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IOT based Garbage Management System for Smart Cities

Mohamed Asif Hassan A.H
U.G Student
Department of Electrical & Electronics Engineering
Easwari Engineering College, Anna University

Jagannathan Srinivasan
U.G Student
Department of Electrical & Electronics Engineering
Easwari Engineering College, Anna University

L. Keshav Bharadwaj
U.G Student
Department of Electrical & Electronics Engineering
Easwari Engineering College, Anna University

Harish Ganesan
U.G Student
Department of Electrical & Electronics Engineering
Easwari Engineering College, Anna University

Dr. S. Sudha
Head of Dept. & Professor
Department of Electrical & Electronics Engineering
Easwari Engineering College, Anna University

Abstract

Smart cities should be equipped with basic infrastructure and technological advancements to provide better ambience and comfort for living. As an important aspect of smarter life, much cleaner and hygienic environment should also be assured. To ensure such a pristine environment, we have designed a project named "IOT based Garbage Management System for Smart Cities" with the help of Internet of Things (IOT) and cloud computing. In the GMS (Garbage Management System), a robot moves on the overhead rail which is constructed along the locality of the smart city. It carries a bin which collects waste from the people in that particular locality. The robot collects the waste and dumps it in the main bin placed at a safe distance from the locality, which when reaches a threshold point, intimates the concerned authorities to clear the waste from it.

Keywords: Embedded Systems, Internet of Things, Cloud computing, Smart cities, Smartphone application

I. INTRODUCTION

Internet and its applications are the backbone of every industrial and research fields. Technological advancements and immense research lead to the birth of two important applications of internet, IOT and Cloud computing.

Connecting any surrounding object in a wired or wireless network is IOT. In addition to the user - user interaction, device – device interactions across the internet is also achieved, thus increasing the omnipresence of the internet [1]. IOT integrates every object for interaction via embedded systems, leading to a vast network of distributed devices communicating with human beings as well as other devices. This factor has helped in achieving a sophisticated and connected environment for the comfort of living. The seamless communication between wearables, smart home, connected car, and the smart city is by having control over the flow of data. The concept of Internet of Things is very much helpful to achieve real time monitoring of sensor data. This obtained data can be put to use by the employment of cloud computing in the system

Transferring, storing and retrieving data are the uses of cloud computing. The result of continuous evolution of existing technologies and paradigms in internet, Cloud computing was developed [2]. Cloud computing has evolved through a number of phases which include grid and utility computing, application service provision (ASP), and Software as a Service (SaaS). Cloud computing shares characteristics with: 1. Client server model, 2. Computer bureau, 3. Grid computing, 4. Fog computing, 5. Dew computing, 6.

Mainframe computer—Utility computing, 7. Peer-to-peer, 8. Green computing, 9. Cloud sandbox [3]. The advantages of cloud computing are, 1. The cloud provider (3rd Party) manages the servers, software, storage, and networking) and electricity needed for the services. Thus, the users only need to "access" the cloud from his location. 2. The user pays only for the usage of the cloud and not for the installation or maintenance of the cloud, thus minimizing the expenditure in the consumer point of view. 3. The users can in practice access the cloud for services anytime from anywhere [4].

By using the advantages of cloud, we are planning to design a garbage maintenance system based on IOT. A new smarter garbage maintenance system is needed because, improper disposal of waste has huge environmental impacts and can cause serious health related problems. It may also affect the aesthetic beauty of the city. Some waste will eventually rot, but not all. People tend to dump waste at random places other than garbage bins or dustbins owing to negligence and lethargy. At times, we may also find garbage bins overloaded, because of the lack of mundane maintenance. This creates unhygienic circumstances and bad odor in the locality. In smart cities, we can employ technological advancements in order to combat the garbage management

problem. Thus, by combining the features of IOT and cloud computing, we have designed a system for the management of garbage wastes in smart cities.

II. LITERATURE REVIEW

Parkash, Prabu V [2]. The paper discusses the usage of IR sensors and RF module in the smart bin setup in addition to microcontrollers to propose an affordable and efficient system for collection of garbage.

Narayan Sharma, Nirman Singha, Tanmoy Dutta [3]. The objective of the study is to find the real time analytics that can be employed for the smart bin system is found, by empirical observations

Gaikwad Prajakta, Jadhav Kalyani, Machale Snehal [5]. The study proposed the idea of using robot mechanism to reduce manual handling for the collection of waste.

S. S. Navghane, M. S. Killedar, Dr. V. M. Rohokale [7]. They proposed the idea of using the smart technologies for the management of waste. The paper also introduced the idea of using Wi-Fi in smart bins.

III. METHODOLOGY

The entire project is divided into three separate modules:

- The User entity
- The Robot module
- The Main bin module

A. The User Entity

1) Mobile Application:

A smartphone application was created exclusively for the system by using Intel XDK, a cross-platform IDE. Language used for programming was node.js. The user requests for service from the application. The application retrieves the GPS location from the mobile and sends it to the Intel Edison development Board for Arduino in the robot module through the cloud server.

2) Cloud Server:

IBM Blue mix (developed by IBM) was the Cloud server used in the project. It was programmed by Java. It connects the mobile application with the intel Edison board. In addition to the transfer of requests, the cloud also gets the data from all the working modules of the project, so that it is possible to locate a fault in case it occurs.

B. The Robot Module:

A robot is used for the collection of garbage process [5]. It is a pick and place model. The robot consists of several servomotors which moves the bin up and down. In addition to the servomotors, several linear actuators are also used for the vertical movement. The robot moves along the cable by the rotation of dc motors coupled on its wheels.

The other modules present in the robot are:

1) Intel Edison Development Board for Arduino:

The Intel Edison development Board for Arduino Fig.1 is present in the robot which carries the bin on the overhead line. The Board is connected to the cloud server. The request from the mobile application is obtained by the board via cloud server. The board controls the movement of the robot. It directs the robot to reach the desired direction.

Fig. 1: Intel Edison Development Board for Arduino

2) Arduino IDE

The open source software, Arduino (Integrated development environment) was used to code and upload it to the Intel Edison development board for Arduino. The programming language used was Java. The Arduino Software (IDE) can be used on various boards available in the market and it was also compatible for the Intel Edison development board for Arduino.

3) GPS Module

GPS (global positioning system) module is generally used to track the position of the person or vehicle inside earth. In our system we have made use of the GPS by interfacing with the board. The GPS tracks its own location and sends it to the board.

The boards find the differential distance between its own position and the data from the user. And directs the motion of the robot to reach the users location. The antenna for better reception is chosen based on the complexity of the locality.

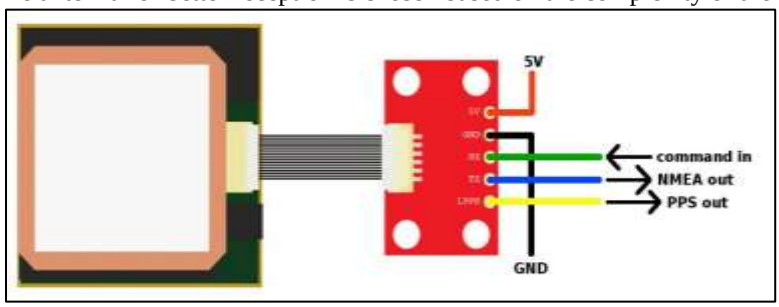

Fig. 2: EM406 GPS with EM406 Breakout

C. *The Main Bin Modules*

The important components of the main bin are:

1) IR Sensor

An Infrared (IR) sensor consists of an emitter, detector and a dedicated circuitry. The Emitter is an IR LED and the detector is a IR photodiode. The IR sensor is used to determine the garbage level in the main bin. The sensor is placed at a point above which, if the garbage is dumped then overflowing occurs. The IR sensor triangulation principle is used to find whether the garbage level has reached the threshold or not.

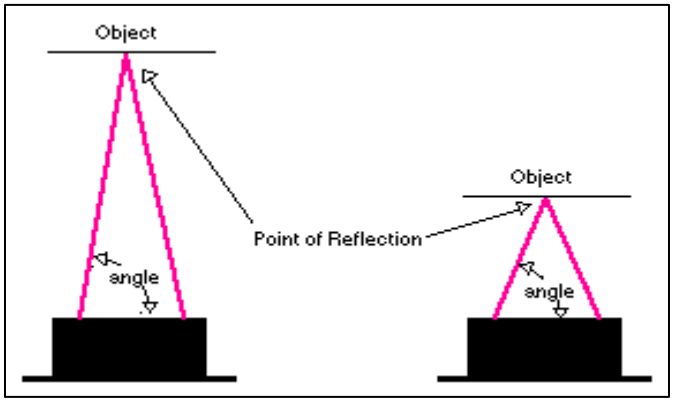

Fig. 3: IR sensor triangulation principle

2) RF Module:

The RF Module consists of a transmitter and receiver module Fig.3. The signal from the IR sensor is transmitted by the RF transmitter, which is then received by the RF receiver module placed away from the source of transmission. This received signals are given to the Intel Edison development Board for Arduino.

Fig. 4: RF transmitter and Receiver module

3) Intel Edison Development Board for Arduino

In addition to the Intel Edison development Board for Arduino used in the robot, another board is set up on the main bin in order to retrieve the data from the RF receiver. It is connected to the cloud server and sends message to the authorities intimating them to clear the garbage from the main bin.

IV. WORKING PRINCIPLE

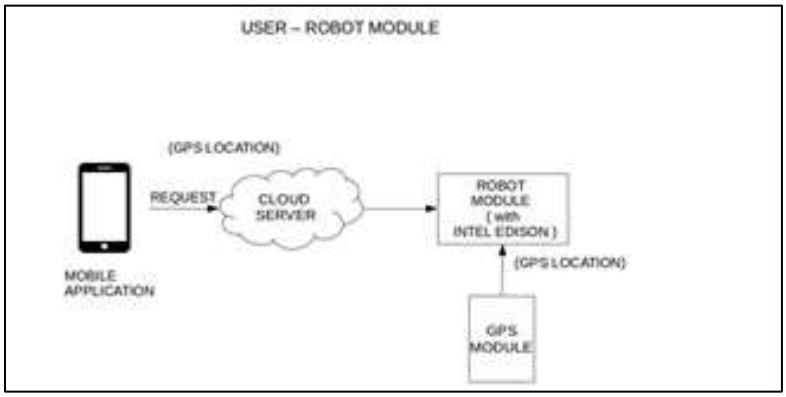

Fig. 5: User-Robot module

The above block diagrams Fig. 4 and Fig. 5 differentiates the whole system into two different modules. The User-Robot module and Main bin module. Here, a common cloud server is established between the modules. The User-Robot module consists of the mobile application, cloud server, and the robot. When the user (person in the locality) wishes to dump the garbage, he requests for the bin from the "Request" button his mobile application Fig.6. The robot gets the GPS location of the user. The GPS module present In the robot itself, determines its own location. It finds the relative distance or the measure of closest distance it should move, so that the user could dump the garbage. On arrival to the closest location to the user, the robot intimates by sending a message to the user's mobile application. The robot is in the form of a "pick and place" robot. It has a mechanical arm which holds the bin. On reaching the location, it lowers the bin so that the user could dump the garbage. After dumping, the user clicks the "deposit" button and then "done" button. The robot ascends the bin and moves to the main bin location.

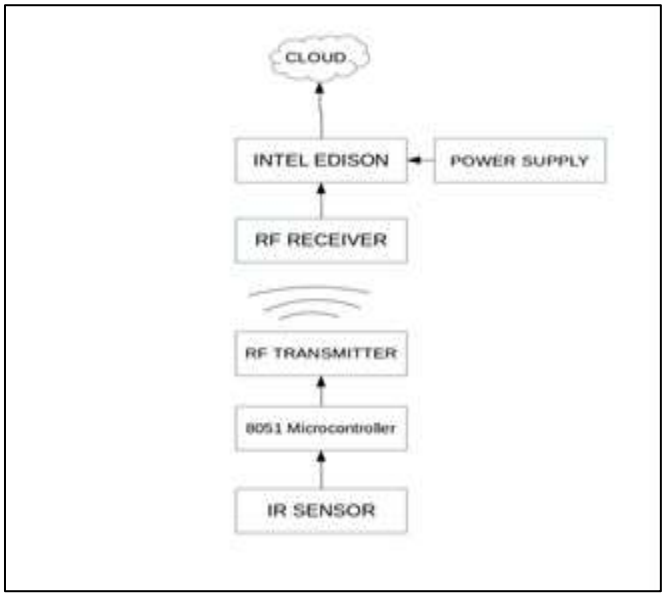

Fig. 6: Main bin module

The robot dumps the acquired garbage in the main bin, which is located at a safe distance from the locality. The main bin is larger than the bin carried by the robot. Thus, it can accumulate large amount of waste. By properly integrating analytics provided by cloud server and electronics we can transmit the data obtained from main bin to the concerned authorities [3]. An IR sensor is placed at the top portion of the bin, above which overflowing of garbage will occur [2]. The sensor is connected to the 8051 micro controller. The IR sensor triangulation is implied on this project, and the initial angle is noted by the 8051 micro controller. It transmits the signal to the intel Edison board for Arduino, present in the main bin through the RF module.

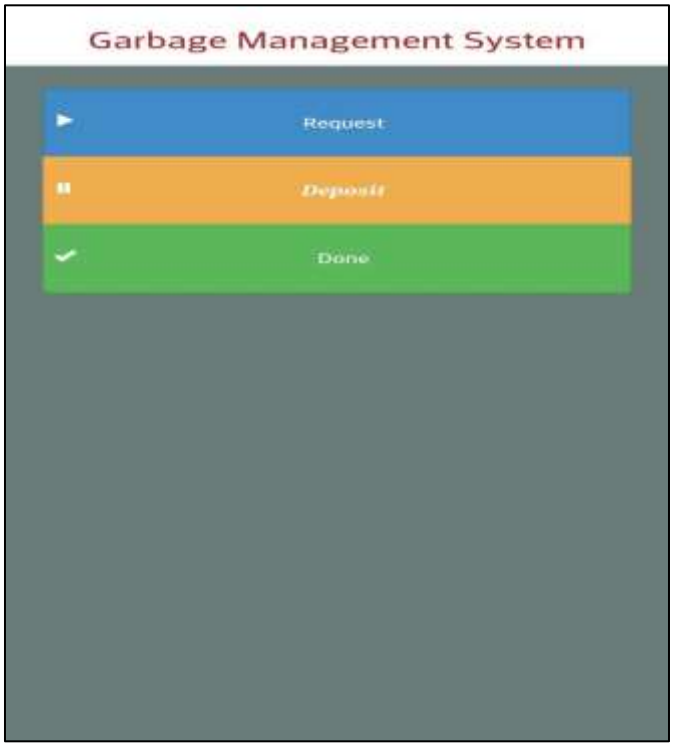

Fig. 6: Smartphone Application

This is an iterative process, as the level of garbage is found continuously. When more amount of garbage is dumped and when it reaches the threshold, the IR sensor triangulation changes. The angle obtained changes in accordance to the initial value The Edison board witnesses the change in the reading, implying that the garbage has reached the threshold and immediate clearing is required. Thus, it sends the information to the cloud server, from which the concerned authorities are intimidated about the required clearing. Thus, the entire management of garbage from disposal by the user to the clearing by the authorities is done in this system

V. CONCLUSION AND FUTURE WORK

This project focuses on implementing a new smarter way for management of garbage. Often, we find dustbins with overflowing wastes and garbage thrown on the sides of the roads. This is because of the laziness prevailing among the public to dump the waste in main bin and also lack of intimidation among authorities about the overflowing garbage. Even though we find garbage vehicles having mundane visits, it is impossible to predict the amount of waste that can be accumulated in a day. Thus, this system helps in intimidating the authorities whenever cleaning is required, and also proves to require lesser human effort and, a much cleaner and hygienic environment can be achieved by implementing this system.
The scope for future work is the implementation of same system with less complex boards at affordable costs

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