Prototype Design Of Automatic Anchovy Drying Robot Using Arduino ATmega 2560

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Abstract. Indonesia has great marine resource potentials due to its geographical location. Among other resources, anchovy becomes the prior Indonesia's marine commodities greatly consumed by domestic residents and demanded by many exporters. Unfortunately, the production process of dried anchovy seemingly encounters several problems, especially in the drying process. Since the drying process uses sunlight, it comes into problems with a cloudy weather or rain. Less intensity of sunlight might make the drying process result not perfect dried anchovy. Moreover, current manual monitoring technique remains ineffective drying process. Thus, this study aims to design a prototype of automatic anchovy drying robot using Arduino ATmega 2560 microcontroller to address the problems. This study considers the uses of Arduino ATmega 2560 as a robot controller, DC motor as a driving system, and LDR and rain sensors as automatic modules. LDR sensors are used as a robot roof drive or anchovy drying container to open automatically when sunlight is detected. In addition, rain sensor serves to close the robot roof when it detects rains and the robot turns into its initial position. This robot is further expected to be able to work automatically and optimally in helping anchovy drying process.

Keywords: Automatic anchovy drying robot, Arduino Mega 2560 microcontroller, LDR sensor, rain sensors

1. Introduction

Indonesia is the largest archipelagic country in the world. It has a total area of 7.81 million km² consisting of 2.01 million km² of land, 3.25 million km² of ocean, and 2.55 million km² of Exclusive Economic Zone. Since the total area of Indonesia's sea is larger than the land area, Indonesia is called as a maritime country with potential marine resources and fisheries. According to the data from the Research and Development Agency of Indonesia Ministry of Maritime Affairs and Fisheries, the fishery potential in 2016 reached 9.9 million tons. National fisheries production in 2015 got 22.15 million tons, which increased 6.29% from 2014 (20.84 million tons), consisting of caught fisheries production (6.52 million tons) and aquaculture (15.63 million tons). As a part of those amounts, the anchovy potential becomes one of the leading commodities in the national fisheries industry sector. Data from Indonesia Ministry of Maritime Affairs and Fisheries show that domestic anchovy production always increased from 2006 to 2014, moreover, Indonesia was in the 7th rank out of the 10 largest anchovy exporting countries in the world in 2014 [1][2][3][4]

One type of anchovies with high economic value and becoming one of the commodities of fishery industry is rice anchovy (Stolephorus sp). Rice anchovy is a main source of animal protein with high calcium that is insoluble in water, available production throughout years, and one of the commodities in the fishery industry [5] [6]. Rice anchovy commodities contribute a lot to fishery
community’s economy because of easy fishing operations and production processes, so that the economic value of its sales is high [7]. The prices of rice anchovy commodities actually depend on the method and quality of the production process up to ready for consumption. Rice anchovy is included in perishable commodity category because its decay process occurs relatively faster. One method to minimize its decay process is by conducting a salting and drying process. Salting process is carried out by boiling the anchovy with high salt content. The boiled anchovy are then dried with several methods [8][9], one of which is by manual drying process using sunlight. During the dry season, the process can be more optimal, however, it might be on the contrary during the rainy season because the sunlight intensity is low. As a result, the situation might spend several times for the drying process only [10].

Henceforth, a solution to address the above phenomena needs to be provided, one of which is by designing a prototype of an automatic anchovy drying robot using Arduino ATmega 2560. This study uses several components including Arduino ATmega 2560 microcontroller, LDR sensors, and rain sensor. This robot is expected to be able to provide optimal contributions in the anchovy drying process during rainy season [11][12][13]

2. Methods

This automatic anchovy drying robot uses Arduino ATmega 2560 microcontroller as the main brain of the operating system, rain sensor, and encoder sensor. LDR sensors act as the input for automatic anchovy drying container drive, limit switch sensor as an indicator to stop DC servo motor, and battery with 12 Volt 3.5 Ampere specifications as an electric energy source. Figure 1 depicts a flow chart of the design of an automatic anchovy drying robot using Arduino ATmega 2560:

![Flowchart of anchovy drying robot’s system design](image)

This robot used a push button as a controller of electrical current from the battery. When the switch button was on, the robot would move and run on specific railroad track until the robot stopped when touching the limit switch at the end of the track. Furthermore, LDR and rain sensors would detect the presence of sunlight and rain during the drying process. There were three LDR sensors used in the present study namely LDR1, LDR2, and LDR3, which were placed on the anchovy drying
container. The three sensors were placed sequentially in the right, middle, and left positions of the anchovy drying container and were directly connected to the encoder sensor. If the right sensor (LDR1) detected light, its reading was greater than the LDR2 sensor (center) so that the motor would rotate one turn clockwise to the right. When sunlight was detected in the LDR2 sensor (center), the LDR2 sensor value was greater than those of LDR1 and LDR3 sensors, consequently, the motor would rotate one turn counterclockwise and the drying container would move to the center. If the LDR3 sensor was bigger than LDR2, the motor rotated two turns counterclockwise so that the container would move one turn to the left following the LDR3 sensor conditioning. When there was rain, the rain sensor would order a DC servo motor connected to the anchovy drying container to close and the robot would move back to its initial position [14][15][16].

3. Results and Discussion

3.1. Designing Automatic Anchovy Drying Robot

This study began with designing a robot prototype using Autodesk Inventor software as a reference. The constructed design included analyses of dimension design and framework and placements of DC servo motors, batteries, sensors, and other electronic component devices. Next step was to configure all electronic components by creating a robot control program, sensor response, and motor rotation, and determining the direction of the motion of the robot towards light detected. The automatic anchovy drying robot framework used acrylic material (3 mm thickness) and aluminum (2 mm thickness). The robot would move following the shape of the railroad track made of an elbow iron with a 5 meter track length. In order to recognize and detect surrounding conditions, several scanner modules or sensors and electronic equipment were required to support the sensors’ functions. This robot was equipped with several sensors and electronic components such as rain sensor, three LDR for detecting sunlight, two DC servo motors to drive the rear wheel of the robot, and an Arduino ATmega 2560 microcontroller located in the controller box, a DC servo motor to drive the cover of anchovy drying box, and push-button switch. Figure 2 shows the result of the design of automatic anchovy drying robot using an Arduino ATmega 2560.

![Figure 2. Automatic anchovy drying robot](image)

3.2. Robot Testing

3.2.1. Testing of Rain Sensor Sensitivity

Rain sensor is a type of sensors that will be active only if the environment conditions are wet or exposed to rainwater. If the sensor is exposed to rain, the path between the port and ground will be connected, so that the voltage value on the port will be zero due to direct connection to the ground. The results of the rain sensor test on the automatic anchovy drying robot detected rain when the limit switch sensor was 1 and the rain sensor was 900. The robot would order the DC servo motor to rotate
and close the anchovy drying container followed by the movement of the robot backward to the initial position [17][18][19][20]

3.2.2. Testing of LDR Sensors

LDR sensors testing was performed by using analog pins 14, LDR1 using analog pins 13, and LDR2 using analog pins 12, so that the results of the light intensity values were revealed as in Figure 3. This program served to calibrate LDR sensors because the sunlight intensity was not always similar day to day. The values of the calibration results would be used as a reference for the use of LDR sensors in determining the moves of anchovy drying containers. The testing of the three LDR sensors was conducted every day at 09.00 to 15.30 by assuming that the drying process could run optimally with maximum received sunlight intensity, especially in the morning until noon. LDR sensors to read the sunlight intensity included LDR1 (right), LDR2 (center), and LDR3 (left) sensors depending on the movement of the sun from east to west.

The testing results of LDR sensors showed that LDR1 sensor value produced an average value of 750 when getting the sunlight intensity at 09.00 to 11.30. As a result, the value became the benchmark of LDR1 to move the anchovy drying container automatically to the right. The testing result for LDR2 sensor conducted at 11.30 to 13.30 obtained an average value of 806, of which the value was used as a benchmark for LDR2 to move the anchovy drying container automatically to the center. The result of LDR3 sensor testing conducted at 13.30 to 15.00 depicted an average value of 802, which became a reference of LDR3 sensor to move the anchovy drying container automatically to the left. The values of the three sensors became the input data on Arduino ATmega 2560 microcontroller to automatically drive the DC servo motor, which was connected with the anchovy drying container, when the robot was operated in a place with sufficient sunlight intensity.

![Figure 3. LDR sensor reading](image-url)
3.2.2. Testing of Robot Drive Motors

The testing of DC servo motors on the robot drive wheels was carried out using L293D motor driver. This method aimed to determine the rotation of the motor to enable proper operation and set the rotation speed of the DC servo motor shaft using L293D motor driver. Figure 4 shows the testing results of the DC servo motor using the L293D motor driver. The testing results explained that the use of L293D motor driver was able to regulate the stability of the second rotation of the DC servo motor that was used as an automatic anchovy drying robot. Both motors rotated stably with a clockwise rotation of 255 PWM.

![DC servo motor testing program using the L293D motor driver](image)

**Figure 4.** DC servo motor testing program using the L293D motor driver

3.2.3. Testing of Drying Container Movements Affected by Sunlight Intensity

The anchovy drying container was automatically programmed to move by following the movement of sunlight detected by the LDR sensors in 3 stages of motion; the container moved at an angle of 30° towards the horizontal plane to the right, angle of 0° to the middle, and angle of 30° to the horizontal plane to the left. Figure 5 conveys the results of the movement of the anchovy drying container with different angular variations.

![Container movement images](image)

**Figure 5.** The container is set (a) to the right of 30° with LDR value of 995, (b) to the mid of 0° with LDR value of more than 1010, (c) to the left of 30° with LDR value of more than 915

Based on the data above, the data were collected in accordance to the validity of LDR sensor readings toward sunlight intensity. This testing process was carried out in an open place to determine the effect of sunlight intensity on the movement of anchovy drying containers conducted at 09.00 to 15.00 during a week experiment. Table 1 portrays the testing results in the first week of the experiment:
Table 1. First-week testing results of automatic anchovy drying robot

| Day | Time  | LDR1 | LDR2 | LDR3 | MCU Time | Container Position |
|-----|-------|------|------|------|----------|-------------------|
| 1   | 07:00 | 590  | -    | -    | 0.00     | Right             |
|     | 07:01 | -    | 100  | -    | 0.00     | Middle            |
| 2   | 07:00 | 690  | -    | -    | 0.00     | Left              |
|     | 07:01 | -    | 100  | -    | 0.00     | Middle            |
| 3   | 07:00 | 590  | -    | -    | 0.00     | Right             |
|     | 07:01 | -    | 100  | -    | 0.00     | Middle            |
|     | 07:00 | 590  | -    | -    | 0.00     | Right             |
|     | 07:01 | -    | 100  | -    | 0.00     | Middle            |

Table 1. explains that the anchovy drying container automatically worked well if the LDR reading value was greater than 900. In the first to the seventh day of experiments, the LDR reading value was valid according to the desired reading level (more than 900). Invalid data or data error only happened on the third day experiment with the error value obtained as the LDR reading was less than 900. The third day experiment conducted at 09.00 to 11.00 indicated that LDR1 and the drying container were in the right position, while at 11.00 to 13.00 LDR2 and the drying container were in the middle position. At last, at 13.00 to 15.00, LDR3 detected sunlight and the drying container was in the left position.

4. Conclusion

The design of anchovy drying robot using Arduino ATmega 2560 microcontroller aims to optimize anchovy drying process in rainy season. This robot works with the automation principle that the robot conducts the anchovy drying process by detecting sunlight intensity through LDR sensors. The anchovy drying container will move in accordance to the received sunlight intensity with a 30° slope to the right, 0° to the middle, and 30° to the left. The results showed that the anchovy drying container can only move automatically if LDR sensors have a lighting value in accordance to the times when conducting the calibration test. Data show that LDR sensors will work well if the reading value is greater than 900 while the rain sensor will function if the limit switch sensor is 1 and the reading of the rain sensor is more than 900. If the conditions of this parameter are met, the robot will detect the wet or rainy conditions. Further, the microcontroller will send a DC servo motor signal to close the anchovy drying container and the robot will walk back to its initial position or place.

5. References

[1] Anonim, “Main Data Analysis”. Ministry of Marine Affairs and Fisheries Republic of Indonesia 2015
[2] B. S. Poerwadi, “Main Policies of Ministry of Marine Affairs and Fisheries”. Ministry of Marine Affairs and Fisheries Republic of Indonesia, 2017.
[3] Anonim, "Fisheries Productivity of Indonesia”. Ministry of Marine Affairs and Fisheries Republic of Indonesia. 2018.
[4] B. Sulistiyo, “Information of Marine and Fisheries”. Ministry of Marine Affairs and Fisheries Republic of Indonesia. 2016.
[5] A. Taheri, N. Sarhaddi, G.A. Bakhshizadeh, and S. Sharifian, “Biochemical Composition of Sardinella gibbosa, Clupeonella engrauliformis and Stolephorus indicus Bones from The Oman Sea and Caspian Sea,” *Iran. J. Fish. Sci.*, vol. 16, no. 4, pp. 1312–1324, 2017.

[6] W. Dongbang and A. Matthuajak, “Anchoy Drying Using Infrared Radiation,” *Am. J. Appl. Sci.*, vol. 10, no. 4, pp. 353–360, 2013.

[7] R. Fricke, D. Golani, and B. Appelbaum-Golani, “First Record of The Indian Anchovy Stolephorus indicus (van Hasselt, 1823) (Clupeiformes: Engraulidae) in The Mediterranean Sea,” *BiolInvasions Rec.*, vol. 4, no. 4, pp. 293–297, 2015.

[8] R. Subarkah, Abdurrachim, J. Hendrarsakti, and D. Belyamin, “Drying Characteristic of Anchoy Fish,” vol. 3, no. October, pp. 87–93, 2013.

[9] J. Siringan, P., Raksakulthai, N., Yongsawatdigul, “Autolytic Activity and Biochemical Characteristics of Endogenous Proteinases In Indian Anchovy (Stolephorus indicus),” *Food Chem.*, vol. 98, no. 4, pp. 678–684, 2006.

[10] A. Indriani, Hendra, and Y. Witanto, “Error of Assembly Microcontroller Arduino Mega and ATmega in the Control of Temperature for Heating and Cooling System,” *Appl. Mech. Mater.*, vol. 842, pp. 324–328, 2016.

[11] J. P. P. Arenales, H. C. Hernandez, and J. J. S. Gonzalez, “Innovation in Coffee Post-Harvest : Development of an Automation System for The Drying Process .,” vol. 2, no. 4, pp. 1–9, 2017.

[12] V. Vijayavenkataraman, S. Iniyan, and R. Goic, “A Review of Solar Drying Technologies,” *Renew. Sustain. Energy Rev.*, vol. 16, no. 5, pp. 2652–2670, 2012.

[13] Z. Jusoh, H. Husni, and H. Ja’afar, “Development of Arduino Smart Clothes Hanger Embedded System for Disabled,” *ARPN J. Eng. Appl. Sci.*, vol. 12, no. 10, pp. 3266–3270, 2017.

[14] M. Zolkapli, S. A. M. Al-Junid, Z. Othman, A. Manut, and M. A. Mohd Zulkifli, “High-Efficiency Dual-Axis Solar Tracking Development Using Arduino,” in *Proc. 2013 Int. Conf. Technol. Informatics, Manag. Eng. Environ. TIME-E 2013*, pp. 43–47, 2013.

[15] A. Faroqi, M. A. Ramdhanli, L. Kamelia, C. Hidayat, and R. Aenur, “Automatic Water Clarity Monitoring and Filtration System Using Light Dependent Resistor Based on Arduino Uno,” in *IEEE Conference Publication*, 2018, pp. 1–4.

[16] A. B. Afarulrazi, W. M. Utomo, K. L. Liew, and M. Zarafi, “Solar Tracker Robot Using Microcontroller,” in *ICBEIA 2011 - 2011 International Conference on Business, Engineering and Industrial Applications*, 2011, no. September 2014, pp. 47–50.

[17] A. O. Oyubu, “Rain Water Detector-Alarm System,” *Int. J. Adv. Res. Technol.*, vol. 4, no. 6, pp. 1–5, 2015.

[18] P. B. Andrade, P. E. Cruvinel, and Elmer A. G., “Module for Virtual Calibration of Sensors of Agricultural Spraying Systems (Temperature, Pressure and flow) Using an Arduino-Based Architecture and a Controller Area Network Bus (CAN),” in *IEEE Conferences Publication*, 2018, pp. 352–357.

[19] K. Hiroi and E. All, “Accurate and Early Detection of Localized Heavy Rain by Integrating Multivendor Sensors In Various Installation Environments.,” in *IEEE Conference Publication*, 2013, pp. 1–4.

[20] M. M. Rashid, M. R. bin M. Romlay, M. M. Ferdaus, and A. Al-Mamun, “Development of Electronic Rain Gauge System,” *Int. J. Electron. Electr. Eng.*, vol. 5, no. 4, pp. 245–249, 2015.