Design and Development of a prototype for simplified separation of plastic waste

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Abstract—With the rise of sensor technology, robotics and automation there is a new era of waste disposal management systems applied in variety of applications in the recycling and waste processing industries. Due to the rise in urbanization, there is a vital need for waste management. The technological growth and innovation can contribute to achieve environmental sustainability. There are many compelling reasons for choosing these approaches. To manage the waste, automatic sorting systems are needed to be developed on the lower level as well as higher levels. This paper presents an effective waste management system which is helpful in sorting plastic and metallic waste by using sensor technology. We discuss a new way of disposing the waste in household areas and in workplaces. The robotic arm and the sensor technology are used for the detection and identification of different types of wastes. An effective system is built for separation and providing information to the authorities concerned.

Index Terms—Arduino Uno, Capacitive Proximity Sensor, Inductive Proximity Sensor, Segregation, Waste Management

1 Introduction

Solid waste management is the pervasive problem and is very essential to sort the waste at base level. The waste can be sorted and managed in numerous types of techniques but all of them are manual which makes it cumbersome. There is a necessity to simplify the concept of Garbage Disposal at different areas especially at places like homes and marketplace. Most of the separation techniques involve manual labors, but this project is a completely automated. The papers that were reviewed dealt with just concepts and ideas which were not implemented due to high cost and complexity. Even though the automatic separation was done, the outcome was not up to the mark.

Though the world is in a stage of up gradation, there is yet another problem that has to be dealt with i.e. Garbage.

Garbage bins being overloaded and the garbage being spilled out from the bins can be seen all around. This leads to various diseases as large number of insects and mosquitoes breed on it. A big challenge in the urban cities is solid waste management. Hence, smart dustbin is a system which can eradicate this problem or at least reduce it to the minimum level. Majority of viruses and bacterial infections develop in polluted environment. Safeguarding the environment using technology sources is needed at present. Majority of the public environment seems to be polluted with the waste material. So, modernization of the restaurants is needed by imparting the smart technology.

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Amounts of waste are largely determined by two factors: First, the population in any given area, and Second, its consumption patterns. According to the UN, between now and 2025, the world population will increase by 20% to reach 8 billion inhabitants. With this increase in population, the responsibility towards waste management also increases. Our waste administration frameworks and our economic situations, even taking care of business, are unequipped for taking care of the developing measures of waste universally. So unless a new paradigm of global cooperation and governance is adopted, a tidal wave of uncontrolleddumpsites will be the principal waste management method, especially in Asia. On the west coast of America, San Francisco leads the way with a landfill disposal diversion rate of 72% and the city has set itself a target of zero waste to landfill by 2020.
This paper gives us one of the most efficient ways to keep our environment clean and green.

Dustbin is a common means and a basic need everywhere. It is observed that often the garbage get collected due to irregular removal of garbage present in the dustbin. In the proposed paper, a new model for the municipal dustbins which intimates the centre of municipality for immediate cleaning of dustbin has been proposed. Our project deals with new way of disposing the waste in household and workplace. Till today it is being seen that the waste disposal everywhere is going through different steps.First we dump it in the dust bin which consists of the mixture of all the non-biodegradable and biodegradable waste from household or workplace. Then the waste is separated into biodegradable and plastic waste and sent to further processing if any.

2 Literature Survey

Many systems have been developed for segregation of waste. Most of them deal with separation of only one kind of

waste orawareness of keeping environment clean. Some of the systems are mentioned below:

A vision-based navigation method was presented for robot trash collection task in which a robot searches and collects the litter and moves to trash bin to deposit all piece of litter. However it had the limitation that the robot travelled through the unwanted paths, even when the obstacle was nearby [1].

This paper explains about the system actively monitoring the waste collection process and providing real time feedback such as waste collection status, live tracking of trucks and trash bins etc. The system could also receive complaints from residents about uncollected wastes as well as the illegal disposal of wastes [2].

In this paper, an indoor trash detection and collection system using autonomously directed robotic exploration algorithm is used. The hardware response was recorded and evaluated in real time. But the drawback was that, this algorithm was confined to limited area [3].

This paper deals with an advanced trash collection system with smart binsthat alerts the authorised collector by sending alert messages. This system has a drawback of more man power required for the separation of wastes and also the individual has to wait till the dust bin is full [4].

This paper describes the solution for the trash management especially in the city of Bengaluru, India. It mainly uses the concept of internet of things for the better trash management system. In this approach, sensors are placed in the bins located at public areas, to sense the level of the garbage in the bin. But this paper does not provide any solution for the separation of the trash, due to which after trash collection the waste separation is done by humans itself which is a tedious work [5].

This paper gave an idea that the smart bins will transmit information about its full status and harmful gas levels. Proposed system provides efficient and optimized routes to collect maximum waste with less cost and fuel. The system provides estimated dates for collection of waste, real time bin status, expected fill up water for the bins, and optimized shortest path for waste collection. The problems that came across were lack of information about the collecting time and area. Also there is lack of proper system for monitoring, tracking the trucks and trash bins that have been collected in real time. There is a loss of productivity. There is no quick response to urgent cases like truck accident, breakdown, long-time idling and also to clients complaints about uncollected waste [6].

3 System Architecture

3.1 Materials Required:

1. Capacitive Proximity Sensor(PNP-NO)
2. Inductive Proximity Sensor(PNP-NO)
3. Arduino Uno R3
4. Ultrasonic Sensor HcSrO4
5. GSM Module
6. LDR

3.1.1 Capacitive Proximity Sensor:

Capacitive Type sensor detects the presence of any dielectric material in the proximity of its sensing face. They are used for detecting non-metallic objects, liquid level and other sensing application. Capacitive proximity sensors are similar to inductive proximity Sensors. The main difference between the two types is that capacitive proximity sensors produce an electrostatic field instead of an electromagnetic field.

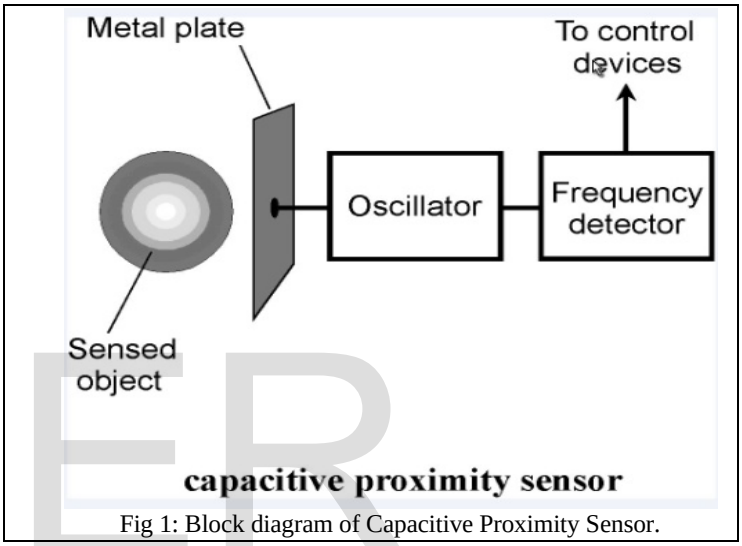

Fig 1: Block diagram of Capacitive Proximity Sensor.

The sensing surface of a capacitive sensor is formed by twoconcentrically shaped metal electrodes of an unwound Capacitor. When an object nears the sensing surface it entersthe electrostatic field of the electrodes and changes the Capacitance in an oscillator circuit. As a result, the oscillator begins oscillating. The trigger circuit reads the oscillator'samplitude and when it reaches a specific level the output stateof the sensor changes.

As the target moves away from thesensor the oscillator's amplitude decreases, switching thesensor output back to its original state.

Capacitive proximity Switches will sense metal as well as non-metallic materials suchas paper, glass, liquids, and cloth.

3.1.2 Inductive Proximity Sensor:

An inductive proximity sensor belongs to the category of non-contact electronic proximity sensor. It is used for positioning and detection of metal objects. The sensing range of an inductive switch is dependent on the type of metal being detected.

The sensor consists of an induction loop. Electric current generates a magnetic field, which collapses generating a

current that falls toward zero from its initial transmission when the input electricity ceases. The inductance of the loop changes according to the material inside it and since metals are much more effective inductors than other materials the presence of metal increases the current flowing through the loop. This change can be detected by sensing circuitry. This then signals some other device whenever metal is detected.

Common applications of inductive sensors include metal detectors, traffic lights, car washes, and a host of automated industrial processes. Because the sensor does not require physical contact it is particularly useful for applications where access presents challenges or where dirt is prevalent.

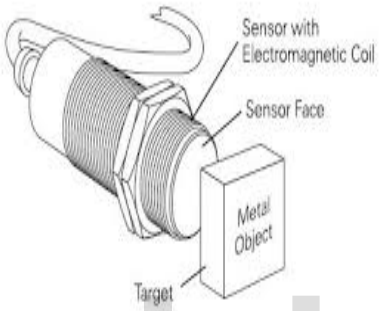

Fig 2: Inductive Proximity sensor

3.1.3 Arduino Uno R3:

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.This board is used as the main controller for the proposed prototype. This board is configured using the Arduino IDE platform for all sorts of Arduino devices.

Fig 3: Arduino Uno R3

3.1.4 Ultrasonic Sensor-HCSr04:

The Ultrasonic sensor emits an ultrasound at 40,000 Hz which travels through the air and if there is an object or obstacle on its path it will bounce back to the module.

Fig 4: Ultrasonic sensor HCSr04

Considering the travel time and the speed of the sound the distance is calculated. The HC-SR04 Ultrasonic Module has 4 pins, Ground, VCC, Trig and Echo. The Ground and the VCC pins of the module needs to be connected to the Ground and the 5 volts pins on the Arduino Board respectively and the trig and echo pins to any Digital I/O pin on the Arduino Board.

3.1.5 GSM Module:

GSM is a mobile communication modem; it is stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.

Fig 5: GSM module

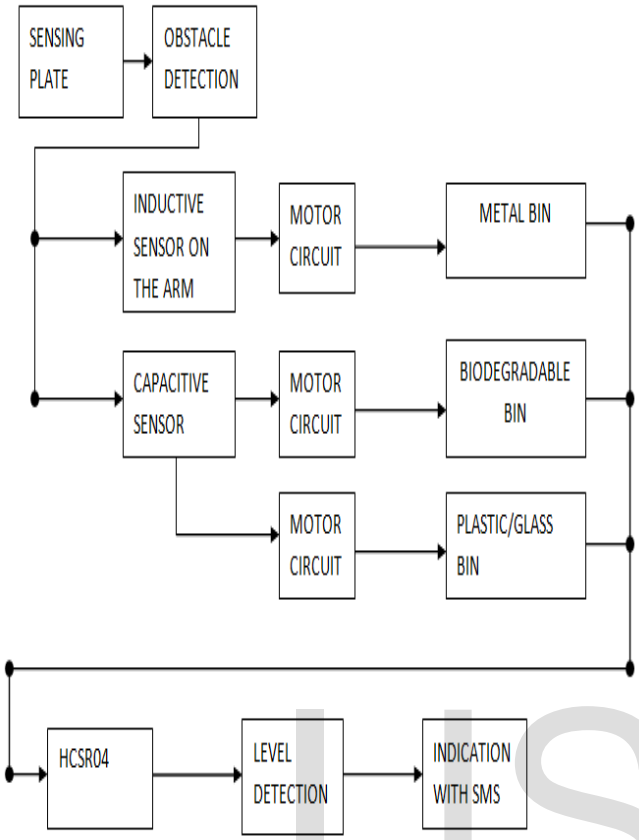

Fig 6:Block Diagram of Setup

4 METHODOLOGY

Initially, a robotic arm is programmed to perform the actions as per our requirement. The processing element here is Arduino. The Arduino is coded based on our requirement for automatic control of the robotic arm.

The prototype setup consists of three bins with the robotic arm along with the inductive sensor placed in between them. A plate is kept in front of the arm so that the trash falls on it for further processing. Inductive type sensor detects the presence of any metal in the proximity of its sensing face. If the object is metal then the sensing plate rotates towards the metal bin, else it goes for further detection processes as shown in the figure 7.

Next, the capacitive sensor comes into action. It detects any material other than glass and plastic. If so, the sensing plate rotates towards the biodegradable bin and the material falls into it.

If the object is glass or plastic then the sensing plate rotates towards the non- biodegradable bin and the material falls into it which is shown in the figure 8.

Human effort and maintaining the ethics of safe and uniform waste disposal as shown in the figure 9.

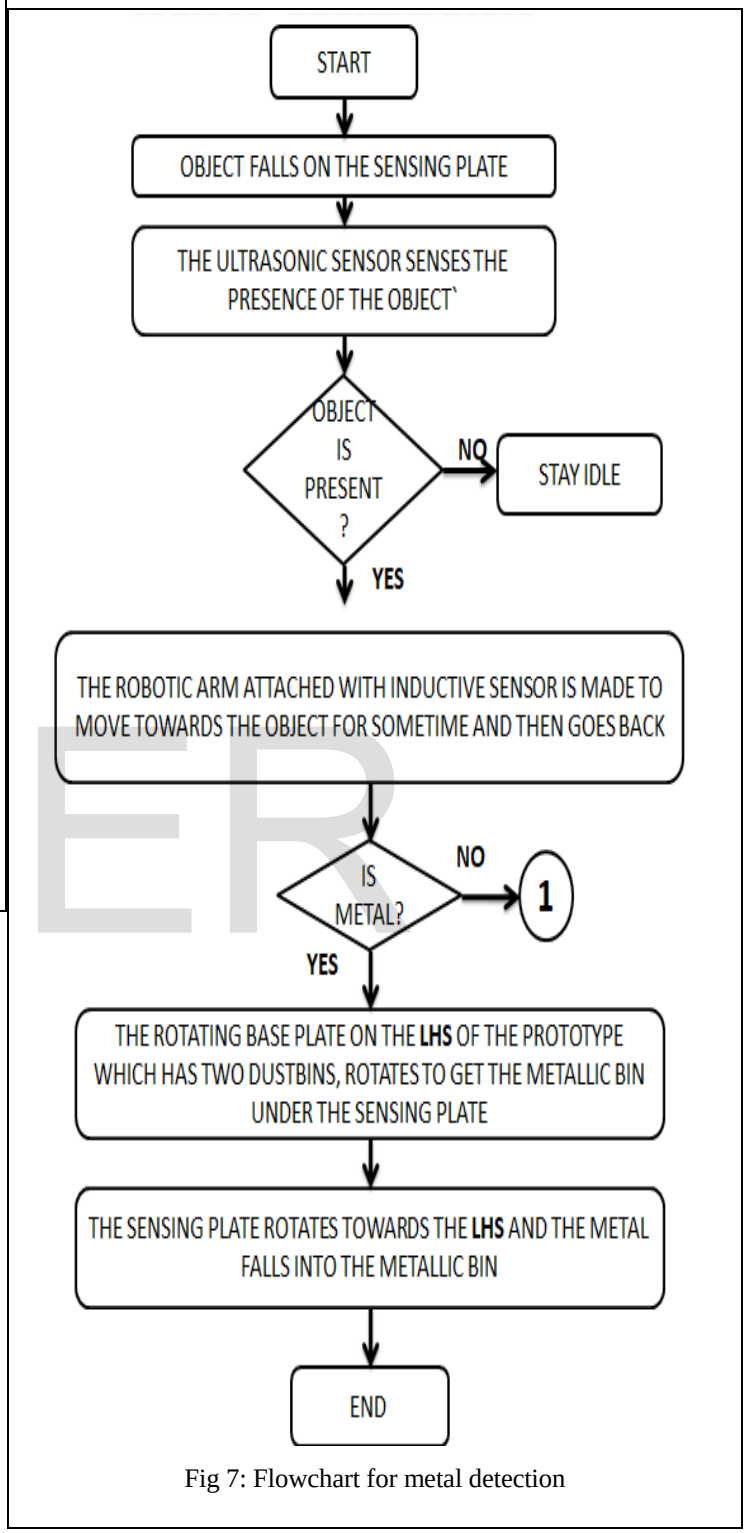

Fig 7: Flowchart for metal detection

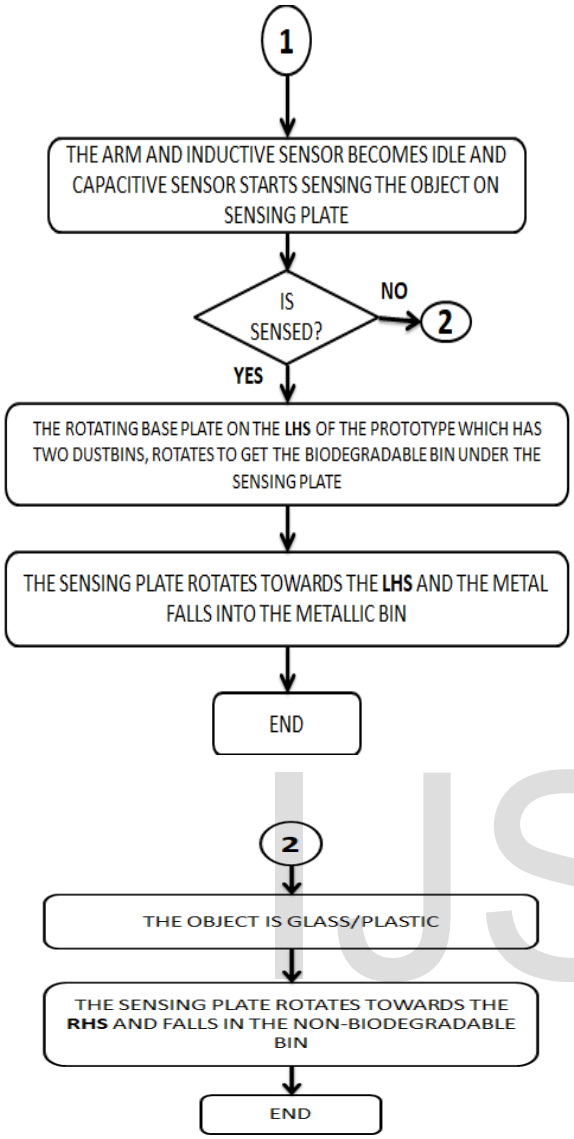

Fig 8: Flowchart for glass/plastic detection

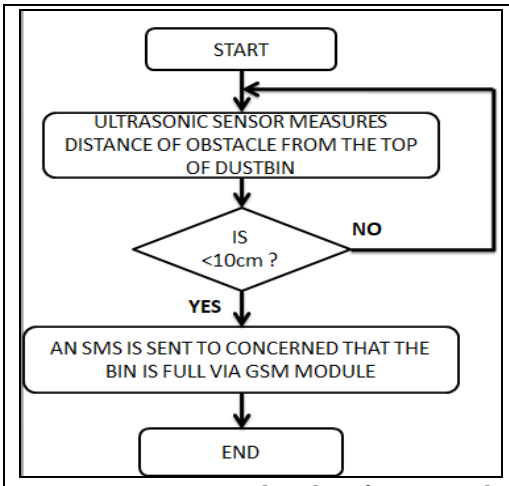

Fig 9: Flowchart for SMS indication

5 Outcome And Future Scope

5.1 Outcome:

The project outcome can be depicted using the following table: The sensors are synchronized to detect and separate the different types of wastes. The system is developed such that the plastic materials are not sensed and all the other types of wastes are sensed and separated.

SL.NO	TYPES OF WASTES	SENSED	NOT SENSED
1.	PLASTIC		YES
2.	WOOD	YES	
3.	EDIBLE WASTES	YES	
4.	METALS	YES	
5.	GLASS	YES	

5.2 Future Scope:

Due to the rise in urbanization, the population of urban areas have been increasing over the years and wastes produced per person in an area keep on increasing day by day.

This paper gives a brief idea on the initial stages of waste segregation which helps in reducing human labour which results in reducing the cost of recycling. This technique of separation will be useful if implemented on a larger scale especially in industries like manufacturing industries and public places.

This paper would help in designing different sensors for detecting and sensing various types of materials like wood, glass, plastic etc.

As the improvements in technology are increasing especially in the field of Internet Of Things, Artificial Intelligence and Cloud Computing real time status of the bin can be monitored continuously.

6 Conclusion

This prototype is designed to effectively separate glass and plastic materials automatically at low cost and effort. The separated biodegradable wastes can be used for applications such as composts and biogas. The system can be further developed into a more effective one so as to segregate more precisely in situations which has more variations in the wastes. Through this system we can realize a compact, low cost and user friendly separation system for urban house hold, college and offices to streamline the waste management process.

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