high humidity. On the other hand, in summer, hot and humid weather can accelerate the decay of poorly drained clothes and shoes. However, it's not just seasonal factors that cause wet clothes and shoes to dry out, situations and conditions such as impossible nights and the inability to see the scorching sun can also play a role in drying out.

2. Literature Review

2.1. Design

System design or commonly called design is a series of processes of translating the results of the analysis of a system into a programming language, the purpose of which is to describe in detail how the existing components are implemented. Meanwhile, the meaning of build or build a system is the activity of creating a new system, replacing or improving an existing system, either in whole or in part.

2.2. Monitoring System

A monitoring system is a process to collect data from various resources. Usually the data collected is real-time data. In general, the purpose of monitoring is to obtain data or views in order to obtain feedback for certain needs.

2.3. System Control

A control system is the process of regulating or controlling one or several quantities (variables, parameters) so that they are at a certain price or in a certain price summary (range). In the industrial world, a safe and high-efficiency work process is required to produce products

with good quality and quantity and with a predetermined time. Automation is very helpful in terms of smooth operation, security (investment, environment), (production costs), product quality etc.

2.4. Shoes

Shoes are footwear worn on human feet to protect and provide support while walking, running, or performing other activities. In general, shoes consist of an upper that covers the top of the foot, a bottom that supports the sole of the foot, and a sole that is located at the bottom to provide contact with the ground surface. Shoes can be made of a variety of materials, such as leather, fabric, rubber, or synthetic materials, and they can be designed for a variety of purposes, including fashion, sports, work, or outdoor activities. Apart from being a foot protector, shoes are also often part of a person's personal expression and fashion style.

2.5. Microcontroller

A microcontroller is a functional computer system in a chip. It contains a processor core, memory (a small amount of RAM, program memory, or both), and input and output equipment. In other words, a microcontroller is a digital electronic device that has input and output as well as control with programs that can be written and deleted in a special way, the way the microcontroller actually works reads and writes data. Just for example, imagine yourself when you start learning to read and write, when you can do that you can read any writing, whether it's books, short stories, articles and so on, and you can also write the opposite.

2.6. DHT11

The DHT11 sensor is a sensor module that functions to provide temperature and humidity information that has an analog voltage output that can be further processed using a microcontroller. This sensor module is classified as a resistive element such as a temperature measuring device such as NTC. The advantages of this sensor module compared to other sensor modules are in terms of the quality of reading sensing data, which is more responsive which has speed in terms of sensing temperature and humidity objects, and the data that is read is not easily interfered with.

2.7. ESP8266

NodeMCU ESP 8266 is a complete chip which includes a processor, memory and also access to GPIO. This causes ESP8266 to directly replace Arduino and is coupled with its ability to support wifi connections directly. IoT (Internet Of Things) is growing along with the development of microcontrollers, Ethernet-based and wifi-based modules are increasingly numerous and diverse starting from Wiznet, Ethernet shield to the latest Wifi module known as ESP8266.

2.8. Fan

A fan is a mechanical device used to create a continuous flow of gases such as air. In any refrigeration system, which uses gas as a conductor, the fan is a mandatory unit that creates airflow in the system. This system can be seen in simple fans used in households or external cooling fans for internal combustion engines.

2.9. Relay 4 Channel

A 4 Channel Relay Module is a piece of hardware used to independently control four different electrical channels or circuits. Each channel usually consists of a relay that can be controlled electronically. A relay is an electromagnetic switch that works by connecting or disconnecting the flow of electricity to another circuit. 4 Channel Relay Modules are commonly used in various electronics and automation projects, such as lighting control systems, security systems, smart home automation systems, and more.

2.10. Blynk

Blynk is an app for iOS and Android OS to control Arduino, NodeMCU, Raspberry Pi and the like over the Internet. This application can be used to control hardware devices, display sensor data, store data, visualize, and others. The Blynk application has 3 main components, namely Applications, Servers, and Libraries.

2.11. Power Supply

Power Supply or in Indonesian Language called a power supply is an electrical device that can provide electrical energy for electrical devices or other electronics. Basically, this power supply or power supply requires an electrical energy source which then converts it into electrical energy needed by other electronic devices. Therefore, power supply is sometimes also called the term Electric Power Converter.

2.12. Limit Switch

A limit switch is a tool that functions to disconnect and connect the electric current on a circuit, based on the mechanical structure of the limit switch itself. Limit switches have three terminals, namely: central terminal, normally close (NC) terminal, and normally open (NO) terminal. As the name implies, limit switches are used to limit the work of an operating tool. NC, NO, and central terminals can be used to disconnect the flow of electricity on a circuit or vice versa.

2.13. LCD

LCD is one of the electronic components that functions as a display of data, whether characters, letters or graphics. LCD (Liquid Cristal Display) is a type of electronic display made with CMOS logic technology that works by not producing light but reflecting the light around it against the front-lit or transmitting light from the back-lit. LCD (Liquid Cristal Display) functions as a data viewer in the form of characters, letters, numbers or graphs.

3. Analysis and Design

3.1. Flowchart System

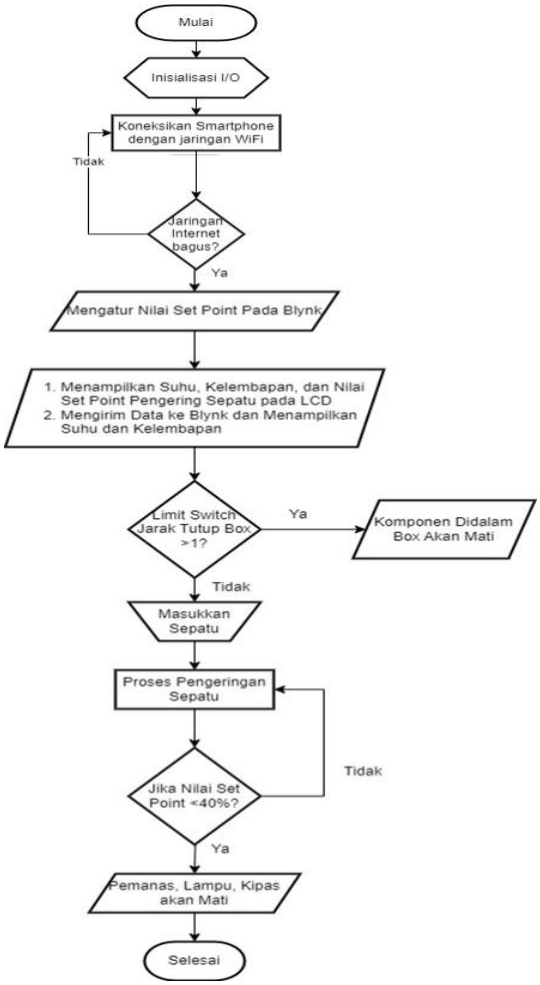

Fig.1: Flowchart System

The following is an explanation of the series and symbols used in the process on the flowcart as shown in the Figure:

1. Start: This is the symbol of the beginning or beginning of the process.
2. I/O initialization: This is the process of initializing the input/output of the device to be used.
3. Connect the Smartphone to the WiFi network.
4. Good internet network? If Yes then go to the next step, and if not it will repeat the connection of the smartphone with the WiFi network
5. Setting Set Point Values on Blynk: This is a process for setting set point values on the Blynk application, which is an IoT platform for controlling and monitoring devices.
6. Displaying Temperature, Humidity, and Set Point Values of the Shoe Dryer on the LCD and Sending Data to Blynk and Displaying Temperature and Humidity: This is a process to display temperature, humidity, and set point data on the LCD, and send the data to the Blynk application for display.
7. Limit Switch Erak Close Box >1?: This is a process to check whether the limit switch on the dryer box is closed or not. If it has not been closed (>1), it will proceed to the next process.
8. If Yes: This indicates that the limit switch is closed, so the process continues. Components in the Box Will Die: This is the process of turning off the components in the dryer box.
9. Components in the Box Will Die: This is the process of turning off the components in the dryer box.
10. If the Set Point Value <-40%?: This is a process to check whether the set point value has reached -40% or not. If not, it will be continued to the next process. and if Yes: This indicates that the set point value has reached -40%, so the process continues.
11. Heaters, Lights, Fans Will Turn Off: This is the process of turning off the components that play a role in the drying process.
12. Finished: This is the symbol of the end or completion of the process.

3.2. IoT Flowchart

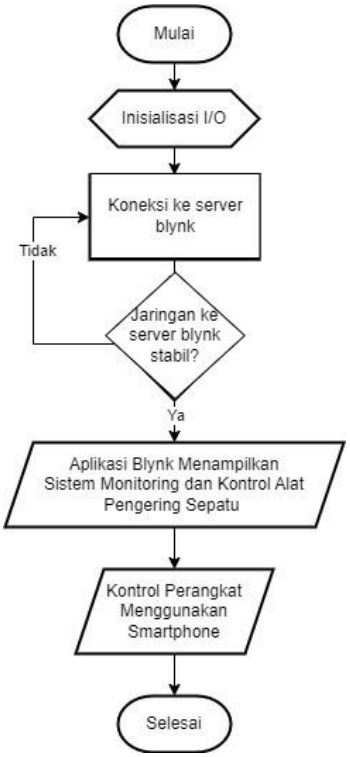

Fig. 2: IoT Flowchart

Well, here's the sequence of stages of the IoT-based shoe dryer monitoring and control system flowchart:
1. Get Started
2. I/O Initialization
3. Connect the Smartphone to the blynk server
4. Network to blynk server good?
5. Blynk Application, Displays IoT-based shoe dryer monitoring and control system information
6. Control the Device Using a Smartphone
7. Done

3.3. Block Diagram

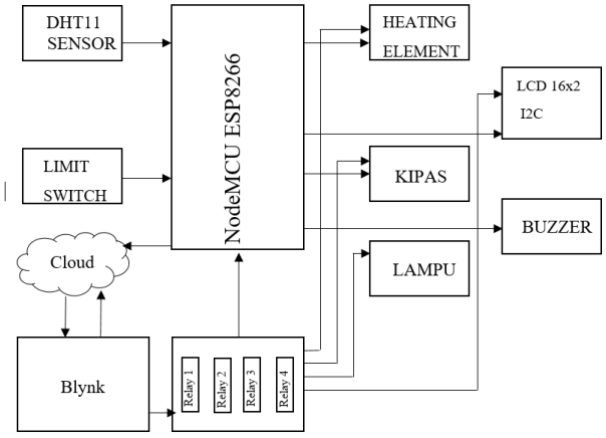

Fig. 3: Block Diagram

The following is an explanation of the diagram block in figure 3:

1. Each sensor is connected to a NodeMCU ESP8266 to program and initialize data, such as determining the value of each sensor that will be used as input.
2. Supporting components such as Limit Switch, Buzzer and LCD are connected to the NodeMCU ESP8266 to be programmed and initialized with the data of each component so that each component can function as needed.
3. NodeMCU ESP8266 connected to Blynk in order to be able to send and receive data that later the data that has been received by NodeMCU ESP8266 will be sent via the internet network to the Blynk application for data monitoring.

3.4. Overall Tool System Networking

This series is composed of the components needed to design the tool so that the data tool works as desired.

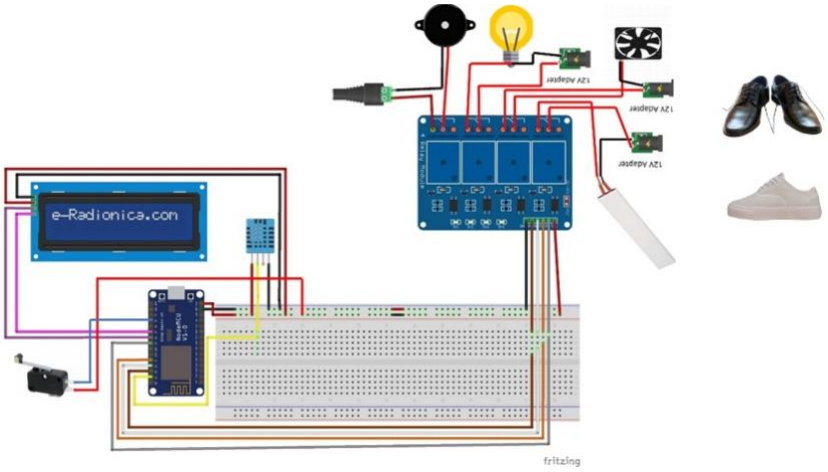

Fig .4: Tool Design Network

3.5. DHT11 Sensor Design

The design scheme of sensors – microcontrollers is as follows:

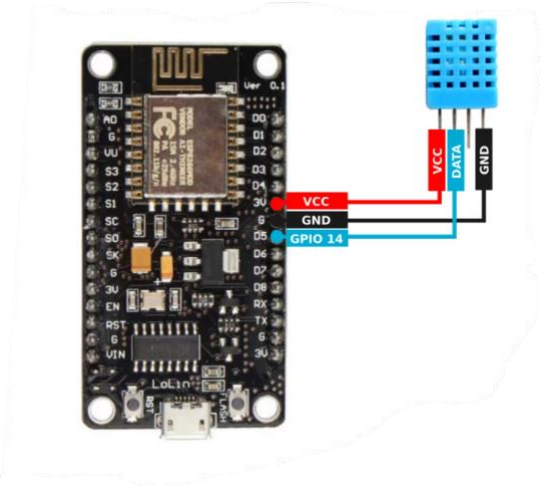

Fig.5: NodeMCU ESP8266 network and DHT 11 sensor

In Figure 5, the design schematic of the NodeMCU ESP8266 and the DH11 sensor uses a black wire and a red wire to connect the VCC and Ground pins between the NodeMCU ESP8266 and the DHT11. Data from the DHT11 sensor is transmitted using a blue wire connected to pin D5 NodeMCU ESP8266.

3.6. NodeMCU ESP8266 and Heating Element Design

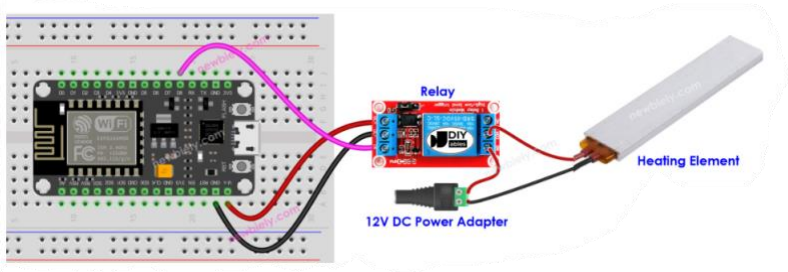

Fig. 6: NodeMCU ESP8266 and Heating Element design scheme

In Figure 6 of the ESP32 NodeMCU design scheme and the Heating Element, the heating element typically has two pins:
The positive (+) (red) pin must be connected to a 12v DC power supply
The Negative (-) pin (black) must be connected to the GND of the DC power supply
The code below will turn the heating element on every five seconds and turn off every five seconds, many times.

3.7. LCD Display

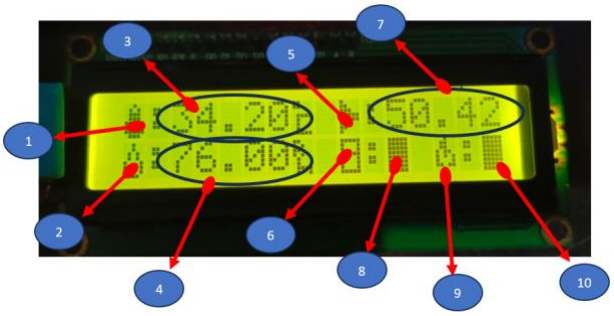

Fig. 7: LCD Display

Information:
1. Icon actual temperature
2. Icon actual humidity
3. Actual temperature value (centigrade units)
4. Actual humidity value (unit % Rh)
5. Icon setpoint humidity
6. Shoe dryer door icon
7. Shoe dryer setpoint value (can be set via blynk dashboard)
8. The on off indicator for the door sensor, will turn black box when the sensor is on, and will be blank white when the sensor is off
9. Icon heater
10. The on off indicator for the heater work status, will turn black box when the heater is running, and will be blank white when the heater is not working.

3.8. Blynk Display

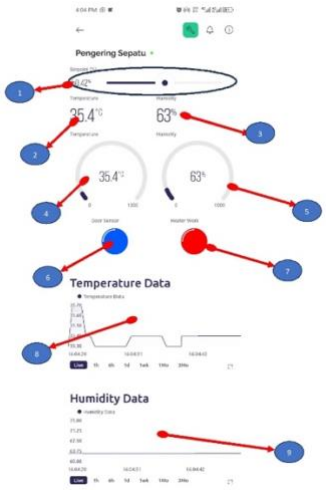

Fig. 8: Blynk Display

Caption from Figure 8:
1. Slider setpoint, can be set to specify the desired humidity or dryness level of the shoe, the value set here will be accepted by the microcontroller.
2. Actual temperature value (unit of degrees Celsius).
3. Actual humidity value (unit % Rh).
4. Actual temperature value with gauge display.
5. Actual humidity rating with gauge display.
6. The indicator for the door sensor, will turn on if the sensor is on, and will turn off when the sensor is off.
7. Heater work indicator, will turn on when the heater is working, and will turn off when the heater is not working.
8. Chart chart for historical temperature actual data.
9. Chart graphs for historical humidity actual data.

4. Conclusion

After carrying out the design and manufacturing stage of the system which is then continued with the testing and analysis stage, the following conclusions can be drawn:

1. The IoT-based shoe dryer monitoring and control system that has been designed is able to dry shoes efficiently by reducing the risk of bacteria and mold growth, and allows users to monitor and control the drying process remotely through an app.
2. This system can be a practical and innovative solution to maintain the cleanliness and durability of shoes, and has the potential to be further developed with more advanced automation features and integration with other IoT platforms.

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