A Study on Automatic Solid Waste Management System for Smart City

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Abstract : This study has been undertaken to overcome on rapid flow of solid waste in smart cities to avoid the unhygienic surroundings. The overflowed garbage bins are creating an unhygienic environment in most of the cities. This will further lead to create the different types of unnamed diseases and this will degrade the standard of living. An efficient smart garbage management method has to be developed to overcome these conditions. A effective methods can be found out easily by using Internet of things(IOT). Many designs were proposed and has both advantages as well as disadvantages. This paper discuss on Smart Garbage Management in Cities using IoT, Microcontroller and wi-fi process. This survey involves various ideas that can be easily implemented in smart garbage management

***IndexTerms* – Smart Bin, Sensor, Microcontroller ,Wi-fi,Internet Of Things,Smart Garbage.**

I. INTRODUCTION

Due to rapid population growth, disorganization of city governments, a lack of public awareness and limited funding for programs, garbage management is becoming a global problem. Due to the lack of care and attention by the authorities the garbage bins are mostly seem to be overflowing. It has to be taken into care by corresponding authorities and should think what method can be followed to solve ongoing problems are discussed related with IOT. Internet and its applications have become an integral part of today's human lifestyle. It 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 to user ,user to device ,device to 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. IoT can be used to provide a platform for smart garbage management.. Effective actions will be taken if the corresponding authority is not concerned regarding the cleaning of bins. The implementation of smart garbage management system using sensors, microcontrollers and GSM module assures the cleaning of dustbins soon when the garbage level reaches its maximum. If the dustbin is 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. This reduce the total number of trips of garbage collection vehicle and hence reduce the overall expenditure associated with the garbage collection. It ultimate helps to keep cleanness in the society. Smart collection bin works with the sensors will show us the various levels of garbage in the dustbins and also the weight sensor gets activated to send its output ahead when its threshold level is crossed. If dustbins are not cleaned in time, the details will be forwarded to higher authority.

II. SMART CITY

The first question is what is meant by a 'smart city'. The answer is, there is no universally accepted definition of a smart city. It means different things to different people. The conceptualization of Smart City, therefore, varies from city to city and country to country, depending on the level of development, willingness to change and reform, resources and aspirations of the city residents. Even in India, there is no one way of defining a smart city. Some definitional boundaries are required to guide cities in the Mission. In the imagination of any city dweller in India, the picture of a smart city contains a wish list of infrastructure and services that describes his or her level of aspiration. To provide for the aspirations and needs of the citizens, urban planners ideally aim at developing the entire urban eco-system, which is represented by the four pillars of comprehensive development-institutional, physical, social and economic infrastructure. This can be a long term goal and cities can work towards developing such comprehensive infrastructure incrementally, adding on layers of 'smartness'. 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 and application of 'Smart' Solutions.

III CASE STUDIES ON SOLID WASTE MANAGEMENT

3.1 SOLID WASTE MANAGEMENT IN ASIA

As urbanization and economic development increases in Asia, nowhere is the impact more obvious than in society solid waste. Today, the urban areas of Asia produce about 760,000 tones of solid waste (SW) per day, or approximately 2.7 million m3 per day. In 2025, this figure will increase to 1.8 million tons of waste per day, or 5.2 million m3 per day. These estimates are conservative; the real values are probably more than double this amount. Local governments in Asia currently spend about US $25 billion per year on urban solid waste management. To carry out integrated solid waste management, local governments need partners. The general community, which is probably the most important stakeholder in waste management activities, must also actively, participates in the solutions by modifying their behavior patterns. in 2025 about 52 percent of Asia ‘s population will reside in urban areas, and evidence that urban residents generate at least two times more waste per capita than their rural counterparts. Given these factors, it is clear that solid waste management efforts must target priority urban areas.

3.2 SOLID WASTE MANAGEMENT IN US

As a nation, Americans generate more waste than any other nation in the world, officially with 4.4 pounds (2.0 kg) of Municipal Solid Waste (MSW) per person per day, with another study estimating 7.1 pounds per capita per day. Fifty five percent of this waste is contributed as residential garbage, while the remaining forty five percent of waste in the U.S.'s ‘waste stream' comes from manufacturing, retailing, and commercial trade in the U.S. economy. over 14 pounds of non-recycled, un reused items, often ending up into landfills and incinerators per day, eight pounds over the national state daily throwaway average. "Wasteful" states Michigan, Mexico, Wisconsin and Oregon as well as Washington also dominated the list's 5-year period. The generation of SW has grown steadily over the past thirty years, from 88 million tons per year, or 2.7 pounds per person per day in 1960, to 229.9 million tons, or 4.62 pounds per person per day in 1999. The largest component of the SW stream is paper and paperboard products (38.1%), with yard trimmings the second most predominant component (12.1In 1960 about 7 percent of MSW was recycled, and in 1999 this figure had increased to 27.8 percent. How MSW is managed is shown in the bottom of two pie charts on the next page. Although the majority of solid waste is still sent to landfills, statistics indicate that there is a clear trend away from reliance on this method. Combustion of MSW and recovery through recycling are now a common practice in the United States.

3.3 SOLID WASTE MANAGEMENT IN MALAYSIA

National Space Agency Malaysia (ANGKASA) under Ministry Of Science Technology, Innovation Malaysia (MOSTI) taking an initiative to developed Smart Waste Management System (SWMS)**.** SWMS is one of the modules developed in Spatial Smart City Service Delivery Engine (SSCSDE) Project funded by Most under Techno fund grant. The Objective of the project is to develop a spatial service delivery engine that are capable of exploiting the smart (geospatial) technologies to support city operations which includes managing, using, and exploring spatial data with scientific analysis in all possible phases of the decision making process in the organization. The reason and idea for choosing SWMS as one of the development module is to monitor the environment by enforcement. Local authority always have difficulty to monitor the job done by waste collection services provider. Contractor doing waste collection services seems doing collection not follow the schedule as per agreed in contract. Hence SWMS will act as automatic enforcement system to penalize the contractor who break the contract. This solution not only help local authority to monitor the contractor, it’s also brings information of garbage container status and report automatically when it’s full. This valuable information can be used by local authority for monitoring purpose and enforcement. For waste collection contractor this information provide alerts on the status of containers in terms of fill levels in order to optimize collection routes based on historical and real time information hence save operation cost.

IV CASE STUDIES ON SMART BIN

4.1 ENEVO

Enevo one is a comprehensive logistics solution that saves time, money and the environment. It uses wireless sensors to measure and forecast the fill-level of waste containers and generates smart collection plans using the most efficient schedules and routes. The solution provides up to 50% in direct cost savings. Receive automatically generated schedules and optimised routes which take into account an extensive set of parameters future fill level projections, truck availability, traffic information, road restrictions, container and content types the vehicle can collect etc. New schedules and routes are planned not only looking at the current situation, but considering the future outlook as well. Enevo using WSN and Ultrasound sensor for measuring the fill level of waste container [3].

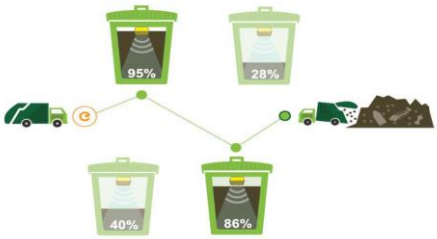

Fig 1 Enevo system Architecture

4.2 IR Sensor

Dustbins are the primary infrastructure required. Separate dustbins are allocated for dry and wet waste respectively, each of which is equipped with suitable low power sensor circuitry to detect the fullness and heaviness, and transmitters to send a message to the nearest GCV when it is full. Sensor circuitry Infrared (IR) light is electromagnetic radiation with a wavelength longer than that of visible light, measured from the nominal edge of visible red light at 0.74 micrometers (μ m), and extending conventionally to 300 μ m. These wavelengths correspond to a frequency range of approximately 1 to 400 THz, and include most of the thermal radiation emitted by objects near room temperature. Microscopically, IR light is typically emitted or absorbed by molecules when they change their rotational-vibration movements. Infrared light is used in industrial, scientific, and medical applications.

4.3 BIO Sensor (load sensor)

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.

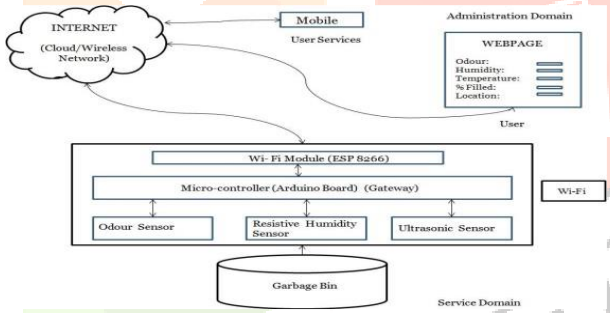

Fig 2 Block Diagram of Bio sensor

4.4 SENS Dumper

SENS dumpster filling level monitoring SENS dumpster is an innovative device that monitors the filling level of a dumpster. SENS dumpster works with any kind of waste and fits to any type of dumpster. It makes use of a volumetric sensor that provides information of the level of filing of a dumpsters. SENS dumpster can be applied to any kind of waste, and a temperature sensor is able to detect significant temperature increases that may result in fire. SENS dumpster is a fully ZigBee wireless device that can be integrated to any ZigBee network deployment within the smart-city.

Fig 5 SENS dumpster wireless device to monitor filling level of dumpster.

V CASE STUDIES ON DESGIN VIEW OF SWM

5.1 SMART WASTE MANAGEMENT USING INTERNET OF THINGS

On the basis of level of wastes present in the waste bins a smart waste is collected from the cities. The level of waste present in the dustbin is calculated by using ultrasonic sensor and the data obtained is transmitted to a server through internet for storage and processing mechanisms. The data from every smart dustbin is collected and it will be kept for prediction process .so that we can avoid overflow of garbage present in the smart bin. In this paper we are going to see technical information about (A) Ultrasonic sensor (B) Access Network Interface
(C) Database (D) Artificial Intelligence, fig 6 shows architecture of smart bin using IOT

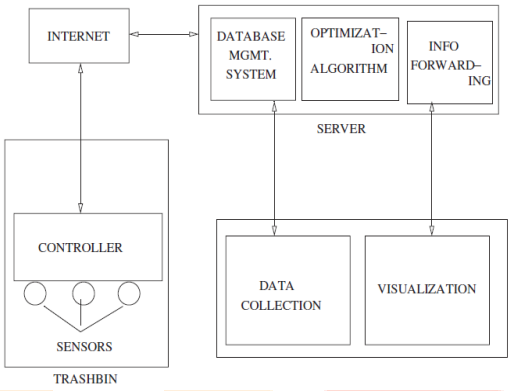

Fig 6 Architecture of Smart bin using IOT

(A)Sensors: The waste collected by the trash bin is measured by using the ultrasonic sensor from the top of the bin to calculate the distance from the trash bin . The ultrasonic sensor can be used in this prototype that can provide measurement from 2cm to 400cm with 3mm accuracy e.g., Ultrasonic Sensor Module (HC-SR04).The sensor uses the battery and it is essential to optimize the battery usage for achieving larger lifespan of the devices. The strong influence on energy consumption is need to improve Sensing and data forwarding rates, and wireless technology. once or twice in a day so that the data can be collected and forwarded to the server .
(B)Access Network Interface: By using wireless link the data is collected and transferred to a remote server. For our work, a network access technology is considered as WiFi.(C)Database: The data collected by the sensors and the trucks uses MySql for storage.(D)Artificial Intelligence (AI): Though artificial intelligence algorithm is the forecast of waste levels for the future and it will help to select the daily Waste bins. (E) Optimization algorithms: Once the filled waste bins have been identified, shortest path for collection of trash bin is done. The source to destination path must be sent to the collectors in understandable format . It helps the driver to easily follow the path. To make better selection of routes we use can data such as GPS location.

5.2 SOLID WASTE MANAGEMENT SYSTEM USING ZIGBEE

Solid waste management system using zigbee framework of system is shown in fig. 7. It has three stages , 1.It is composed by smart waste bin attached with sensor node. 2.A gateway is used for communication purpose between sensor node and control station.3. The data storage and controlling actions are done by control station. The solid waste collection , transportation monitoring and management for greener environment are good enough to ensure the practical.

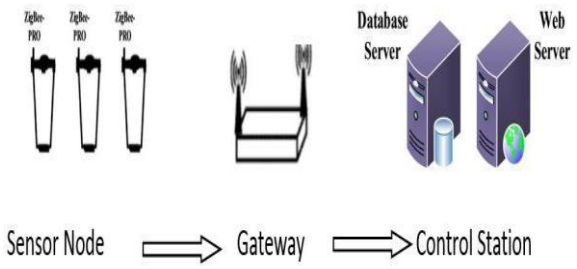

Fig 7 Framework of the system

5.2.1THE SMART BIN

The smart bin is composed of ultrasonic sensor mounted on it. The ultrasonic sensor is used to measure the distance produced in the bin and the data is sent to the gateway through Zigbee communication [4].

5.2.2GATEWAY

The smart bins send the data to the gateway. At control station, the data acquired from the gateway are stored in the local database. There are different ways of wireless communication, the use of ISM bands eliminate the need of telephone operator subscription. A cost reduction of 50% has been estimated [6].

5.2.3 CONTROL STATION

The sensor transfers the real time data such as waste level in a bin through gateway and it is stored into database. The database and DBMS are stored in the central server. For bin status monitoring and operator interaction with the system a web based interface are used . The data can be used by control station to feed programs like optimization engines, routing and scheduling applications [5].

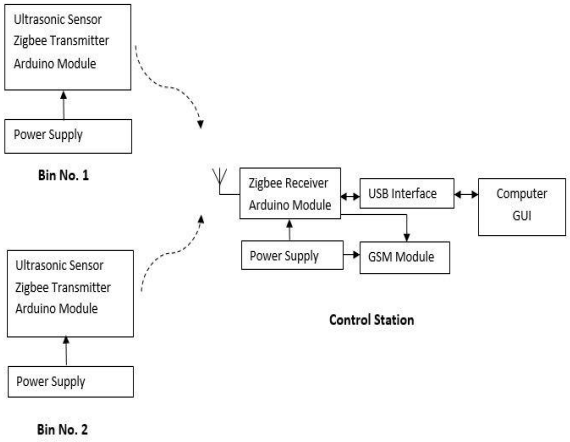

Fig 8 Block Diagram Of Proposed Model

5.3Intel Galieo MICROCONTROLLER BASED SOLID WASTE MANAGEMENT FOR SMART SYSTEM

In this paper we are going to see about different component used in the Smart Dust bin System:IR Sensor,8051 microcontroller, Power Supply, RF Transmitter, RF Receiver, Intel Galileo microcontroller and the web browser. According to the Fig 9 there are two parts of transmitter section and receiver section. In transmitting section ,IR sensor detects the level of garbage filled in the dustbin .If the dustbin gets filled the information is transferred to 8051 Microcontroller. The data stored into the microcontroller is transmitted to the web browser using RF transmitter. To drive the system the +9V Battery power supply is given to the 8051 microcontroller In receiver side the same data wirelessly transmitted to the Central system (Intel Galileo microcontroller) using RF Transmitted. Intel Galileo microcontroller gets the signal from 8051 microcontroller by RF Transmitter .The IGC transfers the data to the web browser. After getting the information the user replace the filled garbage dustbin into empty dustbin.

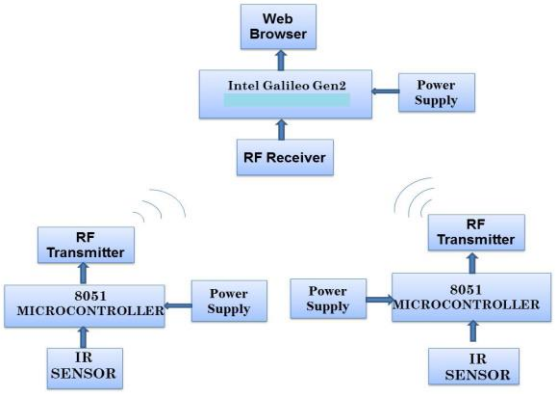

Fig 9 Block Diagram of IOT

5.4 SMART WIFI DUSTBIN SYSTEM

This architecture shows overall description of our system and it consists of 1.Database, 2.Microcontroller, 3. Display, 4. Wi-Fi Router. The user simply put some garbage in to the dustbin. The electronic device are already connected to the dustbin ,if the user put some garbage to the bin the sensor will identify it and display the unique id for user. User opens the address of our web application in to the browser.User put the unique id in to the textbox and submits into the web applications. Then system checks the id and compare with database value, if it matches the system gives password of Wi-Fi network device to user or if it not matches it will send failed message for user. After matches the password user can be able to use internet facility. In Smart Wi-Fi dustbin system design two main modules:

5.4.1 Hardware Module : In this system the hardware part is design by using the IR sensor, Microprocessor 8051, LCD. The unique number usees Embedded C language

5.4.2 Web Application: In this process we use java technology to develop web application and it maintains the database of admin .The admin consist of user and passwords data by using MySQL database for storing the data.

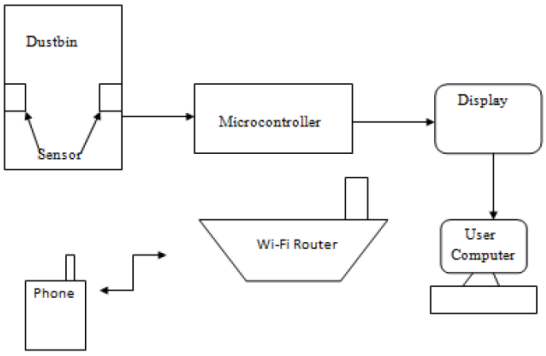

Fig 10 The Proposed System Architecture

5.5 AVR MICRO CONTROLLER FOR SMARTBIN

An AVR microcontroller is used in this model. In which it is interfaced with Wi-Fi modem and garbage is equipped with ultrasonic sensor. The software used in this paper is Adriano compiler, IoT Gecko, MC Programming Language C.

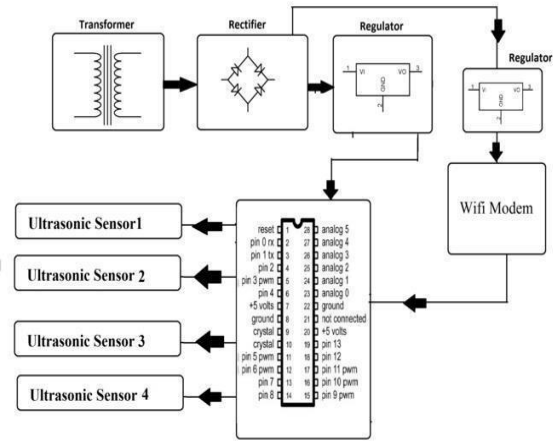

Fig 11 Block Diagram of IOT garbage system

5.5.1 AVR MICROCONTROLLER

AVRs are available with 8-pins to 100-pins, although anything 64-pin or over is surface mount only. Most people start with a DIL (Dual In Line) 28-pin chip like the ATmega328 or the 40-pin ATmega16 or ATmega32. PC microprocessors are always at 32-bit and

now 64-bit. This means that they can process data in 32-bit or 64-bit chunks as they are connected to data buses this wide. The AVR is much simpler and deals with data in 8-bit chunks as its data bus is 8-bit wide, although now there is now an AVR32 with 32-bit bus and an ATxmega family with a 16-bit data bus.

5.5.2 LED

LED Modules are a great LED Lighting source for indoor or outdoor project. LED Modules are designed to be used in channel letters and signs but can also be used in home remodel projects, accent lights, and even outdoor patio and landscape lighting. LED Light Modules are a great versatile product because there is lead wire between each LED Module. It makes them easy to cut and re-connect for any custom project. We have UL Super Nova Modules and more affordable non-UL LED Modules, all are water-resistant, non-UV proof.

5.5.3LCD DISPLAY

An LCD is a small low cost display. It is easy to interface with a micro-controller because of an embedded controller(the black blob on the back of the board). This controller is standard across many displays (HD 44780) which means many micro-controllers (including the Arduino) have libraries that make displaying messages as easy as a single line of code.

5.6 SOLAR POWER SMART WASTE BIN USING ARDUINO

Solar power smart waste bin using arduino consist of ultrasonic sensor, arduino UNO ,GSM/GPRS, solar panel etc. The scheme basically consists of an ultrasonic sensor that functions as the distance calculator. The ultrasonic sensor attached to the smart waste bin which is placed in public areas are used to measure the distance in front of the bin and if the distance fall below a particular value the presence of humans can be identified. A buzzer can be activated by using H Bridge for indicating the operation and lid can be opened. The entire system works with the renewable solar energy and a constant supply of voltage to charge the battery.

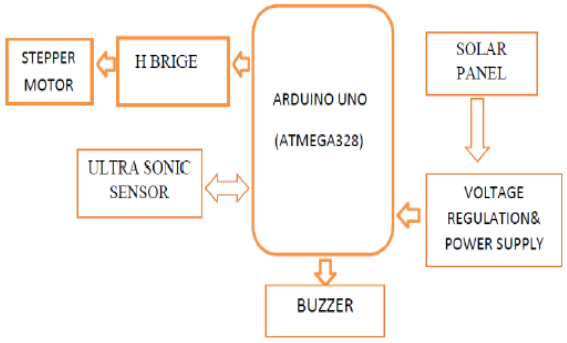

Fig 12 Block Diagram Using ATMEGA

VI CONCLUSION

In this paper we have discussed an effective methods and details of various smart garbage management system which are useful for providing hygiene environment in cities. As the level of garbage in the bins crossed the threshold, it will be informed to the corresponding authority, if it was found ignored then the details will be forwarded to the higher authority to take necessary actions. Thus a hygiene and clean environment can be provided. This survey helps in identifying all possible smart garbage management methods that can be implemented to make city clean.

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