Smart Underground Sewage and Solid Waste Management System-Implementation based on IoT

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Abstract: *In recent times, certain actions are taken to improve the level of cleanliness in the country. A lot of stinking and sewage problems cause bad hygienic conditions that lead to human illness and deadly diseases. To avoid these problems "Smart underground sewage and solid waste management system" is designed where it can overcome these in an innovative and efficient way. This idea can be implemented for smart buildings, cities, colleges, hospitals, public spots and bus stand. A precautionary system is developed where this issue of sewage and dustbin overflow can be reduced by early sensing of increase in its level. The system design comprises of a sensor to sense the level, a controller to command, a communication network to register the complaints on blockage and continues increase in the level of sewage. The system rather simply monitoring the level using an ultrasonic sensor, it generates signals to the required departments through the SMS and controlling using NodeMCU, communication using GSM modem which displays SMS to the mobile, Ubidots is a software to transfer the data to remote users and display the location regarding prior to overflow using GPS.*

Index terms: *sewage system, GPS, precautionary system, Ubidots, NodeMCU, GSM modem, Ultrasonic sensor.*

1. Introduction

Most of the cities adopted the underground drainage system and it should be in a proper manner to maintain cleanliness of the cities. If the drainage maintenance is not proper, the pure water gets contaminated with the drainage water infections and diseases may get spread. If drainage gets blocked during the rainy season, then it will create problems in our life. The traffic gets jammed, then the total green environment becomes clumsy, totally it changes the environment in different directions. So, it is the main responsibility of the municipal corporation to clean the drainage and garbage bin instantly and moreover public also should take care of their city. The main objective of this project is to keep the city neat, hygienic and healthy. This system is a design of WSN [11] platform for underground drainage and garbage maintenance system for IoT applications. To overcome the above problems only the solution is to maintain the smart underground manhole [2] and smart garbage container[1]. With this smart device, we propose an approach based on

IoT for underground sewage and solid waste management system. In this system, we use an ultrasonic sensor to measure the distance and an IoT module to communicate and GPS modem for finding the location where it overflows. The maximum level is set for manhole and garbage bin. It is maintained by an ultrasonic sensor [5] and sends the information to NodeMCU [6] controller. It sends the information to the municipal corporation using IoT platform Ubidots [7] software. If the internet facility is not available the information is sent as on SMS using GSM modem [8]. This design provides three-way alert systems, which include route map, display, and message alert system. The total system is controlled by a NodeMCU microcontroller.

The remainder of the paper is organized as follows: Section 2 describes the related works, section 3 discusses proposed methodology, section 4 give an explanation of the results section 5 justify the conclusion, finally section 6 brings the future scope of system, and section 7 gives the references.

2. Related works

Shaik, suvarna proposed in their work [9] The system consists of sensors, collect different types of data from sensors and transfer to the Raspberry Pi3 controller. The acquired output from the controller is sent to the control room through the email and also display on the personal computer.

G. Gowthaman, K. Hari Haran in their [10] system simply monitoring the level, it generates alarm signals via complaints to the required departments through mail and SMS regarding prior to overflow.

Muragesh S. K and Santhosha Rao [6] explain in their system monitoring the water level and atmospheric temperature and pressure inside a manhole and to check whether a manhole lid is open. It also monitors underground installed electric power lines. In real time, UDMS can remotely monitor current states of the manhole.

Yash narale apurva jogal et.al**,** [11] also gives a description of a water-wise system and detection method to detect leakage defects in sewer pipeline. Also, some part of condition rating model for underground Infrastructure Sustainable Water Mains and Intelligent system for the underground pipeline, assessment, rehabilitation, and management are explained.

Eunice David Likotiko, Devotha Nyambo gives an explanation in their work about the waste level data are updated and recorded continuously and are provided to decision algorithms to determine the vehicle optimal route for waste collection to the distributed bins in the city. Several simulation cases executed and results validated. The presented solution gives substantial benefits to all waste stakeholders by enabling the waste collection process to be more efficient.

Sunil Raj Thota, S. Neelima et.al, explains in their paper each trash can contain a smart device for level detection of the trash can which transmits the garbage/trash level with its token ID, accessed by the concerned municipal/regional authorities through the mobile app, so that they can take immediate actions to clean the trash can once it gets filled.

3. Proposed methodology

Today's drainage system is not high-tech. So whenever there is blockage it is difficult to figure out the exact location of the blockage. Also, alerts of the blockage are not received immediately. Hence detection and reconstruction of the blockage become time -consuming. It becomes very difficult to handle the situation when pipes are clogged completely. Due to such failure of drainage line people face a lot of problems.

Present System Proposes

- Find the location where overflow occurs.
- The system monitoring the flow of sewage from the pipes.
- Use of ultrasonic sensors gives the better result.
- Get the prior alerts of blockages and locate them using IoT. Trace location using GPS and send SMS through GSM.

3.1 System Architecture

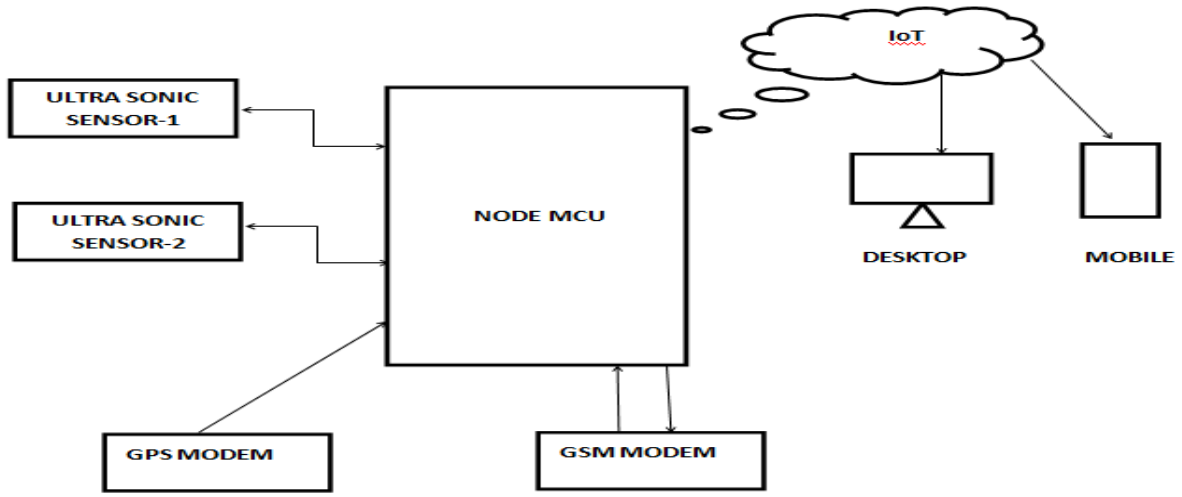

Figure 1: Block diagram of system

3.1.1 Ultrasonic Sensor

The ultrasonic sensor is used to calculate the distance to an obstacle. We compute the time which it takes to signal to come back. An ultrasonic sensor has two mesh holes one part is used for sending the sound out and another one is a microphone, which can measure the sound again. Without any disturbance, ultrasonic sensor has an outstanding capability to sense deep details. Ultrasound can propagate through any kinds of media including solids, liquids, and gases except vacuum. Time taken by the pulse is for to and fro travel of ultrasonic signals, while we need only half of this.
Therefore, time is taken as time/2.

Distance = Speed * Time/2

3.1.2 GPS Module

The Global Positioning System (GPS) is a satellite-based navigation system made up of at least 24 satellites. GPS works in any weather conditions, anywhere in the world, 24 hours a day. GPS receivers use this information and trilateration [12] to calculate a user's exact location. GPS satellites transmit at least 2 low-power radio signals. The signals travel by line of sight, meaning they will pass through clouds, glass, and plastic but will not go through most solid objects, such as buildings and mountains. However, modern receivers are more sensitive and can usually track through houses.

3.1.3 NodeMCU ESP8266 Wi-Fi Module

NodeMCU is an eLua based firmware for the ESP8266 Wi-Fi SOC [13] from Espressif. The NodeMCU firmware is a companion project to

the popular NodeMCU dev kits, ready-made open source development boards with ESP8266-12E chips. It's a SOC with integrated MQTT protocol stack that can give any microcontroller access to the Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

3.1.4 GSM Modem

GSM module is used to establish communication between a computer and a GSM system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. It is used for sending SMS and MMS to remote users having a mobile phone without internet facility.

3.1.5 Ubidots Platform

Ubidots is an IoT Application Development Platform that automates the process of IoT application creation for enterprises and individuals to deploy any IoT solution to scale and do quickly. The Ubidots platform is a user-focused point and click on IoT app builder with data analytics, dashboard visualizations, device management tools, BI events, and alarm engine, and end-user authentication to give users the data Ubidots collects, enhances, and delivers sensor, actuator, and beacon data that matters for businesses and users understand systems better, ultimately improving overall efficiency.

3.2 Working

The proposed system uses ultrasonic sensors, NodeMCU, IoT, GPS and GSM Modems for monitoring the garbage as well as drainage levels and sends the data to remote users i.e., Municipal commission system. This setup needs Wi-Fi facility to monitor the garbage as well as drainage level in dustbins and underground drainages continuously. The overall setup is used to maintain the smart and clean cities and reduce pollution and diseases.

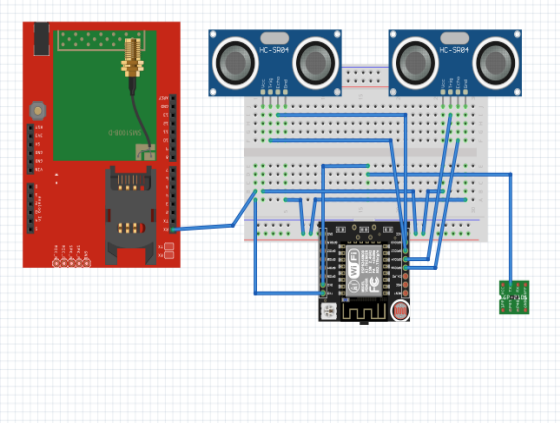

Figure 2: Working diagram of system

In this project work, two ultrasonic sensors were utilized to sense the level of manhole and dustbin. First one is placed in underground which is used to measuring drainage water level in underground drainages. This sensor detects the drainage water level in the underground drainage management system. The second ultrasonic sensor is used for measuring dust or garbage level. This sensor detects the garbage level in particular smart dustbins.

Ubidots is software which helps as a barrier to transfer the data to remote users with the help of Wi-Fi facility. Under particular threshold level, GSM modem can directly send the message to the user along with a location that how can be captured through GPS modem. The whole process can be managed through Node MCU. The remote users can access the data by using remote devices like PC's, laptops and mobile phones.

3.3 Algorithm

- Power up hardware.
- Initialize hardware Module.
- Upload and run the code into hardware module.

- Microcontroller senses the sensor value.
- When level increases the information will display on the dashboard.
- GPS trace location of that place.
- By using GSM location will be sent.
- If any sensor exceeds than its set value. Then GSM through message will be sent.
- IOT used for sensor related data will be updated on the web server.
- All information will be display on the Ubidots dashboard.
- STOP

3. Results

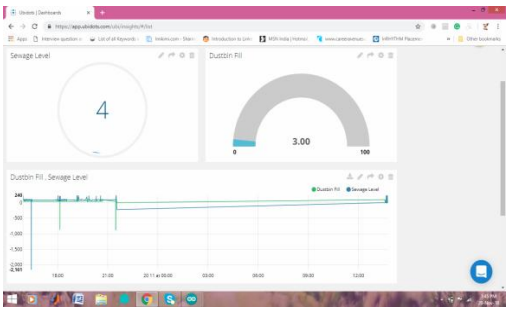

Figure 3: Initial values of ultrasonic sensor

The above figure shows the initial step of reading distance measurements using ultrasonic sensor.

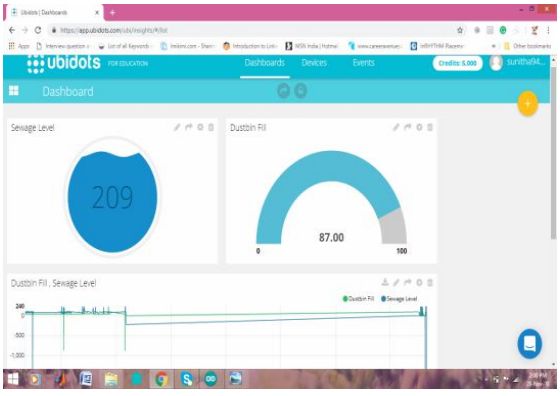

Figure 4: The Level indication of sewage and dustbin

Above figure shows the both sewage and drainage filling levels of manhole and dustbin. When ultrasonic sensor senses water level in the manhole and level of garbage filled in the dustbin then the results are displayed in the connected IoT platform as ubidots dashboard.

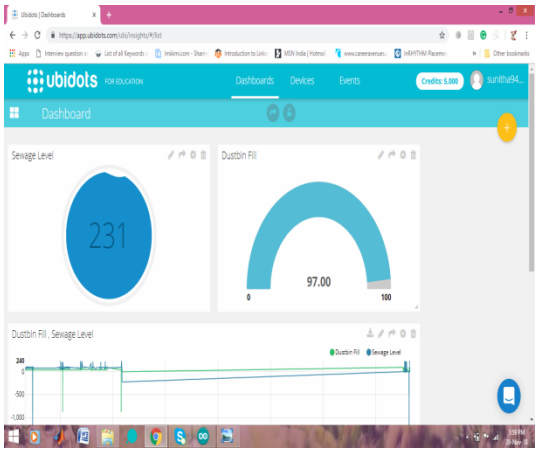

Figure 5: Filling level of both manhole and dustbin

This figure 5 is the sewage level indicator which displays the level of sewage within the manhole. This sewage level indicator helps to monitor the water level to control the overflow.

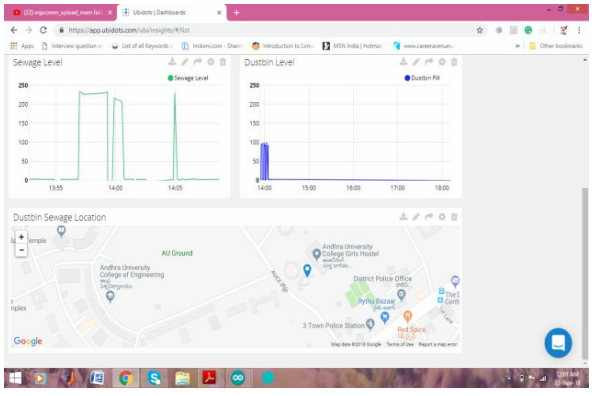

Figure 6: Display the location of the manhole

This figure shows how to change the level in manhole and dustbin according to time in a graphical representation. In this x coordinate

represents the time, y coordinate represents the length of the manhole. And also displays the current location of the manholes which is easy to reach.

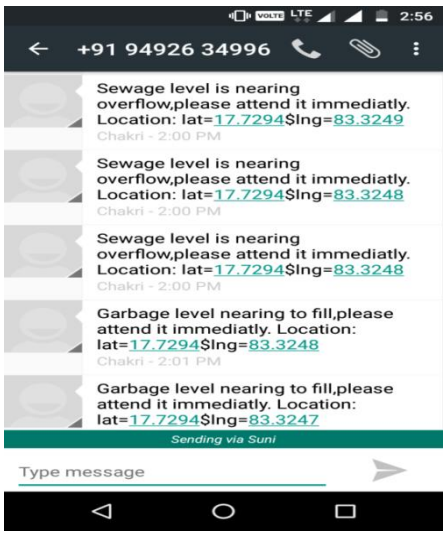

Figure 7: Display the SMS using GSM

The above figure displays the SMS using GSM module when internet connectivity is not available at remote users. It is divided in to parts, Sewage level and garbage level. If anyone goes nearer to overflow the corresponding message sent to Municipal Corporation.

5. Conclusion and discussions

Internet of Things is applicable for monitoring regular smart city applications by means of low cost and economic valuable sensing system. For measurement of parameters of the smart city by smart sensors and transmission of results via the internet is displaying in simple language. By evaluating past literature review we came to know that there is a need to notify municipal corporation about the received condition of the city directly via internet. so all results are directly sent to municipal corporation via send SMS command in ArduinoIDE software and Ubidots IoT platform to take appropriate action against it. So, monitoring smart city applications maintain a healthy and hygienic environment to live by using IoT technology and become the development of smart and safe cities.

6. Future scope

This project addresses all automated Internet of Things for Underground Drainage phases of the practical development of an Underground Drainage Monitoring and Solid Waste Management System through IoT applications for metropolitan cities. A real life, demanding application is selected as a reference to guide. Aspects of sensor network platform considered are: platform structure, flexibility and reusability, optimization of the sensor nodes, optimization of the communication, error recovery from communications and node operation, high availability of service at all levels, application server reliability and the interfacing with IoT applications. This project can be used to guide the specification, optimization, and development of sensor network Platforms for other IoT application domain.

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[23] Smart Trash Can Monitoring System using IoT - Creating Solutions for Smart Cities
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