SMART WASTE MANGEMENT FOR METROPOLITAN CITIES

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The smart way of doing things done is the concept behind the smart city's development with less man power and maximum utilization of the technology in the day today life. The use of technologies is very significant towards the development of smart cities. Automation is the key part in the smart cities irrespective of various needs and applications. At places, whether it is a rural or urban area or apartment or multi storey buildings, there occurs the accumulation of wastes. The applicability of a proper waste management system is significant at this point. Rise in urbanization and increase in population matches up to the quantity of solid waste in today's life. Therefore, solid waste management and managing the condition of the waste bins possess a major challenge in metropolitan cities like Chennai, India. Waste bins are part of our lives for decades and mostly the condition of the waste bins is overflowing due to improper waste dumping, collection and management leads in foul smell and unhygienic condition which inherently results in environment pollution.

The old-fashioned method of management of solid waste is an unwieldy and intricate process, which utilizes enormous human effort, valuable time and hefty cost and is not well matched with advancement in technologies. One of the smart ways of monitoring the things is the use of "Internet of Things" (IoT). Through IoT, devices with internet connectivity can be monitored and controlled remotely. We have proposed a waste management system by utilizing the concept of IoT to connect the different dust bins at different locations and also to identify the level of waste in a dust bin through a centralized system. Hence, the concerned persons will be notified about each bin status and there by achieving the removal of wastes in a proper way.

A smart bin for waste management is designed using an Arduino microcontroller, Wi-fi module and sensors to indicate the level of waste, to detect harmful gas and closing of lid thereby giving a solution to collect the waste in proper way. Real time monitoring and collection of solid waste for smart city services, where each bin is installed with Arduino microcontroller,

ultrasonic sensor and Radio Frequency (RF) transmitter on the top of the container which sends signal to the control centre through GSM/GPRS when the bin is filled. Smart Garbage Management System is developed where, IR sensors embedded on dustbins for waste level detection, GSM 900 modem is used to send waste level data collected by microcontroller, with an additional graphical user interface using MATLAB software.

A smart waste management system is proposed by an on-site and real time monitoring of waste as well as a data elaboration through decisional algorithms. An automatic smart waste management system is presented, where smart vehicle system with a local base station and a trash system with smart monitoring & controlling hut having two load sensor and IR proximity sensor were used and addressed. A step had been taken to connect the various sensor or actuators in a network through an Access Point (AP) to the cloud and investigated on three different sensor applications. Power consumption, Interference impact and range performance analysis are also evaluated for each application and discussed. Smart community is an emerging application of technological advancement of IoT. Smart community architecture is defined and realized by connecting individual homes through IoT.

Waste bins are part of our lives for decades and mostly its condition is overflowing due to improper waste dumping, collection and management, which leads in foul smell and unhygienic condition, thus inherently results in environment pollution. Therefore, in this paper, design of a Waste Bin with real time monitoring is presented and a smart waste management system is proposed using the recent technical advancements of automation and Internet of Things (IoT). The capacitance sensor in the bin continuously monitors the level of the bin in real time and communicates to the central cloud where the bins are connected. Ultrasonic sensor is used to open and close the lid of the bin whenever the persons are nearby the bin. Such smart bins are connected to the cloud, where the bin status is communicated, recorded and monitored by the local bodies through and android app or a centralized server. Thus, the designed smart bin and proposed waste management system have better level of smartness compared to existing ones in metropolitan cities in a centralized manner.

A similar application of the smart community in Neighbourhood Watch and Pervasive Healthcare is presented and challenges involved are also discussed. A possibility of using Mobile-2-Mobile (M2M) solutions for management of road traffic linking IoT is investigated. The use of Industrial Wireless Sensor Networks (WSN) in IoT environment is also proposed. In this work, the design of a smart sensor interface by connecting the sensors in WSN allowing the reconfigurability by reading the data in parallel as well as in real time using ARM Controller is also discussed in detail. Similarly, a smart home control network is developed and evaluated for the smart control of lighting systems in smart homes by using a scalable architecture combining WSN and Power line communications (PLC) technologies. This also results in less radio interference and allows an easy replacement of nodes in a WSN. An IoT-based Smart Garbage system (SGS) is reported, which are operated in Gangnam district, Seoul for a period of one year resulting in the reduction of food waste by 33%. Battery based smart dust bins are connected in wireless mesh network and a router and server is used to transfer the information collected in this work.

IoT architecture for optimized waste management in smart cities is also realized, where LoRa LPWAN (Low Power Wide Area Network) technology is used for the transmission of data collected from the microcontroller connected ultrasound sensor nodes. A Spatial Smart Waste Management System (SWMS) is implemented in Malaysia in order to manage the wastes by giving alerts about the waste level in a bin to the contractor for optimizing the collection routes and penalizes if not collected the garbage on time. IoT and Wi-Fi is also introduced based on reduce, reuse and recycle concept. It is like an enforcement system that makes the people to classify the waste for recycling and also used Device Bit and Blynk applications for real time monitoring [17]. A step is taken towards the detailed analysis of various waste management models and an IoT based reference model is implemented and compared with the existing models to identify the best choice and research challenges.

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According to the literature found and discussed numerous efforts were made in solid waste management and in IoT. However, the major challenge is to bring together the best method of Solid waste management and the technical advancements of IoT. Therefore, in general, a smart waste monitoring system consists of sensors, transmission medium, waste level data acquisition and collection system and connectivity to the cloud has to be found inside a waste bin for having smartness in the system. Inspired from the literature and the Swachh Bharat initiative of the Government of India, the main objective of this paper is to design and develop an IOT Enabled Smart Waste Bin with Real Time Monitoring for efficient waste management system. The developed system intends to reduce valued human resources effort, time and cost as well as to protect the environment and healthy living of the people with the help of Modern technologies such as cloud system, Wi-Fi, ultrasonic ranger sensor, capacitive action.

Inspired from the literature and as a preliminary study, design of a smart waste bin is presented in this section. This section also describes the use of different sensors, actuators and controllers associated with the design of the smart bin. The waste levels detection using the capacitance method is also presented. Further, a smart waste management system utilizing the designed smart bins is also addressed as a proposed system using the recent technical advancements of automation and the Internet of Things (IoT).A Design of Smart Dust Bin, where the smartness is achieved by having ultrasonic sensors, capacitive sensors, microcontrollers, servo motors, Node McU and integrating to form a

complete autonomous system. The waste level inside the bin is determined by estimating the distance between the bottom of the bin and the lid using ultrasonic sensor. In addition to this, the level of waste is also estimated. Block diagram of Smart Dust Bin. Change in capacitance principle by having parallel plates inside the bin. The sensors are connected with the controller and the levels are continuously recorded in the cloud. When the waste level exceeds the threshold value, which is set according to the dimension of the bin, the controller alerts the responsible municipal persons or the sanitary inspector with the bins ID, bin location and the bin level.

An automated opening and closing of the bin lid is also incorporated by having another ultrasonic sensor, which opens the lid of the bin whenever it perceives a person nearby to the bin. A power supply unit provides a necessary power to the operation of the bin. Once the bin is emptied and serviced, it returns to the default operation. A commonly used cylindrical plastic trash bin with the dimension of 30x20x60cm with lid is used to develop the smart bin. The smart bin uses two SRF 04 ultrasonic transceivers for the detection of waste level and to perceive the motion of a person nearby bin respectively.

The ultrasonic sensors are operated with the frequency of 40 KHz and the time-of-flight method is utilized to estimate the level of waste inside the bin and also to estimate the motion of the person when he falls inside the threshold value of 30cm. Ultrasonic sensor 1 is mounted facing the bottom of the bin, which measures the level of waste inside the bin with the threshold of 25%, 50%, 75% and 90% of the bin depth of 60cm. Similarly, ultrasonic sensor 2 used to detect the motion of the person is mounted at the top of the bin facing outside. TowerPro MG995 Metal Gear Servo Motor with 180□ operation is used as the actuator for opening and closing the lid of the bin whenever the sensor perceives the nearby motion of the person. The lid closes automatically when the person moves away from the threshold distance. A rechargeable Lithium Polymer (LiPo) battery of 2200mAh, 11.1V is used as a power supply to the entire system. Entire electronic system is mounted within a weather proof casing and fixed in the trash bin.

In waste bin monitoring system using zig bee and Global mobile communication system (GSM). The sensors are place in the common garbage bins placed at the public place when the garbage reaches the level of the sensors. Then that indicated will give in indication to the driver by ARM7 they sending SMS using GSM technology. The technology use by Zig bee, Global mobile system (GSM), ARM 7 Controller. The range of communication of the zig bee is almost 50 meters. They use for range GSM Module, analysing the image we get an idea about level of garbage. The zig bee and GSM system would be able to monitor the solid waste collection process. This technique overcome some disadvantages which are use of minimum route, low cost, fuel use, clean environment.

The waste management is built around several element. Waste item, domestic bin, trash bags, collective containers and collecting vehicles. The waste flow starts from the waste item and the domestic bin to end in the collecting vehicles. Use the waste identification for sorting process. Base on RFID technology new trash bag is added in a collective container. The technology use Radio Frequency Identification (RFID), Smart vehicular and Trash Bag. They only identify RFID tags garbage bins, Low data speed, high cost. The zig bee and GSM system would be able to monitor the solid waste collection process. This technique overcome some disadvantages which are use of minimum route, low cost, fuel use, clean environment. [3] A single directional cylinder is suspended next to the lid of dustbin. The piston is free to move up and down vertically inside the dustbin to a certain level. A plate is attached to the cylinder for compressing the garbage. The shape of this plate depends upon the shape of the dustbin. The compressing plate consists of a side hole through which the leaf switch is suspended upside down. Technology use Piston, Switch, microcontroller, the single directional cylinder, smart dustbin. Only use for smart dustbins, they are not providing garbage collection. Smart Dustbins can prevent the accumulation of the garbage along the roadside to a great extent thereby controlling the widespread of many diseases. It can prevent pollution and also prevent the consumption of the spread out garbage by the street animals.

A laser diode is a p-n junction diode which produces a narrow beam of light that is intense, focused and coherent. In a LASER diode a mirrored resonant

chamber is used to reinforce the light waves so that the light emitted by the device is at a single frequency and of the same phase. A photo detector is a device that converts light signals into electrical signals, which can be amplified and processed. Technology use Dustbins, LASER Diode, Photo Detector Diode, Road Side Units (RSU), and Garbage Collecting Vehicle (GCV). Only support for simulation of Transmission Control Protocol (TCP), routing and multicast protocols over wired. The dynamic routing of GCV compared with static solution is much more efficient and will be much effective when more than one dustbin fills up at the same time. The initial planned route is saved so that when real-time data is received only portion of the planned path may be changed.

For the garbage detection, weight sensor can be used. It gives the weight of the garbage in the dustbin. But it doesn't provide any information about the level of the garbage in the dustbin. Hence author used Infrared (IR) sensor for garbage detection. IR sensor radiates light which is invisible to the human eye because it is at infrared wavelengths, but it can be detected by electronic devices.IR transmitter consists of LED which send the IR beam. Technology use Infra-red sensor (IR), Microcontroller, Global System for Mobile (GSM), graphical user interface (GUI). Infrared sensor (IR), Global System for Mobile (GSM). They only use GSM network. Power and internet supply continue on. Smart garbage management system using IR sensor, microcontroller and GSM module.

This system assures the cleaning of dustbins soon when the garbage level reaches its maximum. Arduino is best described as a single-board computer that has deliberately been designed to be used by people who are not experts in electronics, engineering, or programming. It is inexpensive, cross-platform (the Arduino software runs on Windows, Mac OS X, and Linux), and easy to program. Both Arduino hardware and software are open source and extensible. Arduino is also powerful: despite its compact size, it has about as much computing muscle as one of the original navigation computers from the Apollo Programmers, designers, do It yourselves, and artists around the world take advantage of Arduino's power and simplicity to create all sorts of innovative devices, including interactive sensors, artwork, and toys.

To do awareness between the citizens about the dry waste and wet waste by doing the workshop, the program is very important, because of that the segregation of solid waste will happen on the source only. In India current now very few people know the difference between wet waste and dry waste. And these people mostly belong from urban elite's society, people from the slum areas don't know about the segregation, in fact, there is very less attention of urban local bodies found in such areas towards cleanliness. Therefore, to do the awareness about the cleanliness, segregation of waste in every citizen of society, the city is very important. The situation that we are seeing in the urban slum areas current now by seeing that we must have to awareness in between people. We as an educated student, by NGO's, by urban local bodies help. Therefore, a load of segregation will definitely reduce.

Classification of municipal solid waste:

India is always from an ancient era known as a diverse country by culturally, by language and also by climate, geographically and because of that the need for policies implementation of different areas is also have to do differently. But the current situation we are seeing that the policymakers rely only on very less information, data for making implementing the policies, therefore, there need to do the classification of Municipal solid waste by region wise.

Increasing Urbanization and shortage of funding:

Everyday urbanization of the country like India is increasing and because of that, the load on the civic infrastructural thing like water, sanitation, housing, solid waste management is also increasing. Therefore, to provide the infrastructural facilities in good manner to each and every citizens of the society it is responsibility of the urban local body means municipal corporations of that city and as we found that there is a lack fund is getting to municipalities and also not proper management of funding because of that the issue of solid waste management is increasing more in the urban areas.

Implementation of rules at ground level:

It is found the policy, act, rules under the policy act only written on the paper when its implementation time come at ground level then there is not at all

implementation found, because in the municipal corporation employees not get proper training also we found that the very fewer officers of ULBs do their work dedicatedly, therefore, dedication, proper training, finding the lacunas in the implementation of the policy is really important to implement the Municipal Solid waste rules.

Resistance for notification of new landfill site:

Selection for new landfill site to the Municipalities is very difficult because no one wants the garbage site near their house. Therefore, there always resistance have to face the municipalities from the people to choose the site for landfills.

Improper coordination between Centre and State:

There is always a lack of communication, coordination found in between centre, state and urban local bodies, for providing funding and because of that, it impacts on the policy implementation.

Appropriate technological solution, Outsourcing, and PPP:

New appropriate technological solutions are really important for the implementation of solid waste management. Like composting, biogas plant, vermicomposting then usage IOT based solution. And for adopting such technologies to municipalities definitely need the help of industries, NGO's and therefore public-private partnership is really important to implement it, that we found very less in the current situation.

Unsuccessful waste to energy products:

A country like India is still struggling for making the waste into an energy source and the reason behind only lack of awareness, lack of funding, lack of finance, lack of technical education and its training, carelessness of urban local bodies, therefore, to focus on all this aspect is really important.

Conclusion:

In most of the metro cities globally poses a on effective waste solid waste management and maintenance of the waste bins. In this work an IOT enabled Smart Waste Bin with real time monitoring is designed and presented. In addition to the waste level measurement by using ultrasonic sensors, a sensing mechanism based on simple parallel plate capacitance is also developed and presented. Experimental investigations are carried out where the waste level of the smart bins is measured using the parallel plate capacitance and ultrasonic sensors and the statuses of the bins are communicated to the cloud effectively. The results prove the efficiency of the designed smart bins qualitatively. A smart waste management system incorporating robotic smart bins, where the smart bin has the mobility to move to the waste dock localizing itself in the environment, is also proposed in this work. This system could find an application in smart buildings where the waste management could be practiced autonomously in a smarter way. Our future work is to investigate the performance of the proposed traditional and robotic waste management system in outdoor and indoor environment
respectively in our Institutional campus.