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An Economic Automatic Waste Segregator using Arduino

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Abstract-Efficient waste management is one of the major problems of the present era. The segregation, handling, transportation and disposal of waste are to be properly managed so as to minimize the risk to the environment. The economical value of waste is best realized when it is segregated. The traditional way of manually segregating the waste utilizes more human effort, time and cost. This work proposes An Economic Automated Waste Segregator (AWS) which is a cheap and easy to use solution for a segregation system at households, so that it can be sent directly for processing. It is designed to sort the refuse into metallic waste, wet waste and dry waste.

Index Terms-Automation; Economic; Waste Segregation, Inductive proximity sensor

1. INTRODUCTION

The economical value of waste is best realized when it is segregated. Segregation of waste at dumping sites consumes more time and manpower. Sorting of wastes at base level (domestic level) helps in its proper recycling and disposal at the dumping sites. So for easy disposal sorting of waste on the basis of type is very important. This work proposes an Automatic Waste Segregator (AWS) which is a cheap, easy to use solution for a segregation system at households; so that it can be send directly for processing. The main goal of this paper is to design and develop a segregation system which sort wastes automatically into wet, dry or metallic. The AWS uses an inductance sensing mechanism to identify metallic items and resistive sensors to distinguish between wet and dry waste. This system will be helpful for municipal corporations in sorting the collected wastes as it reduces sorting time and manpower required. Besides this, the system utilizes low cost components for the successful segregation of most type of waste. When installed in apartments or small colonies, it proves to be beneficial in sorting the waste at the site of disposal itself.
The remainder of this paper is organized as follow:

The following section describes related works. Section 3 describes working of the proposed system. Section 4 describes the results and further analysis.

2. RELATED WORKS

Subhasini Dwivedi [6] proposes a solid waste treatment plant for separating plastic, glass bottles and metal cans from solid waste material. The system uses different capacitive, proximity sensors to detect each object which is moving on a conveyer belt and segregate into different bins with the help of hydraulic cylinder flaps. The entire system is controlled by a programmable logic controller.
S.M .Dudhal [4] describes paper deals with waste segregation using programmable logic controller. The system is developed for separating out metal from waste materials. The system consists of an automatic feed system through which waste is fed into a conveyor belt, sensors and a robotic arm to which an electromagnet is attached will extract the metal from the waste and will deposit it into a bin.
Ruveena Singh [3] describes about a smart waste sorting system which automatically segregate waste into two categories namely degradable and biodegradable wastes. The proposed system consists of a lid, on which the waste material is placed. There is a sensor which transmits the signals and that signal is received by the microcontroller, depending on the signal received the lid of the system works and put the waste into corresponding bin.
Pavithra [2] describes paper deals with a smart trash system with the integration of communication technologies like ZigBee, for truck monitoring system. The system consists of IR sensor to sense the level of trash, gas sensor to sense the amount of toxic gases and ZigBee for the communication purpose. The technologies which are used in the proposed system

are good enough to ensure the practical and perfect for solid waste collection process monitoring and management for green environment. The smart trash receptacle, gives a solution for unsanitary environmental condition in a city. This prevents many diseases caused due the toxic gases emanating from the overflowing trash can.

M.K Pushpa [1] describes paper about microcontroller based automatic waste segregator. The proposed system uses an inductive proximity sensor to detect metal waste and blower mechanism to segregate between wet and dry wastes. A simple 8051 microcontroller forms the heart of the system. It controls the working and timing of the entire sub sections.

3. IMPLEMENTATION

The main goal of the project is to design and develop a sorting system that sorts the waste automatically into three categories namely metal waste, wet waste, and dry waste. Figure 1 shows the block diagram of AWS. The system mainly consists of Arduino Nano, inductive proximity sensor [6], resistive plates, IR sensors [3] and servo motors [5].

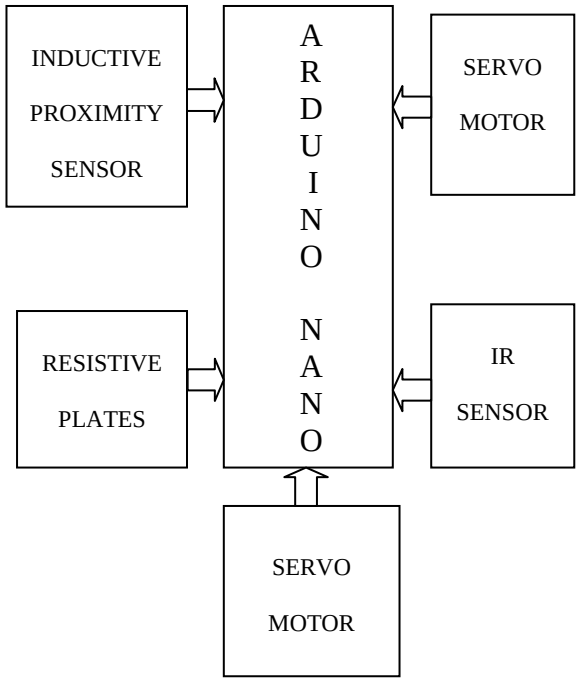


Fig. 1. Block diagram of AWS

The system starts when the waste material is put into the system. Waste is pushed through a flap into the inclined plane having the inductive proximity sensor. An upper enclosure ensures waste does not fall out of the sensing area. When the waste is dumped, the object slides over the incline to roll over the inductance coil which is used to sense any metal object. If the object is metallic a change in parallel resonant impedance of the metal detection system is observed. The object again continues and drops into the resistive sensing module. An IR and photodiode [2] combination is placed here to check the presence of waste. As and when waste falls between resistive plates, a change in IR value is detected. That change is used as the threshold to start the calibrations. Here, a decision is made if the waste is wet or dry based on its relative permittivity. After the identification of waste, a circular base which holds containers for dry, wet and metallic waste is rotated. The collapsible flap is lowered once the container corresponding to the type of garbage is positioned under it. The waste falls into the container and the flap is raised. The waste in the containers now can be collected separately and sent for further processing.

3.1. *Entry system and initialization*

The waste is dumped into the Automatic Waste Segregator which marks the entry of the waste and starts up the system. It then initializes the sensor modules. The initialization of all modules ensures that any dynamic changes in the environment do not affect the sensing.

3.2. *Metal detection system*

The object moves over the incline and falls on the inductive proximity sensor [1] [4] which contain an inductive coil. The inductive coil is a part of a parallel inductance and capacitance (LC) circuit. This measures the parallel resonance impedance of a parallel LC circuit and returns data as a proximity value. This data changes whenever another metallic object is introduced in the vicinity of the coil.

When an alternating current is passed through a coil it generates a magnetic field [7]. When a metallic object is introduced in the vicinity of the coil, eddy current is induced on its surface. The eddy current is a function of the distance, size, surface area and composition of the target. This generates a magnetic field which opposes the original magnetic field which is generated by the coil. The inductive coupling between the coil and the object creates a mutual

inductance effect on the coil which decreases the parallel resonant impedance of the circuit which in turn is reflected by an increase in the proximity count value. Magnetic fields do not affect the metal detection system. It can detect any conducting material irrespective of its magnetic properties. The waste continues down the incline towards the resistive sensing module

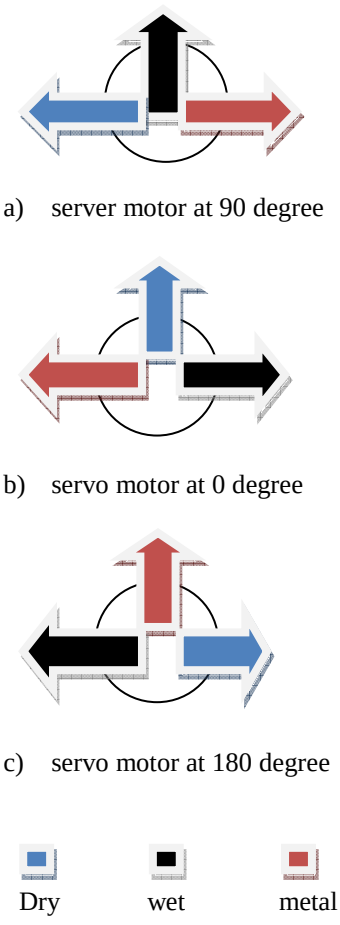
3.3. *Resistive sensing module*

Two pairs of copper cladded plates of size 10*7 cm are placed along the walls of the structure which are inclined to each other at an angle of 60°. This arrangement is made to ensure that waste of all sizes can be sensed. The area between each pair of plates increases as it moves away from the apex of the structure. The sensitivity of the plate decreases with its increase in area, hence smaller plates would accurately sense objects of smaller size. Even though the sensitivity of the larger plate is decreased, it is designed to detect larger objects which will yield a change sufficient to be identified.

The property used for segregation of waste is the relative dielectric constant. Once a dielectric is introduced between the plates the resistance value between the plate's changes and subsequently a voltage change is detected. Wet waste has a higher relative dielectric constant than that of dry waste because of the moisture, oil and fat, content present in kitchen waste. If the change in the voltage is greater than threshold then the type of garbage is inferred as dry waste, else it is wet waste. Thus, the type of waste is identified as either wet or dry

3.4. *Segregation module*

To achieve the segregation, two servo motors [5] are used. The containers are placed on a circular base which is mounted on the axle of a servo motor. The circular base rotates as the axle of the servo motor rotates. If the container corresponding to the type of garbage is not under the flap then the motor is rotated clockwise or anticlockwise. The servo motor is given three different positions or angles for the three types of wastes detected. The motor thus always comes to the required position according to the signal obtained. The default bin at the circular base is the dry bin. To avoid overshooting of the container due to the momentum of the base, the servo motor is rotated at lower speeds by using pulse width modulation (PWM) which is generated from the microcontroller's timer. Once the required container is positioned under the flap, a second servo motor lowers the collapsible flap by rotating the motor clockwise by 180° it then waits for 2 seconds to ensure that the waste falls down and finally raises the flap back to the initial position by rotating the motor anti clockwise by going back to 50°. PWM is used to rotate the motor. Thus the segregation is completed. Rotation of circular base is as shown in figure 2.



a) server motor at 90 degree

b) servo motor at 0 degree

c) servo motor at 180 degree

Fig. 2. Rotation of circular base

The flow of the software implementation is as shown in figure 3

4. RESULTS

The project has been tested for different categories of waste namely wet, dry and metal. Wet waste means organic wastes such as vegetable peel, garden wastes etc, dry waste include paper wastes, plastic bottles etc, and metallic waste include safety pins, foil paper etc.

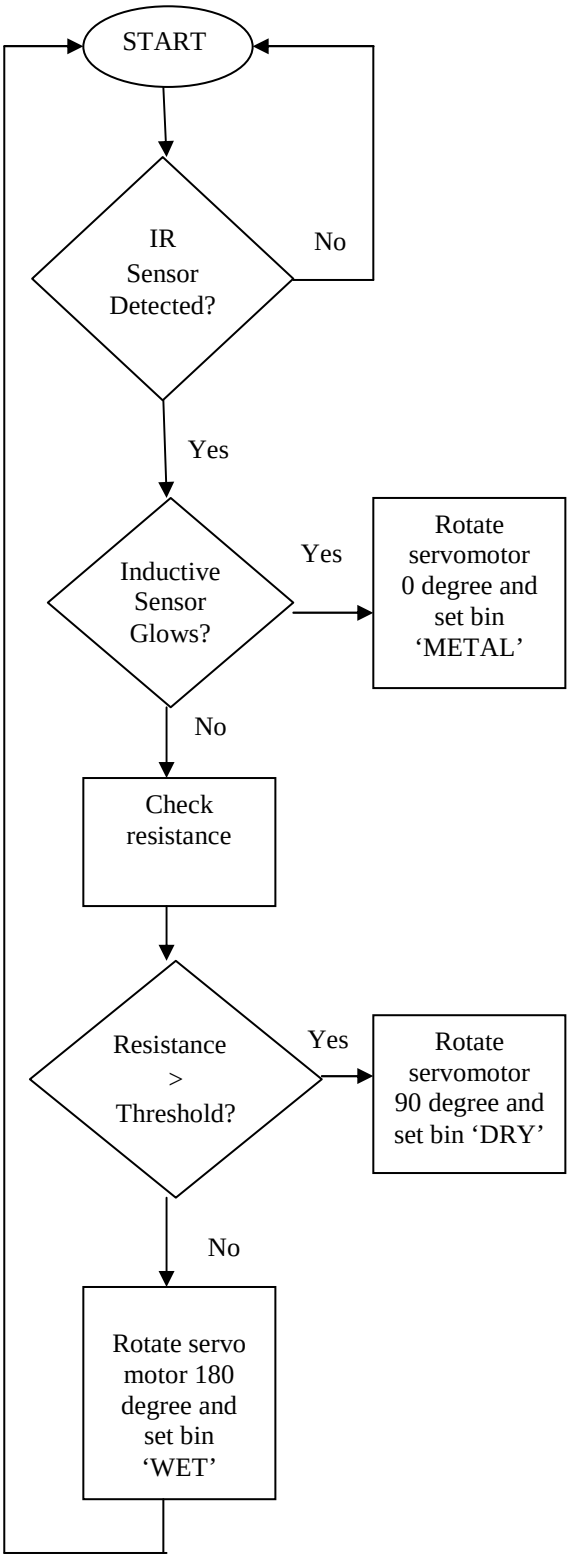


Fig. 3. Flow chart for software implementation

Table 1. Voltage and resistance values across resistive plates for different wastes

Wastes	**Voltage across resistive plates in volts**	**Resistance value of resistive plates in mega ohm**
Metal	0	0
Plastic	4.84	0
Banana peel	4.37	7.8
Wet leaves	4.74	1.56
Aluminum foil	0	0
Potato peel	4.37	0.58
Dry cloth	4.26	0

The segregation of metals is done by inductive proximity sensor. Hence if a metal is detected the resistive sensing module will be inactive. Table 1 describes the value of voltage and resistance for different type of wastes.

The system uses two type of sensing mechanism to segregate waste into three different categories. An inductive proximity sensor is used to detect the metallic garbage and resistive plates segregate the waste into wet and dry category. This system can be made more efficient by using different sensors for different type of waste. More bins can be added to this project as per the demand of user. Since the system is cheap and approachable everyone can buy it and use it.

Table 2 represents the result of waste segregation which shows whether the tested waste belongs to metal, dry or wet. Table 3 represents the rotation of circular base according to the waste detected. For metal waste, the motor connected to circular base rotates in anticlockwise direction. If detected waste is dry then no rotation is there and if it is wet waste motor rotates in the clockwise direction.

Fig. 4. Automatic Waste Segregator

Table 2. The result of waste segregation

Wastes	Type of waste detected
Foil paper	Metallic waste
Banana peel	Wet waste
Lemon	Wet waste
Potato	Wet waste
Poly bag	Dry waste
Paper	Dry waste
Keys	Metallic waste

Table 3. Rotation of circular base according to detected waste

Wastes	Angle (in degrees)	Movement of bin
Foil paper	0	Anticlockwise
Banana peel	180	clockwise
Lemon	180	clockwise
Potato	180	clockwise
Poly bag	90	No rotation
Paper	90	No rotation
Keys	90	Anticlockwise

5. CONCLUSION

Automatic Waste Segregator has been successfully implemented for the segregation of waste into metallic, dry and wet waste at a domestic level. The system can segregate only one type of waste at a time with an assigned priority for metal, wet and dry waste. The experiment has been conducted for wet, dry and metallic wastes. It is found that the change of resistive count value is greater for wet waste and very less for dry waste. Other objects like glass and wood have intermediate relative dielectric constant and thus are detected as dry waste. Experimental result shows that the waste has been successfully segregated into metallic, wet and dry using the Automatic Waste segregator.

Acknowledgments

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