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Intelligent Remote Safety Monitoring of Sewage Workers

[1] Ms. S Lavanya Devi, [2] N Prabu, [3] S Ramesh, [4] G Keerthana, [5] E Vasupradha
[1] Assistant Professor, [2,3,4,5] UG Student
Department of ECE, Jerusalem College of Engineering, Pallikaranai, Tamil Nadu, Chennai, India

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ABSTRACT
In order to ensure the health of workers working under these harsh conditions, there is a need to develop technologies. In this project, we intend to provide a system that can detect, monitors and analyze the amount of harmful gases in real time using IOT technology. This project includes a device which has various sensors that detect the toxic gases, water level of the sewage which is placed in the manhole, and a wearable sensing device for the worker. If it reaches the certain threshold level, it sends the information to the authority using GSM and the location to the hospital via GPS.
Keywords : IOT technology, GSM, GPS, Wearable sensing device

I. INTRODUCTION

Sewage environment IoT device and IoT platform to monitor poisonous gas has been proposed as a solution to help the sewer workers who put their lives at jeopardy, and ensure minimal health risk. Because of these poisonous gases, the death rate of sewer workers has increased in the recent years. The lack of treatment of sewage after crossing dangerous levels leads to the deaths of thousands of sewage cleaners throughout the year from accidents and various diseases such as hepatitis and typhoid that occur due to sudden or sustained exposure to hazardous gases. Septic tanks are devices which are found commonly in different types of localities, ranging from residential areas to largely developed industrial areas to provide solutions for treatment of sewage wastes. Sewage gases generally arise from the natural decomposition of sewage and their mixtures formed by slurries which leads to the production of toxic wastes that release hazardous gases. These gases can be lethal if inhaled in high concentrations or for a prolonged period of time. Septic tank gases are primarily constituted of methane, subtle traces of carbon dioxide, some parts of Sulphur dioxide, ammonia, hints of hydrogen sulphide (H2S), nitrogen dioxide and traces of carbon monoxide. In order to evaluate the gases which are present in sewage environment, sensors have been used to analyze the amount of hazardous gas and send an alert.

The hazardous gases like hydrogen sulphide, methane and carbon monoxide emitted from sewage are sensed by gas sensors every moment and updated when it surpasses the normal grade. The project aims at designing a prototype for monitoring a sewage plant or septic tank in real-time for keeping a check on concentration levels of gases. The designed system can be installed in various sewage facilities, both rural and urban. The system can be made to work properly in both domestic as well as industrial plants, by changing small specifications of design. For remote access of concentration or ppm levels, Thing Speak IoT platform can be accessed from anywhere in the world via internet.

II. LITERATURE SURVEY

The sewage inspection framework forms were used to save workers lives in unsafe conditions. It sends a reminder to the offices that employ these workers when the ppm levels of specific gases go beyond the prescribed levels. Arduino is used in the survey [2] but Arduino cannot handle so many sensors at a time it would not be an effective approach. When these sensors attempt to give inputs to the Arduino processor simultaneously, complexity increases and hence inappropriate outputs. The device used in the survey [6] does meet the needs that would be expected by a sewage monitoring system. But again, it had no facilities which our prototype overcomes.

1. Respiratory health problems of sewage workers[1]

It studies the presence of noxious gases of sewage and parts of it. Study shows that gases like H2S, NH3, NO2, SO2, HCHO are the primary gases present in high amounts whichlead to several respiratory problems in sewage workers working in Primary settling tanks, Screening tanks, Aeration tanks and Mechanical de-watering of the sludge. Workers face general manifestations to acute respiratory manifestations which include problems like Headache, Dizziness, Fatigue, Dry cough, Chest tightness, Acute bronchitis etc. Although, no solution has been proposed or implemented to tackle this issue.

2. An efficient Cloud-based management of IoT device for air quality monitoring and cloud computing[2]

The proposed system tracks the ozone at ground level and the air pollutants causing asthma and other respiratory diseases. It tests ppm levels of pollutants, Cloud-based platform manages the data from air quality sensors.

3. IoT Sewage Gas Monitoring and Alert System Sewage regions Arduino Uno [3]

This has proposed a system to measure the ppm levels of gases only. Although, their system does not consider that temperature and humidity also play a major role in wellness of sewage workers on duty. Detection of blockages in advance is another necessity which has not been addressed in this system.

4. Sewage level Maintenance Using IoT[4]

The system design includes a sensor that detects sewage level, a controller to order, a communication network that records complaints about continuous rise in sewage level, and if any, blockages. To record the data a database must be maintained. The system generates warningsignals prior to overflow by means of complaints to the specified departments via mail and SMS.

5. Web-based real time Underground Drainage [5]

Incorporates a varied network of low-cost and long-lasting components that enables municipal authorities to track the sewage environment and water levels at all times, in effect ensuring the sewage workers' safety and well-being. The Light sensors are an effective way of ensuring that the man hole is always sealed, and also to confirm that the system and all its components are intact and are not vulnerable to theft. Yet as a drawback, night time renders these light sensors useless. As of now, no solutions are offered for this.

6. A Sensor for Nuisance Sewer Gas Monitoring [6]

In 2017, Mahyar Mohaghegh Montazeri and his team, proposed a sensor for sewer gas monitoring. Nuisance gases such as H2S are the main cause of unpleasant odor and alsocorrosion in the sewer pipes. Although there are treatment methods available, they are expensive to use and have negative side effects. Hotspot monitoring helps to apply the treatments to specific locations of the sewer, and hence minimize their side effects. Here we present a new sensor and supporting platform for nuisance sewer gas detection and monitoring. The sensor is fabricated using a highly-selective microfluidic gas channel coupled with a sensitive metal oxide semiconductor (MOS) sensor and a designed supporting platform consists of a custom syringe pump, automated sample delivery and vaporization chamber. To demonstrate the sensor sensitivity

regarding detection of hydrogen sulfide (H2S) (i.e., one of the main components in the sewer gas mixtures), different concentrations of H2S in a liquid phase are identified using special feature extraction methods. This shows the sensor capability and potential in identifying and measuring the concentration of H2S and other nuisance gases in a mixture.

III. PROBLEM STATEMENT

Sewage management is an important aspect of municipal infrastructure and undoubtedly, it affects our daily hygiene. Poor sewage /drainage management can cause urban floods which is most common in crowded cities. This problem can be addressed by using sewage monitoring and alerting system based on IOT, sensor technology and wearable technology.

Figure 1 – Man with sewage proof suit

IV. COMPONENTS REQUIREMENTS

A. ARDUINO UNO

Arduino Uno is a microcontroller-based board on the ATMega328P. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (integrated development environment).

Figure 2- Arduino Uno

B. MQ-7 SENSOR

Sensitive material of MQ-7 gas sensor is SnO2, which with lower conductivity in cleanair. It makes detection by method of cycle high and low temperature, and detect CO when lowtemperature (heated by 1.5V). The sensor's conductivity is higher along with the gas concentration rising. When high temperature (heated by 5.0V), it cleans the other gases adsorbed under low temperature. Please use simple electro circuit, convert change of conductivity to correspond output signal of gas concentration. MQ-7 gas sensor has high sensitivity to Carbon Monoxide. The sensor could be used to detect different gases contains CO, it is with low cost and suitable for different application. It makes detection by method of cycle high and low temperature, and detect CO (carbon monoxide) when low temperature (heated by 1.5V). The sensor's conductivity is higher along with the gas concentration rising. When high temperature (heated by 5.0V), it cleans the other gases adsorbed under low temperature.

Figure 3 – MQ7 Sensor

C. MQ-135 SENSOR

The gas sensor module consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads. This currentis known as heating current through it, the gases coming close to the sensing element get ionized and are absorbed by the sensing element. This changes the resistance of the sensing element which alters the value of the current going out of it. When no gas digital output is 1 and analog output gives 1023 max value. The sensor needs a load resistor at the output to ground. The lower the value, the less sensitive is the sensor. The higher the value, the less accurate is sensor for higher concentration of gas.

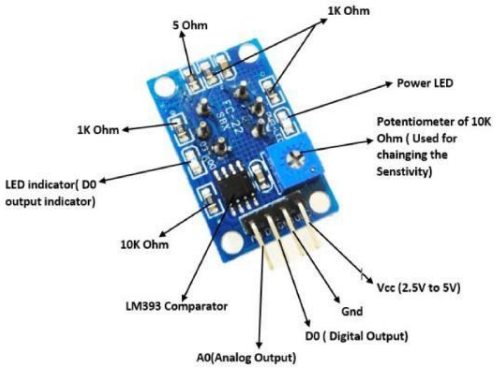

Figure 4 – MQ 135 Sensor

D. MQ-4 SENSOR

The MQ4 methane gas sensor is extremely used for detecting gas leakage at home or in industries like Methane (CH4) & CNG Gas. This gas sensor is highly responsive in very littletime, so based on the sensitivity requirements; it can be adjusted through a potentiometer. Thisis an analog output sensor, used like a CNG (compressed natural gas) sensor within the series of MQ sensors. So, this sensor is suitable for detecting the concentration of natural gas like methane within the air. For this sensor, if the gas concentration increases then the output voltage will be increased. This sensor works with 5V DC and draws 750 mW around. MQ4 gas sensor is simply used to detect the gas by using an analog pin or digital pin. Once the sensormodule is powered with 5Volts then it starts detecting the methane gas. Once it is detected then the LED will start glowing otherwise the LED will be OFF. Before working with these gas sensors, we have to set aside pre-heating time before you can work with them. Now, bringin the sensor to the methane gas & notice that the voltage throughout the output LED will be high like 5V, so the LED will be turned ON otherwise it will be turned OFF, so the voltage will be low like 0V. Similarly, the analog pin can also be used for detecting methane gas.

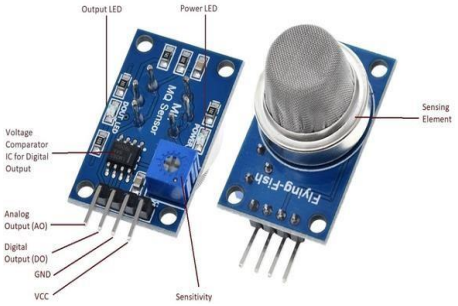

Figure 5 – MQ 4 sensor

E. WATER LEVEL SENSOR

The sensor has ten exposed copper traces, five of which are power traces and the remaining five are sense traces. These traces are interlaced so that there is one sense trace between every two power traces. Normally, power and sense traces are not connected, but when immersed in water, they are bridged. The power and sense traces form a variable resistor (much like a potentiometer) whose resistance varies based on how much they are exposed to water. The more water the sensor is immersed in, the better the conductivity and the lower the resistance. The less water the sensor is immersed in, the poorer the conductivity and the higherthe resistance. The sensor generates an output voltage proportional to the resistance; by measuring this voltage, the water level can be determined.

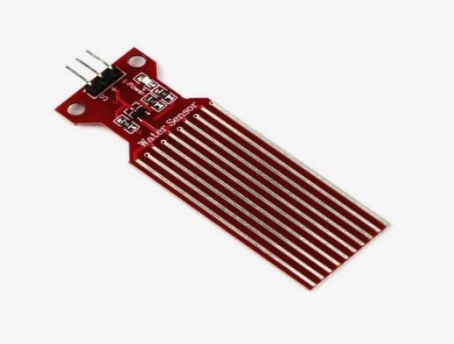

Figure 6 – Water level sensor

F. ESP8266 Wi-Fi MODULE

The ESP8266 WIFI Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WIFI network. The ESP8266 is capableof either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers.

Figure 7 – ESP8266 Wi-Fi module

G. GSM MODULE

A GSM module could be a chip or circuit that will be used to establish communication between a mobile device and a computing machine. It describes the protocols for second generation digital cellular networks used by mobile phones. It's the default world customary for mobile communications. GSM system was developed as a digital system using time division multiple access technique for communication purpose. A GSM digitizes and reduces the information. It sends the data down through a channel with two different streams of client data, each in its own particular time slot [6]. The digital system can carry 64 kbps to 120 Mbpsof data rates. The specifications of GSM module are, Supply voltage: 4.5V-5.5V, Current consumption: 500 mA, Operating temperature: -40 C to 85 C.

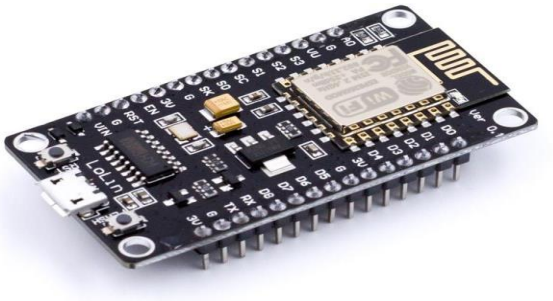

Figure 8 – GSM module

H. ARDUINO IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as **Windows, Mac OS X, and Linux.** It supports the programming languages C and C++. Here, IDE stands for **Integrated Development Environment.** The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuine and Arduino board with the IDE to upload the sketch written in the Arduino IDE software.

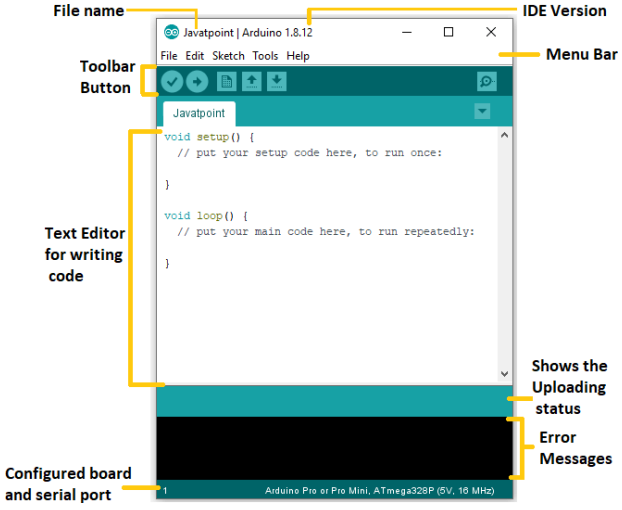

Figure 9 – Arduino IDE

I. ARDUINO IOT CLOUD

Arduino IoT Cloud is an application that helps makers build connected objects in a quick, easy and secure way. You can connect multiple devices to each other and allow them to exchange real-time data. You can also monitor them from anywhere using a simple user interface. Arduino IoT Cloud is fully integrated in the Arduino Create ecosystem, you will be able to generate a template code in Arduino IoT Cloud and then edit and upload it to your board using the Arduino Web Editor.

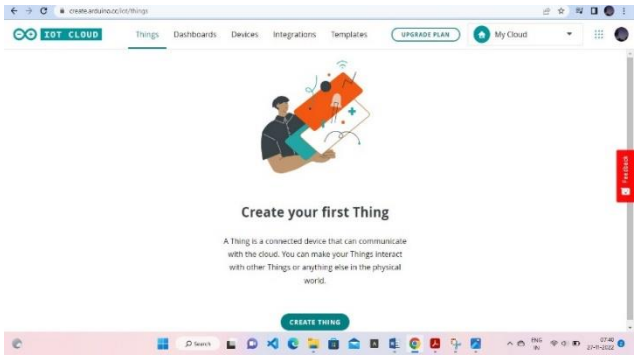

Figure 10 – Arduino IOT cloud platform

J. IOT DASHBOARD

An Internet of Things (IoT) dashboard is a data visualization tool that transforms, displays and organizes a collection of data captured and transmitted by network connected devices. The primary purpose of an IoT dashboard is to provide human readable information-at-a-glance to remotely monitor historical and real-time IoT data.

IV. SYSTEM DESIGN

The demonstration of the system design is carried out in the real time environment. The hand-held device is inserted into the drainage, it displays the concentration toxic gases using set of integrated gas sensors at different levels. Arduino board has ATMEGA328P processor and displays gas concentration through sensor values in the Webpage. A particular value is fixed as a threshold value to these sensors. The threshold value is decided based on the calibration of the sensor. The value sensed by the sensor is checked against the threshold value, the values will be monitored using IoT and the alert is given to the worker through Buzzer.

V. RESULT

The result of the project can be viewed from the Arduino IoT cloud platform, where we create a thing (Device) and configure it with the ESP8266 Wi-Fi module. Now, connect it to the Wi-Fi network. With the pre-installed compiler in the platform write the necessary codeto the board and upload it. Now the output from the sensor can be viewed in the dashboard. The corresponding graph and the mobile view output can be viewed.

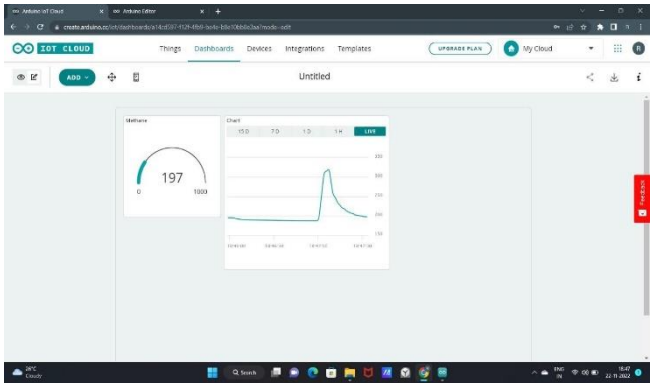

Figure 10 – Output from IoT Cloud

VI. APPLICATIONS

- Sewage management services
- Chemical industries

VII. CONCLUSION

The Internet of Things (IoT) has grown incredibly popular in recent times due to its various applications, which have surfaced way for a safer, smoother, and easier way to live. The issue of sewage cleaning is one

of the major concerns and challenges of the matter, despite the existence of several techniques. IOT applications for monitoring drainage systems in metropolitan cities are described in this paper. A major purpose of this device is to detect toxic gases, to alert and to minimize gas concentration levels for good working conditions. When the gas level exceeds the threshold limits, it alerts the sewage workers ans it shall send an alert on the connected mobile device to the authorized people who are remotely located in the job.

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