IoT-Based Monitoring and Design of Automatic Fish Drying Equipment Using Fuzzy Logic

Y Alvinika1, D B Setyohadi2 and M Sulistyoningsih3

1,2,3 Magister Informatika Universitas Atma Jaya Yogyakarta Yogyakarta, Indonesia, 55281
Email: 205303283@students.uajy.ac.id1, djoko.budiyanto@uajy.ac.id2, margaretha.mg@uajy.ac.id3

Abstract - Fish is a food source that is widely consumed by Indonesians and overseas. Fish is widely liked because fish provides many health benefits. The problem that is often faced is the drying process of fish, so far the traditional manual drying of fish takes a long time, if the drying process uses sunlight, the drying can take a long time between 4-7 days until the water content reaches 10%. One method of dealing with the problem is the design of IoT-based monitoring and the design of an automatic fish drying device using Fuzzy Logic. The temperature and humidity control system in fish dryers to describe the problem of controlling changes in temperature and humidity that fluctuate throughout the day as happened during the transition period. To realize the fuzzy logic on automatic temperature and humidity control in fish dryers, a sensor is needed as the system input in the form of a DHT22 sensor, and a NodeMCU microcontroller is also needed to implement the fuzzy system into a programming language that can be accepted by hardware in the form of a heating element. Internet of Thing (IoT) based fish dryer monitoring system to control temperature and humidity, weather, on fish dryer using a smartphone. From the experiments carried out on system testing by comparing with the thermometer, the relative error rate of the temperature system is 1.62% and the humidity is 1.96% which indicates the system is successful according to the design.

1. Introduction

Indonesia's sea area covers an area of 5.9 million km², consisting of 3.2 million km² of territorial waters and 2.7 km² of waters in the Exclusive Economic Zone, this area does not include the continental shelf. Geographically, Indonesia is located on the equator which has two seasons, namely the rainy season and the dry season. In the dry season, the sun gets more heat than in the rainy season. So that in the dry season, the hot sun is needed for various needs, one of which is for drying salted fish. Human dependence on the sun's heat to dry salted fish has not been abandoned, because there are no tools and technology capable of helping humans to release dependence on solar heat. The salted fish dryer is a device used to dry wet salted fish using the heat of the sun [1].

The process of treating fish commonly involves salting and drying. The wiring process that often occurs in fishermen in traditional drying, drying is done by drying the fish for more than 3 days if the weather is good or sunny and turning the fish 4 times so that it dries evenly so that there is no rot in the fish. Fish drying system to monitor the efficiency of fish integration using IoT which can be accessed in real-time using a smartphone, away from spoilage in fish. The way IoT technology works in drying fish prioritizes the performance of the sensors used based on the ability to detect the state of the fish. Some of the sensors used in this study include the DHT22 temperature and humidity sensor. The DHT22 sensor is used to read the temperature and humidity in the fish room. how the Rain sensor works to read in case of rain. LDR sensor to read in case of low light. To be able to obtain input data from the sensor, the Arduino Uno microcontroller and the ESP 8266 wifi module are used for the module for sending data to the cloud for mobile access. This research focuses on the method of drying fish using the fuzzy method to process the drying of fish properly while drying the fish by utilizing IoT technology as management in controlling and monitoring temperature and humidity, weather on the fish dryer. so that
this method is expected to be able to help control the drying of fish properly and monitor cell smartphones.

2. Literature Review

Various studies on fish dryers in fisheries have been carried out. The method of drying fish has been developed for a long time, after a technique for drying fish using crude oil gas and using several sensors to determine the drying of the fish through temperature and humidity controllers [2]. By utilizing the iron heating element like a heating material, it is hoped that it can be used to replace the sunlight so that the fish drying process can be done at any time without depending on the need for sunlight when drying fish [3]. Fisheries with a fish drying system in the greenhouse provide great benefits, apart from being safe from star attacks, like stealing fish and safe for the weather in the greenhouse and also more manageable. Drying fish in a greenhouse is also installed on the temperature and humidity in the room and also the fish to determine the dryness of the fish that are dried in the greenhouse [4][5]. Drying fish uses the sun very much in Asia and Africa, so fish drying is very developed and installed. How many sensors are installed in automatic technology for drying fish [6]. The fuzzy logic system is used to determine the factors or types of fish based on data taken and tested using line data and a rule base generated using domain experts [7][8]. The use of fuzzy logic is very important for the fish drying industry because fish drying can be controlled to dry fish using logic fuzzy[9]. Three kinds of models are used to describe drying kinetics: Fick's theoretical model, Peleg's and Weibull's empirical model, and Fick's model which integrates a fuzzy model to calculate effective diffusivity [10].

controlled drying, adequate temperature, and relative humidity in the drying warehouse must be guaranteed during the drying stage [11]. IoT systems for controlling and using conductivity sensors, data processing using the Fuzzy logic method, and monitored directly via computers and smartphones. [12]. Mobile applications are also supported in gathering data and creating necessary notifications [13]. IoT is very important for users to control fish and the IoT system can also be monitored via a smartphone to see the fish's crustiness and can be controlled via a smartphone [14]. Research on automatic systems using fuzzy logic in drying fish with IoT technology is proposed to have clear differences compared to other studies related to fish drying.

3. Proposed Method

3.1 Hardware

The hardware used in fish drying systems and monitoring of fish dryers in general are as follows.

| Hardware                  | Total | Specification          |
|---------------------------|-------|------------------------|
| Modul wifi                | 1     | NodeMCU ESP8266        |
| Sensor light              | 1     | LDR                    |
| Sensor Rain               | 1     | Rain                   |
| Temperature and Humidity sensor | 1   | DHT22                  |
| Relay                     | 1     | Relay 2 Ch             |
| Dimmer                    | 1     | BTA16 Zero             |
| Motor Driver              | 1     | L298N                  |
| Power Supply              | 1     | 5V                     |
| Heating element           | 1     | -                      |
| Fan DC                    | 1     | -                      |
| Motor DC                  | 1     | -                      |

Table 1 shows components used in the fish dryer with the system. There are three main sensors, one wifi module, one heating element, and one drive, a microcontroller.

3.2 Method

The fish drying system method uses a fuzzy logic method with IoT technology on the fish dryer using several sensors and a wifi module NodeMCU ESP8266. The sensors will detect the system
including the temperature and humidity level of the fish dryer. In this fish drying system, the sensor used will provide input to the fish drying system so that the dryer can be evenly distributed. Therefore fish dryness must be taken into account well.

a. Fuzzy Logic

The concept of fuzzy logic was first introduced by prof. Lotfi Astor Zadeh in 1962. Fuzzy logic is a method used in rule-based decision making used to solve problems in systems that are difficult to model.

b. Membership Functions

The membership function is a curve that shows the mapping of input data points into their membership values (often called membership degrees) which have an interval of 0 to 1. Several functions can be used, namely.

c. Linear representation

In a linear representation, the input mapping to the degree of membership is described as a straight line. This form is the simplest and is a good choice for approaching an unclear concept. There are 2 states of a linear Fuzzy set.

\[ \mu[x] = \begin{cases} 
0; & x \leq a \\
(x - a)/(b - a); & a \leq x \leq b \\
1; & x \geq b 
\end{cases} \]  \hspace{1cm} (1)

Upper Linear Representation

\[ \mu[x] = \begin{cases} 
(b - x)/(b - a); & a \leq x \leq b \\
0; & x \geq b 
\end{cases} \]  \hspace{1cm} (2)

Down Linear Representation

d. Measuring Fish Drought

The measurement of fish dryness is measured as a parameter, namely the water content in the fish. how to calculate the water content in fish after drying using the formula, namely [15]:

\[ \text{water content (%)} = \frac{\text{wet fish weight - dry fish weight}}{\text{wet fish weight}} \]  \hspace{1cm} (3)

e. Flowchart

The design and manufacture of this tool consist of several hardware components whose working system is controlled by software embedded in the microcontroller so that all systems can be interconnected with each other. The fish dryer working system is designed automatically by considering the input from the outside, namely the temperature and humidity sensor reader.

Figure 1 shows the work process of the temperature and humidity control system on the dryer with the fuzzy method, where this system works when the DHT22 sensor detects the temperature and humidity...
in the dryer. Furthermore, the system will fuzzy the two inputs. After calculating, the system performs defuzzification to obtain output in the form of values that need to be streamed to the heater for monitoring temperature and humidity in the fish dryer and the temperature and humidity readings will be displayed on the smartphone.

4. Result And Discussion

Implementation The proposed fish drying system works based on data to be sent from sensors installed in the fish drying box because there are data on how many sensors are installed such as temperature and humidity sensors, rain sensors, and light sensors. What is the lower limit of the temperature value of the fish dryer is 50°C. The humidity limit for fish is 10% for the fish drying process which is determined by calculating the humidity value and the drying room temperature value. The automatic system dryer is designed to work on drying fish quickly, in the fish drying box especially to detect the condition of the fish and the weather, both temperature and humidity levels, and weather.

![Figure 2. Conceptual design of IoT in a fish drying system](image)

Figure 2. will explain a block system diagram for designing a fish dryer. The device is turned on the first time, the NodeMCU ESP8266 microcontroller will turn on and the sensor will decisive. The motor driver will turn on and the relay will turn on. The user turns on the wifi connected to NodeMCU. Sensor data will be read on the phone and control controls will be connected. The data from NodeMCU ESP8266 will be sent to the server. applications that are connected to the internet, users can view real-time data and users can control the DC motor on the cellphone to enter and exit the fish drying rack. if the humidity of the fish is below 10% then the buzzer will sound and ModeMcu will send to the cloud to get a notification when the fish is dry. The test results of drying milkfish in the drying system with the fuzzy method are carried out at the beginning using low temperatures until reaching peak temperatures or at optimal drying temperatures, namely 0 at a temperature of 50°C. Then measured every hour until the moisture content of the fish dryers reaches 10%.

4.1 Measure Temperature

A fish dryer with a temperature of 29°C to 50°C requires a process of reaching 50°C because it only uses 1 heating element and 1 fan to drive the heater through the air that is sucked by the fan. This temperature heat flow becomes longer. So it is shown in Figure 3. Graph of fish drying temperature from the beginning to a temperature of 50°C.

![Figure 3. graph of fish drying temperature testing](image)

4.2 Measure the humidity of the fish
Testing of drying fish in the drying system using the fuzzy method is carried out at the beginning by using the lowest temperature until it reaches the highest temperature at the optimal temperature for drying fish, namely at a temperature of 50°C. Then measurements are taken every one hour until the water content in the fish reaches 5% using the DHT22 sensor to find out the humidity in the fish monitored via a smartphone.

![Figure 4. Drying System Testing Graph](image)

Figure 4 Is a test graph of drying fish in the system using the fuzzy method. In the graph, it can be seen the decrease in water content significant with a decrease in water content of approximately 2% to 3.5% at each clock so that the grinding can be done quickly.

### 4.3 Measuring Fish Drought

Measuring the air content in the fish Bandeng, as a measuring tool for dryness in fish from wet to dry, the drying is done automatically to get 25% of the air content in the fish after 9 hours of drying through a heater automatically with varying humidity.

\[
\text{water content (\%) = } \frac{\text{wet fish weight} - \text{dry fish weight}}{\text{wet fish weight}} \times 100\% 
\]

\[
\frac{1 \text{ Kg} - 0.75 \text{ Kg}}{1 \text{ Kg}} \\times 100\% = 0.25 \text{ Kg} \times 100\% = 0.25 \text{ Kg} \div 1 \text{ Kg} = 0.25 \text{ Kg} 
\]

![Figure 5. Graph of the Measuring Fish Drought](image)

### 5. Conclusion

Based on IOT-based monitoring research and the design of the Fuzzy Logic Automatic Fish Drying System that has been tested, it shows that. The fuzzy method can be applied to control temperature and humidity in fish dryers with an electronic component in the form of MCU Mode which functions as a place for implementing Fuzzy programs and several other components. The DHT22 sensor which is used as a temperature and humidity reader is characterized by an increase in temperature and a decrease in humidity according to the hygrometer thermometer with average temperature error and average humidity, the error indicates that the system design was successful in following the design. In the fish drying test, the drying time for the system was 9 hours or faster than conventional drying, namely for 2
days in the sun. The NodeMCU microcontroller used has a wifi module as a link between fish dryers and smartphones for monitoring temperature and humidity sensors, rain sensors, and light sensors that can be monitored via a smartphone.

6. References

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