International Journal of Scientific Research in Computer Science, Engineering and Information Technology
ISSN : 2456-3307 (www.ijsrcseit.com)
doi : https://doi.org/10.32628/CSEIT12064114

IoT based Sewage Monitoring and Alert System using Raspberry PI

Jyothi Chillapalli*, Yogesh H. Jadhav
Computer Science and Engineering, Amity University, Mumbai, Maharashtra, India

Article Info
Volume 6, Issue 4
Page Number: 567-573
Publication Issue :
July-August-2020

Article History
Accepted : 25 Aug 2020
Published : 31 Aug 2020

ABSTRACT

The recurrent deaths of sewage workers make surveillance of sewage an urgent activity. Therefore, in order to ensure the health of workers working under these harsh conditions, there is a need to develop technologies. In this paper, we intend to provide a system that can quantify and analyze the amount of harmful gasses in real time and send an warning message when the levels are beyond the threshold. This project attempts to device an IoT technology using Raspberry Pi, ThingSpeak platform, and Pushover application. The gas levels along with humidity and temperature shall be observed. The experimental results show that whenever the gas levels exceed the threshold, the authorized individuals receive an alert on the connected mobile devices. In addition, the device offers live streaming of video to check blockages, if any. The directions for future research have been included at the end of the conclusion.

Keywords : Internet of Things, Raspberry Pi, Thingspeak, Pushover Application, threshold, alert message, live video.

I. INTRODUCTION

Sewage pipelines are filled with toxic gases, inhaling these gases for a long duration can lead to various chronic diseases. High concentrations of gases like Hydrogen Sulfide, Ammonia, Carbon Dioxide, Methane often leads to deaths. The lack of treatment and protection leads to the deaths of many sewage cleaners throughout the year. Manual system installation and data generation is both difficult and dangerous each time. So there is a growing need for automated data generation and monitoring. In this paper we suggest sewage tracking using IoT technology. The developed system will help to track the sewage environment 24/7 by the authorities that employ those workers. They will be able to analyze and take precautions in real-time, based on the system-generated graphs. The system comprises gas sensors namely methane and carbon monoxide, apart from which an additional sensor that will measure the humidity and temperature is connected. The IoT analytics platform produces graphs and sends warnings whenever the gas values go beyond the standard limits. The attached camera can provide live video on the HTTP server, which can be used to identify blockages that guide workers to take the appropriate precautions. The proposed prototype can be changed based on the requirement of the

industry. It can be used for monitoring the sewage conditions at different locations.

II. LITERATURE SURVEY

Varieties of the sewage inspection method have been used to save the lives of employees in hazardous environments. It sends an alert to the organizations that hire these staff, when the ppm levels of particular gases go over the strict limitations. In survey[1], This paper mainly focused on the worker's ventilation capacity, smoking habits, and work duties. The differences in ambient air pollution between new and old sewage plants clarified the variation in the health problems observed among the sewer workers. Survey [3] introduces a system called "Polluino" that monitors air pollution via Arduino. It is a cloud-based platform that manages the data from air quality sensors. It focuses on the ground-level ozone and particulate matter might cause asthma and respiratory diseases. The method proposed by survey[4] does not recognize that temperature and humidity do play a major role in the health of sewage employees on duty. Another need not discussed in this method is the identification of blockages in advance. Survey [8] focuses on sewage level maintenance, the system generates warnings via mail and SMS to the specified departments before overflow. Underground Drainage and Manhole Monitoring System (UDMS) [12] is a system for measuring the water level in a manhole and for checking whether there is an open manhole lid. It also controls underground installed electrical power lines.

III. PROPOSED SYSTEM

A. Introduction

In the current proposal, we prefer to use various gas sensors, such as MQ4 (methane sensor) and MQ7 (carbon monoxide sensor) to measure the quantity of toxic chemicals in waste, as well as humidity and temperature sensor (DHT 11). One receiver end is provided at completely different nodal locations for management of the current system. The system provides a large volume of data from the sewage to the control panel. These data are stored in the form of graphs on the ThingSpeak IoT database. The React application is used to set thresholds, ThingHTTP is linked to the Pushover Application to receive messages if the values are above the normal survival rates.If the operators want to understand the changes in the amount of sewer gas, humidity, and temperature over time, the graphs on the ThingSpeak IoT platform can be analyzed. Additionally, the Raspberry Pi camera provides the live video streaming feature to detect blockages so that it helps the sewer workers take the required equipment.

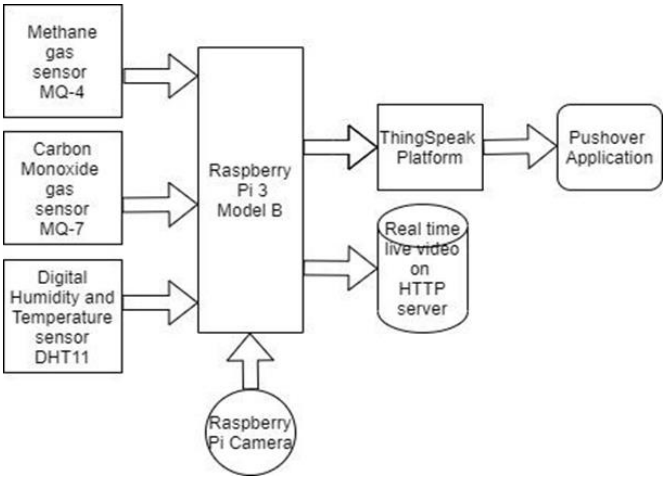

Fig. 1: Block diagram

A. Hardware Description

The Raspberry pi, Sensors and Raspberry Pi camera are key components of this project model. Raspberry pi provides access to sensor information derived from methane (MQ-4) and carbon monoxide (MQ-7), Humidity and Temperature sensor (DHT11).

In practice, these values were used to calculate the ppm values in real time which are then consistently

transferred to the cloud with the support of the ThingSpeak IoT platform. Using the ThingSpeak Tool the graphical representations of the ppm values of these gases are plotted. Ultimately, when the readings exceed the threshold values, the warning will be sent to the user's smartphone, React application is used to activate the ThingHTTP application, which in turn sends the alert messages to the registered devices' Pushover application. The ppm data rates of the sensor are reported and watched by the authority to avoid accidents and to save the sewer staff from diseases caused by these harmful gases.

Raspberry Pi 3 : The Raspberry Pi 3 is a single board computer. Operating System: Raspbian. It provides 40 GPIO pins, a camera slot for Raspberry Pi Camera, USB port, HDMI port, etc.

MQ-4 Methane Gas Sensor : This is used to detect methane gas. It has four pins Analog Output, Digital Output, Ground and VCC. Detection Range: 200 - 10000 ppm.

MQ-7 Carbon Monoxide Gas Sensor: This is used to detect the presence of carbon monoxide gas. It has four pins similar to MQ-4. Detection Range: 20 - 2000 ppm.

DHT11 Digital Humidity and Temperature Sensor: It has three pins Data Output, Ground and VCC. A capacitive humidity sensor and a thermistor are used to measure the surrounding air and give a digital output on the data pin. Adafruit Library is used to read the sensor data.

MCP3008 Analog to Digital converter: *It has* has 8 input channels and 10-bit resolution. It is used to read the values obtained from the analog output pins of the sensors.

Logic Level Converter (5v to 3.3v): *It* enables secure and easy communication between devices operating at different logic levels. A bidirectional Level Converter- 4 Channel is a small system that safely steps down 5V signals to 3.3V AND at the same time raises 3.3V to 5V.

Raspberry Pi Camera Board: It is capable of 1080p video and still images and connects directly to Raspberry Pi. Resolution: 5 MP.

IV. METHODOLOGY

Figure 2 shows the single board computer Raspberry Pi 3, Sensor data logging, SMS generation and reception using software.

Calibrating the sensors: The MQ-X sensor analog output pin is connected to the RXI of Logic Level Converter and RXO is connected to Channel 0 pin of MCP3008 IC. The sensor itself produces an analog voltage, which can be transformed with an ADC. The transformed value can be used to obtain the ppm value of the sensed gas.

Other Connections:

MQ-4 digital pin to GPIO

pin 6 MQ-7 digital pin to

GPIO pin 26

DHT11 data output pin to GPIO pin 4

LLC configuration: The HV and LV is connected to 5v and 3.3v of raspberry Pi. Gnd to Gnd pin of Raspberry Pi.

MCP3008 IC Configuration: VCC and Vref pins are connected to 3.3v pin of Raspberry Pi. Gnd pins are connected to the Gnd pin of Raspberry Pi.

CS to GPIO pin 8

DOUT to GPIO

pin 9 DIN to

GPIO pin 10 CLK

to GPIO pin 11

Putty: Used to enable interfacing between VNC and raspberry pi.

Virtual Network Computing (VNC) – VNC terminal which is used to do programming on Pi.

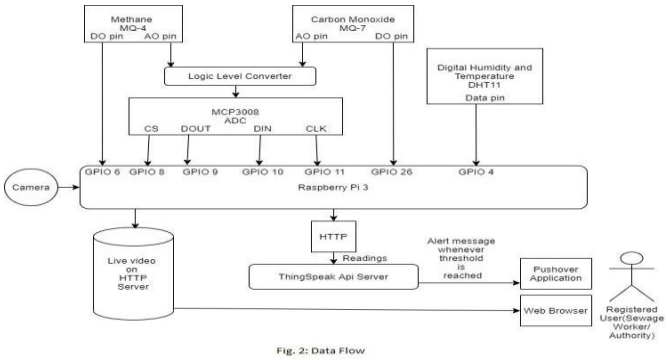

Fig. 2: Data Flow

Connecting Raspberry Pi to ThingSpeak Platform: ThingSpeak is an IoT Analytics platform that allows us to aggregate, visualize and analyze real-time data. A channel is created and the data is then transmitted to and from this channel, and the channel configuration settings are modified based on requirements.

React Application: Works with ThingHTTP to perform actions when a threshold is reached by the channel data.

ThingHTTP Application: Enables communication between websites and computers. It is triggered using React Application.

The ppm values calculated using the data obtained from sensors is transferred to ThingSpeak, Graphs are plotted for ppm values, humidity and temperature.

When the values go beyond the limit, the React app triggers the ThingHTTP of the respective sensor and sends the message.

Connecting ThingSpeak to Pushover Application: Pushover Application makes it easy to receive the update in real time. It has the option of forcing notification sounds to play when the application is open and the screen is unlocked. The message sent from ThingHTTP can be seen on the Pushover Application on the Android/iPhone/Desktop device of the user.

Connecting Raspberry Pi camera board to Raspberry Pi: The Pi has a separate slot for inserting the camera board ribbon. The camera can be enabled by clicking on the 'Enable' option available in 'Interfaces' settings on Pi desktop. Install the Autoconf package on Rasbian and download the Motion deb file. Edit the file. Change the start_motion_daemon to yes and add the ip address along with port number. The command "sudo service motion start" when run on the terminal will start the camera. Now, the live video will stream on ipaddress/portnumber.

V. RESULTS

The complete system is shown in figure 3.

At first, the Raspberry Pi's IP address was configured. Methane MQ-4 gas sensor, Carbon Monoxide MQ-7 gas sensor, Digital Humidity and Temperature DHT11 gas sensors were calibrated. Code for the sensors was written using the VNC terminal. Later, Pi was connected to ThingSpeak Platform. A channel was created with fields like CH4 PPM, CO PPM, Temperature, Humidity %. The ThingHTTP Request was created for every sensor which included the content of the messages. Similarly, four Reacts were created, which included the conditions for ThingHTTP to be triggered.

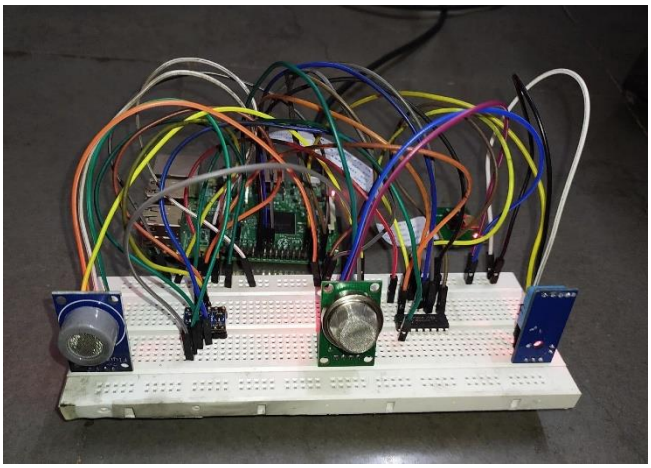

Fig. 3: Real-time implementation of system

The graph of the ppm values on the ThingSpeak platform is shown in the below figures.

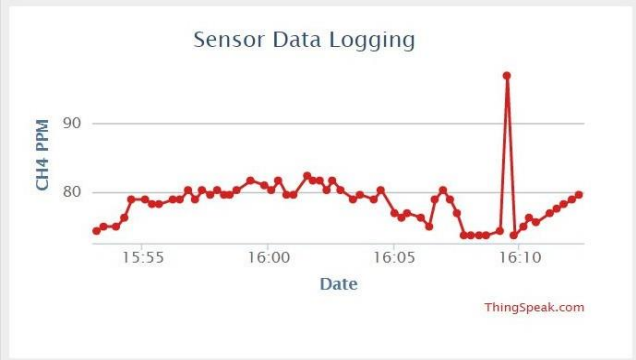

Fig. 4 : CH4 PPM vs. Time

Figure 4 shows the CH4 Methane ppm vs. Time, the values are around 80 ppm and at 16:10, we can see a steep rise, which goes above 95 ppm.

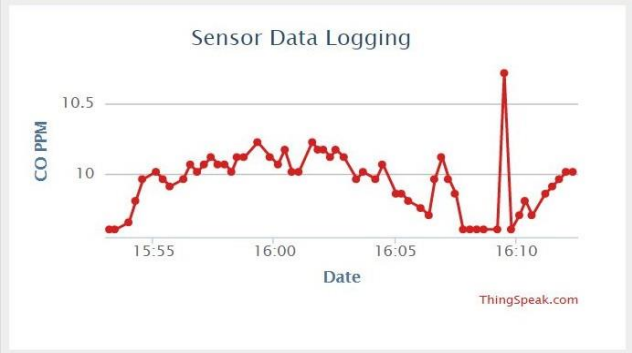

Fig. 5: CO PPM vs. Time

In Fig. 5 shows, the values can be seen fluctuating between 9.5 - 10.5. The highest point in the graph can be seen at 16:10 which is above 10.5.

The temperature was usually 31 - 33 degree celsius as shown in fig. 6 and the humidity ranged from 50 - 70 percent as depicted in fig. 7.

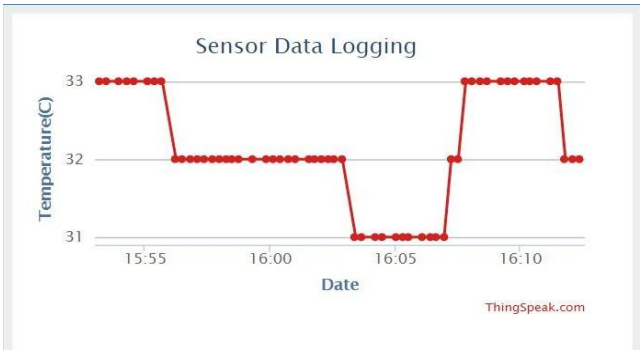

Fig. 6: Temperature vs. Time

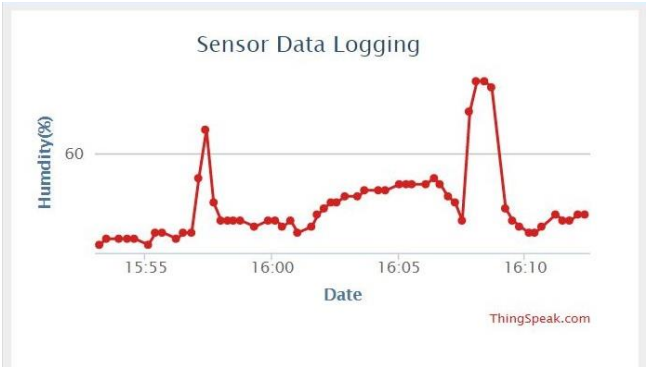

Fig. 7: Humidity vs. Time

The system was kept active the whole day to obtain a vast range of data. Meanwhile, when the ppm values, humidity and temperature exceeded the limit set on Reat Application. The ThingHTTP of the respective sensors were triggered and messages got sent to the Pushover Application. The user received the messages as shown in Fig. 8.

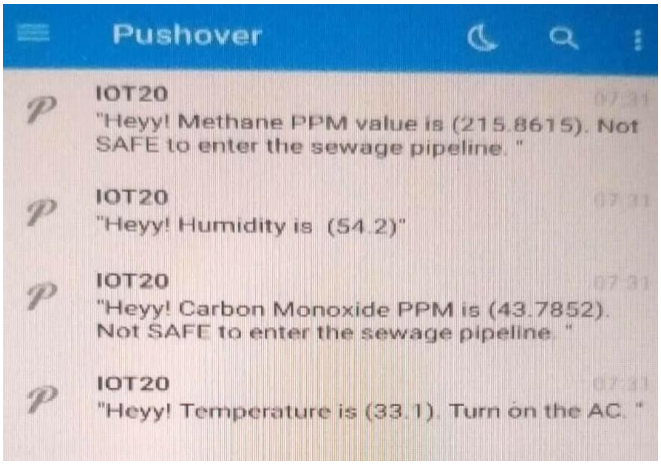

Fig. 8: Message received on Pushover Application

VI. CONCLUSION

Through natural decomposition, drainage always leads to production of toxic gases. These gasses can be harmful if inhaled for a long period of time and can lead to chronic diseases, if they are absorbed in the body at high concentrations. These toxic gasses are extremely hazardous for sewer workers and often lead to death. The goal of this project is to provide a technique to measure the harmful release of gaseous materials into the drainage system and thereby give the authorities a warning message to save the lives of the sewer workforce. The previous system failed to take into account several variables such as humidity, temperature, and live video generation. The humidity and temperature sensors, in addition to the gas sensors, can help determine the sewage's overall environment. The sensor values were utilized to measure each gas's voltage, density, and ppm. And the graphs were plotted in real time on the ThingSpeak platform using those values. This provides the authority with a means to track the sewage remotely. In addition, the ThingHTTP application allows the user to set the thresholds and adjust them according to the requirement. The device provided the planned performance whenever the gas levels exceeded the thresholds, and the user received the alert message on the Pushover Application. In addition, the Raspberry Pi camera's live video can help sewage workers detect blockage. There may be potential changes to enhance the overall efficiency of the proposed program. MQ- 135 Ammonia and Nitrous Oxide, MQ-136 Sulphide Hydrogen gas sensors are equally dangerous to human beings so can be added to the system. Chassis can be used to mount the designed prototype so that the camera can have broader coverage, and sensors can gather data as the system moves. An alarm/siren can be installed to warn people around the area of some unfortunate occurrence of an incident in and around the sewage for the sufferer's emergency rescue. With respect to, the values stored in the database with the corresponding date can be used as a dataset for the machine learning algorithms and the desired output can be obtained.

VII. REFERENCES

[1]. Saad A., Ebrahim Y., and Abdel-Shakour A. "Respiratory Health Problems of Sewage Workers." 2003 Environmental and Occupational Medicine Department, and Air Pollution Research Department National Research Center.

[2]. Hamid Raeisi Vanani1, Mohammad Shayannejad1, Ali Reza Soltani Toudeshki1, Mohammad Ali Arab1, Saeid Eslamian1, Vijay P. Singh2, Kaveh Ostad-Ali-Askari. (2018). "Feasibility Study for Improving the Quality of Refined Sewage Due to the Advancement of Soil." Water Engineering Department, Isfahan University of Technology, Isfahan, Iran. Department of Biological and Agricultural Engineering & Zachry Department of Civil Engineering,Texas A and M University, 321 Scoates Hall, 2117 TAMU, College Station, Texas, U.S.A.

[3]. Fioccola, G. B., Sommese, R., Tufano, I., Canonico, R., and Ventre, G. "Polluino: An efficient cloud based management of IoT devices for air quality monitoring." 2016 IEEE 2nd International Forum on Research and Technologies for Society and Industry Leveraging a better tomorrow (RTSI), 1–6 (Sep.).

[4]. Nitin Asthana, Ridhima Bahl. "IoT Device for Sewage Gas Monitoring and Alert System". 2019 1st International Conference on Innovations in Information and Communication Technology (ICIICT)

[5]. Liu, Z., Wang, Z., Chen, R., and Wu, X.. "Intelligent residential security alarm and

remote control system based on single chip computer". 2008 3rd IEEE Conference on Industrial Electronics and Applications, 159-161(June).

[6]. Keshamoni, K. and Hemanth, S., "Smart gas level monitoring, booking & gas leakage detector over IoT". 2017 IEEE 7th International Advance Computing Conference (IACC), 330-332(Jan).

[7]. Haswani, Navin & Deore, Pramod. Web-based real-time underground drainage or sewage monitoring system using Wireless Sensor Networks. 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA).

[8]. B. Sumathy, G. Gowthaman, K. Hari Haran, G. Keerthee Rajan, A. Sweeto Jeison, "Sewage Level Maintenance using IoT." 2018 International Journal of Mechanical Engineering and Technology (IJMET).Volume:9,Issue:2,Pages:389-397

[9]. R. Girisrinivaas and V. Parthipan, "Drainage overflow monitoring system using IoT (DOMS)," 2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI), Chennai, 2017, pp. 2133-2137. DOI: 10.1109/ICPCSI.2017.8392094.

[10]. Yash Narale, Apurva Jogal, Himani Choudhary, S. P. Bhosale. "Underground Drainage Monitoring System Using IoT", 2018 International Journal of Advance Research, Ideas and Innovations in Technology.

[11]. Prof S. A. Shamikh1, Suvarna A. Sonawane2, "Monitoring Smart City Application Using Raspberry PI based on IoT", International Journal of Innovative Science, Engineering & Technology, Vol 5, Issue VIL, July 2017.

[12]. Prof Muragesh SK1, Santhosha Rao2, "Automated Internet of Things For Underground Drainage and Manhole Monitoring Systems For Metropolitan Cities." International Journal of Innovative Science, Engineering & Technology, Vol. 2, Issue 4, June 2015.

[13]. Lazarescu, M.T., "Design of a WSN Platform for Long-Term Environmental Monitoring for IoT Applications," Emerging and Selected Topics in Circuits And Systems, IEEE Journal on, vol.3, no.1, pp.45, 54, March 2013.

[14]. S.D.T. Kelly, N.K. Suryadevara, S.C. Mukhopadhyay, "Towards the Implementation of IoT for Environmental Condition Monitoring in Homes", Sensors Journal IEEE, vol. 13, no. 10, pp. 3846-3853, Oct. 2013.

[15]. I. Akyildiz, W. Su, Y. Sankarasubramanian, E. Cayirci, "A Survey on Sensor Networks",IEEE Communications Magazines, August 2002.

[16]. Hamzeh Al Zabadi, Luc Ferrari, Iréne Sari-Minodier, Marie-Aude Kerautret, Aziz Tiberguent, Christophe Paris, Denis Zmirou-Navier, "Integrated Exposure Assessment of Sewage Workers to Genotoxicants: an Urinary Biomarker Approach and Oxidative Stress Evaluation", Environmental Health Journal, March 2011.

Cite this article as :

Jyothi Chillapalli, Yogesh H. Jadhav, "IoT based Sewage gas Monitoring and Alert System using Raspberry PI", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 6 Issue 4, pp. 567-573, July-August 2020. Available at

doi : https://doi.org/10.32628/CSEIT12064114

Journal URL : http://ijsrcseit.com/CSEIT12064114