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Automated Dual-Source Squid Dryer with Image Processing Monitoring

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The aim of this project was to develop and fabricate an indoor dual-source drying system that uses IoT to detect moisture during drying. By comparing traditional drying methods to their automated system, the researchers were able to save a total of 34 hours while effectively monitoring humidity and temperature in real-time using image processing techniques. Development and Evaluation of an Automated Dual-Source Squid Dryer with Image Processing Monitoring for Enhanced Drying Efficiency. The study was conducted in Brgy. Canlanipa, Surigao City, Surigao del Norte, with a duration of 1 year. The study involved designing and developing an indoor dual-source dryer system with moisture detection through image processing monitoring, using Arduino Uno, Raspberry Pi 3b, sensors, and a motor. A working prototype was created, validated, and subjected to thorough testing using wet squid samples to evaluate its performance, leading to necessary adjustments and improvements based on feedback and test results. This study developed an automated dual-source squid dryer with image processing monitoring. The system demonstrated faster drying time (14 hours) compared to traditional methods (48 hours) while maintaining good quality. The indoor drying system proved advantageous, being weather-independent and achieving

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dry squid with 10% moisture content. The automated dual-source squid dryer with image processing monitoring achieved a shorter drying time of 14 hours, outperforming traditional methods that took 48 hours, while ensuring high-quality results. This highlights the system's efficiency and dependability for indoor squid drying, unaffected by weather conditions.

Keywords: Dual-source squid dryer; image processing monitoring; Internet of Things (IoT); indoor drying system; moisture detection.

1. INTRODUCTION

The traditional method of drying squid entails a sequence of processes for best preservation [1]. Initially, the squid is meticulously cleaned and prepared by removing internal organs and rinsing with water [2]. Following that, the squid is either split into rings or retained whole, depending on personal choice [3]. To achieve even drying and prevent spoiling, the squid must be rotated or flipped on a regular basis [4]. The traditional way of drying squid, while effective, can be time-consuming and heavily reliant on favorable weather conditions [5]. The traditional method of drying squid has been practiced for generations and can yield satisfactory results, its dependence on natural factors and manual handling make it susceptible to variations in drying time and quality.

Image processing monitoring programs have received a lot of interest in many sectors of fishing since they provide useful insights and automation possibilities [6]. The use of image processing in squid-related monitoring activities, in particular, provides great prospects for improved data collecting, real-time analysis, and automated decision-making procedures [7]. Researchers and industry experts may easily monitor squid populations, behavior, and environmental conditions by employing modern imaging techniques such as object identification and tracking, ultimately contributing to enhanced management strategies and sustainable harvesting practices. Combining image processing technology with Internet of Things (IoT) systems enables smooth data transfer and remote monitoring, allowing for prompt interventions and resource management [8]. The utilization of image processing monitoring applications in the realm of squid fisheries not only enhances the efficiency and accuracy of data collection but also provides a means to address pressing concerns, such as overfishing and ecological impact.

The traditional method of drying squid suffers from several disadvantages [9]. It is highly dependent on favorable weather conditions, making the drying process unpredictable and susceptible to delays or spoilage [10]. Manual handling and periodic flipping of the squid may introduce human errors and inconsistencies [11]. The traditional method lacks real-time monitoring capabilities, resulting in limited data collection and analysis opportunities [12]. These weaknesses can be addressed by the application of a squid dryer with image processing monitoring, as discussed in paragraph two. Such a system would provide a rapid assessment of drying progress, enabling timely interventions and adjustments [13]. Moreover, the integration of image processing techniques would enable real-time monitoring of temperature, humidity, and other parameters, ensuring optimal drying conditions and reducing the risk of spoilage.

This project aims to incorporate automation and dual-source functionality into the squid dryer system for enhanced monitoring and assessment. By utilizing image processing techniques, real-time analysis of temperature, humidity, and other parameters can be achieved, ensuring optimal drying conditions. The integration of dual sources, such as Arduino Uno and Raspberry Pi 3b, enables precise control over the drying process and facilitates wireless accessibility through the web camera interface. Ultimately, this combination of automation, dual-source functionality, and image processing monitoring promises to revolutionize the assessment and efficiency of the squid drying process.

2. MATERIALS AND METHODS

A. *This section presents the materials and methods in the development of Automated Dual-Source Squid Dryer With Image Processing Monitoring.*

Fig. 1. DHT11 temperature and humidity sensor

It is a commonly used sensor that provides accurate measurements of temperature and humidity in various applications [14]. Its compact size, low power consumption, and reliable performance make it a popular choice for monitoring environmental conditions in IoT projects.

Fig. 2. Raspberry Pi 3 B+

The Raspberry Pi 3 B+ is a single-board computer that offers enhanced processing power, improved networking capabilities, and extensive connectivity options [15]. With its compact size and versatility, it is widely used in various projects, ranging from IoT applications to media centers and educational platforms.

Fig. 3. LED ring light

The LED Ring Light is a lighting device made out of a circular arrangement of LED lamps. It produces homogeneous and diffused lighting, making it perfect for photography, videography, and other applications requiring even illumination.

Fig. 4. 5V single relay

A single relay is an electromechanical switch that can control the flow of electric current to a connected device. It is commonly used in automation and control systems to enable or disable power to a specific circuit or component.

Fig. 5. Stepper motor

A stepper motor is a type of brushless DC motor that converts digital pulses into precise mechanical movements. It is widely used in applications that require accurate positioning, such as robotics, 3D printers, and CNC machines.

Fig. 6. LCD

The LCD (Liquid Crystal Display) is a flat panel display technology commonly used for visual output in electronic devices. Its ability to display alphanumeric characters, graphics, and images makes it a versatile choice for various applications, ranging from consumer electronics to industrial control systems, providing clear and readable information to the users.

Fig. 7. Power inverter

A power inverter is an electronic device that converts direct current (DC) power from a battery or solar panel into alternating current (AC) power, which is compatible with standard household appliances and electrical devices. It is commonly used in off-grid systems, vehicles, and emergency backup power solutions, providing a convenient way to access AC power in situations where it is not readily available.

Fig. 8. Charge controller

A charge controller is a device used in solar power systems to regulate the flow of electrical charge between the solar panels and the battery bank [16]. It ensures that the batteries are charged efficiently and prevents overcharging or damage to the batteries by controlling the charging process. Charge controllers also help optimize the performance and lifespan of the battery system in solar installations.

Fig. 9. 12V DC motor

A 12V DC motor is an electric motor that operates on 12 volts of direct current. It converts electrical energy into mechanical energy, making it suitable for a wide range of applications such as robotics, automotive systems, and small appliances [17]. The 12V rating indicates the voltage required to power the motor and determines its speed and torque characteristics.

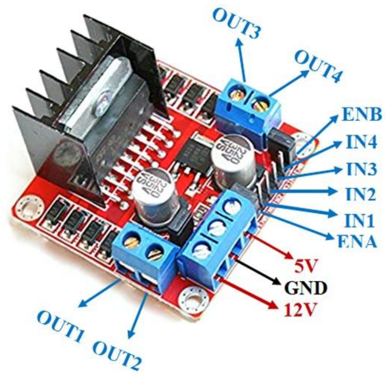

Fig. 10. L298N motor driver

The L298N motor driver is a popular integrated circuit used to control and drive DC motors and stepper motors. It provides a convenient way to control motor speed and direction by accepting input signals from a microcontroller or other control devices. It offers a high level of flexibility and power, making it suitable for a variety of applications such as robotics, automation, and motor control systems.

2.1 Methods

B. *These are the methods used in the development of the Automated Dual-Source Squid Dryer with Image Processing Monitoring*

1. *Design and develop an indoor dual-source dryer system capable of detecting moisture during drying with image processing monitoring.*

In the initial step, conduct research on indoor dual-source dryer systems, moisture detection, and image processing monitoring to gather relevant information [18]. Design the system architecture, integrating Arduino Uno, Raspberry Pi 3b, sensors like DHT11, and a motor for the drying mechanism. Develop hardware connections with proper wiring and compatibility, create the Arduino Uno software program for sensor and motor control, configure Raspberry Pi 3b for wireless communication, and set up the web camera interface. Implement image processing algorithms for real-time monitoring of humidity, temperature, and other parameters [19].

2. *Create a working prototype for testing and review.*

Assemble the hardware components, including the drying chamber, Arduino Uno, Raspberry Pi

3b, sensors, motor, and relays, following the established design [20]. Install and configure the required software on the Raspberry Pi 3b to enable communication and control among the components [21]. Validate the prototype by testing its functionality, ensuring proper power supply and connectivity, and verifying its capability to detect moisture during the drying process using the integrated sensors.

3. Testing the device using the electronics devices.

Conduct thorough testing of the device by simulating drying scenarios using wet squid samples [22]. Monitor and record the device's performance, including moisture detection accuracy, temperature stability, and real-time data provided through image processing monitoring [23]. Analyze the collected data and compare the results with traditional drying methods to assess the effectiveness and efficiency of the automated dual-source squid dryer [24]. Gather feedback from users, professionals, and stakeholders involved in the testing process, and make necessary adjustments and improvements to the prototype based on the feedback and test results [25].

3. RESULTS AND DISCUSSION

The study's results and discussion of the squid dryer, including the considerable differences between indoor and outdoor drying. The squid dryer's performance in terms of time, temperature, and mass, and the device's drying efficiency.

3.1 Design and Development of the System

The schematic diagram is seen in Fig. 11. The direction and the flow indicates whether the components are inputs or outputs. Solar energy is collected by the solar panel and converted into electrical energy, which is stored in the battery. The solar charge controller charges the battery and supplies electricity to the system at the same time (inverter). The Arduino Uno is powered by an inverter USB (Universal Serial Bus) in 5Vdc 1 amp, and all of its data signals, such as LED ring light (pin 7), Servo motor (pin 8, pin 9, pin10, pin11), Main Source (pin 5), Heater Fan (pin 6), and 12V DC motor, are linked to the Arduino Uno. Humidity Sensor/Temperature (pin 2) Sensors are also passive sensors. The temperature within the chamber is measured by the temperature sensor. The Arduino Uno microcontroller is used to send commands to the Arduino. The raspberry power port received 5Vdc, and the camera was linked to the camera slot module. The Raspberry Pi 3b+ camera both processes and transmits data to the microcontroller. The data from the Raspberry Pi 3b+ camera and temperature sensor are encoded on the SD card when in the drying mode. It is also displayed on the LCD. The drying stops when the squid reaches 10% moisture content which is considered as dry. The buzzer will turn on to notify the researcher that the squid is dry [16-20].

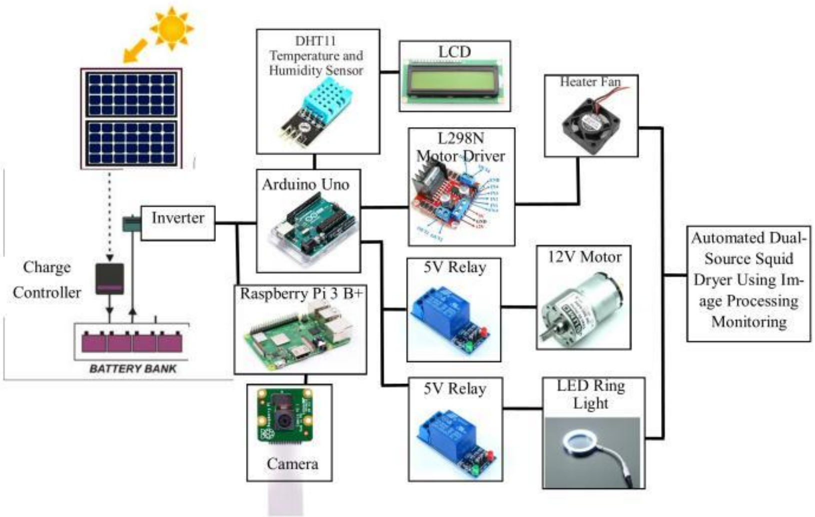

Fig. 11. Schematic

Fig. 12. Frame design

Fig. 13. Pictorial diagram

The frame of the drying chamber provides structural support and stability to the device, ensuring proper alignment and functionality of the components. It is designed to accommodate the drying chamber, sensors, motor, and other hardware components, maintaining their position and facilitating efficient drying operations.

A pictorial diagram visually represents the system's components and their connections using simplified illustrations. It provides a clear and concise overview of the system's architecture and helps users understand the physical layout and interrelationships between different elements of the system.

3.2 Working Prototype

The automated squid dryer chamber represents the final prototype with all the equipment and programs successfully installed and running. It is a fully functional system ready for use in drying squid efficiently and effectively.

3.3 Testing of the Study

In Fig. 15, a captured photo of dry squid is displayed. To predict images using MATLAB, the loaded image was resized to dimensions of 384 by 256 pixels. This resizing process ensures that the image is appropriately formatted and compatible with the image processing algorithms employed in MATLAB for accurate prediction and analysis.

The grayscale image of the dry squid was obtained by converting the original image into grayscale mode. This conversion enables the calculation of roughness and the weight of blackness, which are important parameters for analyzing the squid's texture and appearance. By working with the grayscale image, accurate measurements and assessments can be made to further understand the squid's quality and characteristics during the drying process.

Fig. 14. Automated squid dryer chamber

Fig. 15. Captured photo of dry squid

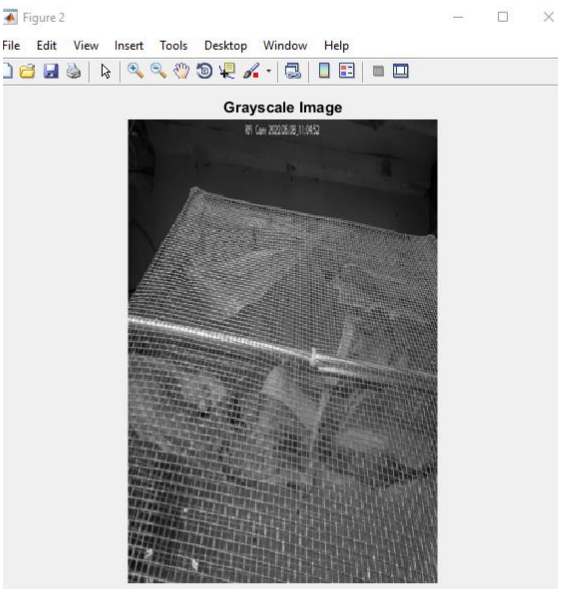

Fig. 16. Grayscale image of dry squid.

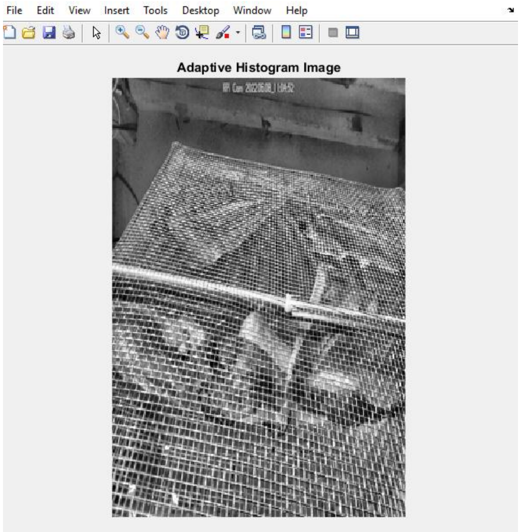

Fig. 17. Adaptive histogram Image of the dry squid

Adaptive Histogram technique and RGB segmentation were applied to calculate the average color values. Then results were randomly compared to the trained image values and then get the values that are closely the same as the result value.

Lastly, Matlab gets the classification name of the closest trained value and then shows the output on the MatLab terminal.

Table 1. Moisture content of the dy squid

Moisture Content	Time	
(%)	24 hours	48 hours
100	200g	
80	111.1g	
50	133.33	
30		153.33g
10		181.81g

The table above shows the effects on the Squid with different moisture content in a traditional way of drying. It takes 48 hours to achieve 10% moisture content which is considered as dry.

3.4 Analysis Method

Moisture content

During drying, the mass to be dried was measured using a digital balance at regular intervals (i.e., 30 min) and the current moisture content was calculated using the following equation.

$$M_t = 100 - \frac{W_0}{W_t}(100 - M_0)$$

Mt: moisture at time t
Mo: initial moisture
Wt: the volume at time t
Wo: initial volume

Table 2. Comparison results for traditional and automated dryer

	Automated Squid Dryer	Traditional Drying
Time for Drying	14 hrs.	48 hrs.
Quality	Good	Good

Table 2 shows that an automated dryer dries faster than traditional drying. In terms of quality, there is no significant difference. However, indoor drying has an advantage since it is not dependent on the weather unlike the traditional.

Fig. 18. 10% dry squid

Normally the dried fishes or squid contain an average of 10 to 20% of moisture. Fig. 18 shows the output product of the automated dual-source squid dryer with image processing monitoring.

4. CONCLUSION

Designed and developed an automated dual-source squid dryer system. The prototype, consisting of the drying chamber, Arduino Uno, Raspberry Pi 3b, sensors, and image processing algorithms, demonstrated efficient and effective drying capabilities. The system's performance was analyzed through testing, comparing it to traditional drying methods. The results showed that the automated dryer significantly reduced drying time, achieving dryness in just 14 hours compared to the 48 hours required by traditional methods. The quality of the dried squid was comparable in both approaches, but the indoor drying system offered the advantage of being independent of weather conditions. This study highlights the potential of automated squid dryers with image processing monitoring for improving drying efficiency and ensuring consistent quality.

5. RECOMMENDATION

Based on the study's findings and the conclusions obtained, the following recommendations are given:

1. Investigate the potential benefits of incorporating additional heaters to expedite the drying process. This could enhance the overall efficiency and reduce the drying time, leading to increased productivity.
2. It is advisable for future researchers to include a circuit breaker in the system design to enhance safety measures. This will help protect the equipment from electrical overloads and minimize potential hazards.
3. Consider utilizing deep cycle solar batteries as the power source for the system. This renewable energy option can provide a more sustainable and environmentally friendly solution, reducing reliance on traditional power sources and lowering operating costs.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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