Automated Dual-Source Squid Dryer with Image Processing Monitoring

Abstract- This study is to design and develop a working prototype for an indoor dual-source drying system that is capable of detecting moisture during drying by utilizing the internet of things (IoT). The researchers used Arduino Uno to control sensors, 12v DC motor, and switching relays. For the web camera interface which can be accessed through wireless networks, we used Raspberry Pi 3b. The prototype uses a heater which is monitored through a temperature sensor for the squid sample to dry at a stable temperature. In this study, we have compared traditional drying and our automated drying system which results in saving a total of 34 hours. The researchers' project successfully monitored and detect humidity and temperature in the chamber's atmosphere in real-time.
Keywords - Internet of things, Arduino Uno, Raspberry Pi, Drying, Squid

I. INTRODUCTION

Cephalopods or commonly known as squid are regarded as priceless delicacies anywhere in the world. Due to its low shelf life, squid is preserved either chilled or dried. This method is used if the squid is used for domestic or international export. The process of drying involves the evaporation of moisture from the surface of the fish and the migration of moisture from within the fish to the surface. In addition to the temperature and humidity of the air, the movement of air over the fish affects drying. The demand for this product is high in Asian countries like Korea, China, and Japan, due to its flavors and convenience. Researchers proved that dried squids are a good source of polyunsaturated fatty acids and protein. This is one reason why the demand for dried squid is high.

The advantage of drying fish or squid is that compared to other preserved forms of fish or squid, dried fish that has been dried through the sun or dehydrated is highly concentrated. Due to the reduction in water content, microbial activity cannot run at a normal rate, reducing fish spoilage. It is also an ancient technique for preserving products, especially from the sea. In comparing wet and dry materials, wet materials are known to grow microbes and are easy to spoil. On the other hand, due to the shrinkage that is caused by drying goods ease of handling increases. Various methods are known for drying. Among the methods of drying, sun drying is known as the most convenient, and financially friendly, and only requires little to no equipment.

Heat pump drying and hot air drying are other methods of drying squid. A one-sun-dried squid is dried using combined infrared and heat pump drying, as well as combined infrared and hot air drying. In each method, squids are dried at three different temperatures of 40, 45, and 50 degrees Celsius. Convective drying uses hot air. The drying process uses warm air as the heat source. temperature, velocity, relative humidity, and other drying factors are all controlled by the humidity carrier. Contamination sources can be effectively controlled, resulting in products of reasonably high quality. Microwave drying is an alternative way of increasing the quality of dried goods while also saving electricity. Microwaves have longer wavelengths and lower accessible energy quanta than visible, ultraviolet, or infrared light. (Huizhi Chen,1 Min Zhang,1 Zhongxiang Fang,2 and Yingqiang Wang)

The researcher decided to make a device that is dry squid indoor because the Philippines is a tropical country, that is why the weather is unpredictable. The coastal zone's multiple uses are due to the large range of goods and services it provides (food, pharmaceuticals, nutrient recycling, flood management, and typhoon protection) (fisheries, aquaculture, agriculture, human settlements, harbors, ports, tourism, industries). For better efficiency, the researcher will make an automated system to reduce human effort.

This automated squid drier will result in a higher output rate in less time and the availability of the areas that are most needed. Because the squid drier is indoor, it may be used at any time and in any location. It is also beneficial to fish growers to keep this dryer running at all times. This study documented the design and equipment used in the automated squid drier, as well as the experimental findings, obtained utilizing image processing monitoring.

Dry goods have been in the hearts of every Filipino people which is why the researchers sparked interest in choosing this study and also to combat environmental contamination that may be present in manual drying.

Review of Related Literature

The squid was traditionally consumed in Japan in the form of sun-dried squid. Although developments in freezing and cold storage facilities have made fresh or frozen squid more accessible to Japanese customers in recent years, seasoned and unseasoned dried squid remains popular. Around 400,000 raw squids were processed into a range of dried and seasoned squid items in 1977. While sun-drying is still practiced in some rural parts of

Japan, it has mostly been replaced by automated equipment, which is not only faster and more efficient but also eliminates the risk of spoilage due to unfavorable weather conditions.

Splitting and gutting the raw squid, removing the ink sac, cartilage, and skin, and drying the mantle, arms, and fins are the general procedures for preparing dried squid goods. The arms and fins may be removed and processed separately, seasonings may be added, and the dried squid may be shredded, rolled flat, or molded, depending on the type of product needed. Some products do not remove the skin. The numerous forms of dried squid products differ in look, flavor, texture, and moisture content. The Japanese employ a variety of words to describe various dried squid products, some of which have overlapping meanings. "Chimmi," a Japanese name for any seasoned and prepared fish product, was coined in 1986. *(Daniel J Sheeshy and Susan F. Vik, 1980)*

Solar radiation is an important component of various renewable energy sources. It is the primary and continuous input variable from the virtually limitless sun. Solar energy is likely to play a major role in the future, particularly in poor countries, but it also holds promise for industrialized countries. The information in this document has been chosen to give a complete picture of solar energy sources and conversion technologies. Explanatory background material has been introduced for this purpose, with the goal of providing engineers and scientists with introductory preliminaries on the subject from both an application and research standpoint. Solar energy applications in low and high-temperature collectors are discussed, along with future research prospects. Photovoltaics are also discussed for future energy generation. *(Z Sen,2004)*

Because of population growth and technological improvements, the world's energy consumption is rapidly increasing. For future energy demand, it is consequently critical to choose a stable, cost-effective, and eternal renewable energy source. Solar energy, like other renewable energy sources, is a promising and readily available energy source for addressing long-term energy challenges. Because of the tremendous demand for energy and the fact that the main energy source, fossil fuel, is finite and other sources are expensive, the solar sector is constantly growing all over the world. It has become a tool for developing countries' economic position and sustaining the lives of many poor people because it is now cost-effective as a result of years of rigorous research to speed up its growth. (NadarajahKannan DivagarVakeesan,2016)

A picture can be used to represent a scalar function with two independent variables. All mathematical operations can be thought of as changes to or processing the initial image. Special scanning techniques can be used to implement an important class of modifying operators without the use of a fast-access memory storage device. It was discovered that the two major operators investigated thus far may be useful. The first is contour enhancement, which generates a line drawing from an image with continuous tones. The second is contour outlining, which produces a line drawing from a picture with continuous tones. For particular classes of partial differential equations, the general notions introduced may allow the method to be extended to analog computers. With the adaptability and flexibility of when a preset operation on picture material is required, the system provides a viable solution. *(L. S. G. Kovasznay and H. M. Joseph, "Image Processing," in* **Proceedings of the IRE***, vol. 43, no. 5, pp. 560-570, May 1955, doi: 10.1109/JRPROC.1955.278100.)*

Image enhancement, pattern detection, and efficient picture coding are just a few of the applications for image processing techniques. The mathematical processes that are likely to be encountered, as well as approaches to execute them using optics and digital computers, are explored, as are image description and image quality evaluation. Many previous findings are reviewed, new ones are presented, and some unanswered questions are posed. *(T. S. Huang, W. F. Schreiber and O. J. Tretiak, 1971)*

According to (*R. D. Labati, V. Piuri and F. Scotti,2011.)* Image processing is used in the field of Medicine.

The visual examination of peripheral blood samples is a crucial step in the leukemia diagnostic process. In telemedicine applications, automated solutions based on artificial vision approaches can speed up this procedure while simultaneously improving accuracy and uniformity. Unfortunately, no public picture datasets are available to test and compare such techniques. We present a new public dataset of blood samples in this work, which is specially built for evaluating and comparing algorithms for segmentation and classification. The categorization of the cells is supplied for each image in the dataset, as well as a specific set of figures of merits to compare the performances of different algorithms equally. This program intends to provide a new testing tool to the public.

By exploiting the expanding ubiquity of radio-frequency identification (RFID), wireless, mobile, and sensor devices, the Internet of Things (IoT) has presented a potential opportunity to construct powerful industrial systems and applications. In recent years, a wide range of industrial IoT applications have been developed and deployed. This article examines current IoT research, key enabling technologies, main IoT applications in industries, and research trends and difficulties in order to better understand the evolution of IoT in industries. This review paper's key contribution is that it methodically describes the present state-of-the-art IoT in industries. (*L. D. Xu, W. He and S. Li, 2014)*

The Internet of Things (IoT) has received a lot of research attention in the last year. IoT is a component of the future Internet that will consist of billions of intelligently communicating 'things.' The Internet of the future will be made up of heterogeneously connected gadgets that will expand the world's borders with physical and virtual things. The Internet of Things (IoT) will provide new capabilities to connected objects. The definitions, architecture, essential technologies, and applications of the Internet of Things are thoroughly reviewed in this survey. First, several definitions of IoT are presented; second, developing methodologies for IoT implementation are examined; third, certain unresolved concerns linked to IoT applications are investigated; and finally, the major obstacles that need to be addressed through research are highlighted. *(Shancang Li, Li Da Xu, 2022)*

Conceptual Framework

This study is anchored upon the existing relationship of the efficient use of power source in a squid dryer with a dual-source power system with image processing monitoring, hypothesize result.

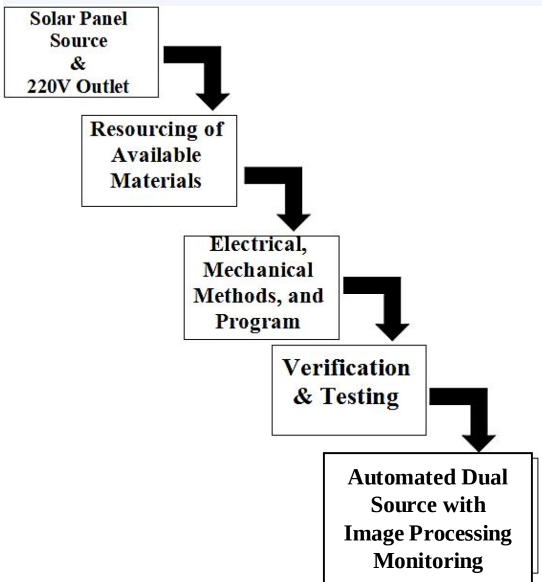

Figure 1. Waterfall Diagram of the Study

As shown in Fig. 1, illustrates the Waterfall Diagram of the entire sequence of development of the research project. The first block is the power supply of the project, it is a dual-source so it can work at any location. Then, the electrical, and mechanical methods and programs are required for the implementation. The design is based on the resourced available materials. Humidity sensors, relays, heating elements, led lamps, and servo motors are all used in monitoring systems After it is implemented through verification and testing which includes the operation of the project prototype. Lastly, is implementing the Automated Dual Source Squid Dryer with Image Processing Monitoring.

Objectives

The objective of this project is to build and install a system that uses a Raspberry Pi, Arduino Uno, and sensors to reduce human interaction and avoid the inconvenient and time-consuming drying procedure.

1. To design and develop an indoor dual source dryer system capable of detecting moisture during drying with image processing monitoring.
2. To create a working prototype for testing and review.
3. Testing the device using the electronics devices.

II. METHODS

Research Design

This research design will guarantee the existence of the device and the evidence gathered allows the researcher to successfully address the research challenge. The researcher uses a both qualitative and quantitative.

Project Design

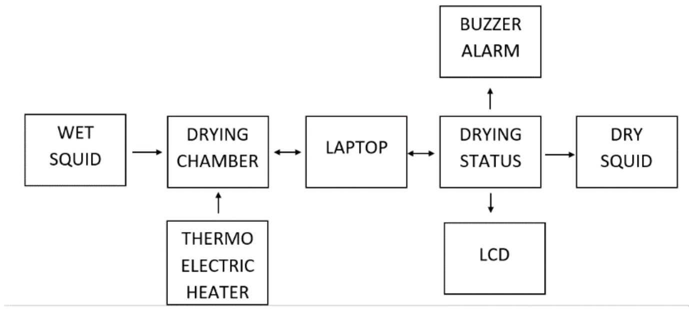

Figure 2. Block Diagram of the Project

The diagram of the project shows eight boxes, the first box represents the wet squid as a raw input followed by the drying chamber where the squid is being loaded. Then proceed to the drying mechanism. From drying, it will go to the laptop. As the drying is continuing data such as humidity, and the temperature inside the chamber, are displayed in the LCD user interface. This will be encoded in local storage which is the database. As for the laptop it uses to communicate with the Arduino for image monitoring and if the squid is dry the buzzer will turn on so the researcher notices. Finally, the output of the system is the dried squid.

Project Development

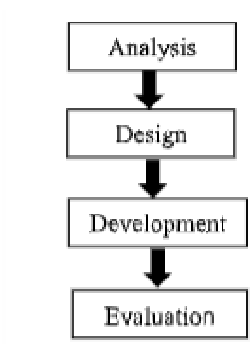

Figure 3. The Flow of Project Development

Fig. 3 shows the flow of the development of the study. To achieve the solution of the problem identified analysis phase obtain in this study, searching for different technologies that will applicable and feasible to the problem identified. After analyzing the study, the block diagram is also obtaining to represent the design, to overview the structure of this system.

At this point, we obtain the development project by applying the different stages. We used the Gantt chart to monitor and accomplish the target time allocated for this project.

In this process, we evaluate the characteristic of the performance of the system to obtain an accurate and efficient output

Project Evaluation

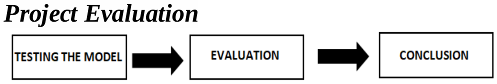

Figure 4. The Flow of Project Development

Fig. 4 shows the general overview and flow of the gathered quantitative and qualitative data. First, testing the model to guarantee that the evidence gained allows the researchers to successfully address the research problem of this study. Table comparisons show the different effects of both techniques used.

Project Implementation

The project will be implemented at a place where it can be tested and performed. Researchers conduct a test and survey together with the participants, the fishermen, and professionals. If the project can fulfill the process expectation and the project's outcome, the researchers and participants will manage and monitor it. Professionals and fishermen will test the project if it applies to the use of solar drying systems with the Internet of Things (IoT). If the project fails to produce the expected results, the researchers will address the issue and re-test it.

Project Settings

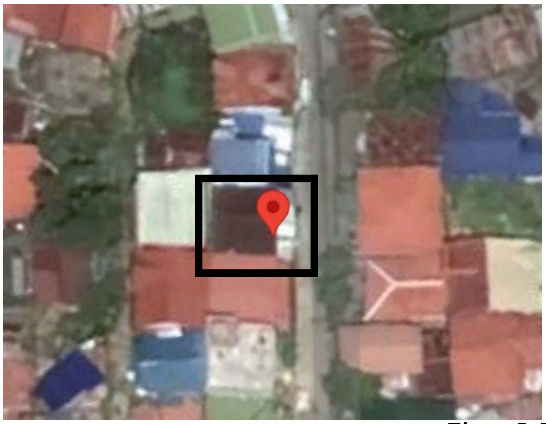

Figure 5. Location of the place

The Automated solar drying system can be placed anywhere indoor. The said project will be placed and tested in Brgy. Canlanipa, Surigao City, Surigao del Norte Professionals/fishermen are invited to participate, observe and give feedback to the project about automated dual-source squid drying using transfer model technique. Researchers chose this location because it's easier to conduct a survey.

Participants of the Study

The participants of this project study are mainly the project beneficiaries, who include the farmers and professionals. The proficient evaluators are chosen to concur to their mastery that would offer assistance to confirm whether the framework's execution is palatable and sufficient for the proper implementation. In contrast, the user/evaluators/ ranchers are chosen to assess whether the framework is worthy enough to utilize the said venture.

Table 1. Participants of the Study

PARTICIPANTS	f(n=10)	%
Professionals	3	30%
Fishermen	6	60%
Agricultural Engineer	1	10%
TOTAL	10	100%

Instruments

1. DHT11 Temperature and Humidity Sensor - It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin.
2. Multi-tester - An electronic measuring instrument that performs several measurement functions at once

III. RESULTS AND DISCUSSION

The study's findings 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.

Technical Materials of the System

Fig. 6. DHT11 Temperature and Humidity Sensor

It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin.

Fig. 7 Raspberry Pi 3 B+

The Raspberry Pi is a series of single-board computers. They are low-cost, high-performance, and the size of a credit card

Fig. 8. LED Ring Light

Led ring light or Led light bulb is an circular electric light that produces light using light-emitting diodes (LEDs).

Fig 9. 5V Single Relay

It comprises components that make switching and connection easier and act as indicators to show if the module is powered and if the relay is active or not.

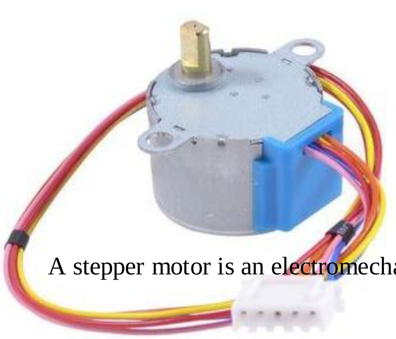

Fig. 10. Stepper Motor

A stepper motor is an electromechanical device that converts electrical power into mechanical power.

Fig. 11. LCD

Used to display data in many other electronic devices.

Fig. 12 Power Inverter

A power inverter or inverter is a power electronic device or circuitry that changes direct current (DC) to Alternating Current (AC).

Fig. 13. Charge Controller

The charge controller regulates the amperage and voltages that is delivered to the loads and any access power is delivered to the battery system so the batteries maintain their state of charge without getting overcharged.

Fig. 14. 12V DC Motor

Motor in a category of electrical equipment that converts direct current electrical power to mechanical power.

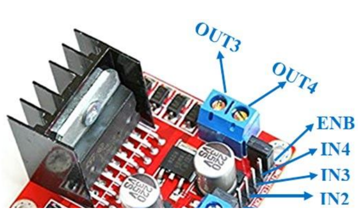

Fig. 15. L298N Motor Driver

Makes the actuator move according to the commands or inputs (high and low).

3.1 Design and Development of the System

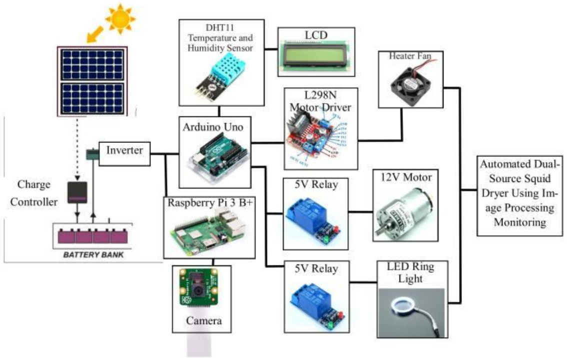

Fig. 16. Schematic

The schematic diagram is seen in Figure 6. 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.

Fig. 17. Frame Design

The frame of the drying chamber.

Fig. 18. Pictorial Diagram

3.2 Working Prototype

Fig. 19. Automated Squid Dryer Chamber

Figure 8 is the finish prototype where all the equipments and programs are all installed and run successfully.

3.3 Testing of the Study

Fig. 20. Captured photo of dry squid

How MATLAB Predicts Images. The Loaded image was resized into 384 by 256 pixels.

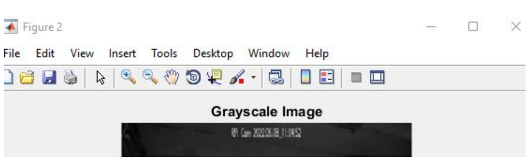

Fig. 21. Grayscale image of dry squid.

The image was converted into the GRAYSCALE mode to calculate the roughness and weight of blackness.

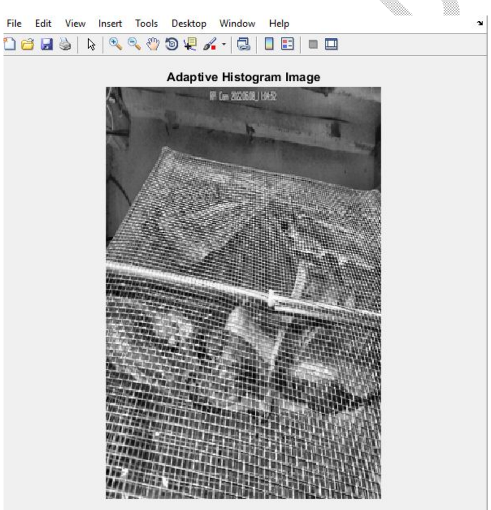

Fig. 22. Adaptive Histogram Image of the dry squid

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 2. 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.

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.

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

M_t: moisture at time t
M_0: initial moisture
W_t: the volume at time t
W_0: initial volume

Table 3. Comparison Results for Traditional and Automated Dryer

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

Table 3 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. 23. 10% Dry Squid

Normally the dried fishes or squid contain an average of 10 to 20% of moisture (Haque 2004). Fig. 23 shows the output product of the automated dual-source squid dryer with image processing monitoring.

IV. CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Dry squid or Bulad Pusit is produced from freshly cleaned squids that have been sun-dried. However, due to the weather, drying squid is difficult. This problem inspires the researcher to make an indoor automated squid dryer.

The researchers have successfully designed and developed an indoor dual-source dryer system that is capable of detecting moisture by image processing through the internet of things (IoT) as shown in fig. 19.
he prototype works successfully and it can monitor or detect humidity and temperature in the chamber atmosphere in real-time. Based on the result, the researchers successfully design and construct a solar drying system that can distinguish between squid moisture content.

The researcher successfully tests and was able to dry squid in just 14 hours. The MATLAB Predicts the images through the grayscale and adaptive histogram image by resizing the load image into 384 by 256 pixels.

Recommendation

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

1. The next researchers can add more heaters to speed up the drying process.
2. For the next researchers can add circuit breaker for safety.
3. Future researchers use only deep cycle solar battery.
4. We suggest adding a Wifi Module so the system will be full IoT.

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