Portable waste capacity detection system based on microcontroller and website

I G M N Desnanjaya¹, I M A Nugraha²

¹ Computer Systems Engineering, STMIK STIKOM Indonesia
² Fisheries Mechanization, Marine and Fisheries Polytechnic of Kupang

Email: ngurah.desnanjaya@stiki-indonesia.ac.id¹, made.nugraha@kkp.go.id²

Abstract. Waste becomes a problem that is often found in everyday life. It requires special attention towards the condition of the saltation, especially in the garbage disposal. The condition for garbage disposal must always be in a state of preparation, otherwise it may cause garbage to continue to pile up and scatter. Some issues were faced such as the slow handling of waste management caused by one-to-one garbage check as well as the high cost spend in vehicle fuel. In this study, the portable capacity is in the form of the capacity of dirt, water, ultrasonic sensors, and websites. This system can help the dustmen in monitoring the capacity of the waste, so they do not need to check all the one-to-one garbage. The data collection techniques consisted of literature studies, a system of reading, tool-making stages, website-making steps, and system testing stages. The result of the test revealed that the system could function as expected. The system can perform measurements with an average error of 0.66% in 10 times trials. The SIM900 connection with Microcontroller and the internet was successfully done. The testing in the storage was filled and monitoring on the website page was based on the condition of the trash.

1. Introduction

Internet of Things (IoT) is a term widely discussed recently. The Internet of Things aims to expand the benefits of being connected with the internet connection [1] such as electronic devices, and many more [2]. These objects can be implanted with sensors that are always active and widely connected with both local and global networks [3][4]. These objects are designed to provide information about the surrounding environment [5][6]. For example, the equipments that are designed to monitor environmental hygiene conditions through the use of internet network [7][8].

The cleanliness of the environment is one thing that is very important to be maintained. Waste is a problem that is often encountered in everyday life, so that waste conditions become something that requires special attention, especially in the trash. The condition of the trash bin must always be ready to be filled and when it is full, it must be immediately followed. Otherwise, the waste will continue to pile up and scatter. Garbage transport carried out by the dustmen is still fairly slow and consumes a lot of vehicle fuel, all because the dustmen still have to check all the trash cans one by one [9].

In this research, a system which consists of movable or portable hardware and software to display the condition of the waste was designed. In designing the hardware, Arduino was used as a controller and two types of sensors [10] [11], namely the Ultrasonic Sensor and the VL53L0X sensor. SIM900 was used for the process of sending data from the trash to web hosting. SIM900 allows Arduino to be
connected to cellular networks. With this module, Arduino can receive and send SMS, make voice calls, and be able to connect to the internet. The data sent to web hosting were displayed on web pages.

2. Project Description

System requirements analysis is the process of identifying the needs required in building a new system and evaluating existing problems. In building this system, several stages were carried out starting from the block diagram, schematic flowchart, and tool design.

2.1 Block Diagram

The following is the block diagram of the Trash Capacity Detection System. The input, process, and output can be seen in Figure 1. This system used Ultrasonic sensors and VL53L0X sensors as input recipients, then processed by Arduino and sent to web hosting by SIM90. The output was displayed on the website page.

![Figure 1. System Block Diagram.](image)

2.2 Schematic Diagram

The following is a schematic overview of the overall capacity of the trash bin. Figure 2 shows SIM900, an Ultrasonic Sensor, and two VL53L0X Sensors that were already connected to Arduino.

![Figure 2. Schematic Circuit Diagram.](image)
2.3 Flowchart
At this stage, a Flowchart design was arranged. It is used to describe and simplify a series of processes or procedures thus, they are easily understood and easily seen based on the sequence of steps of a process.

![Flowchart Diagram]

**Figure 3.** Flowchart of sending data from the tool to Web Hosting.

2.4 Project Design
The next process is the design of the component box placement. In this system design, there are three component boxes, namely, the top box, the right box, and the left box. To connect the three boxes, a cable was used.
3. Implementation and Results

3.1 SIM900 Testing
At this stage, the process of testing the SIM900 connection to the Arduino Nano and to the Internet is carried out. Here is a picture of the test results from SIM900 to Arduino Nano and to the Internet [12].

Figure 5. SIM900 Testing Result.

Figure 5 shows that the connection process of the Arduino Nano and SIM900 was successfully carried out. Then, there is the process of activating the network registration, entering GPRS service, deactivating GPRS, activating a single IP connection, setting the SIM card APN, making sure the APN settings are correct, starting the GPRS connection, requesting an IP, all have directed an ok status and SIM900 has also gotten an IP 100.103.237.76 to connect to the Internet.

3.2 Testing of Ultrasonic Sensor Distance
At this stage, the process of testing the distance reading by Ultrasonic sensors was conducted. This test was carried out on a bin that has a height of 28 cm and added to the distance between the sensor and the lid of the bin 2 cm so that the total distance becomes 30 cm. In this picture, the height of the trash can was measured by the meter and using an Ultrasonic sensor.
Figure 6. The Testing of Ultrasonic Sensor.

Table 1 shows the results of the comparison test of Ultrasonic sensors, where the error is the difference in values obtained from the results of distance measurements using a steel tape measure and Ultrasonic sensors. In this trial, there were 2 errors with an error value of 6.6% and from 10 times trials, the test obtained an average error on the sensor reading of 0.66%.

Table 1. Comparative Test Results of Ultrasonic Sensors.

| High  | Sensor | Error | %Error |
|-------|--------|-------|--------|
| 30 cm | 31 cm  | 1     | 3.3    |
| 30 cm | 30 cm  | 0     | 0      |
| 30 cm | 30 cm  | 0     | 0      |
| 30 cm | 30 cm  | 0     | 0      |
| 30 cm | 30 cm  | 0     | 0      |
| 30 cm | 30 cm  | 0     | 0      |
| 30 cm | 30 cm  | 0     | 0      |
| 30 cm | 30 cm  | 0     | 0      |
| 30 cm | 30 cm  | 0     | 0      |
| 30 cm | 30 cm  | 0     | 0      |
| 30 cm | 31 cm  | 0     | 0      |
| 30 cm | 30 cm  | 1     | 3.3    |

Average of error 2 0.66

3.3 VL53L0X Sensor Distance Reading Testing

This stage presents the process of testing the distance reading from the right and left sides by the VL53L0X sensor. Table 2 shows the results of the comparison test of the right VL53L0X sensor, where the error is the difference in values obtained from the measurement of distance using the VL53L0X sensor. In this trial, there were 4 errors with an error value of 12.3% and from 10 times trials, the test obtained an average error on the sensor reading of 1.23%. While on the left, where the error is the difference in values that is obtained from the distance measurement using the VL53L0X sensor. In this trials, there are 5 errors with an error value of 16.5% and from 10 times trial, the test obtained an average error on the sensor reading that is 1.65%.

Table 2. VL53L0X Sensor Comparison Test.

| No. | Right | Left |
|-----|-------|------|
|     | Error | %Error | Error | %Error |
| 1   | 0     | 0     | 0     | 0     |
| 2   | 1     | 4.1   | 0     | 0     |
| 3   | 1     | 4.1   | 1     | 4.1   |
| 4   | 0     | 0     | 0     | 0     |
3.4 Website Testing

At this stage, the website page testing process was carried out to find out whether all website pages can function properly. Table 3 is a list of results from tests that have been carried out.

Table 3. Website Test.

| Page               | Test                  | expected results                          | Result  |
|--------------------|-----------------------|-------------------------------------------|---------|
| Admin homepage     | Admin login           | Go to admin main page                     | It works|
| Add Location Page  | Input location        | Data input successful                     | It works|
| View Location      | Click the marker to get status information and description | Successfully displayed location, status and description | It works|
| Data Table         | Click the delete button to delete the trash data | Successfully displayed trash data and deleted trash data | It works|
| Password           | Change password       | Successfully changed password             | It works|

3.5 Overall System Testing

At this stage, the whole system testing process was carried out to find out whether the whole system can function. The test for the whole system can be seen as follow.

Table 4. System Testing.

| Condition            | Trash Can | Status on Webpage |
|----------------------|-----------|-------------------|
| Empty trash can      | ![Trash Can](image) | ![Status on Webpage](image) |
| Condition                                | Trash Can | Status on Webpage |
|------------------------------------------|-----------|-------------------|
| The trash can is filled a little         | ![Image](image_url1) | ![Image](image_url2) |
| The trash can is half-filled             | ![Image](image_url3) | ![Image](image_url4) |
| The trash can is almost full             | ![Image](image_url5) | ![Image](image_url6) |
| The trash can is full                    | ![Image](image_url7) | ![Image](image_url8) |
| The empty trash on the left side         | ![Image](image_url9) | ![Image](image_url10) |
| The empty trash on the right side        | ![Image](image_url11) | ![Image](image_url12) |

### 4 Conclusion

From the tests conducted on the Portable, Trash-Based Arduino Trash Capacity Detection System and the Website, the following conclusions can be drawn. In designing and building a Portable Trash Capacity Detection System based on Arduino and Website, several stages were carried out namely the
system design stage, the tool manufacturing stage, the website creation stage, and the system testing stage. Overall, it can be concluded that the system can work well. The system can measure the distances through the Ultrasonic Sensor at the top with an average error of 0.66% from 10 times measurement and through the VL53L0X sensor on the left and right with an average error of 1.23% on the right and 1.65% on the left testing times. SIM900 with Arduino nano and the internet was successfully connected. The tests on the trash cans that are filled under the conditions of empty, few, medium, almost full, and full monitored on the website pages is in accordance with the conditions on the trash.

References
[1] Ajey L 2019 Internet of things (IoT) Destructive Technologies for the Militaries and Security. Smart Innovation , System and Technologies (Singapore: Springer) 132 187 – 195
[2] Jensen T and Durham M 2016 Internet of things Advancing Microelectronics Everything in Electronics Between The Chip and The Stystem (USA: IMAPS) 43 4
[3] Gregorio F, González G, Schmidt C, and Cousseau J 2020 Signal Processing Techniques for Power Efficient Wireless Communication Systems (AG: Springer International)
[4] Andrea Z, Nicola B, Angelo C, Lorenzo V and Michele Z 2014 Internet Of Things For Smart Cities IEEE Internet Things Journal 1 22 – 32
[5] Bhaskar R, Uma 2015 Raspberry Pi Home Automation With Wireless Sensors Using Smartphone IJCSMC 4 797 – 803
[6] Louis K F, Hy S, Kuanchin C 2014 Website Usability: A Re-Examination Through The Lenses of ISO Standards Int. J. Wirel. Networks Broadband Technol. 3 1 – 20
[7] Soia A, Konnikova O, and Konnikov E 2019 The internet of things in Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019 (Spain) pp. 8587 – 8591
[8] Srinivasan C R, Charan G, and Babu P C S 2020 An Iot Based Smart Patient Health Monitoring System Indonesian J Electr Eng Comput. Sci. 18 1657–1664
[9] Badan Pusat Statistik 2018 Statistik Lingkungan Hidup Indonesia (SLHI) 2018 (Indonesia: Badan Pusat Statistik Indonesia)
[10] Desnanjaya I G M N and Iswara I B A I 2018 Trainer Atmega32 Sebagai Media Pelatihan Mikrokontroler dan Arduino J. Resistor (Rekayasa Sisttem Komputer) (Bali: STIKI Indonesia) 154 – 64
[11] Desnanjaya I G M N and Sudipa I G I 2020 Sistem Informasi Pengendali Kulkul Bali Berbasis Web Jurnal Teknologi Informasi dan Komputer (Bali: Universitas Dhyana Pura) 6 107 – 115
[12] Desnanjaya I G M N and Sudipa I G I 2019 The Control System of Kulkul Bali Based on Microcontroller 5th International Conference on New Media Studies (Bali) pp. 245–251