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Survey on Sensing Algorithms for Solid Waste Management

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Abstract: ***Solid waste management is one of the common problem where every city requires the solution. With increase in urbanization, there is a tremendous increase in production of waste materials. The municipality authorities provides the services for waste production to surroundings and ourselves hygiene. In order to ensure the efficient waste management process, we use a solid waste bin with integration of sensing systems and algorithms. Human detective sensing device detects the motion of object near the bin and opens the lid which is interlinked with lid sensing device. Waste filling level sensing device measures the height and gives the information about the waste filled in bin and sends and alert message which helps us to prevent the overflow and bin were collected only when they are completely filled.***

Index Terms: Solid waste management, integration, sensing systems.

I. INTRODUCTION

In solid waste management, a solid waste bin was designed in order to achieve the real time bin present status which has greater advantage of consuming the minimum energy. In process of waste management, the services costs high such as every year 20 to 35 percent of the budget was consumed. In many cases, the waste bins are collected which are partially filled which leads to the wastage of many resources. For collecting the waste in efficient way, the optimization technique is applied for the waste management process to get the real time bin status by measuring the waste filled in bin. For this, the dynamic scheduling was added to waste management process. We use more than one sensing device and integrate each other and combine them using algorithms to the efficient results. The sensing devices we use in this model are human detective sensing device, lid sensing device and waste filling level sensing device. For many waste management process, it takes long vehicle trips, more working hours which consumes more energy. So, in order to avoid those things, we consider a solid waste bin which consumes minimum energy. We have many solutions for waste management system and still it is the common problem and many places requires efficient solution to this problem. Municipal authorities provided a service for collecting the waste but the limitation is that it costs high and per year 20 percent of the budget of municipality has been used for collecting waste.

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The main reason for this problem is that the most of the bins are collected which are not completely filled i.e.… partially filled bins so that many resources are being wasted. Optimizing and improvement of the waste management process is achieved through measuring the level of waste filled in the bin gives the real time bin condition. Solid waste management system is a process of storing, collecting, transporting and disposal of the solid wastes in a landfills. By integrating the several collection mechanisms, the transportation of the waste materials from different locations, storage, recovery strategies for the recyclable materials, quantity and the volume reduction of the waste particles are improved.In general the solid wastes are more generated in very common and public places such as households, commercial areas, working institutions, construction sites, parks, forest areas where domesticated animals live, streets and many other places. There are few existing methods which are used for solid waste management. Let us now discuss about the existing method along with their limitations. In image processing method, the solid waste bin was designed in such a way that the waste filled in the bin was captured by bins processing image. The limitation of this method is that by processing bins image, the real time bin condition is not so approximate and the data it gives mostly depends on the existing or historical data. Using ultrasonic method, the bin status was given by using the sensor called ultrasonic sensor which is used to measure the distance. The main limitation of this method is that the system does not respond whenever the waste was thrown is the bin. Using infrared sensing method, the level of waste filled in bin was captured using infrared image where the container can have both solid and liquid materials. The limitation of this method is as same as ultrasonic method. Using infrared LED method, this is a system which is designed for collecting the cardboard waste using LED where it measures the level of waste filled in the solid waste bin container. The limitation is that the system was activated once an hour to measure the solid waste bin level container and raises an alert message whenever the waste in the bin exceeds the level.

II. LITERATURESURVEY

The survey includes the following papers. It includes many algorithms and efficient methods along with the disposal and recycling of the waste materials. For door to door waste collection system, we collect waste in an individual manner and whenever the recyclable materials are found then, they are collected separately [1].

For this process, we use heuristic algorithm which helps in collecting recyclable materials separately. For debris flow early warn system, we use integration scheme which helps us to give the alert warning sign [2]. We had a great effects of losing our lives, living areas and many other. Whenever we had a chance to debris attack, it sends an early warning. We use ultrasonic senor for measuring the distance which plays a major role in sensing the distance gives the overflow or underflow conditions, measuring the distance of landfills filled with waste [3]. The working of this ultrasonic sensor is consistent at different conditions such as hot, cold, rainy or any other.

Table-1. Literature Survey

Ref	Description	Algorithm	Observation
[1]	Separation of recyclable materials.	Heuristic algorithm.	Reduce 23% costs.
[2]	Effects of debris flow avoided by alert system.	SWE integration scheme.	Improves data sensing and early warning signs.
[3]	Measure the distance from ground to object.	Constrained optimizatio n technique.	Measures the distance at any conditions.
[4]	Current state of art systems analysis.	Heuristic algorithm.	Improves routing methods.
[5]	Disposal of locations can be tracked.	IOT oriented approach.	Efficiency in waste collection process.

Current state of art system analysis is similar process of door to door collection method as it helps to collect the waste materials in real time [4]. Using tracking device, we can track the locations of the disposal wastes helps us to collect the waste efficiently. The data acquisition is one of the tracking device used in this system [5]. Ultrasonic sensor sends a wave and gets back a reflected wave if it detects any object. This sensor measures the distance by calculating the time between transmitting and reception sound waves [6].

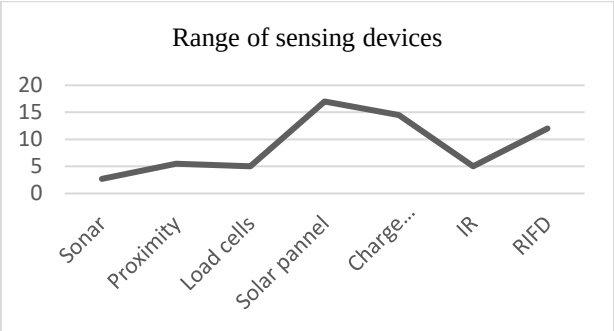

Figure-1: Range of different sensing systems

Proximity sensor is used to detect the objects without physical touch by generating the electromagnetic radiation [7]. Being a transducer, the load cells creates an electric signal which is proportional to the force applied [8]. A charge controller is battery where it controls the voltage and current and helps us to prevent from overcharging which has greater effects [9]. An infrared sensor is one of detecting sensor which detects the objects of its surroundings by sending or receiving infrared radiations [10]. RIFD (Radio Frequency Identification) is a technology where digital data we use in the system are processed by radio frequency reader [11].

III. PROPOSED SYSTEMS

For efficiency of the solid waste management system, we need the real time bin condition which is achieved using three sensing devices. They are human sensing where we use PIR sensor which detects the motion of an object in range and if any object was detected then, a signal was send to the system that human was detected. For lid sensing device, we use servo motor which is used for lid opening or closing operations. Servo motor senses the signal that the human was detected and then it performs the lid operations based on the waste loaded or unloaded parameters. For sensing the level of the waste filled in the solid waste bin, we use ultrasonic sensor which is used to measure the distance. The main advantage of using ultrasonic sensor is that it has the stable readings which helps to give the accurate details.

3.1 Human detective sensing

For detecting the motion of human, we use PIR sensor (Passive Infrared Sensor). PIR sensor is used to sense the human motion by checking the human moved in or out in the sensors range. The actual PIR sensor range is between 5 meters and 12 meters. The PIR sensors are inexpensive, small in size, has low power and is very easy to use and interface.

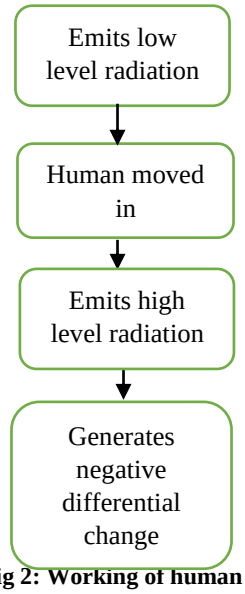

Fig 2: Working of human detective sensing device

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Initially we consider two variables one of them is used to show the sensor status and the other one is used to read the values of sensor. If sensor value is equal to the low which means that the motion of human was detected successfully then the value of the sensor status is assigned to high.If sensor value is equal to the high which means that the motion of human was not detected in the range and so the value of the sensor status is assigned to low

```
Senosrvalue == high
        LED on
Sensorstatus == low
        Motion was detected
        Sensorstatus becomes high
Else
        LED off
Sensorstatus == high
        Motion was stopped
        Sensorstatus becomes low
```

3.2 Lid sensing system

For lid sensing system, the lid performs two operations i.e... Lid open and lid close. We use servo motor which is a small device where the result was shown through an output shaft. The shaft was positioned to particular angular positions by sending servo signal. If input line consists of a servo signal then, the servo motor will be in angular position. If there is any change in the servo signal the, the positions of the shaft also changes. The servo motors are small in size but powerful.

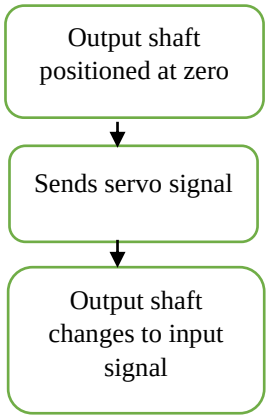

Fig 3: Working of lid sensing device

```
For position = 0, position <= 180, position = position + 1
        Updates position
        Opens the lid
For position = 180, position >= 0, position = position – 1
        Updates the position
        Close
```

Opening and closing operations of the lid can be done by initially assigning the position of the lid to zero. Then, they will perform the operation of the lid by checking the position value. If the position value is equal or less than 180 degrees angle, we will update the position value and performs the open operation so that lid opens. If the position value is equal or greater than 180 degrees angle, we will update the position value and performs the close operation so that lid closes.

3.3 Waste filling level sensing

For measuring the level of waste filled in solid waste bin, we use ultrasonic sensor (HC-SR04) to calculate the distance of an object. The detection capability of this ultrasonic sensor is with high accuracy rate and the readings are stable from the range of 2cm to 400cm. The operations that are being performed by the ultrasonic sensor are not affected to any climatic changes or to any conditions and also affected to black materials, soft materials which are very hard to detect. It has two modules for measuring the distance. They are transmitter and receiver modules.

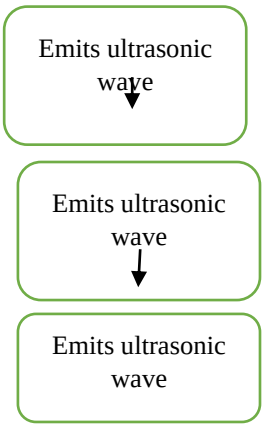

Fig 4: Working of Waste filling level sensing

```
Distance = duration / 58.2
If distance >= maximumdistance || distance <=
minimumdistance
        Sends negative indication
        LED on
Sends distance value to system
LED off
```

S.No	Algorithm	Advantages	Disadvantages
1.	Human detective sensing algorithm	Detects the human and moving objects in high and low value conditions.	Insensitive for very low and slow moving objects.
2.	Lid sensing algorithm	Senses the human motion and updates the position of lid.	Requires more complex control
3.	Waste filling level sensing algorithm	Gives the accurate values of bin condition	Difficulties in reading frequency vales from thin and small surfaces

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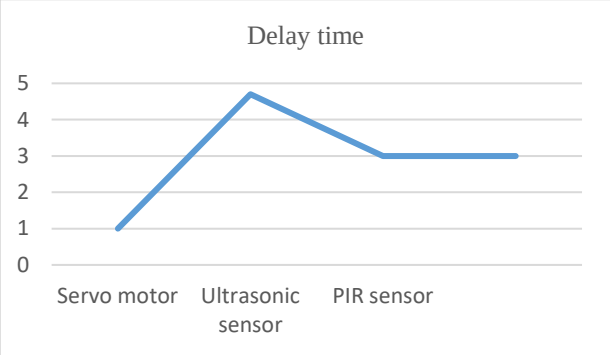
For sensing the level of waste filled in the bin, we consider two variables where one of it is used to calculate the maximum distance i.e. the maximum collected waste was stored. The other one is used to calculate the minimum distance which shows the minimum space available for filling the bin with solid waste. Distance was calculated based on the speed of the sound. (58.2 m/sec) If the distance is greater than the maximum distance, then it sends the message that the bin is about to overflow.

IV. RESULTS AND DISCUSSIONS

This paper presents the implementation of the trash collector using ultrasonic sensor, human detecting sensor and servo motor. Generally the information of the bin status was not so real and the most bins were without Filling completely which results in wastage of resources, the long and more vehicle trips and also the working hours for an employee was also increased. In this system, we get the information of bin condition with the stable readings and also we get an alert message that the bin is about to overflow so that the waste in the bin was collected at the right time with no wastage of resources helps to achieve efficiency in waste management system and also decrease in municipality annual budget.



Here, the time delay shows that how long the output of each sensor remains high after this detection process. In case of PIR sensor, after detecting the motion of a human body, the PIR sensor output remains 3 seconds to 5 minutes. For ultrasonic sensor, it sends a ultrasonic wave of 49KHz that humans cannot hear but when the signal was reflected back then we can listen the signal send by ultrasonic sensor. The time delay for the reflected signal is depends on the distance measurement by speed of sound in air. The servo motor will rotate forth and back for lid opening and closing operations in between the 133 to 74 degrees. When the input button was pressed which means the human detection was done then the input button of servo motor is on. So, when input was on then, the servo motor starts rotating. The time delay is about 1000 milliseconds or one second.

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