ROBOTIC SMART WASTE MANAGEMENT SYSTEM

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Abstract:—The main issue today for pollution is garbage overflow in cities. Efficient waste management is one of the primary issues in the recent times. This paper presents a Robotic Smart Dustbin which helps in efficient waste management. It avoids human intervention, it is embedded with various sensors and cellular network which helps in cleaning process. It helps in detecting the level of garbage in the dustbin, helps in segregating wet and dry waste, helps clean the surrounding environment and sending alert message to municipal authority.

IndexTerms–**Robotic Smart Dustbin, Garbage Collector, Bluetooth Module, Haar Cascade, Machine Learning.**

I. INTRODUCTION

In recent decades the increase in population has in turn led to increase in waste. It creates an unhygienic condition and creates bad odour around the surroundings. This in turn leads in spreading some deadly diseases & human illness. Garbage management is one of the key issues in the recent times.

Urbanization and industrialization have led to increase in the volume of waste generated. The use of new technologies may lead to significant improvement in the waste management process. The key issue of an inadequate waste management is that the garbage bin at public places gets overflowed well in advance before the commencement of the next cleaning process. To avoid all such situations, we are going to implement a system called Robotic Smart Dustbin.

This paper presents a Robotic Smart Dustbin which helps in efficient waste management. It avoids human intervention, it is embedded with various sensors and cellular network which helps in cleaning process. It is embedded with Raspberry Pi and Arduino UNO which helps to send alert message when the garbage is full, helps in segregating wet and dry waste, helps clean the surrounding environment.

The microcontroller is interfaced with a Bluetooth module to send an alert message to municipal authority when the garbage is full. Ultrasonic sensor is places at the top of the dustbin to detect the level of garbage in the dustbin. Moisture sensor is used to separate wet and dry waste. Servo motor helps to flip the lid of the dustbin either right or left. Stepper motor is placed at the bottom of the dustbin for the movement. IR sensor is used to sense any object in front of the it and stop the movement of the dustbin. Raspberry Pi camera is fixed to the top of the dustbin to detect human beings to open the lid of the dustbin so that the people can place the garbage inside it without touching the dustbin for hygienic purpose.

II. RELATED WORK

A lot of technologies have been proposed for smart dustbin. In this section we will discuss few of them.

Smart garbage monitoring and clearance system using internet of things - This paper is proposed IOT based smart waste clean management system which checks the waste level over the dustbins by using Sensor systems. Once it detected immediately this system altered to concern authorized through GSM/GPRS. For this system used Microcontroller as an interface between the sensor system and GSM/GPRS system. To monitor and integrate an android application is developed for the desired information which is related to the various level of waste in different locations. This is ensued the greenish in the environment and support for swachhbharat for cleanness [1].

IoT based architecture for waste management – This work proposes an IoT-based architecture that targets two elements.The first is monitoring the waste volume and content in a waste bin, as well as the bin'ssurroundings. The second entails dynamic scheduling and routing of waste collection vehiclesbased on the relayed information from the bins. The waste bin design detects any obstacles aroundthe bin and monitors illegal dumping in the vicinity of the bin.The routing protocol provides an optimal solution for wastecollection from the filled binsin high density residential areaswhile minimizing the length of the trip. The combinedimprovement of these elements will result in increasing the efficiency of waste collection, reducingand carbon footprint [3].

Deterioration and non-deterioration waste separation using pick and place robot - This paper provides an efficient and simple method fordeterioration & non-deteriorationwaste separation using pick and place robot. A simplest image processing technique for roboticsusing Android mobiles is also a part of the work. In India, degradable and non-degradable wastesin streets are separated by humans. Hence human facing lot of communicable diseases.Android mobile with apk file is used to detect thedegradable (vegetables) and nondegradable(plastic cover) objects and it will send that information to the microcontrollerunit via Bluetooth module. After receiving this information,microcontroller unit will drive the robotic armfor the particularobjects. When microcontroller unit receives '1' means from theBluetooth willfind the non-degradable object and it will takeand put it on to the separate box. Similarly, when itreceives '0'means robotic arm will find the degradable objects and it willtake and put it on to theseparate box [4].

IoT based smart garbage alert system using Arduino UNO - This paper proposes a smart alert system for garbage clearance by giving an alert signal to the municipal web server for instant cleaning of dustbin with proper verification based on level of garbage filling. This process is aided by the ultrasonic sensor which is interfaced with Arduino UNO to check the level of garbage filled in the dustbin and sends the alert to the municipal web server once if garbage is filled. After cleaning the dustbin, the driver confirms

the task of emptying the garbage with the aid of RFID Tag. The notifications are sent to the Android application using Wi-Fimodule [5].

Cloud based smart dustbin system for metro station - This paper presents a viable solution for dustbins at metro stations. The prototype model of this smart dustbin system is built using RFID tags, RFID reader, Ultrasonic sensor, geared motors, servo motors, Arduino UNO, raspberry-pi and solar panel for power supply. The system uses cloud-based monitoring system for garbage monitoring. With the use of cloud-based system there is no need of routine checking of dustbins. To make the system eco-friendly and preserve carbon neutral footprint of metro it uses a miniature solar panel for power supply [7].

An efficient garbage management approach for healthy society - This paper depicts the utilization of our model of Smart Dustbin in dealing with the waste accumulation management. The dustbin itself works as a robot, when it is full on command from authorized person it goes to pre-learned path (for first time user has to guide towards garbage dumping area) and empties itself. An authorized person gives command from Webpage where dustbin status is updated regularly [9].

III.METHODOLOGY

In our proposed system, we proposed a robotic smart dustbin which helps in efficient garbage management system. The robotic smart dustbin is fitted with sensors that help in waste management system. TheIR sensor helps to detect objects and stops the motion of the dustbin. Haar Cascade algorithm isused to detect the face of the human beings and opens the lid when the persons come close to thedustbin. The moisture sensor helps to separate wet and dry waste.

The ultrasonic sensor helps todetect the level of trash in the dustbin and an alert message will be sent to the authorized personusing the Bluetooth module.The buzzer beeps when the dustbin is full indicating that the bin has no free space. A Raspberry Pi camera is fitted to the dustbin to detect any trash around it. SVM and Random Forest Algorithm is used to detect trash around the dustbin. If any trash is detected around the dustbin it moves towards it with the help of stepper motor and cleans the waste using the garbage collector. Periodically the level of dustbin is update to the server. When the bin is full alert message along with the location of the dustbin is sent to the municipal authority. The authority person can open the app and view the level of trash anytime.
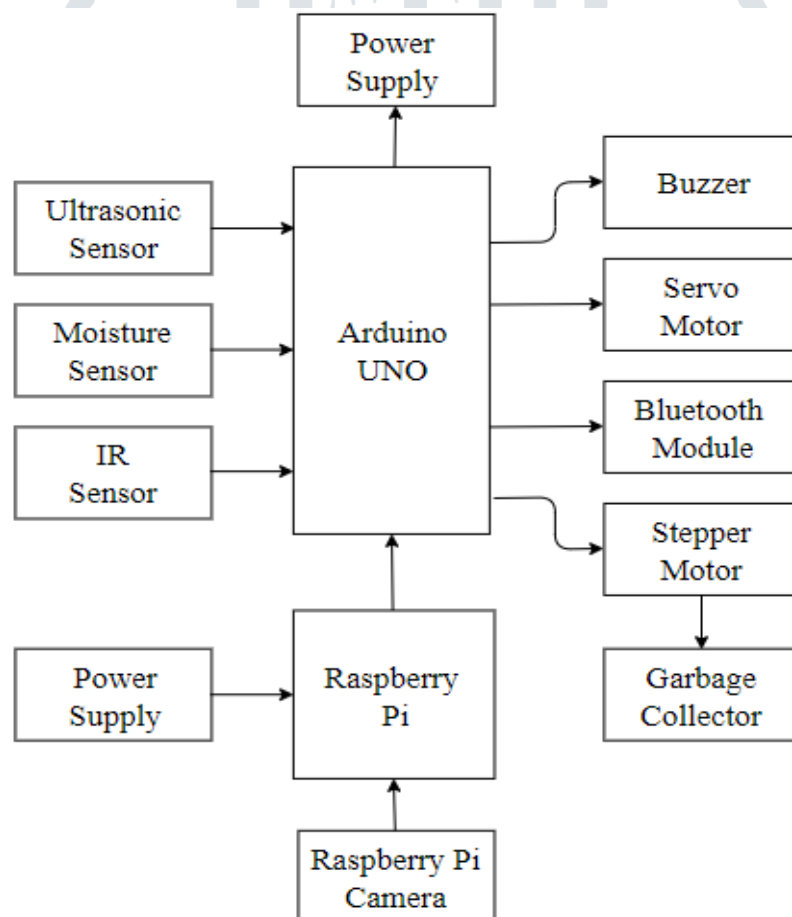

Fig 3.1: Robotic Smart Dustbin Architecture

IV.SYSTEM DESIGN

4.1 Level of garbage detection

Ultrasonic sensor is used to detect the level of garbage in the dustbin. Ultrasonic sensorsends a signal out from the transmitter periodically. When an object is detected the signal bouncesback from the object. This signal is received by the receiver. Arduino board is used to read thesensor output.

Ultrasonic sensor sends the speed and time taken to travel from the lid of the dustbinto the object to the Arduino. Distance program is embedded in the Arduino. When the garbage isless than 5cm from the sensor the buzzer gives abeep sound stating that there is no free space inthe dustbin.Distance is calculated by using the below formula:

$$Distance = (Duration/2) * Speed\ of\ sound$$

4.2 Segregation of wet and dry waste

Moisture sensor it used to detect the wet/dry waste based onthe water content in the wastematerial. It determines the volumetric content in the waste material based on the principle ofcapacitance to measure dielectric permittivity of the surrounding medium. It then sends values toArduino UNO which in turn sends it to the servo motor. The Servo Motoropens the right lid if itis dry waste and left lid if it is wet waste.

4.3 Motion of the dustbin

Two IR sensors is fitted below the dustbin. The IR detects thecolour of the path. It movesin the path of black path on the white road. The dustbin moves in the black path which is placed inbetween the IR sensor. A black path on white road needs tobe created on the footpath for themovement of the dustbin in that specific path. The IR sensor detects the white backgroundandmoves in the path. When both the IR sensor detects theblack path, it stops the movement of thedustbin.

4.4 Object detection

IR sensor is used to detect the objects. It is fitted at the frontof the dustbin. IR sensor detectsthe motion based on the heatradiating/emitting from the objects. When IR sensor senses themotionof any object in its proximity it sends the value to theArduino UNO. Arduino then stops themovement of the dustbin by sending the value to the stepper motor.

4.5 Human face detection

Haar Cascade algorithm is used to detect the face of thehuman being. Raspberry Pi camerais used to capture the images of the person. When the person comes towards the dustbin thecameracaptures the image and using Haar Cascade algorithm itwill identify the face of the human being.If human being isdetected it sends those value to the Raspberry Pi.

Raspberry Piin turn sendsthose value to the Arduino UNO. Which in turnsends indicates the servo motor to open the lid ofthe dustbin so that the person can throw the garbage inside the dustbin withouttouching it. Themain purpose of this feature is to maintain ahygienic environment. It prevents the human beingsfrom deadly diseases, allergies which may be caused by touching thewaste in the dustbin.

4.6 Trash detection

SVM algorithm and Random Forest Algorithm is used todetect the trash in the movingpath of the dustbin. The image iscaptured by the Raspberry Pi camera and is sent to the serverviaRaspberry Pi. In the server the image is converted intograyscale image and is compared with thetrained images using the SVM and Random Forest algorithm. If it matches, then theoutput is sentto the Arduino board which switches ON the vacuum cleaner to collect the waste materials.

Currently onlyone type of data is trained in this system.Thermocol bubblesand differentother types of images are trained. Only if thermocol bubbles are detected the vacuum cleaner willbe ON.The basic concept of this is that initially the machine istrained for multiple datasets (i.e.bubbles and other images).

Once it is trained an RF model is created for these datasets.Then theprediction is done by comparing the input imagebased on the RF model generated.The predicted output is sent to the Arduino board. If bubbles are detected the Arduino willstop the movement of the dustbin and switches ON thevacuum cleaner. Otherwise the dustbin willcontinue its motion without any interruption.

4.7 Bluetooth Module

Ultrasonic sensor detects the level of garbage in the dustbin.When the garbage is less than5cm from the top of the dustbinthe buzzer beeps stating there is no free space in the dustbin.Anandroid app is created to view the level of the garbage.

Themunicipal authority can open the appanytime and can viewthe level of the garbage in the dustbin. When it is less than thespecifiedlevel an SMS will be sent to the authorized person sothat they can send the trash cleaning vehicleto clean the mess on time.

V. RESULTS

```
Distance Value: 3
Buzzer ON
Distance Value: 6
Distance Value: 6
Distance Value: 6
Distance Value: 6
Distance Value: 7
Distance Value: 8
Distance Value: 7
Distance Value: 5
Buzzer ON
Distance Value: 4
Buzzer ON
Distance Value: 10
Distance Value: 9
Distance Value: 9
Distance Value: 8
Distance Value: 9
```

Fig 5.1: Ultrasonic Sensor Output

```
Distance Value: 19
Distance Value: 19
Distance Value: 19
Distance Value: 20
Distance Value: 19
Distance Value: 19
Distance Value: 20
Distance Value: 20
Distance Value: 19
Switched Pressed
Wet Detected
```

Fig 5.2: Moisture Sensor Output

```
Obstruciton Detected
Distance Value: 20
Obstruciton Detected
Distance Value: 20
Obstruciton Detected
Distance Value: 19
Obstruciton Detected
Distance Value: 20
Obstruciton Detected
Distance Value: 20
Obstruciton Detected
Distance Value: 19
Obstruciton Detected
Distance Value: 20
Obstruciton Detected
```

Fig 5.3: IR Sensor Output
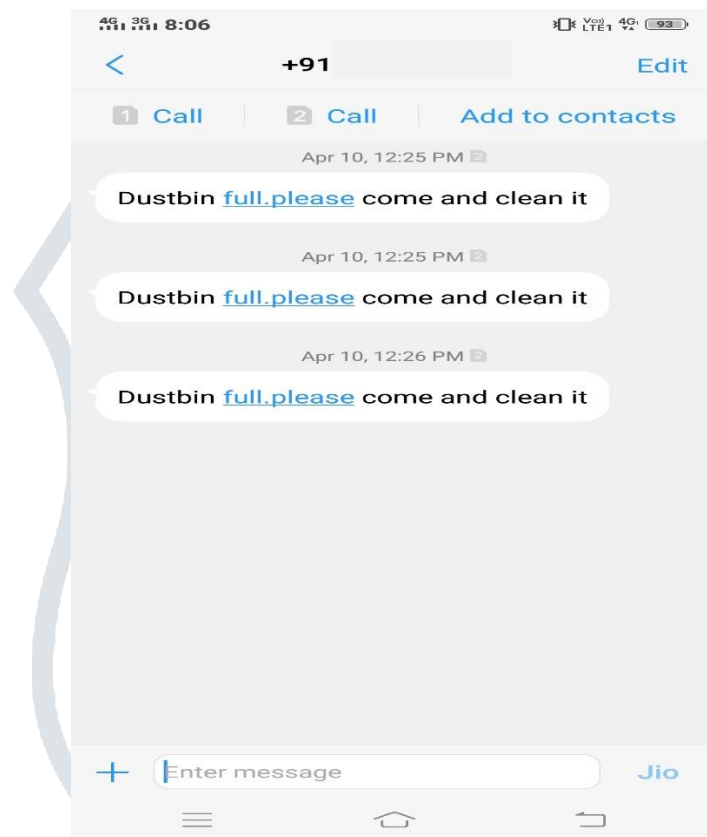
Fig 5.4: Human Face Detection Output

Fig 5.5: Alert message to Municipal Authority

VI. CONCLUSION

This paper designs a system that helps in efficient waste management system. The robotic smart dustbin helps in cleaning the waste in the surrounding area. The dustbin opens the lid of it if it senses the human being in front of it. It also separates the wet and the dry waste. The Raspberry Pi camera fitted to the dustbin detects the waste around it and moves towards it with the help of Stepper motor and cleans it with the help of Garbage Collector. When the dustbin is full an alert message is sent to the municipal authority with the help of Bluetooth module. The Robotic Smart Dustbin provides a smart technology for waste management system, avoids human intervention, helps to send alert message to authorized person, helps clean the surrounding area, reduces human time and effort which results in healthy and waste ridden environment.

VII. FUTURE WORK

Future works concerns on the following aspects:

Security can be provided when there is any theft.The trashdetection prediction is done only for one type of garbage. It canbe implemented for more images in future. The Raspberry Picamera can detect only the face of humans at particulardistance.It doesn't stop or turn back when the human isstanding behind the dustbin. New technique to route the garbage collector vehicle based on the amount on garbage in several dustbins can be implemented.

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