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DESIGN OF MOISTURE CONTENT TEST TOOL ON DRIED CLOVES BASED ON MICROCONTROLLER

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Abstrak
Determination of moisture content in dried cloves is an important step in the processing and storage process to ensure product quality and durability. This study aims to design and develop a microcontroller-based test tool for moisture content in dried cloves. This tool is designed using a DHT22 sensor connected to a microcontroller NodeMCU ESP8266 to measure moisture content in real-time and accurately. The data obtained from the sensor is processed by the microcontroller and displayed on Blynk Apps. The test results show that this test tool has a high level of accuracy and can be used as an efficient and practical alternative in testing the moisture content of dried cloves. The use of this tool is expected to increase the effectiveness of the processing and storage of cloves and reduce losses due to inappropriate moisture content.
Kata Kunci : *Moisture Content, Dried Cloves, NodeMCU ESP8266, DHT22 Sensor, Blynk, Arduino IDE.*

1. Introduction

Technological advancements in electronics have significantly contributed to the creation of sophisticated tools that improve human efficiency and productivity. In this digital era, information systems are essential for effective data and information management. At the heart of many information systems is the microcontroller, a compact computer chip that integrates a CPU, memory, and input/output devices on a single chip. Microcontrollers are critical in automating and controlling various electronic systems, making them indispensable in many fields.

In agriculture, microcontrollers are increasingly utilized to modernize traditional farming methods. Clove plantations in Indonesia, a major producer with 134,000 tons of clove production in 2022, play a critical role in the economy. Cloves are used in various industries, including tobacco, pharmaceuticals, essential oils, and food processing. With 66.84% of clove plantations managed by smallholder farmers, maintaining clove quality is vital to sustain economic contributions. [1]

During harvesting, cloves typically have a high moisture content of 70%-80%. To meet the Indonesian dry clove standard (SNI 01-3392-1994), the moisture content must be reduced to a maximum of 14%. Cloves with moisture content exceeding this standard are prone to mold, leading to poor storage durability. Conversely, moisture content below 11% causes the cloves to crumble easily, degrading their quality. Achieving optimal moisture content is critical to maintaining the market value and usability of cloves.

Several previous studies have developed this concept, such as the research by Busran [2], which created a moisture content measurement system for rubber sap using microcontrollers and Arduino. Another study by Wisastra [3] utilized Arduino to monitor the quality of oil in dried cloves.

2. Literature Review

Cloves

Clove is an ancient spice plant that has been known and used thousands of years BC. The tree itself is native to the Maluku islands (Ternate and Tidore), which was once known by explorers as the spice island. The clove plant (Syzigiumaromaticum) is a tropical plantation plant with the Myrtaceae family [4]. In certain years the plant will produce a lot of production, and in certain years production can decrease by 10-40%. The production pattern of clove plants can be classified into 2-year cycle patterns and 3-4-year cycles.

NodeMCU Esp8266

The ESP-8266 MCU node is a Wi-Fi module that functions as an additional device for microcontrollers such as Arduino to connect directly to Wi-Fi and establish a TCP/IP connection. This MCU node is opensource. The ESP-8266 has on-board processing and storage capabilities that allow it to be integrated with sensors or with certain applications through input and output pins with just programming [5].

DHT22 Sensor

The DHT22 sensor is a digital sensor used to measure air temperature and humidity. The DHT22 sensor has a high level of stability and reliability in the long term. The DHT22 sensor uses a resistive humidity sensor and an NTC-based temperature sensor connected to an 8 bit microcontroller. So the DHT22 sensor has excellent quality, anti-interference ability, fast response and cost. The DHT22 sensor provides very precise humidity and temperature values and ensures high reliability and long-term stability. This sensor has a resistive type humidity measurement component and an NTC type temperature measurement component with an inbuilt 8-bit microcontroller that has a fast response and is cost-effective [6].

Moisture Content

Moisture content is the percentage of water content that can be expressed based on wet weight (wet basic) or based on dry weight (dry basic). Wet weight moisture content has a theoretical maximum limit of 100 percent, while moisture content based on dry weight can be less than 100 percent [7].

Arduino IDE

Integrated Development Environment (IDE). IDE is software that plays a very important role in programming, binary compilation, and microcontroller memory download. In addition to many supporting modules (sensors, monitors, readers, etc.) Arduino IDE (Integrated Development Environment) software is a software that makes it easy to develop microcontroller applications ranging from writing source programs, compilation, uploading compilation results, and serial terminal testing. The source program created for microcontroller applications is the C/C++ language and can be combined with assembly [8].

Blynk

Blynk is not tied to some type of microcontroller but must be supported by the chosen hardware. NodeMCU is controlled with Internet via WiFi, ESP8266 chip, Blynk will be made online and ready for the Internet of Things. Blynk is a digital dashboard where you can easily create interface for each project easily. Blynk is not tied to a specific board, blynk can be used on many hardware devices [9].

3. Research Methodology

Time and Place of Research

This research will be conducted on the campus of Sam Ratulangi University at the Faculty of Mathematics and Natural Sciences. Researchers will use several rooms in the Faculty to test the research and the author's house to develop the tool. The research time will be held from January 2024 to June 2024

Prototype Methodology

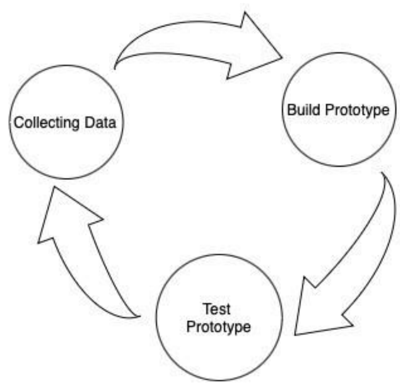

Figure 1. Prototype Method

The Prototype method is an early stage in software development that serves to demonstrate concepts, test designs, and identify problems and potential solutions. The prototype model allows users to understand how the system works effectively.

4. Result

Tools and Materials

Hardware Requirements

The tool made in this research is a tool that can measure humidity in dried cloves based on microcontroller. The hardware used in this research consists of an ESP8266 MCU Node, a DHT 22 humidity sensor, and LEDs as indicators.

Software Requirements

The software needed in this research is Arduino IDE which is used to do coding that contains commands. Furthermore, the software used is Blynk, which is to visualize the output in the form of data and information.

Tool Design

Block Diagram

The design of a microcontroller-based moisture content test tool for dried cloves uses a DHT 22 humidity sensor, and LEDs as indicators that take place on the tool. NodeMCU ESP8266 microcontroller input is obtained from the DHT22 sensor. Data from the sensor will be sent to Node MCU ESP8266 in digital form, then Node MCU ESP8266 will send the output value in digital form and displayed on Blynk.

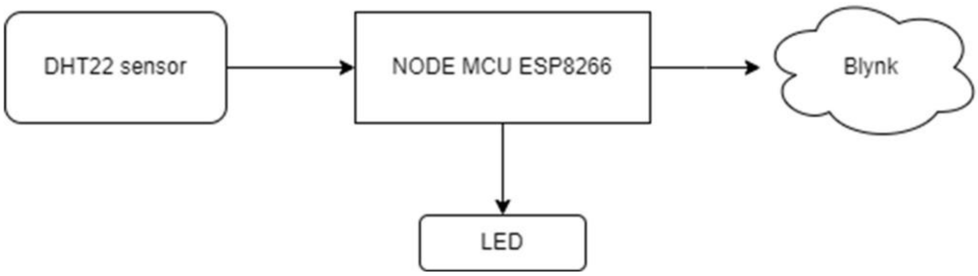

Figure 2. Block Diagram

Flowchart

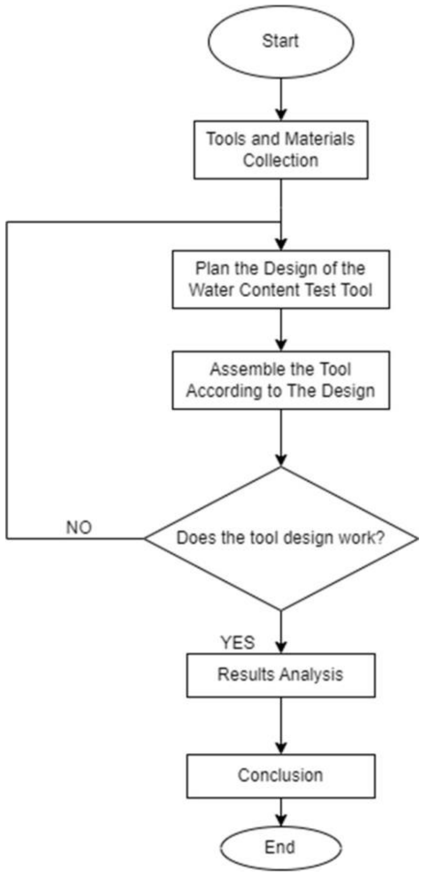

Figure 3. Flowchart

The flowchart shown illustrates the process of making and testing water content test equipment

1. Start : The first step in this process is to start the project with a starting point called "Start".
2. Tools and Materials Collection: At this stage, all the tools and materials needed to make the moisture content test kit are collected.
3. Plan the Design of the Water Content Test Tool: Once the tools and materials are collected, the next step is to plan the design of the moisture content tester. This involves making sketches, diagrams, and technical specifications of the tool.

4. Assemble the Tool According to The Design: Next, the moisture content test apparatus is assembled according to the pre-planned design. This involves assembling the components according to the design instructions.
5. Does the Tool Design Work?: Once the tool is assembled, the next step is to test whether the tool design works properly. This is a decision point that has two possibilities:
   NO: If the tool does not function as designed, the process goes back to the design planning stage to make revisions and improvements.
   YES: If the tool works as designed, the process continues to the results analysis stage.
6. Results Analysis: At this stage, the data obtained from the moisture content test equipment is analyzed to assess the performance and accuracy of the equipment.
7. Conclusion: Based on the analysis of the results, conclusions are made regarding the effectiveness and usability of the moisture content tester.
8. End**:** The process ends once conclusions are drawn, marking the completion of the project of manufacturing and testing the moisture content tester.

This flowchart as a whole illustrates an iterative process involving planning, assembly, testing, and analysis to ensure the moisture content tester functions properly before it is widely used.

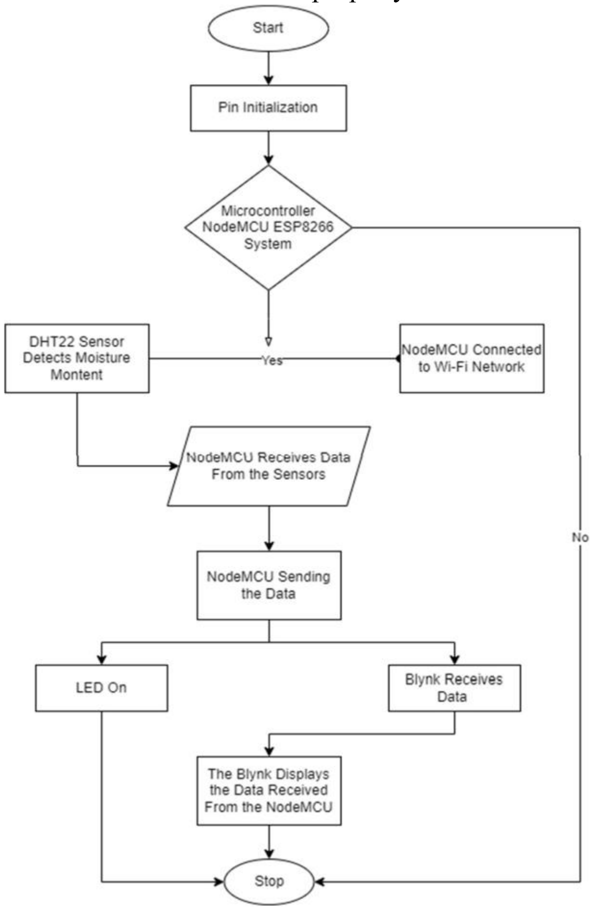

Figure 4 Flowchart overall system design

1. Start: The process begins.
2. Pin Initialization: The NodeMCU initializes the pins used for communication with sensors and other devices.
3. Microcontroller NodeMCU ESP8266 System: The next step is to check if the NodeMCU ESP8266 microcontroller system is functioning properly.
4. If NodeMCU Connected to Wi-Fi Network: The system proceeds to the next step.
5. If not connected to Wi-Fi, the process stops and does not proceed further.
6. DHT22 Sensor Detects Moisture Content: The DHT22 sensor detects the moisture level. This sensor measures humidity and temperature.
7. NodeMCU Receives Data From the Sensors: After the DHT22 sensor detects the moisture, the data is sent to the NodeMCU for processing.
8. NodeMCU Sending the Data: The NodeMCU then sends the data received from the sensor to the Blynk app via a Wi-Fi network.
9. LED On: Simultaneously with the data transmission, the LED is turned on as an indicator that data is being sent or a certain condition is met (e.g., moisture exceeds a predefined threshold).

10. Blynk Receives Data: The Blynk app receives the data sent by the NodeMCU over Wi-Fi.
11. The Blynk Displays the Data Received From the NodeMCU: The data received by the Blynk app is displayed on the app's interface, allowing the user to monitor the moisture detected by the sensor.
12. Stop: After all data is received and processed, the system stops.

Schematic System

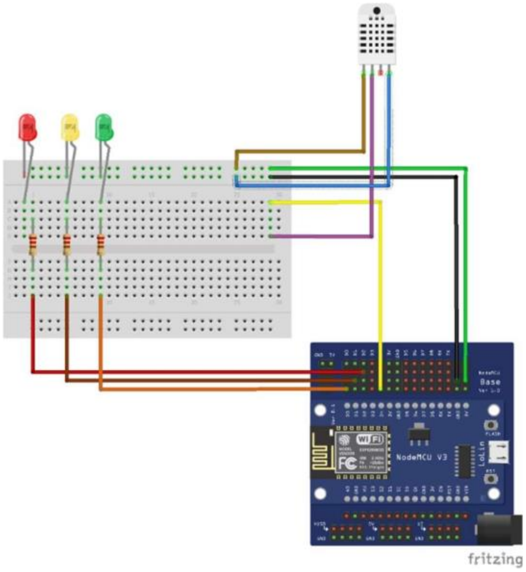

Figure 5. Schematic Diagram

Table 1. *Board NodeMCU to DHT22 Sensor*

Board NodeMCU	DHT22
D4	Data
3V	VDD
GND	GND

Table 2. *Board NodeMCU to LED*

Board NodeMCU	LED
D0	LED Red
D1	LED Yellow
D2	LED Green

Implementation and Testing

Use of Arduino IDE Software

System testing in the Arduino IDE software is very important because this is where the programming is done. The purpose of this step is to choose which type of microcontroller board we will use. Here the one used is NodeMCU 1.0 (ESP-12E Module).

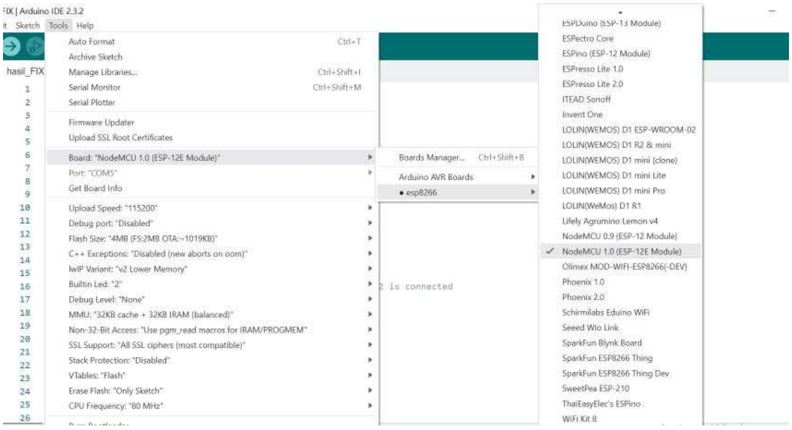

Figure 6. Setting the Arduino IDE Software

Display on Blynk App

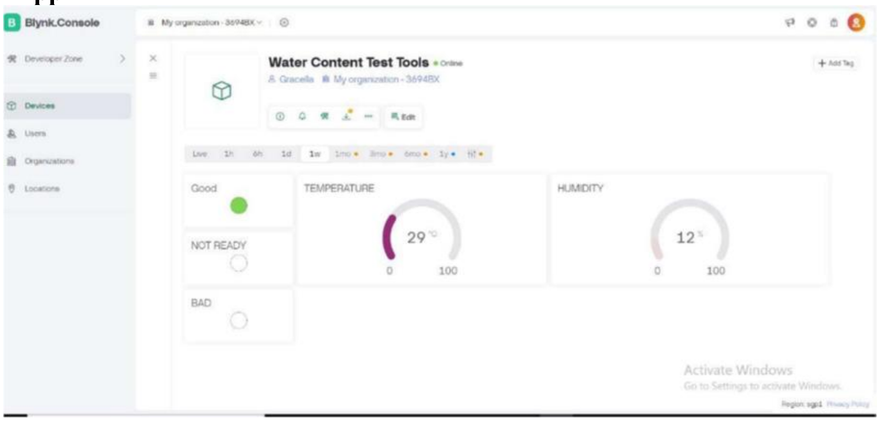

Figure 7. Blynk View of Clove Measurement Good

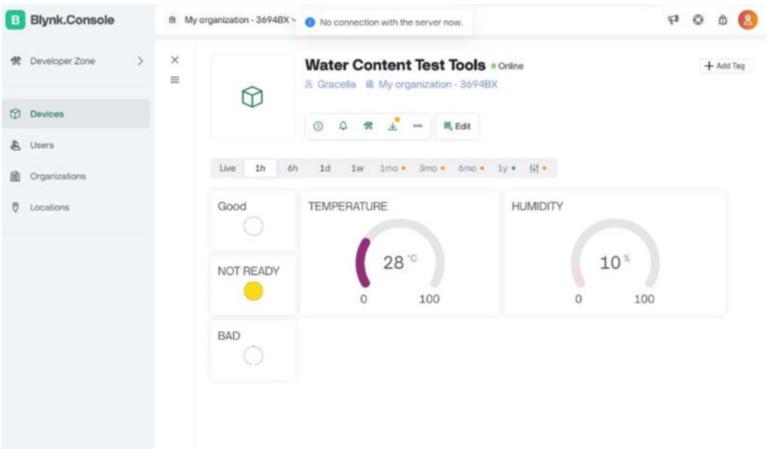

Figure 8. Blynk View of Clove Measurement Not Ready

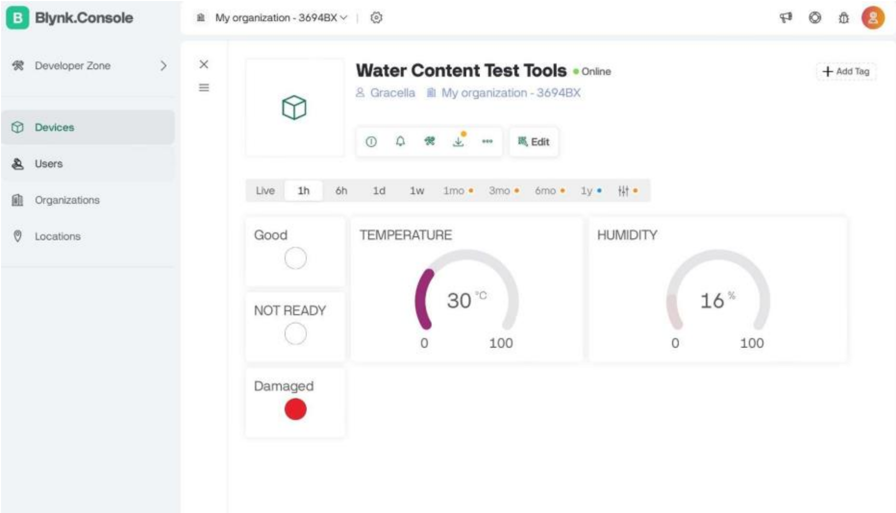

Figure 9. Blynk View of Clove Measurement Damage

Testing

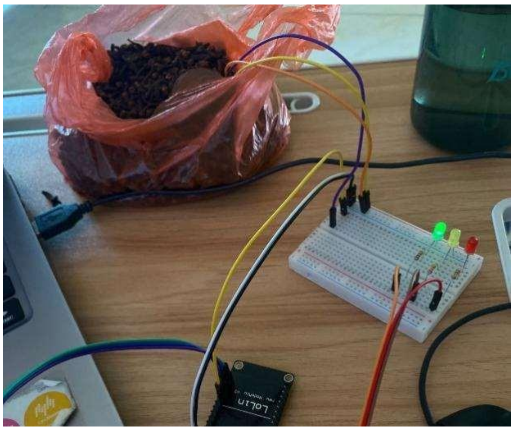

Figure 10. Testimg Tool Good Clove Condition

Figure 11. Testimg Tool Not Ready Clove Condition

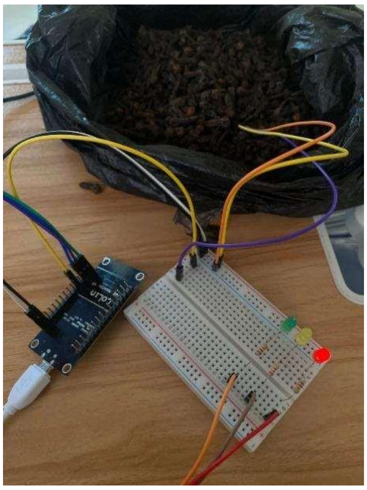

Figure 12. estimg Tool Damage Clove Condition

Tool Testing Result

Table 3. LED Testing Result

Moisture Condition (%)	LED Merah	LED Yellow	LED Green	Description
< 11	OFF	OFF	ON	Not Ready
>=11 & <14	OFF	ON	OFF	Good
>15	ON	OFF	OFF	Damage

Calculation Logic

“Good” if $11 \leq$ humidity ≤ 14

“Not Ready For Sale” if humidity ≤ 11

“Damaged” if humidity ≤ 15

Explanation:

"Good":
The status is "Good" when the humidity is between 11 and 14, inclusive. This means the humidity is within an acceptable range for the product.

"Not Ready for Sale":
The status is "Not Ready for Sale" when the humidity is 11 or below, indicating the product is not in optimal condition for sale.

"Damaged":
The status is "Damaged" when the humidity is greater than 15, meaning the product has exceeded the acceptable moisture level and may be considered defective or unsuitable for sale.

Calibrate Humidity

$$\text{Humidity}_{\text{Calibrate}} = (Humidity\ - 75)\ \text{X}\ \left(\frac{13.0}{88-75}\right)$$

This formula adjusts the humidity value by subtracting 75 without changing the scale, as the calibration factor is 1. Such formulas are commonly used for sensor calibration or correcting biased readings.

5. Conclusion

A device used to detect the moisture content of dried cloves using DHT22 sensor and NodeMCU Esp8266 microcontroller board, having LED as indicator and visualized data output on Blynk has been successfully designed. The designed equipment can measure and distinguish the level of dryness in three dry clove samples but different water content or humidity, namely with dry cloves and are ready for sale having results < 14% and cloves that are not ready for sale with results > = 14% & < 21% and > 21% have bad results that are on cloves that cannot be sold. This tool can also be connected to Blynk so that the outout of this tool can be seen from the web or apps.

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