

An IoT enabled Smart Garbage Management System for Smart Cities – Indian Scenario



Vibin Mammen Vinod, K. S. Tamilselvan, Visvapriya P., Vishnu Devi M., Thiruselvam C. S.

Abstract: *With the ever increasing population and rapid urbanization, the challenge of efficient disposal is a bigger concern in a vast country like India. Numerous techniques and methods have been proposed by various authors but the implementation of the same has found very little patronage. The biggest challenge in waste management is the timely cleaning up of the community bins which are not happening leading to large scale pollution and degradation in the land structure. A novel smart garbage management system suitable for Indian conditions is proposed. The proposed scheme enables the civic body to schedule the clearing of all the bins in the locality by estimating a route map for the traversal. This drastically reduces the manpower, fuel and difficulty in navigation. The level of the waste is measured using the Ultrasonic Sensor. If the wastage level reaches a certain value, i.e. fixed threshold value, an SMS is sent to the concerned authority and if the level of wastes is above 95% the call will be initiated to the municipal corporation. A path planner is developed which enables the traversal in the shortest possible route.*

Keywords: Smart bin, Garbage management, waste management, Arduino UNO, GSM, Ultrasonic sensor.

I. INTRODUCTION

Waste management provides inclusive resources and due to improper waste disposal, world face several crises, irrespective of the developed or developing country. The key issue in waste management is that the garbage bin at public places gets overflow in advance before the commencement of the next cleaning process. This, in turn, leads to various hazards such as bad smell and ugliness which is considered to be the root cause for the spreading of various diseases.

Revised Manuscript Received on February 28, 2020.

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To avoid all such hazardous scenario and to maintain public cleanliness this work is mounted on the garbage system. One of the efficient methods for disposal of waste has been implemented using the Arduino and GSM system. In this method, multiple dustbins are placed throughout the city and the dustbins are provided with Ultrasonic sensors to measure the level of wastes in Garbage bins. It proposes a smart alert for garbage clearance by giving an alert signal to the municipal server. For such instant, cleaning of a dustbin with proper verification based on the level of garbage and interfacing the sensor with Arduino, this system can be implemented. Thereby, the manual process for monitoring the garbage level can be reduced.

II. LITERATURE SURVEY

Due to economic developments, the globally developed wastes are increasing. It is essential that the reliable national data survey on waste composition and generation will provides effective management of waste in Ghana. To obtain this data, certain households for each region were recruited to obtain waste generation, physical composition of waste and to achieve separation efficiency. In this, they mainly focused on some regions of Ghana. In this the wastes are separated in various aspects and the results shows that rate of waste generation was 0.47% kg/person/day, which translates into about 12,710 tons of waste per day per the current population. The rate of biodegradable wastes was 0.318 kg/person/day and non-biodegradable wastes was 0.096 kg/persons/day. This rate gets varied across several geographical locations. Two bins or polythene bags were supplied to each household for sorting and separation. This type of sorting and separation efficiency was 84% for biodegradable wastes and 76% for non-biodegradable wastes [1]. Waste disposal plays major role in day-to-day people's life. In urban and rural areas, every people is facing problem with segregation of waste. Growing population has become one of the main causes for increasing the rate of landfill waste. Municipalities are facing serious problem to manage these dumped wastes. This paper gives clear idea about separation of metal and plastic waste. The separation of metal and non-metal is useful for industrial and domestic use. They have used programmable logic controller (PLC), object sensor, pneumatic cylinder, conveyor belt and a dc motor for separating the waste materials. This method has advantages of scrap separation. This will results in energy better environment performance, minimize raw materials wastage and will reduce the manufacturing costs.



The PLC has an advantage of automation and it has low error rate. This controller has productivity, flexibility and efficiency. This system is basically useful for small scale industries. PLC is an industrial digital controller. It is used to control manufacturing process. This PLC is used in assembly lines robotic devices and in fault diagnosis. PLC is used in big plans in automobile industries. Here, they have used DELTA PLC.

It have eight digital inputs and output pins, 32-bit CPU, program capacity of 16k steps, data register of 10k words, execution speed of 0.35 micro seconds.

In this system, they have used inductive proximity and proximity IR sensor. Metallic wastes are sensed by inductive proximity and remaining object is sensed by IR sensor. The programmable Logic Controller take sensor's output as the input for the module. With the help of these data, PLC will organize the output. They have also used pneumatic cylinder for crushing the waste materials. Both single and double acting cylinder is used. It works on air pressure with the help of solenoid valves. It also have conveyor belt. The belt is run by 12V DC motor. The conveyor belt is efficiently controlled by DC motor.

Small scale industries are more benefited by this system. This system has good scope in future. This system can be implemented by making use of robotic arm to pick and use the re-used materials [2]. Owing to the paradigm, the poor Waste Management has become one such issue and it leads to serious environmental problems and cost issues. In this paper, an IoT-based smart Garbage system (SGS) is proposed for proper disposal of wastes. In an SGS, battery-based smart garbage bins (SGBs) exchange information with each other using wireless mesh networks, and a router and server collect and analyze the information for service provisioning. Further it includes various IoT techniques considering user convenience and increases the battery lifetime through two types of operations. It has been found that this method had achieved the energy efficiency for the separation of wastes at the rate of 16%. The system along with the adaptive user-oriented charge policy resulted in the reduction of waste at the rate of 33%, and was expected to improve the efficiency of waste management [3]. The efficient system to clean the indoor building is implemented by Jamil Abedalrahim Jamil Alsayaydeh. They used Arduino, fan, buzzer, led, ultrasonic sensor and Wi-Fi-module. This project will detect the people coming near to the dustbin and throwing the waste into it. It will be detected by the ultrasonic sensor. The level of waste can be viewed in the Blynk app. If the level reaches the maximum point, it will send the notification. They have used GSM and GPS for tracking location and for sending the notification. They have used buzzer for the security purpose [4]. An intelligent alerting integrated system is created by using Web based IoT. In this system, they have used IR sensor, Arduino UNO and Bluetooth module. If the dustbin is full, the location will be send to the municipal from the android phone and the bins will be cleaned the yardman. The status of the dustbin is viewed automatically in mobile app by transferring the data with the help of Bluetooth module in local cloud. Every dustbin has its own Id and database. Database show the list of bins with their Id and exact location. The information will be collected firstly by the sensor and it

will be send to the microcontroller and then the information will be viewed in the mobile app. The information will also be forwarded to the database and it can be monitored regularly by the authorized admin [5].

III. BLOCK DIAGRAM

Fig 1 shows that the Arduino is interfaced with Ultrasonic sensor to measure the level of wastes. If the waste reaches the certain threshold value which is above 75%, by interfacing the sensor with GSM Module, the message will sent to the Municipal Corporation. If the wastes are reaching above the rate of threshold value of 95%, the call will be intimated to the suitable authority in Municipal Corporation.

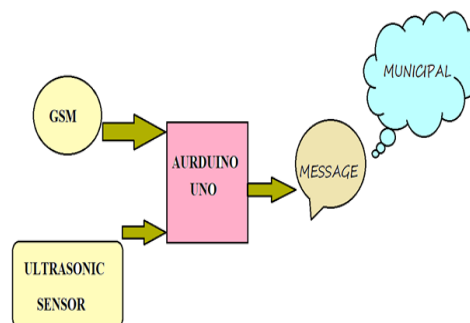


Fig.1 Smart Bin – Block Diagram

In order to prevent the overflow of wastes, the level of wastes is measured using ultrasonic sensor. If the wastes reaches the threshold level, the information about the status of wastes are sent to the corresponding sweeping location or Municipal Corporation. For this purpose, GSM and ultrasonic Sensor is interfaced with the Arduino Board as shown in Block Diagram. As ultrasonic sensor can measure the level of wastes up to a distance of 40 to 70 KHz. Thus ultrasonic sensor is chosen to measure wastes. This message includes the level of wastes and the location where the places are necessary to clean.

A. Ultrasonic Sensor:

Ultrasonic sensor sends out a high-frequency sound pulse and time how long it takes for the echo to reflect back. The sensor has two openings where one opening is used to transmit ultrasonic waves and the other receives them. The speed of sound is about 341 meters (1100 feet) per second in air. The ultrasonic sensor uses this information along with time difference between receiving and sending the sound pulse to determine the distance of an object using the below mathematical expression.

$$\text{Distance} = (\text{Time} \times \text{Speed of Sound}) / 2$$

Time = Time between when an ultrasonic wave is transmitted and when it is received.

It works on the principle of RADAR and SONAR system which is used to determine the distance of an object. Ultrasonic sound is a cyclic sound pressure with a high frequency than the upper limit of human hearing equal to 20 KHz. The starting state sensor will check whether the dustbin is full or not.

If dustbin is full, the SMS will automatically send to the sweeper or supervisor. If the dustbin is empty the control is back to previous state. To measure the distance to an object, the time from transmission of a pulse to reception is measured and converted into range by knowing the speed of sound.

This signal together with noise is then passed through various forms of signal processing, in which special sensors are used for energy measurement. It is then presented to some form of decision device that calls the output either the required signal or noise.

This decision device may be an operator with display, or in some systems this functions may be carried out by software. Further processes may be carried out to classify the target and localize it, as well as measuring the velocity. It has multiple beams to provide all round cover while others only cover an arrow arc, although the beam may be rotated, relatively slowly, by mechanical scanning.

B. GSM:

This is an ultra-compact and reliable wireless module. SIM 900A is a complete Dual band GSM solution in a SMT which can be embedded in the applications to benefit from small dimensions and cost-effective solutions.

SIM900A – It works on the frequency range of 900/1800 MHz. The Modem is coming with RS232 in interface, which allows connecting PC as well as a microcontroller with RS232 Chip (MAX 232). The baud rate is configurable from 9600-11520 through AT commands. The GSM Modem is having internal TCP/IP stack and it is enabled to connect with an internet. It is suitable for SMS, voice as well as data transfer application in M2M interface. The On board regulated power supply allows connecting wide range of unregulated power supply.

C. Arduino UNO:

It is a controller board. It is an open source available freely on the internet. This is based on ATmega328P microcontroller. It has both input and output digital and analog pin. It has 6 analog I/O pin and 14 digital I/O pins and is also programmable with Arduino IDE. It has 16 MHz quartz crystal, a power jack, a reset button and an ICSP header. Its power supply is given by USB cable and 9 volt battery, as it can accept 7 to 20 V.

The word 'UNO' is nothing but the 'first' in Italian language. This board can read inputs like a finger on a button, a twitter message or light on a sensor and it give the output to publishing something on online, turning an LED and for activating a motor. The languages used in Arduino are C/C++ functions that can be called from your code.

IV. PROPOSED SYSTEM

The alerting system is used for the maintenance of the Garbage. When this is deployed a green environment and pollution free city can be achieved. It also decreases the manual work in municipality and also helps to manage solid waste pollution monitoring system. Garbage is the waste which are generated due to various activities, such as industry waste, wet waste like vegetable waste, dry waste, commercial waste, household wastes etc. Improper utilization of the garbage may pose various environmental issues. And many diseases can spread in the city due to improper disposal of

garbage. It may in turn lead to serious case. Dengue and malaria are majorly caused by flying of mosquitoes around the garbage mainly in the place of over flow of garbage. In the busy world, busy people don't have time to maintain and monitor their dustbin, even in their home for household waste. In the same way, the street dustbin also overflows because of improper maintenance by the municipality. This system can avoid that entire problem and give us clean and fresh atmosphere.

The flow of this proposed system is shown in the Fig 2. The flow is that the loop check for the waste in the dustbin, if the dustbin is filled with the garbage, the loop will be moved to the true part that is the GSM will send an SMS to the concern municipal authorities.

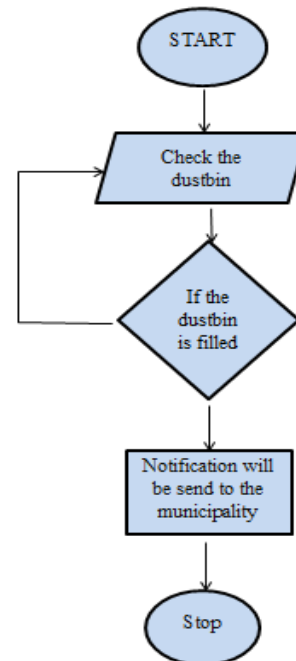


Fig.2 Flow chart of proposed system

If the dustbin the not filled with the garbage, the loop will move to the else part and the loop will be run again and again until it satisfies the condition. The above method gains information to improve the efficiency of garbage monitoring and make the whole process in an efficient and convenient way. In addition to this it will not affect the people in the city and does not cause any harm to the environment and the people living in the city.

V. RESULT AND DISCUSSION

The Fig.3 shows the background output of the code when the program dumped in Arduino. In the background message, in addition to the level of wastes, it will also display the output port to which the pin is connected. Built-in digital-to-analog converter is not present in Arduino, instead of that; it has PWM (Pulse Width Module) output. It is a digital signal; it is used to attain some analog output functions. An analog signal can have much number of values whereas digital signal can have two values either HIGH or LOW.

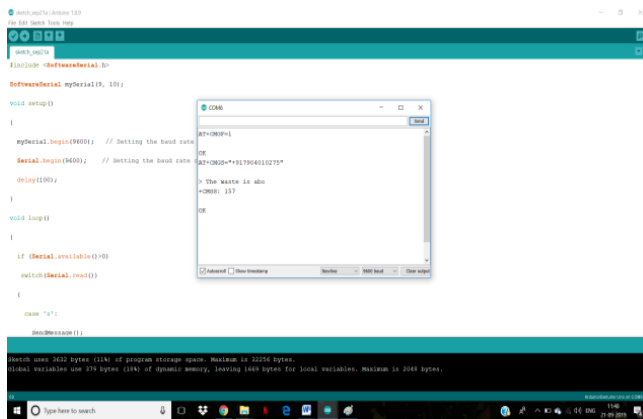


Fig.3 Software output

To convert the analog output into digital output in arduino we are going with PWM. Its value is directly proportional to the duty cycle. The signal frequency for most pin is approximately is 450Hz. With the help of digital means analog result can be achieved in the PWM.

Square waves can be got in the digital control between ON and OFF.

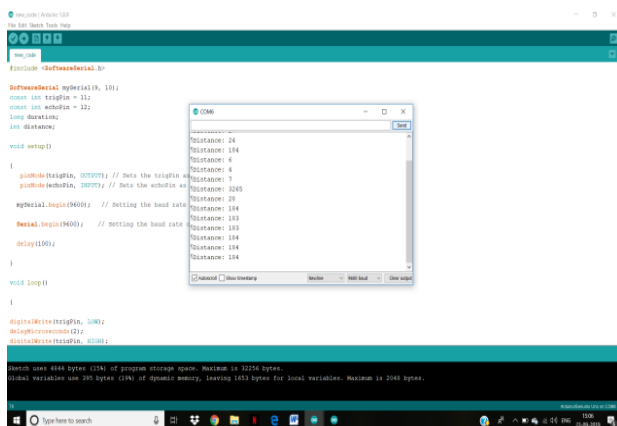


Fig. 4 Output for Measurement of distance by ultrasonic sensor

The Fig.4 represents the output of the ultrasonic sensor when the sensor is interfaced with the control board. The output of the ultrasonic sensor is the distance from the upper part of the garbage to the lower part ultrasonic sensor (to the receiver of the ultrasonic sensor) i.e. it gives the unfilled area of the dustbin. The values are taken at different levels and the results are displayed in the figure. The ultrasonic sensor will have LOW output always (0V) unless it is triggered. If it is triggered it will have HIGH output (5V). For example if the ECHO waves have transmitted for 2 inches, it will have the output voltage of 0.0V. Until 6inches, the output of the ultrasonic sensor is 0.0V. After 7 inches only the ultrasonic voltage increases gradually. The echo waves transmitted by the ultrasonic sensor of 120 dB are safety for the human beings. If it is excess than 155 dB, it will cause heating effect and if it is greater than 180 dB can causes death to human beings. So it will not cause any harm to the society as the needed range for this system is of only minimum. It is eco-friendly to the environment. And our ultrasonic sensor is a water resistance. So it can be effectively utilized for the outdoor purpose even in the rainy season. The ultrasonic

sensor has the property that it has homogeneous velocity for constant medium.

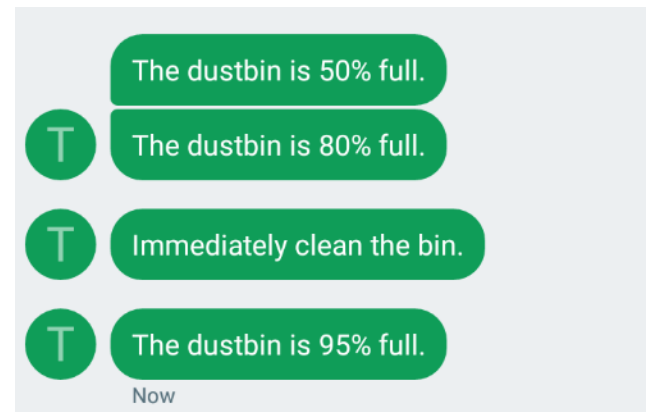


Fig.4 SMS received by municipality

The Fig.4 shows the SMS notification received by the concern municipality in the street. Since the discrete unit of interaction happens only through message in between municipality and public, the message plays a vital role in communication, the information regarding the waste level is calculated and the appropriate message will be sent to the concerned authority. The message will be in the form of percentage of waste filled in the dustbin. The value given by the ultrasonic sensor is converted into percentage by embedded c language dumped in the control board. The message delivered will be in the form of text and the message contains levels of waste and provides suitable information regarding to the levels of wastes like “Immediately clean the bin” because the dustbin was 95% full. Based on the message received by the municipality corporation, further actions will be carried out. Without any human interactions, this sort of sending messages confers safety and beneficial in many areas. As it is one of the fastest ways of communication, the actions can be taken initially so that several difficulties facing has been reduced

- Dustbin when empty – 0% (Ultrasonic Sensor Update the Information to Municipal Corporation)
- Dustbin Level - 75% (when threshold level is reached, the message will be sent to civic body)
- Dustbin Level – 90% (Alert will be given to civic body through calls).

VI. CONCLUSION AND FUTURE SCOPE

This paper describes the development of garbage monitoring system, which is based on Arduino UNO. It is very useful in improving the efficiency of waste disposal management especially in the residential areas, by alerting the municipality for immediate collection. The proposed system can be adapted in all areas because of its reliability, reasonable cost and efficient environmental protection. In this method it is able to achieve above 90% of efficiency. In future, this system can also be installed in the home and if the dustbin gives bad odour, we can identify that it is time to dispose the dustbin, it can be done by placing gas sensor. An app based interface and webpage based interface will be handy for the civic bodies to monitor and manage multiple bins simultaneously.

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