International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

A Review on Internet of Things Based Garbage Bins Detection Systems

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Abstract: ***With networking support the use of low power wireless sensors has increased over the past decade. Use of standardized Internet protocols, new hardware for communication, new generations of microcontrollers have resulted in increasing interoperability which allows information exchange between sensor nodes with large number of peers beneficial for developing flexible, advanced and reusable systems. The dustbins and garbage bins located at the public places of cities often results in bad environment with the stinking place and unhygienic situations for people. To get rid of all these problems an IoT based real time garbage and waste bin(s) detection system by integrating different sensing and communication technologies is proposed. The system in divided into three segments, the first segment consists of bins with sensor nodes installed in it that are moisture, ultrasonic and odour sensor interfaced with microcontroller. Second segment consists of Wi-Fi module for data transfer to the server and third segment is web page. The real time bin status and corresponding notifications are displayed on web page. Web page is developed using PHP and database is generated along with the priority algorithm embedded in it for more efficiency.***

Keywords: IoT, Wi-Fi module, odour sensor, ultrasonic sensor, moisture sensor, web page, PHP, database, WSN

1. Introduction

For thousands of years, analysis of the physical environment is something that humanity has been doing that includes variety of parameters such as measuring distance, time, temperature, etc. In the start rudimentary methods which were based on references as such the positions of the Sun, stars or the sizes of body parts were used. With the standardization of measurement units, the mechanical systems capable of measuring certain physical variables began to appear. At present, humanity is in Silicon Age, and crediting to the electronic revolutions, it is possible with the help of electronic sensors to measure any physical variable.

Physical objects are enabled to see, hear, think and perform jobs by having them "talk" together, to share information and to coordinate decisions by the IoT. From being traditional, these objects are transformed to smart by exploiting its underlying technologies such as ubiquitous and pervasive computing, embedded devices, sensor networks, communication technologies, Internet protocols and applications.

Today's human life involves Internet and its application as its very important part. It has become a daily need of each being in every perspective. The concepts of IoT have been put forth long back but it's still in the process of initial development. Though transportation industries and home industries are witnessing a fast growth with IoT but there are still very fewer articles being published in the study fields [1].

An active high speed internet connection is an important factor as almost entire process requires the use of internet. IoT can be used to control and monitor all the equipments used in daily use. Sensors help to accomplish the majority of the process. They are kept everywhere and convert raw data into digital signals and transmitted them to its control centre. The Internet of Things basically refers to the concept where the surrounding things or objects are connected via wired and wireless networks without user interference. A group of embedded nodes with connected sensors that are able to measure physical variables perform data analysis and communicate with a centralized data collector, or server for data transmission, has been understood as a WSN.

The communication and exchange of information in IoT, takes places to serve advances intelligent services to the users. With various sensors and communication technologies integrated together in the recent development in mobile devices has resulted in the rise of academic interests [2].

There is a critical need for a flexible layered architecture as the IoT should be cable of interconnecting billions or trillions of heterogeneous objects through the Internet. There are number of proposed architectures, amongst which the basic model is a 3 layer architecture, which consists of the Application, Network and Perception layer. However in the recent literature some other models have been proposed adding more abstraction to the IoT architecture. Among them simple architecture is illustrated in the figure below [3]

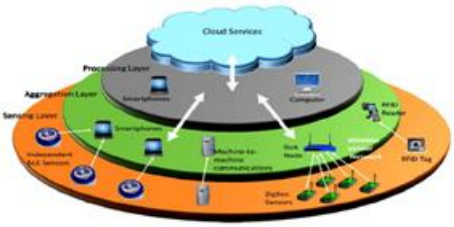

Figure 1.1: Architecture of an IoT [3]

Considering the fact that concept of the 'Internet of Things' varies from one research area to other, it becomes difficult to define the concept. In the publication "Towards a definition of the Internet of Things", the IEEE Internet of

Things group compiled definitions from various Internet associations and research groups which are given below:

"The basic idea is that IoT will connect objects around us (electronic, electrical, non-electrical) to provide seamless communication and contextual services provided by them. Development of RFID tags, sensors, actuators, mobile phones make it possible to materialize IoT which interact and co-operate each other to make the service better and accessible anytime, from anywhere." – Internet Engineering Task Force (IETF), 2010"

"A network of items—each embedded with sensors—which are connected to the Internet."
– Institute of Electrical and Electronics Engineers (IEEE), 2014

"The Internet of Things refers to the unique identification and 'Internetization' of everyday objects. This allows for human interaction and control of these 'things' from anywhere in the world, as well as device-to-device interaction without the need for human involvement."
– HP, 2014.

The initial technical realization of IoT for tracking, identification and storing information of devices was achieved by using RFID technology. While it remains limited to object tracking and extraction of information regarding specific objects. Various tasks such as sensing, actuating, data gathering, storing and processing via connecting physical or virtual devices to the internet are performed by the present IoT. Figure 1.2 shows IoT applications in environmental monitoring, object tracking, traffic management, home automation technology and health care are the recent field of interest for researches in IoT services.

Figure 1.2: The overall picture of IoT emphasizing the vertical markets and the horizontal integration between them [2]

Waste management has become a significant issue in academics, industries and government because of the characteristics and merits of IoT application fields. An absence of proper waste disposal, inefficient waste management policies have resulted in serious environmental issues. Various Researches to handle these problems have been conducted into waste management. This paper proposes an IoT-based garbage and waste bin(s) detection system composed of a number of garbage bins, sensing unit, Wi-Fi modules, and server.

The organisation of rest of this paper is as follows. Section two describes the motivation for creating the IOT-based garbage and waste bin detection system. Section three details the literature review. Section four presents the proposed system structure. The paper ends with the conclusion section.

2. Motivation and Background

In past history, since the human population density and levels of exploitation of natural resources were less, the amount of solid waste generated was significant. But the increase in population in today's world has increased the garbage. To keep the environment clean and healthy, there is a requirement of proper garbage disposal. Improper garbage disposal brings up pollution, health issues, various hazards and in result it affects the environment. Pollution severely affects the growing and populated cities as it contains contaminants which results in instability, disorder and discomfort to ecosystem. Ignorance and lack of cleanliness is spoiling the environment. The proper waste removal and management is greatly effective to improve the health and wellbeing of city's population.

The main goal of this paper is to work on environmental issues due to improper waste disposal and solve them for better health and hygiene of the people. The proposed system fits into the category of IoT applied to external and public environments and it fulfils the following necessary requirements of IoT services [2]:

- **Reliability**: Communication is vital in IoT for service provisioning, applied to exterior and public environment. Trustworthy and reliable communication is needed in order of carrying out communication between devices as this type of IoT has a large service domain. Hence, the bin used in the proposed system interact with each other, based on a wireless mesh network (WMN), providing reliability.

- **Mobility:** IOT devices may be required to shift in the outer atmosphere. The proposed system works with a battery instead of the permanent power source, resulting in a great level of mobility. The mobility of the system is protected with a power-based power supply.

- **Service Continuity:** Data interactions and services should be conducted faultlessly at any time and any location in IoT with a large service domain. Bins are positioned at regular space of distance to ensure service continuity.

- **User Convenience:** The introduction of IoT has improved the user convenience. For user ease, the proposed system reduces the procedure delay time of the existing garbage gathering systems, which enables users to set free their garbage without a long wait and timely elimination of filled bins.

- **Energy Efficiency:** IoT applied to external and public environments relies on an always-on infrastructure and requires mobility, causing a large amount of energy consumption. To solve this problem, the sensors operate

using energy-efficient techniques, increasing their battery lifetimes.

3. Literature Review

The major incapability's of present waste bin collection systems are:

1. Lack of information about the collecting time and area.
2. Lack of proper system for monitoring, tracking the trucks and trash bin that have been collected in real time.
3. There is no estimation to the amount of solid waste present inside the bin and the surrounding area due to the scattering of waste.
4. Lack of quick response to urgent cases like truck accident, breakdown and long time idling.

To remove these problems many system has been developed. Some of such researches is summarised below:

In this paper to reduce the food waste researches have proposed an Iot-based smart garbage system to reduce the amount of food waste. In this system battery based smart garbage bins exchange information with each other using wireless mesh networks, and a router and server collect and analyze the information for a service provisioning and includes various IoT techniques for user convenience. The proposed SGS had been operated as a pilot project in Gagnam district, Seoul, Republic of Korea, for a one year period which showed that the average amount of food waste reduced by 33%.[1]

In this paper, by integrating different sensing and communication technologies real time solid waste bin monitoring system was developed. The system consisted of bins with sensor nodes, gateways and base station. Sensor nodes measure and transmit waste conditions inside bin at every access, gateways forward data to base station after receiving and base station stores data for further use. The system helped to minimize collection route and fuel cost[4]

In this paper, the smart waste bins are connected to internet to obtain the real status information of the start waste bins. The tremendous growth in population in past some years resulted in more waste disposal. A proper waste management system is required to avoid the spreading of diseases. In this, the smart dustbins are monitored and the decisions are taken as per the status of bins. The waste bins are placed throughout the city or campus and are interfaced with micro controller based system with IR sensors and RF modules. IR sensor looks for the level of waste in waste bin and sends the signal to micro controller. The same signal are encoded and forwarded to the RF receiver through RF transmitter. RF receiver receives the signal and decodes it at the central system. An internet connection is enabled through a LAN cable from the modem. That is received, analysed and processed in the cloud that displays the Garbage status in the waste bin on the GUI on the web browser. [5]
In this paper the real time waste management system has been implemented by use of smart dustbins to look for the filled level of dustbins to know if the dustbins are overflowed or not. The concerned person can access the information of all the smart dustbins anytime and anywhere and thus, decisions can be taken in accordance with that. The goals like reduction in cost, resource optimization and effective usage of smart dustbins can be achieved by implementing this proposed system. An indirect reduction in the traffic of system can be done with the help of this system as in the cities, the garbage collection vehicle is been sent to the area each day twice or thrice depending upon the respective population there and sometimes the dustbins may not be full. The concerned authority will have to send the garbage collection vehicle only when the dustbins are full as the proposed system will inform the real time status of each dustbin in real time. [6]

In this paper, for reducing the costs of waste management, and to facilitate automating the waste identification and weight quantity process, radio frequency identification (RFID) and load sensor is used for designing smart waste management system. Waste management is the basic essential for the healthy environment for above two hundred municipalities in Australia, the highest waste generators in the world (OECD 2002). Australia comes under the top 10 household waste producers in the OECD (Organisation for Economic Co-operation and Development) countries. Australia produces waste at the rate of 2.25 Kilograms per person per day. Over 17 million tonnes of waste was disposed in landfills in Australia during 2002-03. Municipalities waste contributed more than 30% in it. Australian households produced almost 95% recycled waste and around 83% re-used wastes in March 2003. Also, more than 1.3 million tonnes of plastic is produced by Australians every year exceeding 71 Kg per person. Around 485000 tonnes of steel cans were recycles in Australia in 2002. That is enough steel to rebuild the Sydney Harbour Bridge almost 4 times. Approximately, 57 sheets of toilet papers are used per person in a day. Waste disposal is a key environmental concern, principally in urban centres in Australia. [7]

In this paper, a design of an electronic system is proposed in order to give a solution for improper waste disposal system. It comprises the use of biosensor sensor and weight sensor along with height sensor to sense the run over of the waste in the waste bin and the intensity of pollution caused by undesired poisonous gases from the waste bins. Afterwards, these sensors are fed to the controller to help the GSM module to send the notification to the respective authority about the status of waste bin. The main aim of this paper is to provide a solution for proper disposal of waste. Effective waste management system is achieved through the use of the sensors in this paper where sensor units are used for sensing, microcontroller for controlling and GSM module for communication and solar energy is used for the power necessary in operating system. [8]

4. System Architecture

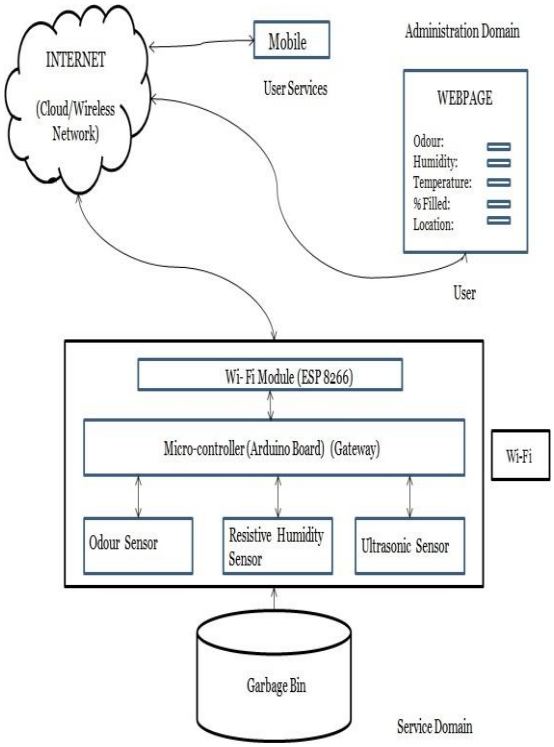

Figure 3: Block diagram of proposed system

The block diagram of the proposed system is shown in figure. The bins installed with sensor unit send the information to the server through wireless communication using Wi-Fi module ESP 8266 which needs Wi-Fi connection that provides peer to peer connection. The proposed system is divided into two sections: an administration section and a service section. In the service section, residents throw away the waste in a bin and that information with the sensors is collected and transferred to the administration section.

The web Server displays the details of sensor value, at real time. The same information is transferred to concerned authority so that accordingly the filled bins are timely evacuated. The priority algorithm is also used for making the system more result oriented.

5. Conclusions

Waste management is a crucial issue in which everyone needs to put responsive immediate action. This proposed system, integrates different sensing and communication technologies to monitor real time bin information that can enrich the efficiency of solid waste collection and ensure the timely removal of waste resulting in green and pleasant environment using IoT. This project holds the belief that overflowing of the trash on the streets could be avoided.

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