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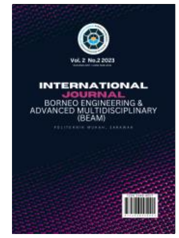

Smart Automatic Black Pepper Drying Tray with IoT Using Wemos

Full Paper

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Abstract

Due to Malaysia's unpredictable weather, farmers find it difficult to complete their work of drying pepper in a day. Existing drying machines are either inefficient or difficult to install and maintain during the drying pepper process. In contrast to the United States, where electric drying is mostly used, roughly 16 billion kW, or 5.8% of total residential power use, is consumed annually. If we compare this electricity usage rate to that of Malaysia, farmers won't be able to pay it. The concept used in the smart black pepper platform is ergonomic which can facilitate the way people work in agriculture. This smart black pepper platform is equipped with smart sensor system to detect rain, weather, sunlight with automation control in order to reduce manpower consumption. The design and prototype for a smart platform for drying black pepper in wet conditions are displayed in this capstone project. The smart black pepper drying tray is made up of the drying rack frame, the linear actuator, sensors, and motor controls, as well as the cover curtain mechanism. Depending on the atmosphere, the gear-chain mechanism in the drying rack frame releases and exposes the black pepper. This document outlines the design development procedures, prototype development, prototype testing outcomes and analysis, as well as some recommendations for future work.

Keywords: - Black Pepper, drying, solar, Wemos

1. Introduction

Pepper is the most significant and expensive spice in the world, as seen in Fig. 1. It is a crucial component in numerous recipes and is employed to flavour meals (Hammouti et al., 2019). The berries of Piper nigrum are used to make a variety of seasonings, including black pepper, white pepper, green pepper, and "Tellicherry" pepper. In the spice industry, these peppers come in a variety of grades. (Jayashree & John Zachariah, 2022).

All around the world, pepper is currently grown in tropical climates. In the Pacific, notably in the Federated States of Micronesia, it is a significant cash crop (the island of Pohnpei). Hawaii and several other Pacific islands are excellent places for the plant to flourish, but cultivation is not very common there. The nations that produce the most pepper on a global scale are India, Indonesia, Brazil, Malaysia, Thailand, Sri Lanka, Madagascar, Mexico, and a few more.

Black pepper is made by manually or mechanically threshing fruit spikes and separating the stalks from the green berries. Afterwards, depending on the amount and duration of sunlight, the berries are sun dried for 4-5 days on mats on top of a raised platform (Sharangi, Upadhyay, Alshammari, Saeed, & Al-Keridis, 2022). The berries are often spread out in a thin layer and turned regularly to facilitate even drying (Dhas & Korikanthimath, 2003).

Fig. 2 shows how to dry the pepper at 55ºC (130ºF) until it has 12% water content. This temperature is suggested for the best colour and flavor (Paul et al., 2021). Higher temperatures are acceptable if the pepper does not exceed 70ºC (160ºF). The time required varies depending on several factors, but it is usually less than a day. One of the most crucial unit processes in the preparation of green peppers is drying the harvested pepper. The most popular way of drying is sun exposure (Vieira et al., 2022). During 4-5 days in the sun, the despiked pepper berries are dried to a moisture content of less than 11% (Gabriel, David, Elpa, & Michelena, 2020).

Fig. 1. Pepper

Fig. 2. Dry the pepper

The problem that farmer faces during the drying process are when sudden rain (Tunde-Akintunde, Afolabi, & Akintunde, 2005). The farmers need a smart and automatic pepper drying tray because current drying process needs to be monitored and collected manually every day. Therefore, the Smart Automatic Black Pepper Drying Tray with Blynk Internet of Things (IoT) was proposed and developed in this paper.

This tray is designed and fabricated to fulfill four main design requirements, which is the first design requirement is that the tray is simple and easy to start and end of the drying process automatically. The second design requirement of this tray is it can start and end the drying process automatically without laborious human power. The third design requirement is the drying process is fully monitored by smart IoT technology to detect the rain drop, the intensity of sun light, temperature, humidity, and to start motor to open the tray or keep the tray under the roof automatically and its duration which all could be monitored and controlled in long distance with wifi technology in real time. A message will be sent when rain detected to handphone. The fourth design requirement is that this machine can be powered by solar panel which adopts green technology and less pollution to the environment. The concept used in the smart black pepper platform is ergonomic which can facilitate the way people work in agriculture. This smart black pepper platform is equipped with a sensor system to detect rain to reduce manpower consumption.

2. Design of Smart Automatic Black Pepper Drying Tray

2.1 Block Diagram

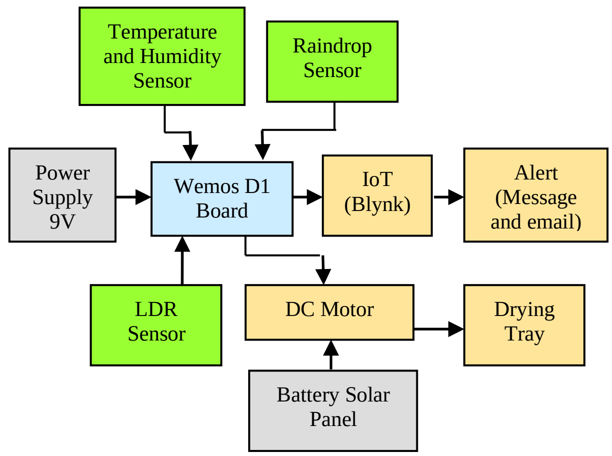


Fig. 3. Block diagram of proposed system

2.1.1 ESP8266 WeMos D1 Board

The WeMos D1 is an Arduino Uno-like wifi board built on the ESP-8266EX, as seen in Fig. 4. The Arduino IDE is compatible with the ESP8266-D1 802.11 (Wifi) wireless microcontroller development board (Gawande et al., 2023). The widely used ESP8266 wireless (Wifi) module is transformed into a complete development board in this way. This board's layout is based on a typical Arduino hardware design, and its dimensions are comparable to those of the Arduino Uno and Leonardo.

Fig. 4. WeMos D1 ESP8266 base board

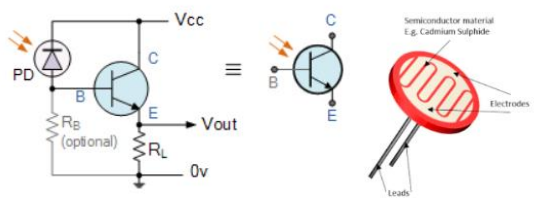
2.1.2 Raindrop Sensor

Fig. 5 shows the raindrop sensor. It is a simple tool for detecting rain. It can be used as a switch when a raindrop falls through the raining board, as well as to measure the intensity of the rain.

Fig. 5. Raindrop sensor

2.1.3 Light Dependent Resistor (LDR) Sensor

As shown in Fig. 6, light-sensitive devices called light-dependent resistors (LDR), often referred to as photoresistors, are frequently employed to detect the presence or absence of light or to calculate the intensity of light. Infrared or visible light (photons) can be converted into an electrical signal by using light sensors, which are photoelectric devices (Setya et al., 2019).



(a) (b)

Fig. 6. (a) LDR Sensor Schematic, (b) Component of LDR sensor

2.1.4 DHT11 Temperature and Humidity Sensor

The DHT11 is a widely used temperature and humidity sensor that includes a dedicated NTC to measure temperature and an 8-bit microcontroller to output temperature and humidity values as serial data, as illustrated in Fig. 7.

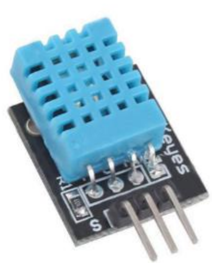


Fig. 7. DHT11 temperature and humidity sensor

2.1.5 Direct Current (DC) Motor

DC motor converts electrical energy in the form of Direct Current into mechanical energy in the form of rotational motion of the motor shaft as shown in Fig. 8. The DC motor speed can be controlled by applying varying DC voltage, whereas the direction of rotation of the motor can be changed by reversing the direction of current through it.

Fig. 8. DC motor

2.1.6 Solar Panel and PWM Solar charge Controller

PWM Solar Charge Controller is an automatic control device used in the solar power generation system, which controls the multi-channel solar cell array to charge the battery and the battery to power the load of the solar inverter as shown in Fig. 9. Solar charge controller is the core control part of the whole photovoltaic power supply system (Antonov, Kanchev, & Hinov, 2019).

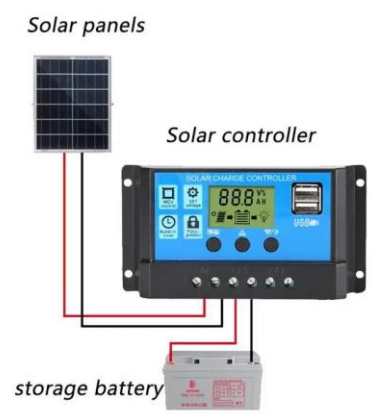


Fig. 9. Solar panel with PWM solar charge controller

2.2 Software Development

2.2.1 Programming Flow Chart

Fig. 10 shows the programming flow chart for smart automatic black pepper drying tray with Internet of Things (IoT). This flow chart starts with reading from LDR sensor, temperature & humidity sensor, and raindrop sensor in determining the tray location of this project. Based on the programming, if the reading of LDR sensor is less than 50, that's mean the tray is in a dark environment and no sunlight detected. The temperature and humidity reading could be read from DHT11 sensor that was selected in this project. Meanwhile, rain sensor could detect the present of rain drops with reading more than 800. Based on all these sensors reading, Wemos will activate motor to move the tray under the roof when bad weather and deploy the tray under the sun when weather is good automatically.

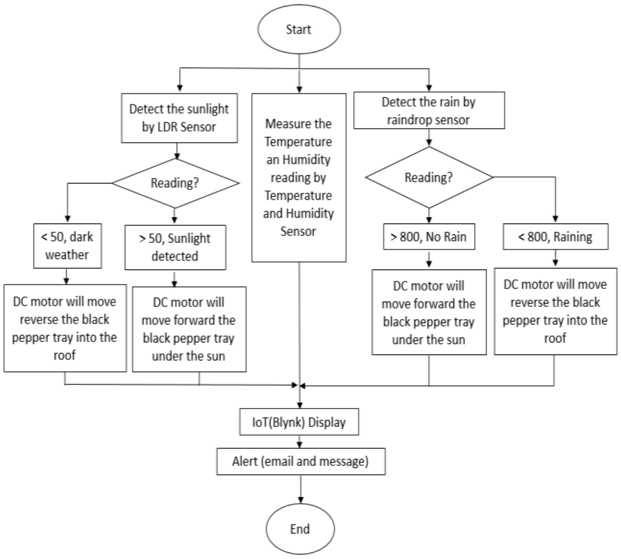


Fig. 10. Flow chart

2.2.2 Arduino IDE Software

A code editor, a message area, a text terminal, a toolbar with buttons for basic tasks, and a series of menus are all features of the Arduino Integrated Development Environment (IDE), also known as Arduino Software (IDE), as depicted in Fig. 11. The Arduino hardware is interfaced with, and programmes are uploaded there.

Fig. 11. Arduino software

2.2.3 Blynk

Blynk was designed for the Internet of Things as shown in Fig. 12. It can control hardware remotely, it can display sensor data, it can store data, visualize it and other things. Rain sensor, light sensor and temperature and humidity sensor will monitor the weather and all the reading will be updated on handphone in live. When rain is detected, a message will be sent to handphone automatically.

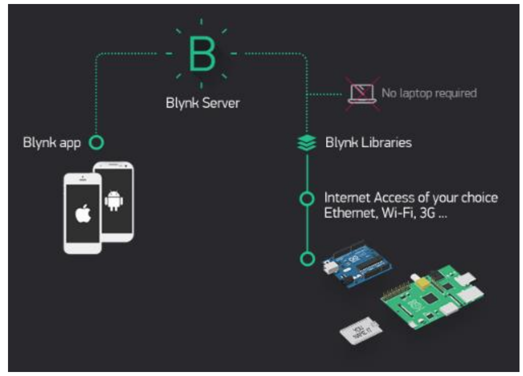
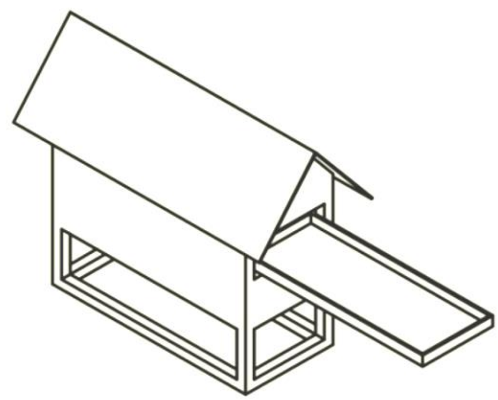


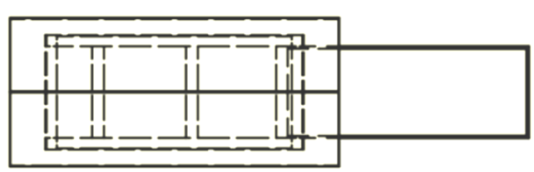
Fig. 12. Blynk

2.3 Casing Design

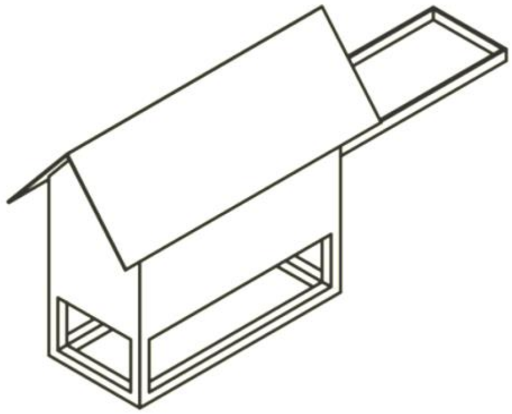
Fig. 13 shown in front side view, top view, and back side view for smart automatic black pepper drying tray with IoT.



(a)



(b)



(c)
Fig. 13. (a) Front side view, (b) top view, (c) back side view

3. Results and Analysis

Fig. 14 shows the design of smart automatic black pepper drying tray with Blynk IoT. Rain sensor, light sensor and temperature/ humidity sensor will monitor the weather and all the reading will be updated on handphone in live. When rain is detected, a message will be sent to handphone automatically. Wemos will activate motor to move the tray under the roof when bad weather and deploy the tray under the sun when weather is good automatically as shown in Fig. 15 until Fig. 18.

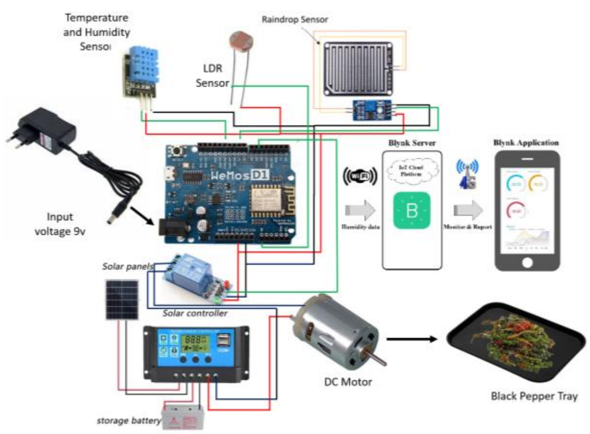


Fig. 14. Design of smart automatic black pepper drying tray with Blynk IoT

LDR sensor is used to detect sunlight, if sunlight is detected, LDR will send a signal to Wemos and Wemos will control the DC motor to move forward. If the weather is dark, then the LDR will send a signal to Wemos to control the DC motor to move reverse to keep a tray of black pepper in the roof. Raindrop sensor is used to detect the rain, if rain is detected, raindrop sensor will send a signal to Wemos for controlling the DC motor to move reserve in the roof. It can be controlled using wifi and apps on the user smartphone as shown in Fig. 19. It can automatically read the temperature in the user smartphone. It can on and off automatically when the user is far from the smart automatic black pepper drying tray.

Fig. 15. Side view

Fig. 16. Front view

Fig. 17. Back view

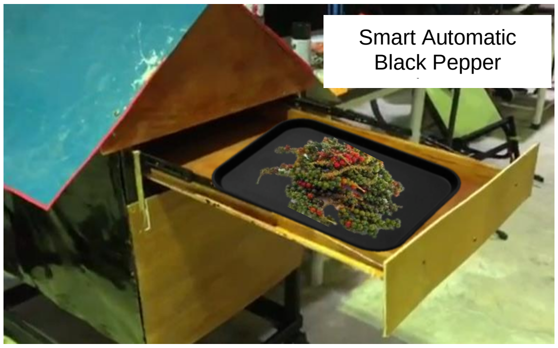


Fig. 18. Smart Automatic Black Pepper Drying Tray

The test run carried out for this project was successful because the tray exited in just 2.5 seconds without touching anything on the project and returned to its original position when the light sensor dropped from 100 to 50. This project is equipped with a frame for a drying rack with a gear-chain system. a control module that includes an WeMos, a DHT11 temperature & humidity sensor, a water sensor, an LDR, and one stepper motor to control the movement of tray which depend on the weather.

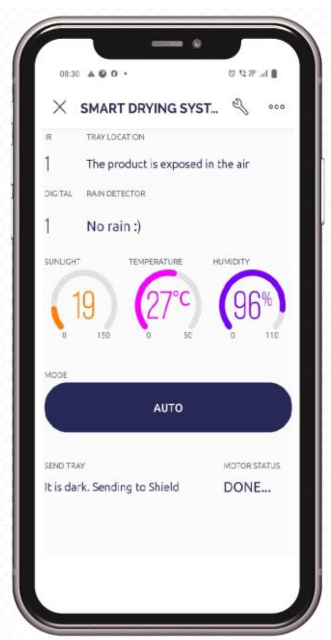


Fig. 19. Smart Automatic Black Pepper Drying Tray with Blynk IoT

Fig. 19 shows the output results from the Blynk application. This app has displayed the measurement for sunlight reading from LDR sensor, Temperature and humidity reading from Temperature and humidity sensor, and raining status from raindrop sensor. Table 1 shows the results and findings for Smart Automatic Black Pepper Drying Tray with Blynk IoT.

Table 1. Results and finding

Testing	Sunlight detected by LDR Sensor	Rain detected by Raindrop Sensor	DC Motor movement
Testing 1	Yes	No	Move Forward
Testing 2	No	Yes	Move Reserve

5. Conclusion

Smart Automatic Black Pepper Drying Tray with Blynk IoT has been created, which is used for drying black pepper under the sunlight. This project can monitor the weather condition with smart sensor and data shown in phone through IoT features. The tray moves in and out from the roof based on the weather condition automatically. This project has adopted solar panel as green technology. This project concept can be applied to other applications such as automatic cloth rack and fish cracker drying tray.

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