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Effective Garbage Management System based on IoT

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Abstract - Over population and growth in metropolitan areas has made garbage management a very important issue. Recent studies indicate direct links between the general cleanliness of an area to the amount of sick people in the vicinity. Health of the general population and animals are at serious risk due to lack of proper waste management. A solution to this issue is proposed in the form of smart garbage management system. Using technologies such as Arduino UNO, ultrasonic senosrs, IoT, GSM, Wi-Fi Module the system will be put into action. At the core of this system, city officials can maintain and track the resources being used to effectively manage the garbage.

Key Words: GSM, Arduino, IoT, Ultrasonic Sensors, Wi-Fi Module

1. INTRODUCTION

One of the main concerns with our environment has been solid waste management which impacts the health and environment of our society. The detection, monitoring and management of waste is one of the primary problems of the present era. The traditional way of manually monitoring the waste in waste bins is a cumbersome process and utilizes more human effort, time and cost which can easily be avoided with our present technologies. This paper addresses a method in which waste management is automated. The IoT Garbage Monitoring system, an innovative way, will help to keep the cities clean and healthy. The Internet of Things (IoT) is a recent communication paradigm that envisions near futures, in which the objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet. The IoT Garbage Monitoring system is a very innovative system which will help to keep the cities clean. This system monitors the garbage bins and informs about the level of garbage collected in the garbage bins via a web page. For this the system uses ultrasonic sensors placed over the bins to detect the garbage level and compare it with the garbage bins depth. Using the GPS, the location of the garbage bin can be tracked and accessed by the person that will collect the garbage.

2. RELATED WORK

Namakambo Muyunda, Muhammad Ibrahim[1] presented that a device (Sensor Node) is developed that can monitor the state of a garbage bin and relay the monitored state to a central database. Sensor data is collected from each bin and displayed on a web page to alert the relevant authorities of the states of the various garbage bins in a given area. Sensor data is then stored for each of the garbage bins to provide analytical information for each of the garbage collection areas. Route planning is provided for the collection based on the selected fill level and priorities of each bin. Trushali S. Vasagade, Shabnam S. Tamboli Archana D.Shinde [2] presented that the system comprises of various technologies integrated in it are IR Sensor Module, alarming System, rotating mechanical shaft, elevator assembly and GSM Module. The software mobile application is developed to involve citizens in a process of managing a solid waste. IR Sensor will play role of detecting garbage present outside the dustbin and to sense the status of the bin. For sensing the garbage outside the dustbin, these sensors are placed at the bottom side of specifically designed half circular dustbin in such a way that sensors will cover all the front area of the dustbin. The rotating mechanical shaft which is having cleaning brush at its bottom will play role of cleaning the waste present outside the dustbin.

Saadia Kulsoom Memon, Faisal Karim Shaikh, Naeem Ahmed Mahoto, Abdul Aziz Memon [3] presented that the dustbin is equipped with ultrasonic sensor and that sensor is connected to WeMos D1 mini which is a kind of Arduino board having built in Wi-Fi capabilities to transfer sensor data to garbage monitoring system. Each bin contains a HC-SR04 model ultrasonic sensor to monitor the level of garbage in bin. Each ultrasonic sensor is connected with WeMos D1 mini and WeMos displays wireless connection to monitoring system. WeMos D1 mini is a cheaper alternative to Arduino UNO along with built in Wi-Fi module ESP-8266 along with 4MB of memory and 80/160MHz of clock speed. Jetendra Joshi, Joshitha Reddy, Praneeth Reddy, Akshay Agarwal,Rahul Agarwal, Amrit Bagga, Abhinandan Bhargava [4] presented the sensor data leveraged from the sensor is stored in Azure SQL database, a Decision Forest Regression model is created in Azure ML which trained using sensor data from Azure SQL database. After the model is trained and saved, a predictive web service is set-up. After the setup, the trained model is deployed as a predictive web-service. The application layer protocol used for uploading the data to the cloud is MQTT. Once the data is on the cloud machine learning techniques are applied on the sensor data and garbage level prediction is done. The data of the predictive analysis along with the data about the current status of the garbage bins is sent to the client app. In the app pickup schedules are generated based on the obtained data.

3. METHODOLOGY

The bin with ultrasonic sensors, Arduino, GSM, servo motor, LEDs, cloud, will notify and coordinate the bin and bin status to the database. Here, GSM is used to communicate with the server which will contain the SIM with the basic speed internet. The ultrasonic sensor which uses ultrasonic waves will check the bin status. Here servo motor is used to close the lid of the dustbin when it has reached a level of storage. The lid will not get closed at a single go, but it will shift at a certain angle so as to not damage the gears of the servo motor. The server will maintain the details of the filled bins, unfilled bins and authority registration. The data related to all the bins will be stored in the cloud. When the data is stored in the cloud it becomes easy to retrieve the data whenever required. The data of the filled bins will be sent to the cloud as a record. The record then helps us to analyse and to study that how many bins are required in an area where the population is more and the amount of garbage being disposed is more.

Once the bin has reached its level then it will shut the lid due to which no extra garbage can be thrown in the dustbin until and unless the bin is emptied. The alert message will be sent to the centralized system. Once it has reached the centralized system, the authority will check the area and the garbage collector who is near that area will be notified with a message sent on the GSM module. It is the duty of the garbage collector to empty the bin and update its status. This can also be traced on android phone using android application. The user end will contain the android app which works on android compatible phone. To make it more easier to keep a regular trace of how much percent the dustbin is full widgets will be created on the android phones without logging in. The data is stored on the cloud which will further help us to generate the records whenever required. The data stored on the cloud can help us to analyse the amount of garbage that is being generated on weekly basis. To make it more understandable and it will be given in the form of graphs where we can easily analyse the content.

4. SYSTEM ARCHITECTURE

The prototype dustbin will have a set threshold value. The ultrasonic sensor has been placed at a certain level to detect the level of the garbage accumulated within the dustbin. A servo motor has been attached below the lid so as to move freely to open the lid as and when a human approaches the dustbin. When the capacity of the dustbin has been reached, the servo motor will not open for other users to put their garbage in it until the authorized collector empties the already present garbage. The Arduino microcontroller which is a programmable microcontroller communicates with the Wi-Fi module providing messages to pass on to the cloud or local server. The centralized system will give messages to the concerned person about the status of the dustbin. In the event of a failure in the working of the Wi-Fi module, the GSM module comes in hand by integrating the Android application. The widget on the mobile screen of the collector would display an alert 3 times of a certain location's dustbin. Any delay or ignorance in performing the task would be reflected on the main website.

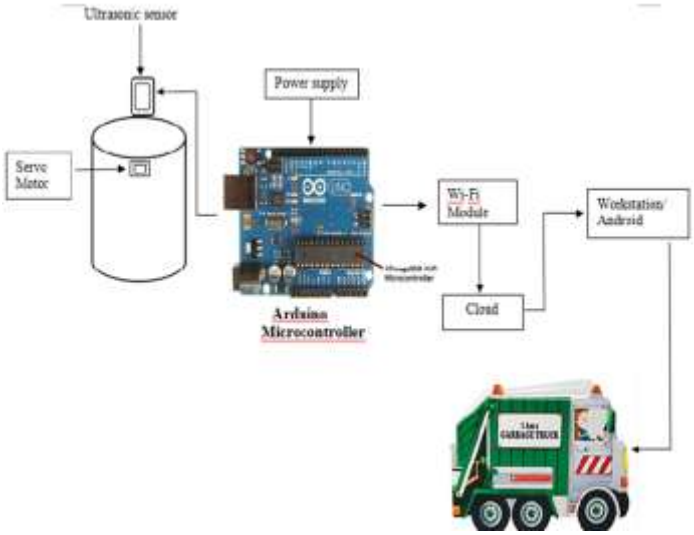

Fig -1: System Architecture

5. HARDWARE REQUIREMENTS

Hardware is best described as any physical component of a computer system that contains a circuit board, ICs, or other electronics. Most hardware only has operating system requirements or compatibility. With regard to the system at hand, multiple hardware components are required for the functioning ranging from sensors to basic everyday modules in mobiles and computers.

5.1 Microcontroller: Arduino UNO

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. It can be connected to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. [8]

Fig -2: Arduino UNO

5.2 Ultrasonic Sensor

Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to hear. They then wait for the sound to be reflected back, calculating distance based on the time required. This type of sensor can be manufactured in a smaller package than with separate elements, which is convenient for applications where size is at a premium. Ultrasonic sensors have two main components: the transmitter which emits the sound using piezoelectric crystals and the receiver which encounters the sound after it has travelled to and from the target.

Fig -3: Ultrasonic Sensor

5.3 GSM

GSM is a mobile communication modem; it stands for global system for mobile communication (GSM). It is a widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services. It operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands. GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates.

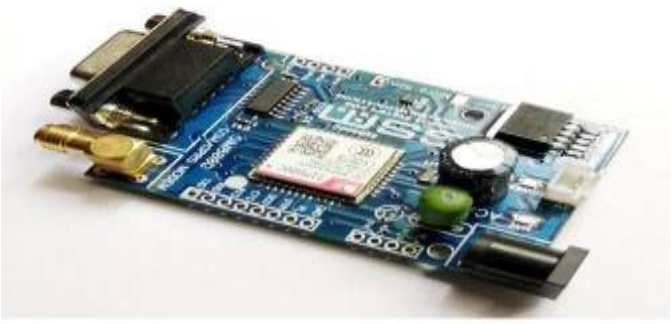

Fig -4: GSM Module

5.4 Servo Motor

A servo motor is a rotary actuator or a motor that allows for a precise control in terms of the angular position, acceleration, and velocity. It has certain capabilities that a regular motor does not have. Consequently it makes use of a regular motor and pairs it with a sensor for position feedback . The servo motor is most commonly used for high technology devices in the industrial applications like automation technology. It is a self contained electrical device, that rotates parts of machine with high efficiency and great precision. Moreover the output shaft of this motor can be moved to a particular angle. Servo motors are mainly used in home electronics, toys, cars, airplanes and many more devices. [7]

Fig -5: Servo Motor

5.5 Wi-Fi module (Nodemcu ESP8266)

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.[9] This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. It is a high degree of on-chip integration allows for minimal external circuitry, including the 0front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existance interfaces. It contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts. The applications of ESP8266 are Smart power plugs, home automation, Wi-Fi location-aware devices, Industrial wireless control, Security ID tags, etc.

Fig -6: Nodemcu ESP8266

6. APPLICATIONS

6.1. Empowerment of Swaccha Bharat Abhiyaan

India generates nearly 62 million tons of waste annually. This may create problems in the environment. Small number of initiatives of waste treatment, e.g., incineration, pyrolysis, bio-refining & biogas plants, composting, recycling and SLFs are available in the country. To make it more effective, smart waste management can be proposed in the government system which may help the municipal communities to maintain and trace the garbage collection on a weekly basis which helps to analyze the management.
This system will create such accountable ways to track the maintenance and progress of an area.

6.2. Transparency between municipality corporation and workers.

The smart waste management system has a centralized website through which it can trace the filling of dustbins and keep track of how, when and by whom it is being collected. This can be done through GSM modules where the worker will get the notification regarding in which area the dustbins are needed to be emptied.

7. CONCLUSION

The developed system is one that provides many useful features for any city that wants to optimise its waste collection process as well as reduce the overall cost of running the collection. This not only gives the city's waste authorities the ability to handle their waste better, but also gives them the ability to predict and plan better their resources. In addition, the system will mitigate the risk of overfilled bins and unsanitary conditions that are caused by the lack of information that is present in the current collection process.

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