AN APPLICATION THAT SEPARATE RECYCLABLE MATERIALS

M. Sungur POLATER, Pinar KIRCI

Department of Computer Engineering, Bursa Uludag University
pinarkirci@uludag.edu.tr
Turkey

Abstract: The aim of the project is to separate recyclable materials and to enable them to be controlled with a mobile application. Recyclable materials react differently to some proximity sensors. These differences can be analyzed and separated according to the results to be drawn. Through the capacitive proximity sensor and inductive proximity sensor, metal, glass or plastic materials moving on a moving belt can be separated by their different responses.
Key words: recycling, metal, sensor

1. INTRODUCTION

In this project, solutions to the problem of sorting recyclable materials, which is an important part of global warming, which is a growing problem, were investigated. Recyclable materials are often recycled as worn and out of shape. This will require the solution to be flexible [1, 2].

Various tests have been carried out to measure the performance of the sensor system. The extent of damage caused by contamination of light-transmitting objects and the presence of light-blocking substances has been tested. As a result of this experiment, it has been observed that the accuracy of the sensor performance is reduced due to dirt. It was concluded that in order to prevent such a situation, the waste collection points should be cleaned. In this study, capacitive sensors are used to measure paper height. However, measurement of the volume does not give reliable results because the sensor is sensitive to moisture [3].

Wastes are processed in recycling facilities and useful materials are recycled. Glass, metal, paper and plastic are separated and compressed processed. There is

only one facility on the island of Malta that separates newly separated household waste. Approximately 40 tons of material are collected daily in this facility. The garbage at this facility is divided into three main classes and a number of categories. These categories are Terephthalate polyethylene (PET), high strength transparent polyethylene (HDPE), low density polyethylene (LPDE), paper, cardboard, and iron. Materials that should not be included in the received mixture are included in the rejected material class. Most of the materials were separated in the study under human supervision. The size, depth and speed of sliding debris on the moving belt play a role in detecting these materials. Infrared rays are used to separate paper or cardboard. It includes measuring the reflectivity of paper and cardboard [4].

The classification method of mixed wastes is based on the electrostatic classification method. Usually unused and waste materials come in the form of paper and plastic. These materials can be recycled for later use. The main purpose of the proposed study is to separate materials such as paper and plastic. We use electrostatic emitter and collector to remove the plastic here [5].

The automatic waste separator is designed to separate waste into three main categories: metal, organic and plastic. Ultrasonic sensors are included to monitor the waste collection process. Sensors are placed in all trash cans. When the waste reaches the sensor surface, it informs a microcontroller. The microcontroller notifies the driver of the garbage truck by sending a text message using GSM technology [6].

This work has a three-tier architecture. Layers use some sensors to measure waste levels, and GSM and Wi-Fi technologies to deliver the received data to its destination. In the third layer, the data from the sensors are stored in a cloud-based system. System; Helps the user in managing solid waste using Wi-Fi, ultrasonic sensor and laser sensors [7].

2. SEPERATION OF RECYCABLE MATERIALS

According to the data obtained by the literature review, in the separation of recyclable materials until today: magnetic separation, separation by barcode reading, object Separation by identification, separation by optical sensors, separation by sound waves and separation by inductive / capacitive sensors are seen.

2.1. The separation with inductive/capacitive sensors

-High accuracy
-Not affected by noise
Differentiation of materials is ensured by inductive and capacitive sensors giving different turns for each type of material. The system operates with high accuracy and noise isolation is easy due to the small size of the sensors. It is an inexpensive, easy-to-maintain system [9, 14, 18].

2.2. The separation with barcode reading system

- Fast work,
-Detection with a single camera sensor
- Describing only a specific brand's products
- Not working if the barcode on the bottle is worn

The barcode reading system is based on the principle of reading the barcode with a camera sensor and separating the material if the barcode matches the database [12].

2.3. The separation with optical sensors

- Identifying different objects,
-High efficiency in standard bottles
- Low yield in non-standard bottles
- Packaging decreases efficiency

Separation system with optical sensors works on the principle of sending light to the material and collecting the reflected light. The variety of packaging around recyclable materials makes sorting difficult, and non-standard sizes are also a problem [11, 16].

2.4. The separation with object identification

-High flexibility
- Requires more processor load than other methods
-A lot of photos need to be collected
- It causes problems with transparent materials

Object identification and separation system works with the principle of training the artificial intelligence with the collected photos and distinguishing the incoming material. In this system, the photographs used in the training of artificial intelligence must be taken from different angles in various and different conditions. Possible materials should be photographed and labeled according to the region [8].

Identifying transparent materials in the object identification and separation system poses a problem. Glass and plastic materials make it difficult to classify similar images. In addition, if the number of collected photos is not high, the accuracy of the system decreases [8].

2.5. The separation with sound waves

-High accuracy
- Affected by noise
-Precision device requirement
-High cost

Separation system with sound waves is a system based on the principle of evaluating the data generated specific to the material by the return of the sound wave sent to the material and back. While the accuracy rate is high in this system, which is a new method, any sound wave may cause the system to malfunction. As a solution, insulation is required with an insulating system. In addition, the receiver and transmitter must be sensitive [10].

2.6. Magnetic separation system

- Suitable for large volumes of waste
-High efficiency in separating metals
-Cost and volume required for the system is high
- Does not offer solutions for plastic, glass and cardboard separation

Magnetic separation system is a commonly used method. In this method, there is no separation when the wastes are collected, they are separated in the facilities after they are collected. The purpose of this system is to separate metal wastes with higher profitability than other wastes and recycle them. Since it cannot provide a solution to the separation of plastic and glass, these wastes are either stored or a mechanism is installed and they are separated and recycled [13, 19].

3. MATERIAL AND METHODS

In this project, a fully automatic machine with a production line that can be adapted to automat devices was designed based on the separation system with Inductive / Enclosed Sensors [15, 25].

What is expected from the system is to classify the incoming recyclable materials according to their raw materials and direct them to the correct box. Then, the entry is recorded in the database, and these entries can be controlled with a mobile application.

In this direction, recyclable materials are separated by using Arduino physical programming card. Then, the program developed with Python programming language, which communicates with Arduino with the help of the pyserial library, recorded the entries in the real-time Fire base database. Later, with the developed Android program, the data in the database was withdrawn and mobile control was provided by the administrator. While the machine is designed, the results of the sensors that ensure the acquisition of data while separating are shown in Table 1 [20, 22-24].

Table 1. Raw material/Sensor

Raw Material / Sensor	Inductive Sensor Result	Capacitive Sensor Result
Glass	No	Yes
Metal	Yes	Yes/No
Plastic	No	No

The process of saving to the database was carried out by the application developed with the Python programming language, the remaining operations were carried out with the machine programmed with the Arduino card.

4. RESULTS

When the capacitive and inductive sensors detect, the red light on them turns on. Figure 1 shows the reaction of the inductive sensor to a material whose raw material is glass. Figure 2 shows the reaction of the capacitive sensor to a material whose raw material is glass.

Fig. 1. Response of capacitive sensor to glass material

Fig. 2. Response of inductive sensor to glass material

Figure 3 shows the reaction of the inductive sensor to a material whose raw material is metal. Figure 4 shows the reaction of a capacitive sensor to a material whose raw material is metal.

Fig. 3. Response of capacitive sensor to metal material

Fig. 4. Response of inductive sensor to metal material

Figure 5 shows the reaction of the inductive sensor to a material whose raw material is plastic. Figure 6 shows the reaction of a capacitive sensor to a material whose raw material is plastic.

Fig. 5. Response of capacitive sensor to plastic material

Fig. 6. Response of inductive sensor to plastic material

In Figure 7, the state of the system after it is started is shown. In the application, the date of the recycling is given as 2021-01-25. Also, the number of detected plastic material is given as 2. The number of detected glass material is given as 5. And the number of detected metal material is given as 4.

Generally correct results have been obtained in the system in trials with materials less than 60 grams and less than 10 cm.

Fig. 7. Android application

4. CONCLUSION

It is seen that there is no single method that stands out in the studies conducted for the separation of recyclable materials. The methods currently used offer solutions according to changing needs, material type and capacity. For example, the Magnetic Separation System is useful for industrial separation. Capacitive / Inductive System is useful for small size separation and when you want to encourage the end user. paper separation methods are more useful when the materials are paper.

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