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Smart Waste Management Monitoring System

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Abstract

The smart waste management monitoring system which is proposed here is to implement a smarter way of conventional waste management using smart sensors to gather fill-level data, presence of garbage around the dustbin and stinking condition from containers and garbage bins, and send it to servers in real-time. An authorized phone number that is present in Waste Management Centres gather fill-level and other information sent from multiple containers which are situated throughout a city/locality. The data acquired as above can be used to systematically plan a route map to collect garbage. The information from bins to the authorized number is sent using communicating modules (GSM/GPRS module). The entire operation is controlled using a microcontroller. This report showcases a potential design for an IoT gateway that can be used to provide a framework for a smart waste management monitoring system.

Keywords*: - Garbage Container, Ultrasonic Sensor, Arduino Board, Bread Board, GSM Module, Jump Wires.*

INTRODUCTION

"Cleanliness is next to godliness" is said and believed from the centuries. In this era of environmental concern, individuals are outwardly interested in the healthy state of their surroundings. Whether it may be a small home of four members or a locality, cleanliness is of equal importance. India being a huge and highly populated nation, effective waste management is the major

concern in maintaining the health and hygiene of the people. Convectional waste management systems which are currently employed in India have static routes and schedules where garbage from containers are collected on fixed schedules, regardless if they are full or not. This type of situation is often seen where dustbin is not addressed even if it is filled and garbage is spread on open streets. This severely affects the health and hygiene of the people. To promote health and hygiene, the "Govt. Of India" under the leadership of "Prime Minister, Narendra Modi" initiated "Swachh Bharat Campaign" and introduced the concept of "smart cities."

"In the approach of the smart cities mission, the objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment with the application of smart solutions". Smart cities don't only mean smart buildings and smart parking areas but "smarter waste management system" is also a major issue to be addressed in developing a smart city.

The smart waste management monitoring system, which is proposed herein, uses smart sensors to gather fill level data from containers and garbage bins and send it to an authorised number in real-time. The authorised phone number, which is situated in Waste Management Centre, gather fill-level information sent from multiple containers which are situated throughout a city/locality. The data acquired as above can be used to systematically plan route maps as shown in below figure 1 and collect garbage.

Fig. 1: Routing for collection of garbage from filled dustbins

METHODOLOGY

This chapter describes the steps to be followed to implement the proposed system and hardware components required. In this project of SMART WASTE MANAGEMENT SYSTEM, we will be using an ultrasonic range sensor to know the amount of garbage collected in garbage containers and this data is sent through GSM/GPRS 900A module to Authorized phone number present at waste management centers [here from called as WMC].

To control this operation, we will be using the ATmega328P microcontroller. The Authorized number present at WMCs will receive an SMS which is sent through the GSM/GPRS module and shows fill levels of each garbage bin in real-time on the phone screen.

Secondly, the ultrasonic sensor, which is fixed at the dustbin, senses if any garbage is thrown on the street instead of in the dustbin; this information is collected by the microcontroller. The siren is then made to ring until the garbage is thrown into the dustbin. Thus preventing the garbage on open streets. Most of the times, even if the dustbin is not filled, it may start stinking, which may lead to an irresistible smell in the locality/city.

The main cause for this stinking smell is the wet waste present in the dustbin. To prevent this, a moisture sensor is fixed at the dustbin.

This sensor senses the moisture content in the waste, and if the moisture content is more than a particle threshold level, the information is sent to the number in the waste management center.

Once this SMS is received, the dustbin is addressed even if it is not full. Thus the locality/city is saved from the irresistible smell of the garbage bin.

HARDWARE COMPONENTS

1) Garbage Container

A waste container is a container for temporarily storing waste and is usually made out of metal or plastic. The curbside dustbins usually consist of three types: trash cans (receptacles made of metal or plastic), dumpsters (large receptacles similar to skips) and wheelie bins (light, usually plastic bins that are mobile). All of these are emptied by collectors, who will load the contents into a garbage truck and drive it to a landfill, incinerator or consuming crush facility to be disposed of.

Fig. 2: Dustbin

2) Ultrasonic Sensor

A special sonic transducer is used for the ultrasonic proximity sensors, which allows for alternate transmission and reception of sound waves. The sonic waves emitted by the transducer are reflected by an object and received back in the transducer. After having emitted the sound waves, the ultrasonic sensor will switch to receive mode. The time elapsed between emitting and receiving is proportional to the distance of the object from the sensor.

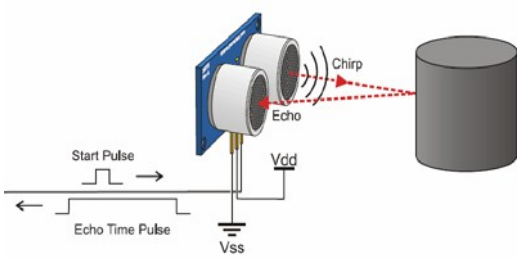

Fig. 3: Working of Sensor

Ultrasonic sensors generate high-frequency sound waves and evaluate the echo which is received back by the sensor, measuring the time interval between sending the signal and receiving the echo to determine the distance to an object.

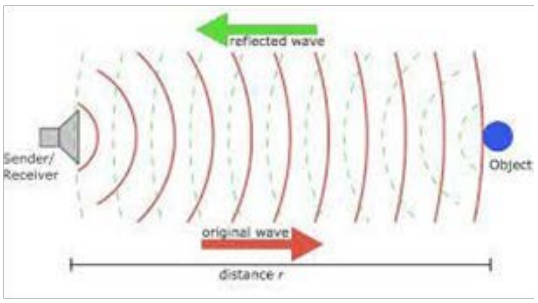

Fig. 4: Principle of sensor

3) Arduino Board

Arduino is a software company, project, and user community that designs and manufactures computer open-source hardware, open-source software, and microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices.

The project is based on microcontroller board designs produced by several vendors using various microcontrollers. These systems provide sets of digital and analog I/O pins that can interface to various expansion boards and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a

programming language named Processing, which also supports the languages C and C++.

The first Arduino was introduced in 2005, aiming to provide a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Fig. 5: Ardunio Board

Software of Arduino

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation and provides a simple one-click mechanism to compile and load programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch".

The Arduino IDE supports the languages C and C++ using special rules to organize code.

4) GSM Module

GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile) is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones, first deployed in Finland in July 1991. As of 2014, it has become the default global standard for mobile communications - with over 90% market share, operating in over 219 countries and territories.

GSM networks operate in a number of different carrier frequency ranges (separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G), with most 2G GSM networks operating in the 900 MHz or 1800 MHz bands. Where these bands were already allocated, the

850 MHz and 1900 MHz bands were used instead (for example, in Canada and the United States). In rare cases, the 400 and 450 MHz frequency bands are assigned in some countries because they were previously used for first-generation systems.

Fig. 6: GSM Module

5) Bread Board

A breadboard is a construction base for the prototyping of electronics. Originally it was literally a breadboard, a polished piece of wood used for slicing bread. In the 1970s, the solderless breadboard (AKA plugboard, a terminal array board) became available, and nowadays, the term "breadboard" is commonly used to refer to these. "Breadboard" is also a synonym for "prototype".

Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. For this reason, solderless breadboards are also extremely popular with students and in technological education. Older breadboard types did not have this property. A stripboard (Veroboard) and similar prototyping printed circuit boards, which are used to build semipermanent soldered prototypes or one-offs, cannot easily be reused. A variety of electronic systems may be prototyped by using breadboards, from small analog and digital circuits to complete central processing units (CPUs).

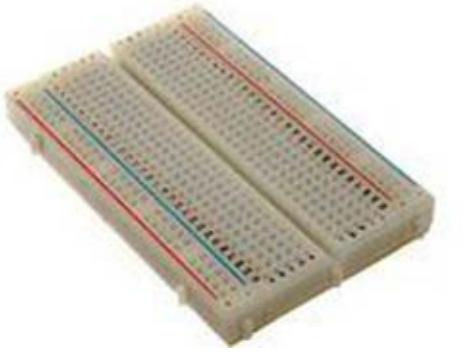

Fig. 7: Breadboard

7) Jump Wires

Jump wires (also called jumper wires) for solderless breadboarding can be obtained in ready-to-use jump wire sets or can be manually manufactured. The latter can become tedious work for larger circuits. Ready to-use jump wires come in different qualities, some even with tiny plugs attached to the wire ends.

Differently colored wires and color-coding discipline are often adhered to for consistency. However, the number of available colors is typically far fewer than the number of signal types or paths. Typically, a few wire colors are reserved for the supply voltages and ground (e.g., red, blue, black), some are reserved for main signals, and the rest are simply used where convenient.

Fig. 8: Jump wires

WORKING PRINCIPLE

The garbage containers transmit signals to indicate that they are over 80% or 90% full and should be emptied. Via the mobile communications network, the signals are sent to a web-based software application used by the waste management company. In the software, the capacity of the container is indicated, which is taken as a basis to plan the best route for waste collection garbage trucks travel only to those containers that actually need to be emptied.

A robust ultrasonic sensor is installed in the garbage container and detects the fill level regardless of what has been deposited inside. The whole system contains **ULTRASONIC SENSOR, ARDUINO BOARD, GSM MODULE, BREADBOARD, POWER SUPPLY (BATTERY).**

The sensor is fixed onto the breadboard. The connection between the Arduino board and sensor is made with the help of connecting wires. The working program is fed into the Arduino board. The gsm module is also connected to the same Arduino board with the help of wires. The power supply to the system is given with the help of a battery.

ADVANTAGES, APPLICATION & CONCLUSION

Advantages

- Less time and fuel consumption as the trucks go only to the filled containers.
- Decreased noise, traffic flow and air pollution as a result of less trucks on the roads.
- Our smart operating system enables two-way communication between the dustbin deployed in the city and the service operator. Therefore the focus is only on the collection of route based fill level of the containers.

- The sensors installed in the containers provide real-time information on the fill level. This information helps determine when and where to prioritise collection.

- Reduces the infrastructure (trucks, containers), operating (fuel) and maintenance costs of the service by up to 30%.

- Applying this technology to the city optimises management, resources and costs, and makes it a “SMART CITY”.

- It keeps the surroundings clean and green, free from bad odour of wastes, emphasizes on a healthy environment and keeps cities more beautiful.

- Reducing manpower required to handle the garbage collection.

Application

- This can be best used by the municipal corporation for their betterment of management regarding the collection of wastes.

- With the help of proper technology (GPS & SOFTWARE APPLICATIONS), we can guide the trucks to choose the shortest path.

- It also favours the “SMART CITY” project and “DIGITAL INDIA”.

Conclusion

By using this method, the collection of waste in the city becomes easier. It helps in reducing air pollution, traffic flow, manpower, time and money. With the help of proper technology (GPS & SOFTWARE APPLICATIONS), we can guide the trucks in selecting the shortest path for garbage collection. This project can add an edge to the cities aiming to get smart and people-friendly.

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