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Implementation of Smart Garbage Monitoring System using IoT

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Abstract: Now-a-days, in many cities/towns, we see that the garbage bins are filled with lot of waste which won't take care by municipal people due to lack of information about it. In this paper, we present a solution for garbage monitoring system using Raspberry Pi and Ultrasonic sensor. A central system made up of Raspberry pi which monitors the garbage bins frequently and collects information about the amount of waste present in the garbage bins with help of ultrasonic sensor placed over it. The collected data will be updated to the municipal officer or to a user who is accessing it via an application in the form of GUI. This system monitors the garbage bins and informs about the level of garbage collected in the garbage bins in a web page or an application. Based on the information collected, the bins which have waste above some prescribed level will be cleaned up. This solution helps us to keep our city clean as well as to reduce traffic that occurs due to unnecessary travelling of municipal vehicles in the city/town.

Keywords: Smart Dust Bin, Smart Garbage Monitoring System, Internet of Things, Ultrasonic sensor, Raspberry Pi, PHP

I. INTRODUCTION

Now-a-days population is growing rapidly lack of public awareness, disorganization of city governments and limited funding for programs leading garbage management a global issue. Due to lack of care and attention taken by the authorities, the garbage bins are mostly overflowing on the roads and tunnels. This must be taken care by corresponding authorities and necessary measures to clean the garbage bins and keep city clean.

Internet and its applications have become an integral part of today's human lifestyle. Internet has become an essential tool in every aspect. Due to the tremendous demand and necessity, researchers went beyond connecting just computers into the web. These researches led to the birth of a sensational gizmo, Internet of Things (IoT). Communication over the internet has grown from user - user interaction to device – device interactions these days. The IoT concepts were proposed years back but still it's in the initial stage of commercial deployment. Home automation industry and transportation industries are seeing rapid growth with IoT. Yet not many articles have been published in this field of study. This paper aims in structuring a state-of-the-art review on IoT. The technology, history and applications have been discussed briefly along with various statistics.

Most commonly used methods to monitor the garbage bins are by using sensors and microcontrollers. The corresponding authority monitors each bin with the help of user-friendly UI (Web Page). Necessary actions will be taken on the people if they did not respond to the updates and empty the bins.

The implementation of smart garbage management system using sensors, microcontrollers, Raspberry pi and GSM module assures the cleaning of garbage bins soon when the garbage level reaches its maximum. If the garbage bins are not cleaned in specific time, then the record is sent to the higher authority who can take appropriate action against the concerned contractor. This system also helps to monitor the fake reports and hence can reduce the corruption in the overall management system. These reduce the total number of trips of garbage collection vehicle and hence reduce the overall expenditure associated with the garbage collection. It ultimately helps to keep society clean. Smart collection bin works with the sensors will show us the various levels of garbage in the garbage bins and the weight sensor gets activated to send its output ahead when its threshold level is crossed. If garbage bins are not cleaned in time, the details will be forwarded to higher authority. Remaining explanation is carried out to the next parts [1].

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II. LITERATURE REVIEW

A. *IoT based Garbage and Waste collection bin*

A dustbin is monitored with a central system showing the current status of garbage on Mobile (web browser) with the help of Wi-Fi. The central system is made up of microcontroller and IR, Weight and Wi-Fi sensors are used to detect the quantity of garbage in the dust bin and send it to the authorised personnel. The status of the garbage will be updated in the HTML page developed to reduce human resource and efforts along with the enhancement of a smart city vision. Considering the need for modern technology the implementation of Smart garbage bin is bit expensive and the sensors used are basic sensors. By using the weight sensor we can only detect weight of the garbage but not how much level the garbage is present and empty or not. The message will be directly sent to cleaning vehicle instead of Municipal office to manage bins [2].

B. *GIS based transportation model for solid -waste disposal in Asansol municipality*

A Geographical Information System (GIS) transportation model for solid waste collection that elaborates plans for waste storage, collection and disposal has been proposed for the city of Asansol in India. An enhanced routing and scheduling waste collection model is proposed for the Eastern Finland, featuring the usage of a guided variable neighbourhood threshold met heuristic. The model was to develop an optimal schedule for trucks on defined collection routes. The data from the bins are processed in the DSS and if it is correct it is sent to organizers of waste collection in this particular place and to the road police. The truck driver doesn't waste time for waiting, he/she goes to the next point and the route is dynamically recounted. When the problem is solved the system recounts the route for one of the available trucks and the waste from unlocked bin is collected. It is combined with dynamic routing algorithms to maximize the efficiency of waste collection [3].

C. *Waste Management as an IoT- Enabled Service in Smart Cities*

Advanced Decision Support System (DSS) is used for efficient waste collection in smart cities. This model consists of data sharing between truck drivers on real time to perform swift waste collection with the help of dynamic route optimization technique. This system handles situation of ineffective waste collection where areas are inaccessible. City is incorporated with surveillance cameras to capture and produce the proof of problematic areas to authorities. The waste collection system is to provide high (QoS) quality of service to the citizens of a city. This system architecture mainly targets on two things - first target is providing software as-a-service (SaaS) products for customers. Mainly, these customers are private companies that are involved in waste collection, owning waste trucks, organize work of drivers, get contracts from municipalities and pass wastes to recycling organizations or city dumps. Second main target is developing a system, which makes possible mutually beneficial communication between all the stakeholders involved in the chain of supplying goods and utilizing solid waste in smart city. This model presents a novel cloud-based system for waste collection in smart cities. This is to provide services for different kind of stakeholders involved in this area - from city administrations to citizens. Still, the design focuses mostly on providing SaaS services to commercial waste management companies [4].

D. *IOT Based Intelligent Bin for Smart Cities*

Infrared sensor (IR sensor) is used which is a multipurpose sensor, which can detect the level of garbage. IR sensor emits the light, which is invisible to naked eye but the electronic components can detect it. It consists of IR transmitter and IR receiver. The output of IR sensor is acquired by The National Instruments myRIO-1900. It is an input output device which is portable and reconfigurable. USB acts as a connector between the NI myRIO-1900 and host computer. It has connectors A and B that acts as an expansion port and a connector C that act as a mini-system port, they carry the signals and these signals are distinguished by different connector names. Sensor senses level of the bin. The GUI gives the output of what level of garbage is filled. Sensor senses level of the bin. The graphical representation to access the output of the sensor is as shown below. It gives the output of what level of garbage is filled. When the level in a bin is reached the threshold, the LED placed at the location of the bin starts blinking. When the blinking LED is clicked, a display opens showing the location of the bin, status of the bin, data and time when the bin gets filled, mobile number and the text to send to the concerned person. But this system does not ensure whether garbage is cleaned or not and transportation cost is another issue [5].

III. ARCHITECTURE OF PROPOSED SYSTEM

The system works with the help of Raspberry Pi and ultrasonic sensor for collecting level of garbage in garbage bin. The collected information is sent to web server and which in-turn displays in a web page.

A. *Raspberry Pi*

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to

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learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spread sheets, word-processing, and playing games [6].

Figure 1: Raspberry Pi

B. *Ultrasonic sensor*

The Ultrasonic Sensor is used to measure the distance with high accuracy and stable readings. It can measure distance from 2cm to 400cm or from 1 inch to 13 feet. It emits an ultrasound wave at the frequency of 40 KHz in the air and if the object will come in its way then it will bounce back to the sensor. By using that time which it takes to strike the object and comes back, you can calculate the distance.

Figure 2: Ultrasonic sensor

The ultrasonic sensor has four pins. Two are VCC and GND which will be connected to the 5V and the GND of the Arduino while the other two pins are Trig and Echo pins which will be connected to any digital pins of the Arduino. The trig pin will send the signal and the Echo pin will be used to receive the signal. To generate an ultrasound signal, you will have to make the Trig pin high for about 10us which will send a 8 cycle sonic burst at the speed of sound and after striking the object, it will be received by the Echo pin [7].

C. *Python*

Python is a widely used high-level programming language for general-purpose programming, created by Guido van Rossum and first released in 1991. An interpreted language, Python has a design philosophy that emphasizes code readability (notably using whitespace indentation to delimit code blocks rather than curly brackets or keywords), and a syntax that allows programmers to express concepts in fewer lines of code than might be used in languages such as C++ or Java. The language provides constructs intended to enable writing clear programs on both a small and large scale. Python features a dynamic type system and automatic memory management and supports multiple programming paradigms, including object-oriented, imperative, functional programming, and procedural styles. It has a large and comprehensive standard library. Python interpreters are available for many operating systems, allowing Python code to run on a wide variety of systems [8].

D. *PHP*

PHP stands for Personal Home Page, it's a Hypertext Pre-processor (no, the acronym doesn't follow the name). It's an open source, server-side, scripting language used for the development of web applications. By scripting language, we mean a program that is script-based (lines of code) written for the automation of tasks. Web pages can be designed using HTML. With HTML, code execution is done on the user's browser (client-side). On the other hand, with PHP server-side scripting language, it's executed on the server before it gets to the web browser of the user. PHP can be embedded in HTML, and it's well suited for web development and the creation of dynamic web pages for web

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applications, e-commerce applications, and database applications. It's considered a friendly language with abilities to easily connect with MySQL, Oracle, and other databases [9].

E. *MySQL*

MySQL is an open-source relational database system (RDBMS). Its name is a combination of "My", the name of co-founder Michael Widenius daughter, and "SQL", the abbreviation for Structured Query Language. The MySQL development project has made its source code available under the terms of the GNU General Public License, as well as under a variety of proprietary agreements. MySQL was owned and sponsored by a single for - profit firm, the Swedish company MYSQLAB, now owned by Oracle Corporation. For proprietary use, several paid editions are available, and offer additional functionality. MySQL is a central component of the LAMP open-source web application software stack (and other "AMP" stacks). LAMP is an acronym for "Linux, Apache, MySQL and Perl/PHP/PYTHON". Applications that use the MySQL database include: TYPO3, MODx, Joomla, Wordpress, phpBB, MyBB, and Drupal. MySQL is also used in many high-profile, large-scale websites, including Google (though not for searches), Facebook, Twitter, Flickr, and YouTube [10].

F. *Web Server*

A web server is a computer system that processes requests via HTTP, the basic network protocol used to distribute information on the World Wide Web. The term can refer to the entire system, or specifically to the software that accepts and supervises the HTTP requests. In this model we have used HelioHost web server, HelioHost is the service offered by HelioNet and is the industry-leading free web host. HelioHost is also operated and supported by HelioNet's Moderators. HelioHost is affiliated with Free-Webhosts.com, which is also affiliated with dozens of other free hosts in competition with HelioHost, and individually rates each individual host. We are pleased to confirm that Free-Webhosts.com has rated our hosting service as the best free host ever worldwide! [11].

IV. PROPOSED METHODOLOGY

The proposed system demonstrates the efficient way to collect the level of garbage in garbage bins. This system consists of the Raspberry Pi, ultrasonic sensor for collecting the data and sending it to the server. The Raspberry Pi acts as a central system for collecting the level of garbage and it is sent to server. Raspberry Pi is coded with Python and on the server side data is taken care by PHP, Webserver and MySQL database for backend storage purposes.

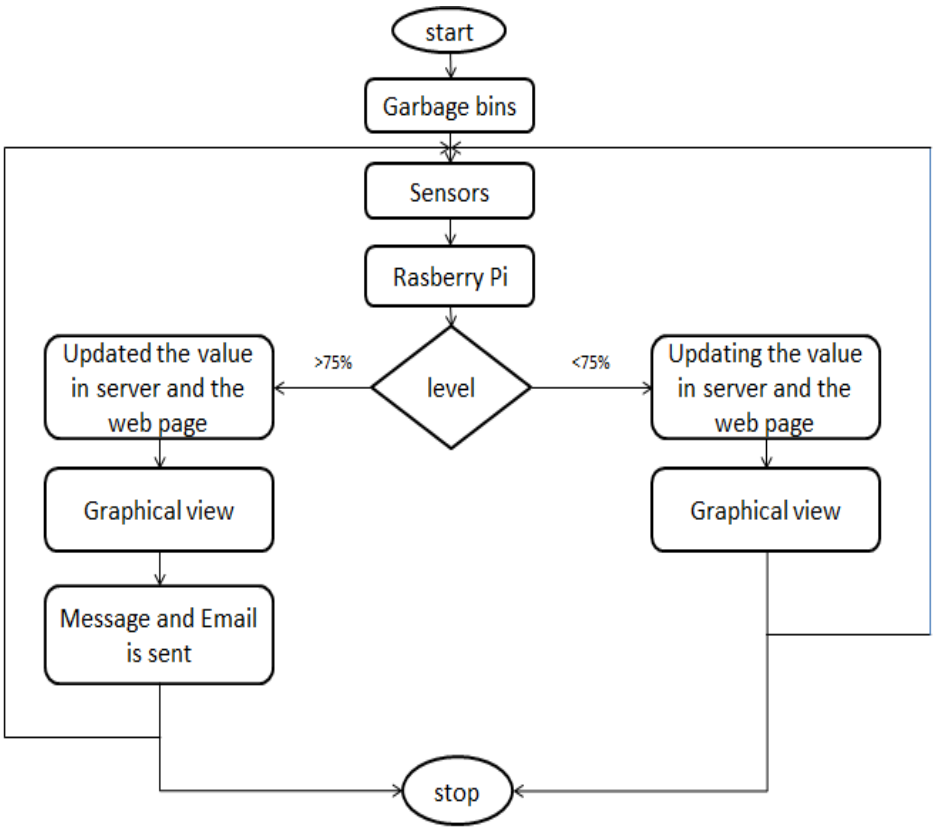

Figure 3: Flow Chart for proposed system

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The above flow chart describes the process of proposed system. In this system, Each and every Garbage bin has sensor associated with it. The sensor calculates the time elapsed for sound wave to travel front and back and this is sent to Raspberry pi. Raspberry pi then calculates the level of the bin by using this time pulse. If the level is greater than 75 then the value is updated simultaneously in the server as well as the web page. The level can be viewed graphically in the form of bar graphs in the web page and the message is sent to the nearest officer and when the level is less than 75% the value is only updated and the message is not sent and this process repeats continuously.

V. RESULTS AND DISCUSSION

The proposed system is more user-friendly and it can be easily implemented. This system consists of Raspberry Pi which acts as a central system and ultrasonic sensor which is used to detect the amount of garbage in garbage bin. The collected data is sent to the web server which in-turn displays results in the webpage developed.

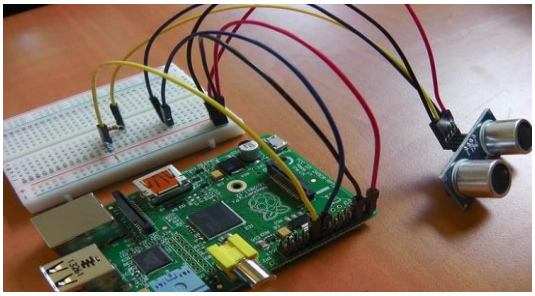

Figure 4: Ultrasonic sensor interfacing with Raspberry Pi

The above figure 4 shows the complete hardware implementation of proposed system. The ultrasonic sensor interfaced with Raspberry Pi with the help of connecting wires. This complete model is placed in the garbage bin after coded as per the requirement.

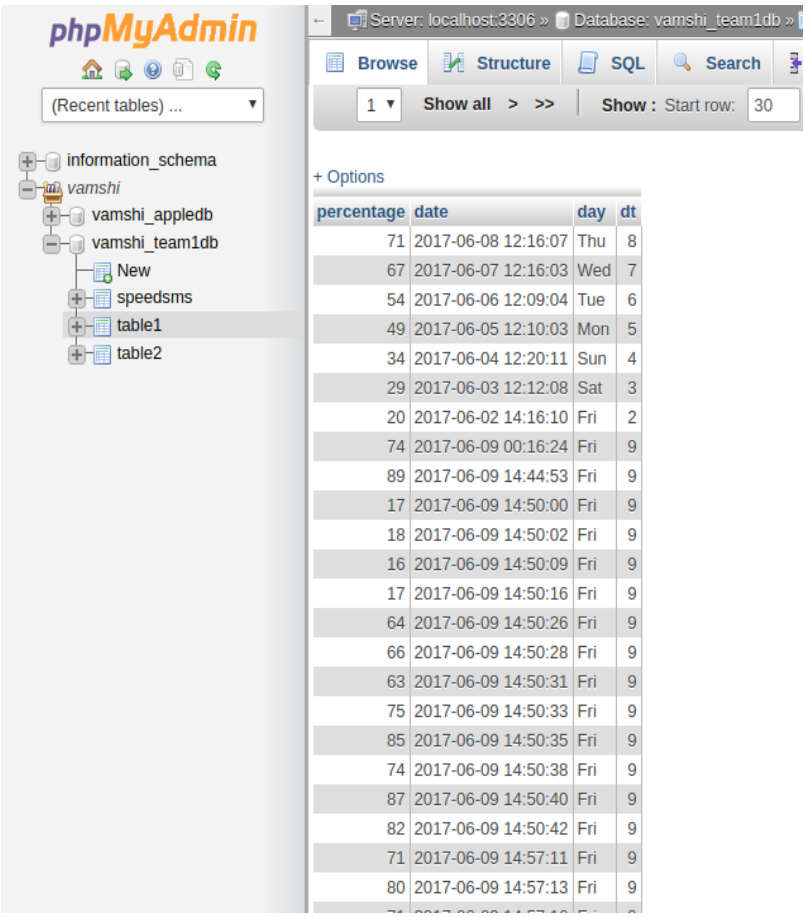

Figure 5: Output results displayed in the database

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The above figure 5 shows the results which are taken from the garbage which displays the date, time and percentage of garbage present in the garbage bin at a particular incident. If the percentage is greater than 75% then the notification message is sent to nearest officer. The officer notifies the concerned person to clean the garbage bin.

CONCLUSION AND FUTURE SCOPE

This proposed work is successfully designed, implemented and tested. This system is very useful to the people and garbage management system. This system is implemented with the help of Raspberry Pi, Ultrasonic sensor, Wi-Fi to collect and transfer the percentage of garbage in bin to the authorities. This helps to keep the city clean and helps in vision of Smart City. This works if the percentage of garbage in bin is greater than 75% then a notification will be sent to vehicle to clean the garbage bin. The percentage also can be seen by the authorities with the help of database and webpage developed. This can be extended by making the system global and all the garbage vehicles can know the status of the bin so that the nearest vehicle with the help of dynamic routing algorithm techniques can clean the bin fast to improve the efficiency of the system.

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