Smart waste management system for metropolitan cities

ABSTRACT

Waste bins are part of our lives for decades and mostly its condition are 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 are 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.

INTRODUCTION

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 is addressed in , 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 center through GSM/GPRS when the bin is filled . Smart Garbage Management System is developed and addressed in 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 in 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. In 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. A similar application of the smart community in Neighborhood Watch and Pervasive Healthcare is presented and challenges involved are also discussed in . A possibility of using Mobile-2-Mobile (M2M) solutions for management of road traffic linking IoT is investigated in . The use of Industrial Wireless Sensor Networks (WSN) in IoT environment is also proposed in . 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 in 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 in , 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 . A smart recycle bin based on 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 DeviceBit and Blynk applications for real time monitoring . 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. 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 intend 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.

CONCLUSION

In most of the metro cities globally poses a challenge 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 dockyard by 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.

ACKNOWLEDGMENT

Authors wish to thank Centre for Automation and Robotics, School of Mechanical Sciences, for the support and lab space provided to carry out this work under the Research Incubation Program, of Hindustan Institute of Technology and Science, Padur, Chennai.

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