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IoT Enabled Garbage Monitoring System

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***Abstract* – IoT is visualized to be a productive global infrastructure where substantial and virtual things possess self-configuring property, existence and intelligent interfaces to articulate with each other and share data. In this system, we focus to give an insight on the implementation of IoT based real time monitoring of garbage levels in trash cans. The garbage levels are monitored using IR sensors and the concerned authorities are notified about the status of the garbage once it reaches the assigned threshold value. Furthermore the paper will present and discuss the idea behind the design and implementation of IoT enabled garbage monitoring system.**

Keywords – Internet of Things(IoT), IR sensor, ESP 8266 node MCU, Arduino IDE..

I. INTRODUCTION

The Internet of Things (IoT) is an abstraction in which surrounding objects are interlinked through wired and wireless networks without manual intervention. In the study of IoT, the objects communicate and exchange information to provide advanced intelligent services for users. The latest advances in mobile devices equipped with various sensors and communication modules, together with communication network technologies such as Wi-Fi and LTE, the IoT has achieved considerable academic interests. The emerging IoT performs sensing, actuating, data gathering, storing, and processing by connecting physical or virtual devices to the Internet. For IoT applications performing these functions, a variety of researches on IoT services including environmental monitoring, object tracking, traffic management, health care, and smart home technology are being conducted. Building a general architecture for the IoT is hence a very complex task, mainly because of the extremely large variety of devices, link layer technologies, and services that may be involved in such a system.

This project is enhanced for creating a hygienic and an aesthetic environment by employing "Internet of Things" (IOT). One of the main concerns with our environment has been garbage monitoring and management which in addition to disturbing the balance of the environment also has adverse effects on the health of the society. The detection, monitoring and management of garbage is one of the primary problems of the present era. The traditional way of manually monitoring the garbage in waste bins is a complex, cumbersome process and utilizes more human effort, time and cost which is not compatible with the present day technologies in any way. This is a beneficial method in which waste monitoring is automated. This system monitors the garbage bins in real time and informs about the level of garbage collected in the garbage bins to the concerned authority for immediate disposal.

II. RELATED WORK

The term Internet of things (IoT) was first proposed in 1999 by Kevin Ashton, who is the co-founder of Auto-ID center at the Massachusetts Institute of Technology (MIT) [1]. IoT has emerged as a new network archetype, which allows various substantial entities in the world to connect with each other. The observed or generated information of these entities have a great potential to provide useful knowledge across different service domains, such as media, healthcare, energy-saving systems, surveillance services, smart homes, smart cities etc.

Monika K A, Nikitha Rao, Prapulla S B, Shobha G [2] in their work, discusses about a smart bin that is assembled with a microcontroller which is consolidated with GSM modem and three Ultrasonic sensors. This smart bin is segregated into three levels of threshold value to keep track of garbage being collected; it is equipped with three ultrasonic sensors at each level. After a time interval, if the trash exceeds threshold level the sensors receives data about the filled level. This acts as an input message for GSM. Their system cannot be feasible because of the expenditure of using multiple sensors on to a single dustbin is a defect also sensors can be damaged due to the rugged operation by users.

Insung Hong, Sunghoi Park, Beomseok Lee [3] came up with an idea of smart garbage system (SGS) to reduce the bulk wastage of food. In an SGS, battery-based smart garbage bins (SGBs) exchange information with each other using wireless mesh networks, and a router and server collect and analyze the information for service provisioning. Their work can be disadvantageous as it

requires high maintenance cost and there is a tradeoff owing to system's battery based power structure.

Kanchan Mahajan [4] proposes a system that monitors garbage bins using a combination of technologies such as ZigBee and Global System for Mobile communication (GSM). It is a system based on ARM 7 for collecting the garbage from a particular area where public garbage bins are overflowing. It consists of sensors that are placed on garbage bins, as the garbage reaches the level of the sensor, an indication will be set to ARM 7 controller. The controller will in turn send an indication to the driver of garbage collection truck as to which garbage bin is completely filled and needs urgent attention. ARM will give indication by sending SMS using GSM technology.

III. PROPOSED SYSTEM

The conventional garbage level monitoring system has proved to be a time consuming process because of manual intervention and is less effective as it lacks real time data transfer. Hence, the idea of an IoT enabled trash monitoring system has been implemented by us which overcomes the drawbacks of legacy monitoring systems. The basic design of the proposed system is to automatically notify concerned authority about the status of garbage bins once the garbage reaches certain specified threshold value. The existing trash monitoring systems are time consuming, less effective and incurs a lot of expenses and most of the time concerned authority are not be notified about the unhygienic environment due the overflowing trash in and around the city.

1. Key Objectives

- Deploy dustbins based on actual needs which improves environment quality, eliminates foul smell and helps to maintain cleaner cities
- Proposed system helps in resource optimization
- Reduces infrastructure, operating and maintenance costs, as well as reduce contamination directly associated with waste collection.

2. System Analysis and Design

System Analysis describes what the system should do, the System Design focuses on how to accomplish the objective of the proposed work which is better understood via Fig 1. It gives an overview of the interaction between components of the proposed monitoring system. The interaction starts with providing power supply to the microcontroller board which is the ESP8266 Wi-Fi module. A power supply of 5 volts is provided to drive the components including IR sensor. The IR sensor is attached to the rim of the dustbin, as trash fills up the hollowness of dustbin gets reduced and creates a dark atmosphere for the sensor to detect the intensity of heat, it begins to blink and transmits the analyzed data in the form of e-mails to concerned authority.

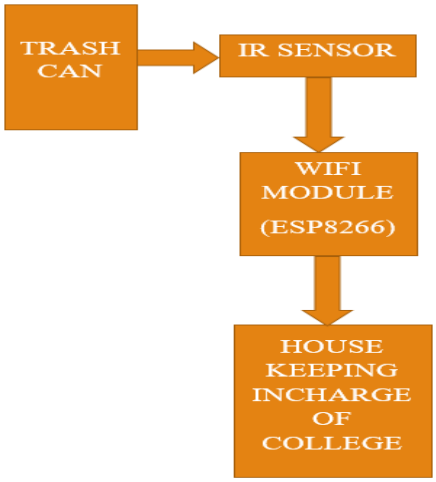

Fig. 1 Block diagram for a Garbage Level Monitoring System.

3. Component Description

ESP8266 Wi-Fi Module - The ESP8266 [5] is an economical Wi-Fi chip with entire TCP/IP stack and MCU potential produced by a Chinese Corporation. This minute device grants access to microcontrollers to associate to a Wi-Fi network and makes clean TCP/IP connections using Hayes-style commands, the ESP8266 has 1 MB of built-in flash.

IR Sensor - An infrared sensor [6] is an equipment to sense some facets of the surroundings. It can measure intensity of heat emitted by an object as well as detects any change in motion. It has very scarce supply current, the light detector and preamplifier are assembled in a single package and the internal filter for PCM frequency.

4. Design Methodology

The various design stages that are followed to implement the proposed idea are as follows-

4.1 Purpose and Requirement Specification

Purpose- A real time monitoring system that monitors the garbage levels at any given point of time.

Behavior- The monitoring system would have auto and manual mode, where it detects and measures level of garbage in trash, after which it transmits data remotely to the concerned authorities. In manual mode, the concerned authorities switch it on or off based on the requirements
System Management Requirement- The system should provide remote monitoring function.

Data Analysis Requirement- The system should provide analysis of data at remote site i.e. to the maintenance staff of the organization.

Application Deployment Requirement- The application should be deployed locally on the device, but should be accessible remotely

Security Requirement- The system should have basic security such as a casing to protect the system

4.2 Process Specification
In this step, the use cases of the IOT system are formally described based on and derived from the purpose and requirement specifications.

4.3 Domain Model Specification
The domain model describes the main concepts, entities and objects in the domain of IoT system to be designed. Domain model defines the attributes of the objects and relationships between objects.

Physical entity: The physical entity in proposed monitoring system are the discrete and identifiable entity in the physical environment such as a trash can, garbage, concerned authority etc.

Virtual Entity: It is a representation of the physical entity in the digital world.

Device: The devices used are IR sensor for detecting the level of garbage and Wi-Fi module (ESP8266) for processing and information exchange.

Resource: It uses on-device resources that is operating system runs on the single-board minicomputer. On device resources is the Arduino software, network resource is the Wi-Fi used for transferring data.
Service: There are two services-

- A service that checks if the garbage has reached the threshold value.
- A service that sends a notification to the concerned authority.

4.4 Service Specification
Service specification define the services in the IOT system, service types, service inputs and outputs, service endpoints, service schedule, service preconditions and service effects. The Wi-Fi service has input and output set to auto mode, because it receives input and output without manual intervention. When Wi-Fi is used for garbage monitoring, the endpoint is the IR mode has it is used for monitoring the garbage levels in a bin, it also follows the HTTP protocol as communication takes place over the web.

4.5 Functional View Specification
Device- it includes IR sensor, ESP8266 Wi-Fi module Communication- The communication function group handles the communication for the proposed IOT system. It uses Wi-Fi for communication.

Services- the Service functional group consists of device monitoring services.

Management- It consists of all functionalities concerned with configuring and management of the system.

Security- The security functional group includes security mechanism such as authentication.

4.6 Operational View Specification
In operational view specification, various options pertaining to IOT system deployment and operation are defined, such as, service hosting options, storage options, device options, application hosting options, etc. We can map the functional groups to operational view specifications for the infrastructure deployments as follows:
Devices: Computing Device (ESP8266 Node MCU Wi-Fi Module) and IR sensor
Communication API's and Wi-Fi
Communication Protocols: link layer- 802.11, network layer – IPv4/IPv6, transport layer- TCP, and application layer –HTTP

5. Implementation

In the embedded working environment, to build the proposed system much care is taken. In this scenario, the selected programming language should support both the hardware components and the application functions. For the proposed system, Arduino Language has been selected as it is a simplified language which is made up of C and C++ languages. If user knows the syntax of C programming language and functions then it is easier to code in the Arduino Language. If not, then only a few commands and syntax will be needed to communicate, Fig 2 is used to depict the complete project flow where the following sequence takes place.

- The flow begins with initializing the setup, in the sense the sensors' setup
- In the next step IR sensor performs garbage level test to check if trash has reached max threshold value or not
- Further, the outputs of sensors are analysed in the third step of the project flow. If the values obtained are in a healthy range, then the power is switched off and testing is stopped. If not, when results above the threshold a notification will be sent to the concerned authority via alert messages and the flow reaches its end.

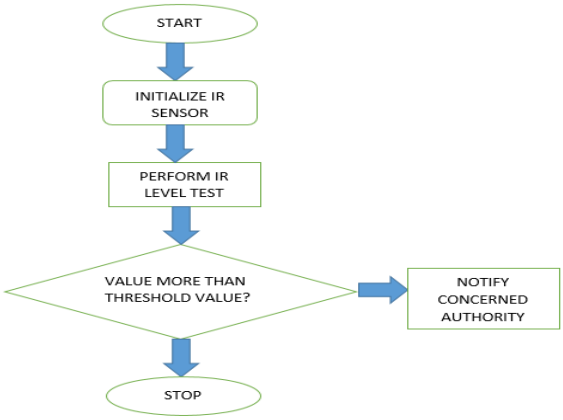

Fig. 2 Dataflow diagram for garbage monitoring system.

IV. EXPERIMENTAL RESULTS

In the garbage monitoring system, results are verified regularly by ascending and descending the amount of trash level in the bin. Every time the garbage level reaches the threshold value proclamation will be discharged as e-mails to the concerned cleaning authority. On the Arduino, when baud rate is set as 9600 we observe the output in serial monitor, which displays the height up to which the garbage is reached in the trash can. Apart from the height being displayed, it also displays messages if the rim of the bin is filled with garbage or not. The threshold value has been set to 5 which on exceeding, a notification is sent. Experiment result of the notification is provided in Fig 3

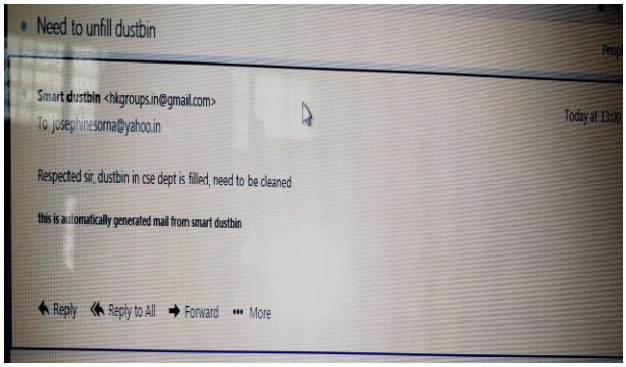

Fig. 3 E-mail notification sent to the concerned authority stating the status of the dustbin

V. CONCLUSION

We have developed and deployed a present time litter monitoring system by adopting smart dustbins to audit level of trash in it. This assures cleaning of dustbins in a routine manner at times when garbage level reaches its specified threshold. This proposed system is also an economical approach to deal with the issue of overflown garbage bins. By implementing the proposed system we observe cost reduction and resource optimization. The scope for the future work of the proposed system can be the idea of developing an alert module with android mobile application, by these authorities from anywhere in and around the locality can look into the increase in garbage levels. Also, we can improve the proposed system more efficiently by using more sophisticated sensors such as ultrasonic sensors.

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