Idea on Smart Sewage Monitoring System Using IoT

Rishabh Chakraborty[1], Hema Singaravelan[2], Shree Mehta[3]
[1, 2, 3] Dept of Electronics Engineering
[1, 2, 3] Vellore Institute of Technology, Vellore, India

Abstract- *Sanitization is really an important to maintain hygiene around the society. There is a famous proverb in English literature that "Cleanliness is next to Godliness." To maintain hygiene in the city lots of sewage workers die every year globally due to lack of information and safety equipment. In this paper we are going to find the solution of this problem and find a proper method with detail analysis to overcome this issue. Additionally, we have compared previous models and covered the loopholes faced in their models. The main thing which generally every model lacks is giving the proper idea of deployment of the proposed model. We have done a detailed analysis and come up with proper deployment idea with proper shielding knowledge of the hardware. The proposed model will save lives of many innocent souls all over the world by giving the information beforehand. Although it is a theoretical research and analysis, additionally we have put some of the results which were obtained during the process.*

Keywords- Deployment, loop holes sanitization and sewage workers

I. INTRODUCTION

Sewage water is contaminated with lots of combinations of toxic as well as nontoxic gases. Some of the toxic gases which might be present in sewage water are ammonia, Hydrogen Sulphide, Carbon Monoxide, Sulphur Dioxide. Out all these gases the most harmful gas is Carbon Monoxide (CO). If it is present in higher concentration the body oxygen is replaced by these gases which results into severe tissue damage or a sudden death. Many such cases occurred in India where many workers died instantly inside the manhole. Thus, the lack of information about the concentration (in parts per million) of these gases lead to a havoc situation which is faced by the poor and innocent workers. The maximum death toll of sewage workers is in India as compared globally. People are suffering from breathing problems, tissue damage and many more diseases due to the lack of monitoring system in India.

According to census report 2018-19 more than one sanitation workers die in every 5 days interval. In Gujarat, seven sanitation workers died while cleaning sewage near a hotel in the year 2019. Another case heard in Chennai where a worker died instantly when he went inside the manhole. These are some other shocking articles we read frequently in newspaper. There are some other reasons like lack of safety gears, pipes are not fixed and no technology is used to decrease the risk. The situation is not only faced in India. Globally, some countries are facing similar or worse than India because of lack of facilities. Supreme Court (SC) has banned workers from sanitation department and asked only machines should be used for performing such cleaning activities. But still local people are hired till now for cleaning without any protective gears or equipment. The poor diplomacy in our country and the politics involved is the main cause that this problem still prevalent in our country. However, keeping the political agenda aside, we can use technology to make protective as well as monitoring equipment to save the life of workers globally. The main idea behind choosing the project is that it can save lives of normal people whose entire family is dependent on him for food and shelter. Thousands of lives can be saved every month all over the world. So, we are going to build a smart sewage monitoring system which will alert the worker in case of emergency beforehand.

II. LITERATURE SURVEY

In this section we have highlighted and found the limitations in the previous proposed models in sewage monitoring system.

1. S. Kumar, S. Kumar, P. M. Tiwari and R. Viral, "Smart Safety Monitoring System for Sewage Workers with Two Way Communication," 2019 6th International Conference on Signal Processing and Integrated Networks (SPIN), Noida, India, 2019, pp. 617-622, doi: 10.1109/SPIN.2019.8711628. In this paper a strap on device was set up to monitor the heart rate and the environment in a sewer to alert the worker already in the sewer to evacuate when needed. They overall provided a good idea to monitor pulse rate, oxygen, methane concentration and made they system into a two way communication process. The strap on device provided insights on the acceleration of heart rate with time and depth, and also as a result of the presence of some harmful gases. It also detects atmospheric oxygen concentration and methane levels. However, the justification about the deployment of the device is missing. Additionally, the worker may face difficulty to work inside the manhole by embedding the device in their

body. The hardware size is more due to which the overall price increases.

2. Pushpakumar R, Rajiv S, "IOT based smart drainage worker safety system", IJITEE (2019), Volume-8, Issue-8, DOI: 10.35940/ijitee.H6576068819. In this paper a methane gas sensor, water flow sensor and a CO_2 sensor were placed inside the manhole to alert the sanitation worker and a control room that may send necessary help when needed to the worker.The system is set up inside the sewer to indicate the toxicity before the worker enters the environment. IoT set up to reach an outer source for help is commendable.The model is expensive.The model is inbuilt into the sewer, no indication as to how to proceed if model seizes to work effectively, in which case we would need another model. It does not address the fact that the sewage workers heart rate increases with time spent in the sewer and no tract of heath of the same person if he were to fall. The system can be improved a bit more accurate by covering up the above points.

Additionally, we have done a literature study from various domains of Science and Technology and found the normal and abnormal values of the parameters which we generally use in any sewage monitoring system. These parameters are pulse rate, concentration of gases inside the sewage, blood oxygen, temperature inside the sewage.

The temperature inside the sewage is generally in the range of 46.4 degree Fahrenheit to 68 degree Fahrenheit. LM-34 sensor is used to carry forward the work.

The CO concentration above 200 ppm is really harmful. The MQ4 gas sensor used detects CO in the range of 200-10000 ppm. The gases concentration varies inside the manhole or sewage for different depths.

The pulse rate and the blood oxygen (SpO2) is measured using MAX30102 sensor. The pulse rate in the range 55 bpm to 110 bpm is considered to be normal for persons in the age range of 18-50 years and the normal SpO2 concentration is 90-95% in our body.

Node MCU is used for IoT application as it is easy to embed and smaller in size.

III. METHODOLOGY

The proposed model generally emphasizes on three important parameters which are sufficient to save the lives of workers and they are (1) CO concentration (2) Pulse rate and SpO2 concentration (3) Temperature inside the man hole. Therefore, three sensors will be assembled to monitor these parameters and take decision on the basis of criticality. This is the detection part which will be assembled with the worker and inside the man hole. There are three sub sections in the project.

The first one is at the worker's side, the second one is the Controller room and the third one is the band to be worn by the worker before entering the manhole. The worker will be provided with safety band before entering the man hole. The band consists of (i) **MAX30102** is a pulse–oximetry sensor used to measure the pulse rate and SpO2 concentration of the worker while he is inside the manhole. (ii) **MQ4** sensor to measure the CO concentration at different depth inside the manhole (iii) **ESP8266 NodeMCU** is used to send the data to the cloud using (IoT) (iv) A SOS button is provided for the worker during emergency which on pressed activates the **Buzzer** in the Control room. The three LED's are connected on the edges inside the manhole. This LED's will help the worker to get alert during emergency situation. **GREEN LED** will be indication that the situation is normal and the worker can go inside for cleaning process. **BLUE LED** will be indication that the situation is getting abnormal and alert the worker. **RED LED** will glow if any one of the parameter becomes abnormal and initially if it glows the workers won't be allowed to go inside. In that case the sanitation should be carried out using machines only. The buzzer will activate when **BLUE and RED LED** glows to alert the worker. A **LM-34** temperature sensor and **MQ4** gas sensor is connected such that they give the information about the condition of the manhole before sanitization works proceed. These LEDs, buzzers and sensors are connected through a **NodeMCU** which sends data and store in the cloud. It updates the data every day in the cloud.

The person who is monitoring the worker's activity near the manhole can check the data in mobile phones with internet connection in the Cloud. Additionally, the Controller Room will be continuously monitoring the values. The added benefit of the proposed model is that, we have programmed the microcontroller in such a way that the ALERT signal will be send as soon any one of the parameters going nearer to the Threshold value (temperature, CO concentration, pulse rate, SpO2 concentration, and smoke). Threshold value is the cut off value beyond which abnormalities occur. So, a lot of literature study is done to get the data and the Threshold value is obtained accordingly. There may be upper and lower Threshold for some parameters.

The LED's are having Acrylic body which makes them water resistant and the rest setup inside the manhole will be properly sealed to protect from water if overflow occurs. The block diagrams for the three subsections can be seen in

the Figure 1, 2 and 3. In Figure 4, we can observe the conditions applied to alert the worker using the Threshold values obtained from the Literature Study.

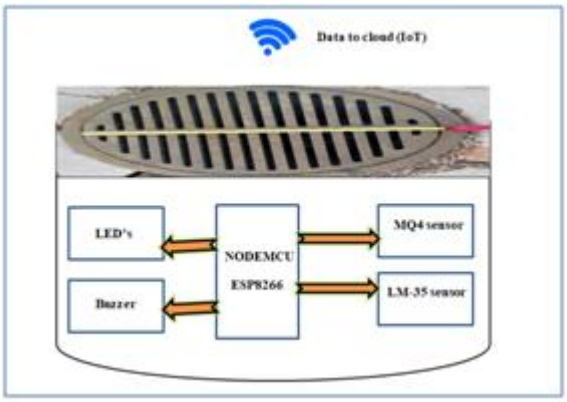

Figure 1 Inside the manhole

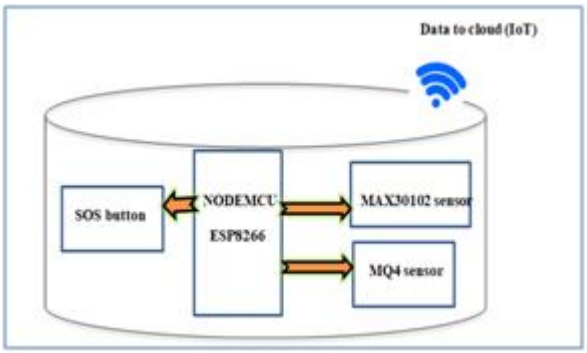

Figure 2 Proposed Band Structure

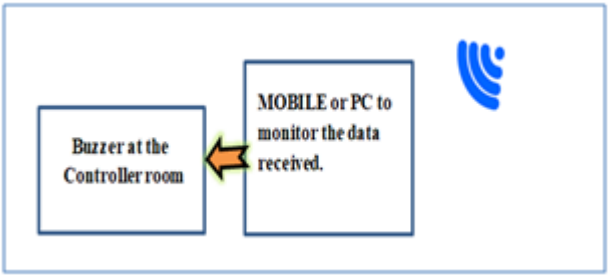

Figure 3 Controller Side

Figure 4 Flowchart for the parameters to ALERT

IV. DEPLOYMENT

The main challenge faced by us is the deployment of the hardware setup. The hardware should be placed in such a way that we get proper readings from the sensors. It should be kept in a safe area such that no one can steal or destroy it. Another important factor is the comfort zone of the worker. The worker shouldn't feel difficulty while working wearing the hardware setup. The only best wearable device is band which will be in the wrist of the worker and therefore it won't hamper him.

The second and the most important thing is to ensure the safety and proper condition of the hardware setup. The hardware setup should be sealed using acrylic compounds and proper pipes for wirings inside the sewage. This ensures proper working of the device for a long time. For maintaining security the hardware for monitoring the internal conditions of manhole will be locked inside the manhole. The band will be with the organization that is going to conduct the sanitizing work. Additionally, the setup will be organised in such a way such that after opening the lid of manhole the worker can judge the condition inside the manhole by seeing the colour of LEDs. This will help in gaining the information about the conditions inside the sewage or manholes easily.

Figure 5 Hand band model

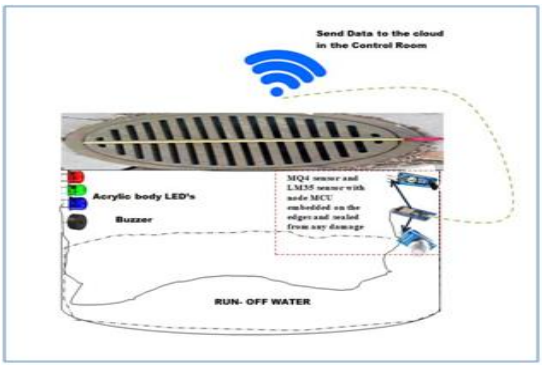

Figure 6 Setup inside the manhole

Figure 7 Hand band model

From Figure 5, we can see the proposed wearable band prototype. It consists of NodeMCU Wi-Fi module to send the data to the cloud. In case of our model we used IoT cloud by MATLAB, "ThingSpeak". Also the band consists of a second MQ4 sensor which will detect the CO level inside the manhole for different depths because the MQ4 sensor inside the manhole is stationary and can read the concentration level for a particular distance. The band will have MAX30102 sensor on the backside which will detect the Pulse Rate and blood level oxygen continuously when the worker is inside the manhole. Additionally, a SOS button is provided for the worker during any emergency situation.

From Figure 6, we can observe that the setup build inside the manhole. The LEDs and buzzers are going to be embedded on one corner of the wall and the sensors on the other corner. The connection will be through another NodeMCU. The setup should be sealed properly with water resistant materials and the wirings must be covered through proper pipes.

From Figure 7, we can see the setup of the Controller house. They will be continuously monitoring the data in the cloud. They will be ready to take necessary precautions and provide proper help to the worker during emergency situation. The control room is not compulsory the person who will be standing the near the manhole can easily monitor the data in his mobile phone. The only basic requirement would be a smart phone with proper internet connection.

V. RESULTS AND DISCUSSIONS

The setup is taken and has been tested in nearby drains to our locality to understand the working of the process Due to nationwide lockdown we can't test the model inside the manhole with proper worker. So, a rough estimate can be seen of the working model as obtained from the drainage system. The band also couldn't be used since we can't go inside the drain. However for the validation we have shown the normal case readings in the form of LCD. The other readings will be taken and experimented after the lockdown ends.

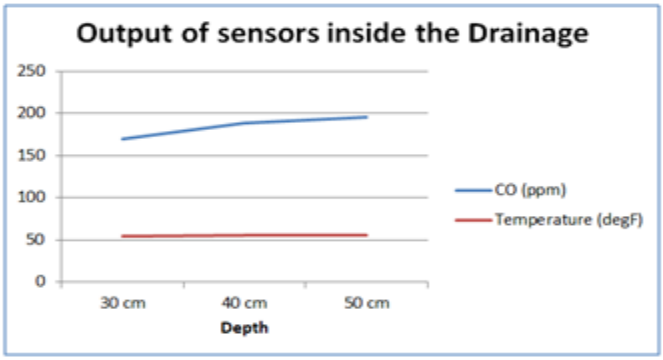

Figure 8 Reading of the CO and Temp sensors

From Figure 8, it can be observed that the temperature inside the drain almost remains constant. However, the scenario will not be the same in case of manhole. There the depth will increase to 1m to 10m and may further increase to certain levels. Due to which the temperature will increase up to a good level as compared to the drainage system.

Additionally, we can see the concentration of CO slightly increases with the increasing depth. Thus it shows that a normal drainage water up to a small depth consist of this much level of CO concentration, than in case of manhole the concentration will increase to 3 times or in fact 4 times based on the contaminated water. This experimental results show how important is it to build a monitoring system using technology and use their benefits.

The data in the LCD as obtained are shown below:

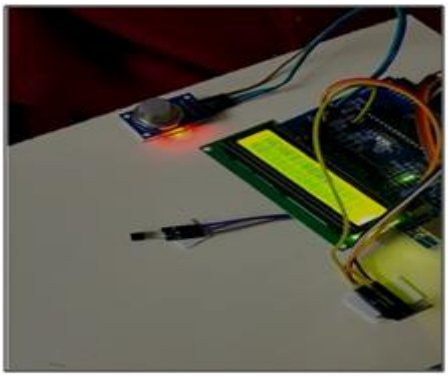

Figure 9 Heart beat reading with the band

Although many models have been propounded so far in Sewage Monitoring System, our proposed model emphasizes on quality rather than quantity. In previous models, lot of sensors were used which makes the system deployment bit difficult. In our system, we used only three major sensors which will detect all the important parameters effectively and hence hardware size and cost decreases. Additionally, many people have used 16 x 2 LCD display in their prototype which we personally feel as of no use in real time for the worker's safety. These sensors are sufficient to make any monitoring system effective, since our major goal is to save the worker's life. So, our project will detect the Heart Rate, Oxygen concentration in blood (SpO2), Pollution index, CO, smoke detection, temperature. Additionally, our model will alert the worker or control room before any emergency situation occurs. It uses the modern IOT technology which leads to store and access data remotely.

The more emphasis is given on CO detection, since it is one of the major reasons workers die and suffer. The propounded system will show the result before the worker moves inside the manhole. Additionally another CO detection sensor is placed on the wearable band such that it can get the concentration values at different depths inside the manhole. Another selling point is the system is made simple, since most of the workers may not be educated so we have given visual outputs in the form of light and sound which the workers can understand. A SOS button is provided in case the worker faces any problem. The reading of the sensors will be stored in the cloud of the Control Department and they can monitor it from the control room and an alert signal will be send to them if any parameter reaches nearer to the threshold value.

VI. CONCLUSION

The proposed model is going to save the lives of many workers since there is lack of safety costumes available for sewage workers. The proposed model is programmed in such a way that before the situation becomes abnormal we can easily predict it. The colour of the LED light will ensure the working condition before the sanitization process starts. If red LED blinks, the conditions are critical and in such case the workers won't be allowed and therefore machines will be used to sanitize. If the condition is normal the worker will be allowed to go inside after wearing the band to ensure safety. Thus the proposed model is going to work like a duplex mode. The monitoring side has to be alert all the time.

The system can be made more enhanced after one or two months of usage. Machine Learning can be used to make proper prediction analysis with the data obtained during these phase of two months. This will enhance the performance of the system by predicting the abnormal situations long before it will occur. Future researchers can work on it, to make the model more effective.

Thus with these information by the proposed model lives of many innocents can be saved without spending much on protective gear equipment. The Government has to invest only once on sensor deployment in all the manholes and a small wearable band as described in the prototype. The overall cost of the system including the labour and electrician charges for deployment would be somewhat close to 5000 INR which is economical.

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[3] A web article on Carbon Monoxide (CO) Concentration https://www.detectcarbonmonoxide.com/co-health-risks/.