International Journal of Research in Engineering, Science and Management
Volume-3, Issue-3, March-2020
www.ijresm.com | ISSN (Online): 2581-5792

Smart Sewage Gas Detection and Monitoring using IoT

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***Abstract*: Most of the cities adopted the sewage system and the duty of Municipal Corporation to maintain cleanliness, health and safety of the cities if the sewage is not properly maintained then it contaminated with the pure water and may spread infectious diseases. The sewage workers are not aware of sudden attack of poisonous gases. Since these gases are odorless, if exposed for a long time that may cause a serious health issues. This project aims to provide a smart solution to the poisonous gases that are released under the sewage and works on the system of live sewage gas detection and monitoring. If the level of the gases crossed its threshold level 10-20000ppm an alert is sent to the workers immediately and also to the controller and the pulse rate of the worker is also noted if the pulse rate is increased or decreased than 60bpm-120bpm then a notification is sent along with their remote location. This project gives a prior notification to the workers to ensure their safety. A gas sensor is used to detect the level of the gas. When the threshold value is lesser than the sensed value and it may send an alert though the buzzer to the workers and if heart beat gets low or high it may send alert through SMS along with its location by the GSM and the live location can be tracked through GPS.**

***Keywords*: Internet of Things, Global System for Mobile communication, Global Positioning System, Heart Beat sensor, Smart Gas Sensor.**

1. Introduction

Sewage environment IoT device and IoT platform to monitor poisonous gas and pulse rate has been proposed as a solution to help these workers who put their lives at peril and ensure minimal health risk. Because of the release of these poisonous gases, the death rate of sewage workers has been increased in the recent years. Due to the lack of treatment of the sewage, leads to the contamination with the pure water and may cause infectious diseases and serious health problems like hepatitis, typhoid etc. sewage are devices which are found commonly in different types of localities, ranging from residential areas to largely developed in dustier areas to provide solutions for treatment of sewage wastes.

Sewage gases are come from the decomposition of the bio-degradable and non-bio-degradable wastes which are mixed with the water and form a slurry like substances these leads to the production of toxic wastes that produce hazardous gases. These gases cause fatal if inhaled over a long period of time. Sewage gases contain methane (CH4), hydrogen sulphide (H2S), carbon monoxide (CO), ammonia, sulphur dioxide etc. To evaluate the gases which are present in the sewage environment several sensors are used to analyze the amount of hazardous gases like carbon monoxide, hydrogen sulphide and methane that are emitted and send an alert. These emission of hazardous gases are monitored every moment and updated every minute when it increases it normal grade. The project aims at designing a prototype for monitoring a sewage plant in real-time for keeping a check on concentration levels of gases. The designed system can be installed in various sewage facilities on both rural and urban areas. The system can be made to work properly in both domestic as well as industrial plants, by changing small specifications of design. For mobile access of concentration or ppm levels, Thing Speak IoT platform can be accessed from anywhere in the world via internet. This project constituted development of an IOT platform as its major part as well as the hardware to monitor the setup. When compared to the pre-existing system, which lacked in the continuous real time monitoring of level of gases and their updating of status.

This system provides solution to the dynamically changing sewer environment. This happens because flow of sewage water varies substantially with time and depends on a number of factors, like water pump condition, gas retention and damage to facility and temperature. This system checks on these factors as minute by minute analysis is accessible from remote locations through online monitoring.

2. Related works

The utilization of a sewage monitoring system sets in place a useful approach to remind individuals or facilities employing the workers and to evacuate areas when ppm levels of certain gases exceeds the threshold value. This saves lives of the employees working in harmful environments and saves them from hazards. Many Organizations often employs sewage tanks and chemical treatment of sewage sites in industries prior to sending in manual workers on site and there is no system is in place to check on hazardous levels. A smart system is defined as a cyber-physical system or an embedded system, that can process sensor data and assure a wireless communication to the server.

There are many different proposed systems researched by the scientist about the environmental pollution and air hazards due to industrial sewage. For example, IoT can be mainly be used to address the air pollution problem, as proposed in pollunio [2] which checks the Ground-level ozone and particulate matter that causes respiratory diseases such as sulphur dioxide, nitrogen oxides or airborne particles caused by emission of polluting gases from vehicles that degrade air quality. In survey [9] which brings in Wireless Sensor Networks(WSN)for air pollution monitoring system called Wireless Sensor Network and Air Pollution Monitoring System (WAPMS). This mainly utilize the Air Quality Index (AQI) as the main parameter and employs data aggregation algorithm to merge data to remove duplicate information's and filter out invalid readings. Proposal [5], the authors have designed an intelligent residential security alarm and remote-control system to check on toxic gas leakage in homes.

The Internet of Things [6-9] is being perceived by analysts as a stand out amongst most of the modern advancements with the plan to significantly change the wellbeing, security and security and addresses real effects inside the general public. This technology can be used in collaboration with sensors, and a smart system is designed for industrial purposes.

3. Hardware design

A. Introduction

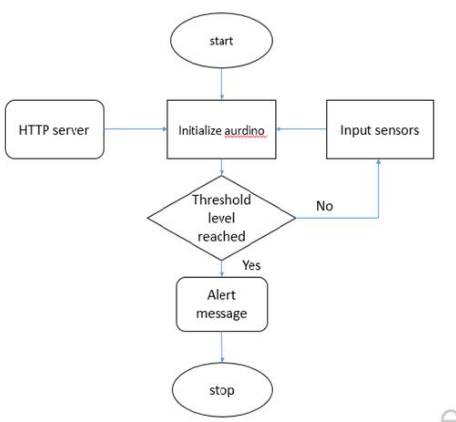

Fig. 1. Block diagram for system design

In this proposed system we have MQ4 gas sensor (consist of methane, carbon monoxide and hydrogen sulphide) which is used to detect harmful gases present in the sewage. Different nodal locations are provided to a single receiver end. The gas sensor produces values(ppm) which are emitted from sewage to the kit. Depending on a set of conditions, the output obtained by the gas sensor is transmitted via the GSM module to the cloud. In this project we have used ThinkSpeak cloud to store the values.

The heart beat sensor is used to check the pulse rate of worker to ensure the health condition of the worker entering the sewer. The pulse rate information's are stored and checked in the ThinkSpeak cloud. A prototype is introduced in strategic locations using sewer map and finding the most accessible location. They are placed at a sewage entry location.

GPS module is used to track the location of the worker who is in danger. The notification is sent to the ambulance service if the heart rate exceeds its threshold value. If the operators want to understand how sewage level changes time to time, then they can analyze the graph obtained by the system on the ThingSpeak IoT platform.

B. Hardware Description

There are two primary components, Arduino UNO and GSM module which make up this project model. The gas sensor is enabled by Arduino UNO which collects the sensor data's (ppm value) from the gas sensor (MQ4) present in the sewage. The real-time ppm values are continuously updated to the cloud using ThingSpeak platform. The ppm values are represented in graphical format which can be analyzed by the operator using ThinkSpeak platform. When the gas sensor values exceed the threshold value, then an alert is given to the worker and the values are stored via GSM module. The stored ppm values can be monitored by the user or the worker so as to avoid any accident that might occur while working at the sewage tanks. The heartbeat sensor is used to monitor the pulse rate of the worker which is useful to ensure their health condition. The GPS is used to track the location of the worker when the pulse rate value exceeds the threshold value.

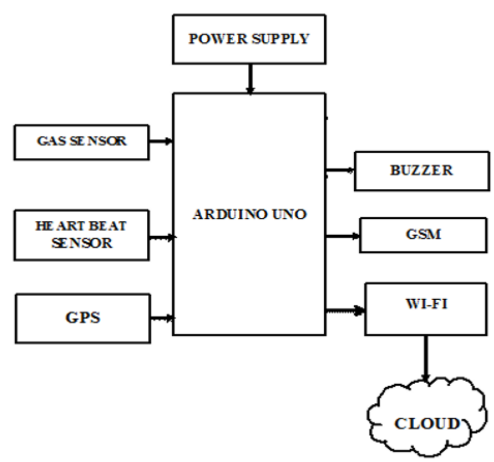

Fig. 2. Block diagram representation

The hardware components used in this paper for implementation are listed below:

Arduino Uno: The Arduino Uno is a microcontroller board based on ATmega328P which comprises of 14 digital input/output pins from which 6 are utilized as PWM outputs. Arduino Uno contains 6 analog inputs, a USB connection, a power jack, an ICSP header and reset buttons.

Gas sensor: MQ-4 sensors are used to sense gas such as methane, hydrogen sulphide and carbon monoxide. It consists digital input signals as Low and High. If the input signal is low, there is no gas affected and vice-versa for high.

Heartbeat sensor: It is used to measure the heart rate (i.e., speed of heartbeat).

GSM module: A GSM module is stands for Global System for Mobile module which is also known as GPRS. It is basically utilized to establish communication between a GSM and the mobile device and compresses the data.

4. Methodology

Figure 3 shows the system methodology which includes Arduino UNO where simulation of sensors, Software based SMS generation and tracking is done on this microcontroller.

Calibrating the sensors: MQ series sensors consist small heater with an electro-chemical sensor in order to measure different kind of gases combinations. It is recommended to calibrate the detector for 5000 ppm of gas concentration and use value of Load resistance (RL) about 20KΩ. The sensor itself yields an analog voltage which is transferred using an ADC. The values transferred can be used for designing to get the ppm values of the gas.

Connecting GSM Module to Arduino: It creates a serial communication between Arduino and GSM module. Hence, the serial pins of Arduino (Rx and Tx) and GSM is done by connecting Rx pin of GSM module to Tx pin of Arduino and Tx pin of GSM module to Rx pin of Arduino.

Connecting Heart Beat sensor to Arduino- The output pin of the sensor is connected to the pin 8 of Arduino. Vcc and Gnd of the sensor is connected to the Vcc and Gnd of Arduino. When we push the button, the system will start to count pulse.

Connecting GPS to Arduino: The NEO-6 GPS module has 4 pins: RX, TX, VCC and GND, which is quite easy to incorporate with using Software Serial on an Arduino Uno. The Tx of GPS is connected with port 3 of Arduino and Rx of Gps to the port 4 of arduino. The Vcc and Gndog GPS is connected to the Vcc and Gps of Arduino.

Connecting GSM Module to ThingSpeak:

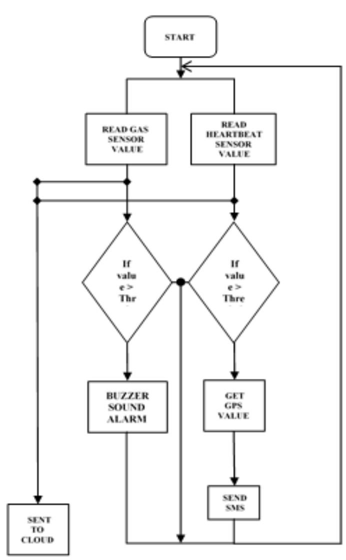

Fig. 3. Block diagram depicting methodology

ThingSpeak IOT platform uses channels to store data sent from devices. By altering the settings in Channel configuration, and creation of a channel is done, and then data is sent to and from to the channel and retrieved in the same way. Channels are made public to share data. Is done by connecting MQTT publish method which can be also used to update the channel feed and the MQTT subscriber to receive messages.

Sending the readings to ThingSpeak server and analyzing graphs using MATLAB in ThingSpeak- ThingSpeak IoT platform is an open source with incorporate Wi-Fi chip. In the proposed design, it is used to take readings from sensors and upload the value of ppm concentration of gas on the cloud using GSM that using HTTP.

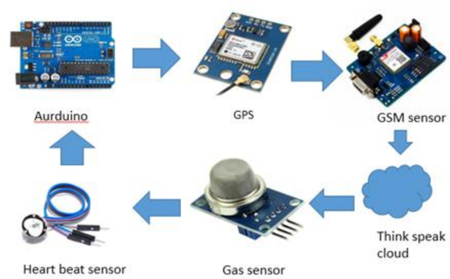

Fig. 4. Design flow

5. Result

The real time implementation of the system is show in figure 5 and corresponding cloud output is shown in figure 6.

We have used ThingSpeak IoT platform to update the ppm values of the gases information and send SMS to the operator or the worker, agency or any user. The hardware setup is first made with coding simulation. The code runs only after the GSM is setup. The following steps are required to initiate the precise work with the proposed system.

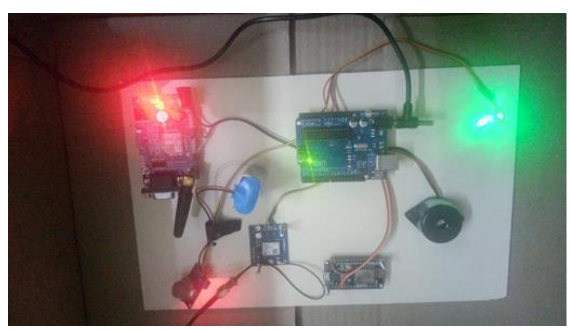

Fig. 5. Real time implementation of system

1. Calibration of sensors.
2. Sensors are exposed to atmospheric containing harmful sewage gases.
3. The readings (ppm values) are updated in real-time over ThingSpeak IoT platform.
4. The heart rate of the worker is monitored in the ThinkSpeak platform.
5. The GPS tracks the location when the worker is in critical

stage depending upon the heart rate.

6. Readings are continuously checked to see if they exceed threshold.
7. As soon as threshold is breached, SMS alert is sent via GSM module.

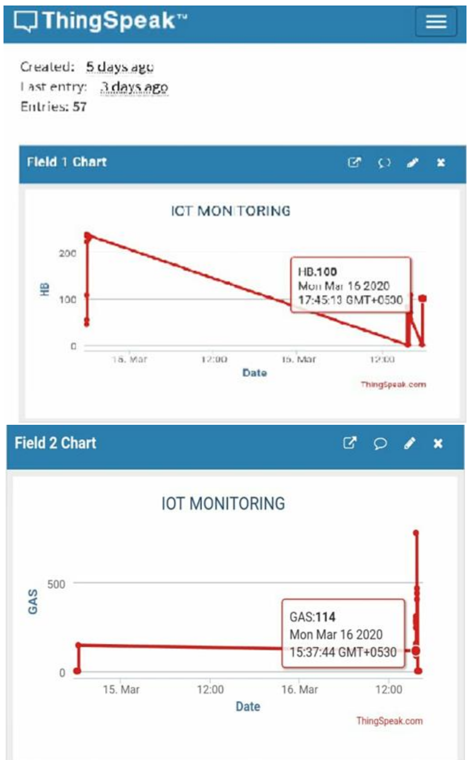

Fig. 6. Graphical analysis of result

6. Conclusion

Sewage are the method used to check on hazardous release of gaseous components into the environment in areas. Due to natural decomposition it often leads to production of toxic gases. These gases can be poisonous if inhaled for a long period of time. This proposed system will help sewage workers to protect their lives from risk and harmful disease like hepatitis and typhoid. According to recent news updates, many sewage workers lost their lives while doing their job by coming across the high concentration of such poisonous gases, which once inhaled led to serious health issues. This proposed system with advanced technology based on IOT will significantly impact the lives of sewage workers which includes more sensors for other toxic gases like sulphur dioxide, hydrogen sulphide (H2S) etc. and heartbeat sensor to check the heart rate of worker and GPS module to provide location information to the ambulance service if the worker is in critical stage. This design can serve a great social cause. Hence, this project will be able to aid the department of health and sanitation, and help fulfill a social cause for the country.

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