Design and Development of the Trash Spliter with Three Different Sensors

Despaleri Perangin Angin\textsuperscript{1*}, Hendrik Siagian\textsuperscript{1}, Eka Dodi Suryanto\textsuperscript{1}, Rahayu Sashanti\textsuperscript{1} and Marcopolo\textsuperscript{1}

Faculty of Technology and Computer Sciences, Universitas Prima Indonesia, Indonesia

Email: *despaleriperanginangin@yahoo.com

Abstract. Trash has become a major problem in everyday life. Until now there is no right method to handle it. This paper discusses a method of development of the trash splitter with three different sensors. There are three sensors that are used infrared, metal, and light sensors. The results obtained are more effective with the results obtained show the devices have similar accuracy garbage sorting is a metal (98%), organic (26.67%), paper (32%), and plastics (58%). The accuracy of the mixed waste sorting is a metal (94.67%), organic (28%), paper (12%), and plastics (41.3%).

1. Introduction
In human life, trash is a problem that has not been handled properly. There are so many processes in human activities that generate trash so the number continues to increase every time [1-2]. In Indonesia, the classification of waste that is often used organic trash, and inorganic trash. Meanwhile, when viewed from the source, the existing trash in urban areas can be divided into several kinds. The types of urban trash are trash from residences, commercial areas trash, industrial trash, litter public places, and medical trash. [3] In his everyday life, every human being produces a number of garbage in the solid form of 1-3 kg. Untreated trash can cause problems and should be overcome. The amount of waste can be overcome by recycling.

To recycle, trash must be sorted first. The sorting process is useful for separating trash by type. To distinguish the type of trash, often the sorting process is done manually by using human power. Humans will sort the type of trash as with a predetermined category. That way, the waste can be reprocessed into useful goods and have economic value. But along with the development of the age and the growing rate of increasing trash, the sorting of waste by manual method becomes not optimal. Lack of human resources in the process of sorting waste and the amount of waste that must be sorted, making a lot of trash that should be recycled ends directly in the final disposal.

Therefore, the problem of the excess amount of trash cannot be resolved by applying the manual sorting method. To overcome the problem, has been investigated tool to shrink the type of trash. Sorting trash can be done by destroying trash prior [4-5]. The method of sorting trash by destroying trash first, there is another method that is by utilizing the sensor to distinguish the type of trash [6]. The sorting of large amounts of trash is easier to use by using sensors.
2. Methodology

Sensors which can be used include the infrared sensor, metal sensor, and light sensor. The sensor consists of a transducer with or without a signal amplifier and processor formed in one sensing system. In control system environment and robotics, the sensor gives the similarity that resembles the eyes, hearing, nose, tongue which will then be processed by the controller as his brain [7-9]. So with a visible light sensor application using a particular method, the trash can be detected and classified according to their kind. More effective and faster sorting can be achieved. The sorting results are expected to be more accurate and faster than the conventional method of manual sorting using human labor [10].

As in the process of designing and testing tools, required components, and other supporting tools. Components and support tools will be divided into two parts, namely hardware components (hardware) having the form of software components (software) which consists of a program or initialize. In the design of automatic waste sorting tool, used several components that act as sensors (inputs) and actuators (output). In addition to sensors and actuators, also used as a microcontroller device that will run the given command. The computer is required as a liaison media between hardware and software. specification of tools, components, and supporting devices are shown in table 1.

Table 1. Supporting tool system.

| No | Name               | Specification             | Amount |
|----|--------------------|---------------------------|--------|
| 1  | Laptop             | Dell inspiron             | 1 piece|
| 2  | Microcontroller    | Arduino Uno               | 1 piece|
| 3  | Program            | Arduino IDE               | 1 piece|
| 4  | Infrared Sensor    | FC-51 (DC 5V)             | 3 pieces|
| 5  | Metal Sensors      | SN04 (DC 5V)              | 1 piece|
| 6  | Light Sensor       | LDR (DC 5V)               | 1 piece|
| 7  | Servo              | SG-90 (DC 5V)             | 4 pieces|
| 8  | Conch Fan          | Brushless DC 5V           | 1 piece|
| 9  | Laser Module       | DC 5V                     | 1 piece|
| 10 | Battery            | Power Bank 5V             | 2 pieces|

As a guide for designing automated waste sorting tools, it is necessary to formulate the necessary system workflows first. The system workflow will be explained using the block diagram. The block diagram of automatic waste sorting tool design can be seen in figure 1.

![Figure 1. System block diagram.](image-url)
The software used is Arduino IDE. Arduino IDE (Integrated Development Environment) is software used to program the microcontroller Arduino [11-13]. The tools will be designed based on system requirements. The design of automatic garbage sorting tool will consist of: (1) The design of an object detecting the presence of garbage, (2) design of sorting metal, (3) Design of sorting organic, (4) Design paper sorting, (5) The design of the plastic sorting.

Software design includes initialization program on the microcontroller, sensor initialization, and initialization of additional support tools. Detect the presence of waste serves to indicate that there is a waste to be processed by the tool. Consists of infrared and servo distance sensors. The metal divider will serve as a metallic waste scavenger. Consists of metal and servo sensors. Organic sorting will serve as organic waste sorting by using the difference method of waste weight. Organic waste tends to be heavier than plastic waste and paper waste. Consists of infrared sensors, servo, and fan pusher. Paper sorting will serve as paper waste sorter by utilizing light reflection difference method by paper. The paper tends to reflect the light on it. It consists of an infrared sensor, light sensor, servo, and laser. Plastic sorting will function as a plastic waste sorter by utilizing the difference reflection method.
of light. Plastics tend to pass on the lights that hit them. It consists of an infrared sensor, light sensor, servo, and laser. The plastic dividing part is the same place in the paper sorting section.

The automated trash sorting tool uses multiple sensors to distinguish the type of trash. Using sensor will affect the outcome of a trash sorting. Placement of the sensor that precisely matches the characteristics of waste which will be detected so that the waste can be sorted. Metallic sensors used to detect objects made from the best metal. The method is used the placement of metal sensors at the beginning of the tool gives good results. The metal sensor is used a roko sn04 with a type of inductive metal sensor. Some of the sensors used can be seen in figure 2.

![Sensor](image1)

![Infrared sensor](image2)

![Light sensor](image3)

**Figure 3.** (a) Sensor roko Sn04. (b) Infrared sensor FC-51. (c) Sensor light LDR.

Infrared sensors can be used to detect the presence of organic waste. But the method of detecting organic waste by way of differences in the weight of organic waste with waste paper and plastic waste is less precise. Often the system fails to sort out organic waste. The infrared sensor used is FC-51. Sensor FC-51 can be seen in figure 2.b[5]. Infrared sensors have been able to detect the presence of objects. However, the use of light sensors still is less than optimal. Differences in paper size and improper paper position affect the light sensor detection results. The method of sorting paper with plastic using the light difference is still less than optimal.

Infrared sensors have been able to detect the presence of objects. The use of light sensors that are synchronized with infrared sensors can provide better detection results than paper waste results. The light sensor used is a sensor module LDR (light dependent resistor). LDR will be very resistant when not exposed to light, otherwise, the value will be very low LDR resistance when exposed to very bright light [14-15].

3. Results and Discussions

Testing the tool is done by entering the garbage object directly. The experiment was carried out with 2 types of garbage, example similar waste, and mixed waste. Each experiment was conducted 15 times to get the average score. After doing the design and testing tool will get the test results in the form of quantitative data. The results of the form design tools can be seen in figure 3.
Figure 4. Results design.

The results of testing tools indicate the sensors used have been able to distinguish types of waste metal, organic, paper, and plastic. The test results of the tool can be seen in each of the test results tables below. Table 2 shows the test results for similar waste. Table 3 shows the test results for mixed waste. Table 4 shows the average results for both types of testing.

Table 2. Results of similar waste testing.

| Type     | Conclusion | Accuracy |
|----------|------------|----------|
|          |            |          |
| Metal    | 0 0 147 0 3 | 98%      |
| Organic  | 26 56 40 27 | 26.67%   |
| Paper    | 48 51 25 26 | 32%      |
| Plastic  | 34 87 11 18 | 58%      |
| Total    | 12.3%      | 53.67%   |

Table 3. Mixed garbage test result.

| Type     | Conclusion | Accuracy |
|----------|------------|----------|
|          |            |          |
| Metal    | 2 4 142 2 0 | 94.67%   |
| Organic  | 28 40 22 42 18 | 28%      |
| Paper    | 18 55 28 39 10 | 12%      |
| Plastic  | 34 62 24 20 10 | 41.3%    |
| Total    | 6.3%       | 44%      |

Table 4. Mixed garbage test result.

| Type     | Conclusion | Accuracy |
|----------|------------|----------|
|          |            |          |
| Metal    | 2 4 289 2 3 | 97.3%    |
| Organic  | 54 96 23 82 45 | 27.3%    |
| Paper    | 66 106 28 64 36 | 22%      |
| Plastic  | 68 149 24 31 28 | 49.67%   |
| Total    | 9.3%       | 48.8%    |

4. Conclusion

From the test results, it can be seen that the choose types of waste metal are the most accurate sorting, followed by sorting plastic waste, organic waste, and paper waste. The test results showed similar waste separation is a metal (98%), organic (26.67%), paper (32%), and plastics (58%). The accuracy
of the mixed waste sorting is a metal (94.67%), organic (28%), paper (12%), and plastics (41.3%). Still, there is an error in the form of garbage stuck tool and fault detection by the sensor.

References
[1] Law No. 18 of 2008 Waste Management, Jakarta: 2008
[2] Antoni R, Sarwoko M and Sunarya U, Analysis and Implementation of Sensor System in Automatic trash Can with Fuzzy Method Based Microcontroller, Faculty Electrical Engineering of Universitas Telkom
[3] E. Damahuri, Dan T. Padmi, Waste Management, Institut Teknologi Bandung 2010
[4] F. Restu, Engineering and Crushing Waste Picker Automatic With simple controls control systems in the Internal Scale State Polytechnic Batam <Integration Journal ISSN: 2085 - 3858, 2013
[5] Nurhadi M I, Siregar S and Hendrarini N, Mechanical Design System sold Waste, Faculty of Applied Sciences, ISSN : 2442-5826, 2015
[6] Russell MH, MH Chowdhury, MS Uddin, A. Newaz, And MM Talukder, Development Of Automatic Smart Waste Sorter Machine, International Conference on Mechanical, Industrial and Materials Engineering 2013 (ICMIME2013) 1 to 3 November, 2013, RUET, Rajshahi Bangladesh, Paper Id: AM - 012, 2013
[7] Septriyaningrum I A, Nugrahadi, D T and Ridwan Ichsan, Design and Development Of Prototype, Journal of Computer Science, Vol 3 ISSN: 2406-7857, 2016
[8] Setiawan D, Syahputra T and Iqbal M, Design of opening tools and cover of automatic garbage truck based on microcontroller
[9] Derry Tri Saputra, Application of Ultrasonic Sensor HC-SR04 On Valve Control System For Water Supplier With Arduino Uno Controlled RFID Control, State Polytechnic of Sriwijaya Palembang, 2015
[10] Mahmuddul Hasan Russell, Mehdi Hasan Chowdhury, Md. Shekh Naim Uddin, Ashif Newaz, And Md. Mehdi Masud Talukder, Development Of Automatic Smart Waste Sorter Machine, International Conference on Mechanical, Industrial and Materials Engineering 2013 (ICMIME2013) November 1-3, 2013, RUET, Rajshahi, Bangladesh. Paper Id: AM-012, 2013
[11] E. Mulyana & R. Kharismanan, Design of Early Warning Equipment Flood Hazard with Arduino Uno R3 Microcontroller, Citec Journal ISSN: 2354-5771, 2014
[12] GeraldEffelix, AndJiangDening, Enhanced Bank Vault (Strong Room) Security System Design, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064, 2015
[13] Elasya Y, Notosudjono D and Wismiama E, Application Of Ultrasonic Sensor Based On ATMega328 Microcontroller For Designing Smoking Place, Electrical Engineering Study Program, Faculty of Engineering, Pakuan University
[14] Eduardus Tuluk, Implementation Tools Pest Repellent Bird In Rice Field Area Using Ultrasonic Wave Based Microcontroller ATmega168, vol.vii Number 21 November 2012 -Journal of Information Technology ISSN: 1907-2430, 2012
[15] Z. Richard, Embedded Systems Handbook, Taylor and Francis Group, 2006

Acknowledgments
The research is supported by thematic programs through the faculty of technology and computer science, Universitas Prima Indonesia, Indonesia.