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Design and Development of a IoT-Based Moisture Detection Device for Corn Seeds

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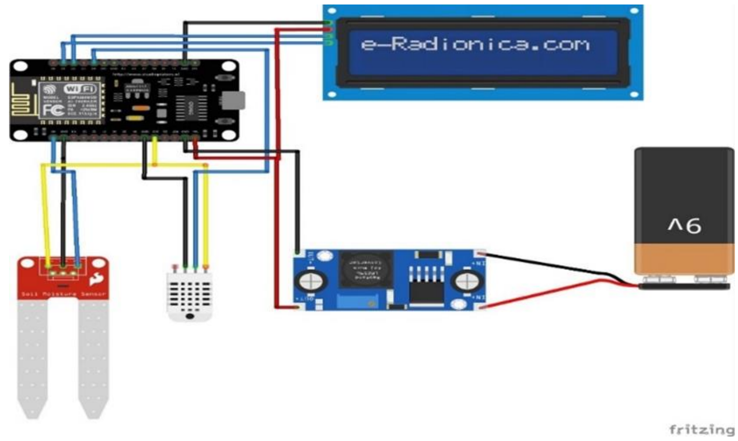
ABSTRACT



Lately the planting of corn has increased and increased in several areas. The increasing popularity of corn is due to its high economic value. Corn that has been harvested cannot be sold immediately because it must meet certain moisture content requirements. Farmers must know the maximum value of the moisture content in the corn kernels resulting from the harvest to meet one of the standards set by the industry. The water content contained in corn kernels can have a big influence on determining its quality or selling value. This study aims to design and implement a device for detecting the moisture content of corn kernels as a tool to help farmers produce dry and good quality corn kernels. This research uses an Internet of Things (IoT) based method by sending the corn moisture content and ambient air temperature values to a mobile phone via the Blynk application. The components used are the NodeMCU ESP2866 microcontroller, YL-69 sensor, DHT-22 sensor, 16x2 I2C LCD, and battery. The results of this study have been able to make a water content detector tool on corn kernels based on IoT that can work well. From several tests carried out at night and in the morning, a low error rate of 2.3% was found on the DHT-22 sensor, while on the YL-69 sensor the tests were carried out on three types of corn samples, namely dry, medium, and dry corn kernels. and wet obtained a low error rate of 3.1%.

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1. INTRODUCTION

The implementation of IoT technology in the field of agriculture has been widely carried out by researchers in the past [1]. The utilization of IoT technology in agriculture will accelerate the development of agricultural modernization, integrate smart farming practices, and efficiently address agricultural-related issues [2]. This enables the collection of environmental data required by farmers, without the need to always be present at the agricultural location. This data is then used to take necessary actions for farmers to achieve favorable outcomes [3].

Indonesia is one of the world's largest agrarian countries with abundant natural resources. The agricultural sector is one of the contributors to the national economy, providing employment opportunities and contributing to non-oil national income [4]. Agriculture is a strategic sector for economic growth, contributing a smaller share but significantly influencing the welfare of society [5]. Corn is a staple food and an important commodity for both humans and animals [6]. The demand for corn as food and industrial raw material continues to rise. The Directorate General of Food Crops stated that corn production has increased by around 12.49% per year over the last 5 years [7].

The global price of corn increased by 1.54% in July 2020 compared to the price in June 2020 [8]. The moisture content in corn seeds can significantly affect their quality and value [9]. Moisture content is the percentage of water content in a material, expressed based on either wet basis or dry basis weight. Moisture content on a wet basis has a maximum limit of 100%, while moisture content on a dry basis is represented by 100% [10].

According to the Indonesian National Standard (SNI 01-4483-1998), good-quality corn should have a moisture content of 13-14% [11]. However, some warehouses or corn commodities in certain regions still use their own standards, where moisture content for dried corn is <16%, for semi-dried corn is 16-20%, and for wet corn is >20% [12].

In light of these issues, this research aims to design a device that can assist farmers in addressing the issue of moisture content in corn seeds [13]. The objective of this study is to develop a system to determine the moisture content in corn seeds using a Soil Moisture sensor and a Microcontroller as a means to provide moisture values for the corn [14].

Siswoko conducted research using an MCU as the microcontroller and an LCD to display the results. The design involved a moisture sensing circuit with a Wheatstone bridge system. The testing results yielded an accuracy level of 95.7% and an error rate of 4.3% [15].

Subsequent research was conducted by Luluk Fauziah and Cinthya Bella, using an Arduino as the microcontroller, two YL69 sensors to measure moisture content, and a DHT11 sensor to measure humidity. The findings indicated that corn with moisture content below 14% is ready for sale, while corn with moisture content above 14% is considered wet and not yet suitable for sale [16].

Ulfa's research utilized an ATMega 328 (Arduino Uno) as the microcontroller, an SHT11 sensor, and an LCD to display readings. The results indicated that very dry coffee fell within the temperature range of 34.7-34.9ºC with a relative humidity of 68.5%, whereas wet coffee fell within the temperature range of 34.7-34.8ºC with a humidity of 70.7% [17].

Nofiatul Khasanah and Bambang Suprianto employed an Arduino Uno as the microcontroller, a DHT11 sensor, and a moisture sensor to determine the moisture content in corn. Their research showed that the lowest moisture content achieved using a ventilator method was 11.41% within a time span of 3.7 minutes, while the highest moisture content achieved using a kerosene and firewood tray was 16.5% with a longer estimated time of 360 and 300 minutes, respectively [18].

2. METHODS

The Internet of Things (IoT) can be defined as a capability that connects objects to each other or various smart computer devices through Internet access [19]. The Internet of Things (IoT) is also a concept aimed at extending the benefits of continuous internet connectivity [20].

According to Satya, the Internet of Things (IoT) is one of the five key technologies supporting the development of Industry 4.0. This technology promotes the concept of connectivity between machines/objects, between humans and objects, or between machines and humans via the internet [21]. Previously low connectivity has been enhanced, with the goal of allowing many smart objects to actively sense activities or environmental conditions, send data to the internet for monitoring and or automatic real-time control [22].

IoT is implemented in various aspects of life using different designs. IoT implementation involves various technologies such as RFID for location and object identification, WSN (Wireless Sensor Network), cloud computing, and web technologies. These devices have built-in sensors and are actively connected to both local and global internet networks. IoT covers various sectors such as homes, transportation, healthcare, and agriculture [23].

2.1. Block Diagram

The block diagram in Figure 1 shows that the DHT22 sensor and the YL-69 sensor are connected to a microcontroller that reads analog sensor values, which are then converted into digital values on the NodeMCU ESP8266 using an ADC (Analog-to-Digital Converter). The digital data is sent to an LCD and also to the Blynk application using internet connectivity.

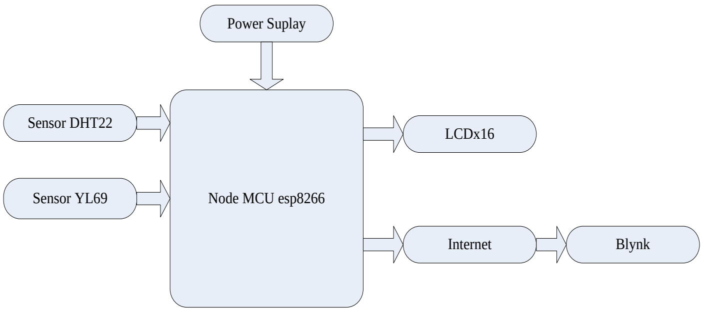

Figure 1. Block diagram

2.2. Equipment Circuit

The equipment circuit, as depicted in Figure 2, consists of components that have been connected to form a circuit used as a reference in the equipment manufacturing process.

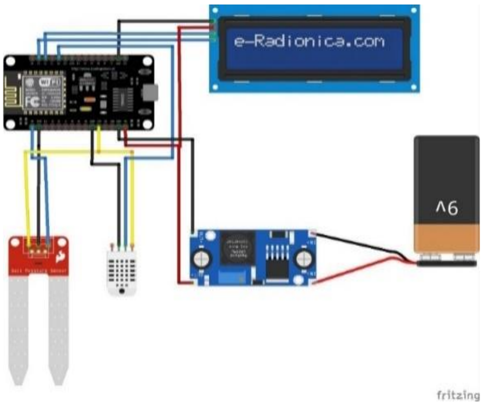

Figure 2. Equipment circuit

2.3. Flow Diagram

For the design process of the IoT-based moisture detection device for corn seeds to achieve optimal results, a flow diagram scheme is illustrated in Figure 3.

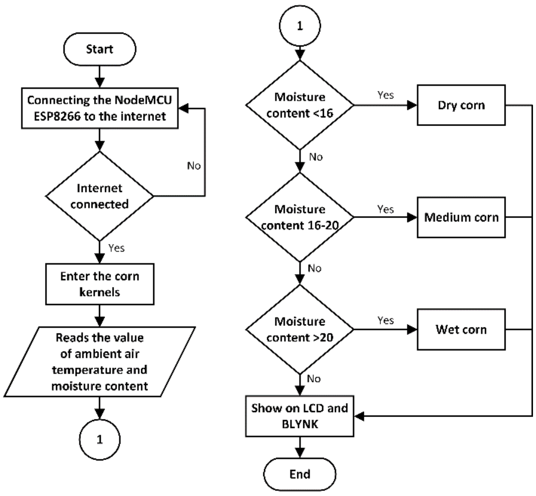

Figure 3. Flow diagram

3. RESULT AND DISCUSSION

From the testing results conducted in the research of the IoT-based moisture detection device for corn seeds, the purpose was to assess the performance of the device and sensors that were developed. The testing encompassed hardware testing, software testing, and testing of the display on Blynk.

3.1. Hardware Testing

Hardware testing in this research was performed to understand the performance of the system used. Hardware testing included testing the DHT-22 temperature sensor, testing the YL-69 moisture sensor, and testing the display on the LCD.

3.1.1. DHT-22 Sensor Testing

The data obtained from the DHT-22 sensor was compared with measurements from the standard HTC-1 instrument can be seen in Table 1.

Table 1. DHT-22 sensor testing results for ambient temperature

No	DHT22 Measurement (°C)	HTC-1 Measurement (°C)	Error (%)
1	28.60	29.4	2.72
2	28.60	29.4	2.72
3	28.60	29.4	2.72
4	28.60	29.4	2.72
5	28.70	29.4	2.38
6	28.70	29.4	2.38
7	28.70	29.4	2.38
8	28.70	29.4	2.38
9	28.70	29.4	2.38
10	29.30	29.4	0.34
11	29.30	29.4	0.34
12	29.30	30.0	2.33
13	29.30	30.0	2.33
14	29.30	30.0	2.33
15	29.30	30.0	2.33
Average			2.31

The Table 1 displays the results of the DHT-22 sensor testing for ambient air temperature conducted on November 4, 2022. The average error value between the DHT-22 temperature sensor and the standard HTC-1 instrument was found to be 2.31%.

3.1.2. YL-69 Sensor Testing

The data collected from the YL-69 sensor was compared with measurements from the standard Grain Moisture Meter can be seen in Table 2.

Table 2. YL-69 sensor readings for moisture content in corn seeds

No	YL-69 Measurement (%)	Grain Moisture Meter Measurement (%)	Error (%)
1	30	28.9	3.8
2	29	28.9	0.3
3	27	28.2	4.4
4	31	29.7	4.3
5	29	28.9	0.3
6	27	28.2	4.4
7	27	28.2	4.4
8	28	28.2	0.7
9	28	29.1	3.7
10	32	29.7	7.7
11	28	29.1	3.7
12	28	29.1	3.7
13	30	28.8	4.1
14	29	29.3	1.0
15	28	28.2	0.7
Average			3.1

Table 2 illustrates the results of the YL-69 sensor testing for moisture content in wet corn seeds. The average error value between the YL-69 moisture sensor and the standard Grain Moisture Meter was determined to be 3.1%.

3.1.3. LCD Testing

The 16x2 LCD display changes based on the moisture content in the tested corn seeds. The LCD display when the corn seeds are dry is shown in Figure 4. Similarly, the LCD display changes based on the moisture content. The display for moderate moisture content in corn seeds is depicted in Figure 5. The LCD display also changes according to the moisture content. The display for wet corn seeds is presented in Figure 6.

Figure 4. LCD display in dry corn seeds condition

Figure 5. LCD display in moderate moisture condition

Figure 6. LCD display in wet corn seeds condition

3.2. Software Testing

Software testing in this research was carried out using the Arduino IDE application. The purpose of this testing was to ensure that the program created in Arduino IDE functions correctly without errors. Software testing for the IoT-based moisture detection device for corn seeds is displayed in Figure 7 as a screenshot of the program.

3.3. Blynk Application Testing

The Blynk application's interface during testing with dry corn seeds is shown in Figure 8. Similarly, the Blynk application interface during testing with moderate moisture content in corn seeds is depicted in Figure 9. The Blynk application interface during testing with wet corn seeds is shown in Figure 10.

Figure 7. Moisture detection program in arduino software

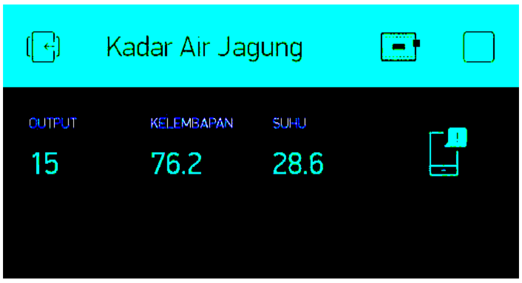

Figure 8. Blynk interface in dry corn seeds condition

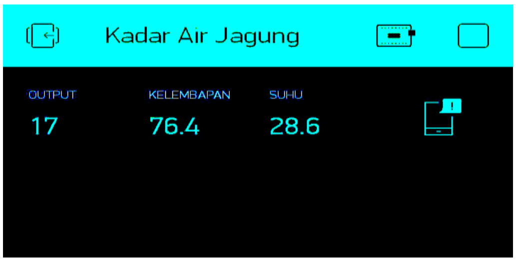

Figure 9. Blynk interface in moderate moisture condition

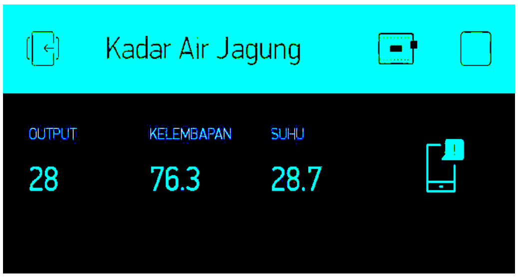

Figure 10. Blynk interface in wet corn seeds condition

4. CONCLUSION

Based on the conducted research on the Design and Development of a Moisture Detection Device for Corn Seeds, several conclusions can be drawn. The device created has been successfully implemented to measure the moisture content in corn seeds and can be utilized to aid corn farmers in determining the moisture level in their corn seeds. Testing was performed under dry, moderate, and wet corn conditions. The device achieved an average error rate of 3.1%. In summary, the device operates effectively with a high level of accuracy.

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