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IOT BASED SMART SAFETY MONITORING SYSTEM FOR UNDERGROUND SANITATION WORKERS

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Abstract: Underground sanitation workers are suffering from various threats like explosion of toxic gases and sudden health changes due to changes of the underground environment. A large number of underground sanitation workers die every year due to the release of harmful toxic gases and lack of facilities available. Also, leaks and bursts are unavoidable aspects that account for loss of life of sanitation workers if left undetected for long period. Our project attempts to develop an IoT based smart safety monitoring system for underground sanitation workers that detects the toxic gases released during underground sewage cleaning process and a system to monitor the health of the underground sanitation workers. This system senses the type of toxic gas along with its severity level. Hence this system will monitor the concentration of methane (CH4), carbon monoxide (CO), hydrogen sulphide (H2S) and other toxic gases with respect to atmospheric Oxygen (O2) and provide alert to the workers and exterior unit when parameters deviate from the safe range. All the monitored parameters are sent to the mobile using third party application using the IoT device. Also, it will promptly alert the workers to stay safe and detect the toxic gases before occurrence of any harm. This IoT based smart safety monitoring system for underground sanitation workers will reduce the manual effort of monitoring the health conditions of workers and also gives a quick check over the problem.

Index Terms **– IoT, Sanitation workers, toxic gases, sensors, NodeMCU, Arduino Pro Mini, underground sanitation system.**

I. INTRODUCTION

Sewage system is an underground system of pipes commonly used to transport waste water and solid wastes from houses and business either to a treatment facility or the water is treated and released into natural water bodies like lakes and streams or in any river to permanently drain out from the area. One of the prevalent and challenging forms of sanitation work in India is that of manual scavenging. Sewer manhole is one of the most important parts of the sewer system, it is a structure through which a person can gain access to the underground waste water and solid wastes. Safety is an important aspect of any working environment especially in underground sewage system. But manholes are not designed for someone to work in regularly, but workers may need to enter inside the manhole to complete their jobs such as cleaning, repair inspection etc. Underground sanitation workers are exposed to unimaginable health hazards including poisoning of gases, sudden health problems due to the temperature and air quality. Presence of hazardous gases will lead to catastrophes. So, the quality of air and other dangerous aspects are to be detected in early stages to avoid harmful threats to the sanitation workers. The lack of prior caring of sewage work is the witness for the deaths of thousands of sewage cleaners throughout the year. Because of lack of monitoring facilities, underground accidents may occur. Also, the underground sanitation workers are prone to various diseases such as cardiovascular degeneration, musculoskeletal disorders, infections, skin problems, and respiratory system problems due to the prolonged exposure to hazardous underground sewage environment.

II. PROBLEM STATEMENT

A large number of sanitation workers die every year due to lack of facilities available, and harmful toxic gases released while cleaning the sewage. Drainage cleaning workers are prone to serious health issues because of prolonged exposure to poisonous gases. Due to the lack of using proper gas leakage detection system, a number of dangerous accidents occurred. Real time health monitoring systems for such workers will prove helpful. To overcome this problem an effective monitoring system is needed. The system must monitor the pulse rate of a person, the toxic gas concentration and the atmospheric oxygen concentration and provide alert to the worker and exterior unit. When parameters deviate from the safe range, these parameters in real time will promptly alert the workers to stay sage and detect toxic gases before any harm.

III. SCOPE OF THE PROJECT

The ultimate aim of the project is to ensure safety to the underground sanitation workers and to avoid death of sewage workers due to the prolonged exposure of harmful gases like methane, carbon monoxide etc., and some causes the death due to unexpected

smoke and fire thus the IoT based developed system helps in detecting the threats and take measures before causing any severe harm to the workers which may also lead to the death.

IV. LITERATURE SURVEY

"Respiratory Health Problems of Sewage Workers" by Saad A et.al., [1] studied 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 which lead 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.

"Feasibility Study for Improving the Quality of Refined Sewage due to the Advancement of Soil" by Hamid Raeisi Vanan et.al., [2] proposed that soil has healing properties and that contamination of sewage water significantly decreases when passed through the soil layer. Using soil as a strainer for municipal wastewater treatment enhances the solution oxygen concentration and reduces sewage oxygen levels, and also removes turbidity, dissolved salts, total coliform and microbial coliforms. One of the drawbacks here is that today it is very difficult to maintain the right soil quality. Soil is not a reliable source to reduce pollutants from the waste water since it is not omnipresent or even if it, quality differs. Moreover, large amounts of wastewater are produced every single day which would require huge amount of right quality soil and human involvement in treatment. This does not address our issue of saving sewage workers from hazardous health problems. We need a sure shot method that would ensure that the sewage workers are safe and taken care of.

"Polluino: An efficient Cloud-based management of IOT devices for air quality monitoring air quality and cloud computing" by Fioccola G. B et.al., [3] proposed the system that tracks the ozone at ground level and the air pollutants causing asthma and other respiratory diseases. The internet of things paradigm originates from the proliferation of intelligent devices that can sense, compute and communicate data streams in a ubiquitous information and communication network. The great amounts of data coming from these devices introduce some challenges related to the storage and processing capabilities of the information. This strengthens the novel paradigm known as big data. In such a complex scenario, the cloud computing is an efficient solution for the managing of sensor data. Cloud-based platform manages the data from air quality sensors.

"IoT Sewage Gas Monitoring and Alert System Sewage regions Arduino Uno, Methane Gas Sensor" by Asthana Nitin et.al., [4] proposed a system to measure the ppm levels of gases only. Although, their system does not take into account 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.

"Sewage Level Maintenance Using IoT" proposed by B. Sumathy et.al., [5] proposed 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 warning signals prior to overflow by means of complaints to the specified departments via mail and SMS.

"Automated Internet of Things for Underground Drainage and Manhole Monitoring Systems for Metropolitan Cities" by Prof Muragesh S K et.al., [6] proposed an Underground Drainage and Manhole Monitoring System (UDMS) adapting and design feature for IoT applications. The proposed model provides a framework for monitoring inside a manhole the water level and atmospheric temperature and pressure and for testing whether a manhole lid is open. It also controls electrical power lines installed underground. UDMS can remotely track the current state of the manholes in real time.

"Integrated Exposure Assessment of Sewage Workers to Genotoxicants" by Hamzeh Al Zabadi et.al., [7] proposed a Urinary Biomarker Approach and Oxidative Stress Evaluation Examining the prevalence of different chemical contaminants and Geno toxicants in sewage environments and evaluating the impact of their constant exposure on sanitation workers and on the health of office workers. The paper attempts to detect the presence of Geno toxicants effectively as a result of tedious testing and field trials, but it fails to give any concrete explanation for the fluctuation seen in the number of HepG2 cells across different age groups of sewage staff. It does not discern how lethal for each age group such Geno toxicants can get.

"Evaluation of Green House Gases Emissions from Sewage Treatment Plants" by ayank Mrinal et.al., [8] proposed to find the assessment of greenhouse gas emissions from various municipal water treatment plants across New Delhi, and assurance of their sewage treatment systems' long-term sustainability. The paper emphasizes on highlighting indirect Green House Gas emissions in the aforementioned treatment plants for sewage water, but the solutions offered to eliminate them are quite indeterminate and ambiguous. To prevent these indirect emissions, it fails to provide clear and effective measures.

"Underground Drainage Monitoring System Using IoT" by Yash Narale et.al., [9] proposed the development and implementation of a network that regulates sewer conditions and provides a means to maintain and control the underground infrastructure using methodical approaches. The model proposed consists of a wide range of complex components which require routine maintenance and observation. The current system lacks a specified network for the simultaneous management of multiple types of sensors. In such a scenario the risk of failure is possible.

"Web-Based real time Underground Drainage or Sewage Monitoring System using Wireless Sensor Network" by Haswani, Navin Deore et.al., [10] proposed to incorporate 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 manhole 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, nighttime renders these light sensors useless. As of now, no solutions are offered for this.

V. PROPOSED SYSTEM

The proposed system will continuously monitor the environmental parameters that changes inside the drainage. The smart sensors like fire sensor, and gas sensors will be utilized for this purpose. The monitored sensor data will be collected and if any abnormalities are detected, it will send the warning in the form of LCD notification and buzzer alert. That is, whenever the sensor values reach the threshold limit, the buzzer will be set to ON to indicate that the workers' environment is not safe and the collected data will also be transferred via communication channel. So, when alert is given to the concerned underground monitoring unit, quick check over of the problem will be done by authorities to take timely remedial actions. Thus, the threat to lives of the sewage workers can be considerably minimized through this timely alert system. Also, this system will reduce the manpower required for monitoring purpose and makes the routine schedule for cleaning drainage. If this system is efficiently implemented in metro cities, it would be easy to monitor and manage the drainage systems with less manual work.

VI. METHODOLOGY

The smart health monitoring device will be equipped with temperature sensor and heart beat sensor these sensors are embedded into NodeMCU. Intelligence of sensors and the system will detect and measure the temperature and heart beat rate of the sanitation workers through the developed device. The identified values are displayed in the LCD display. As the value of the parameters exceeds the threshold value, the system will send the warning alert to the external monitoring unit and also activates the buzzer alarm and LED.

The block diagram shows the pictorial representation of the proposed system and the components required for the system.

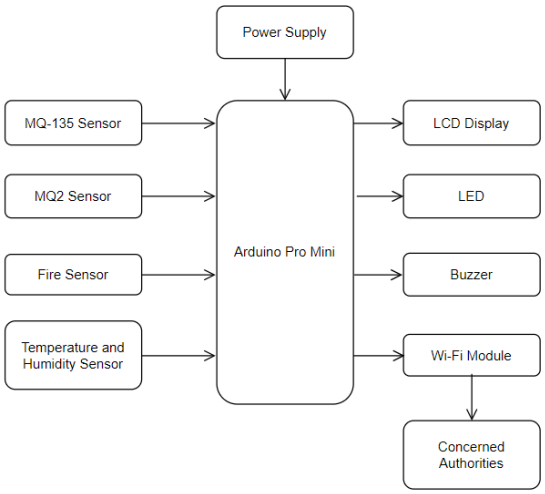

Fig 6.1: Block diagram for health monitoring of sanitation workers

IoT based underground safety monitoring system for underground sewage workers will have: Sensors to detect the toxic gases and fire. The sensors are embedded into Arduino Pro Mini, thus the system will identify the various toxic gases and fire inside the drainage system and also transfers the identified parameters to the external authorities for further remedial actions. The system will sense various harmful gases such as methane (CH4), carbon monoxide (CO), Ammonia (NH4), SO2 etc., The module is implemented using Wireless Sensor Networking (WSN) technology each node will carry its own data along with the data of neighboring node and will pass it to next node by hopping techniques. These entire data packet will be collectively sent by the gateway to the receiver side for continuous monitoring. In the occurrence of any hazardous event the information will be sent to the concerned authority with the help of this IoT device to take timely remedial action to safeguard the lives of sewage workers.

Also, as the level of such gases passes the threshold value, the system will generate the alert using the buzzer alarm through which the sanitation workers stay safe and will take proper action on it.

The block diagram of the underground sewage monitoring system is depicted below:

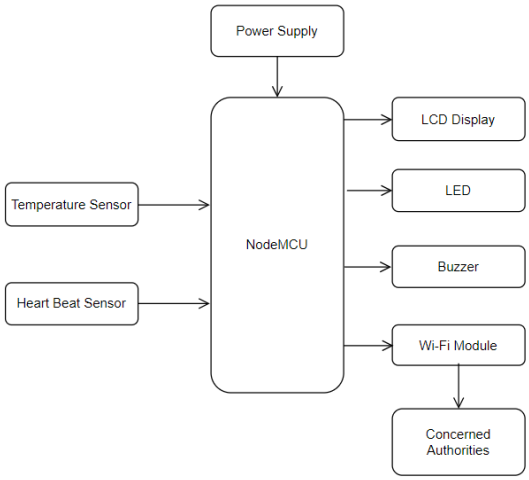

Fig 6.2: Block diagram for monitoring underground sewage system

VII. Applications And Advantages

7.1 Advantages

- Promotes health of sewage workers by using health monitoring system.
- It will be helpful to solve the problem of blocked drainage and manhole overflows.
- It maintains good hygiene particularly in rainy season as it records flow level of the drainage.
- This system reduces the risk to the life of sanitation workers.
- It reduces the underground accidents caused due to sudden flooding of sewage water.
- This system will reduce the maintenance cost as periodic monitoring and timely actions can be taken.
- It will monitor the drainage pipe congestion, from a central location.

7.2 Applications

The underground drainage monitoring system will not only help in monitoring the health conditions of sanitation workers but also helps in reducing the work of government personnel through automatic monitoring and warning system. This system is equipped with various types of sensors like fire sensor, CO2 sensor, temperature sensor and gas sensors which are interfaced with ESP32 microcontroller in order to make the system smart. Whenever the sensors monitor the parameters which exceed the threshold level, the indication of value is being sent to the Microcontroller which then sends the signal to the external unit via mobile application using Wi-Fi and the officials could easily locate which manhole is having the problem and could take appropriate steps. Also, ESP32 updates the live values of all the sensors in the manholes falling under the respective area using IoT.

Thus, this system can be deployed in underground sewage system and mining environment for providing timely monitoring and alert regarding the working environment.

VIII. Requirement Specifications

8.1 Hardware Requirements

- NodeMCU
- Arduino Pro Mini
- MQ-135 Sensor
- MQ2 Sensor
- Fire Sensor
- Temperature Sensor
- Heart beat Sensor
- LCD Display
- LED Light
- Buzzer
- Power Supply
- Power Adaptor
- Connecting Wires

8.2 Software Requirements

- Arduino IDE

IX. Results

In this experiment, the device which is equipped with all the sensors are connected through Wi-Fi, and the data from the sensors are easily transmitted. We use third party mobile application- Blynk in which all the data from the sensors are viewed.

As a result, our device can able to fetch all the values from the sensor and they can be viewed by the authorized person, through third-party mobile application.

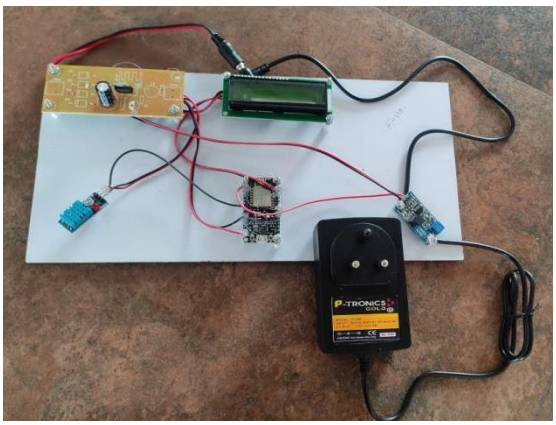

Fig 9.1: Health monitoring kit for sanitation workers

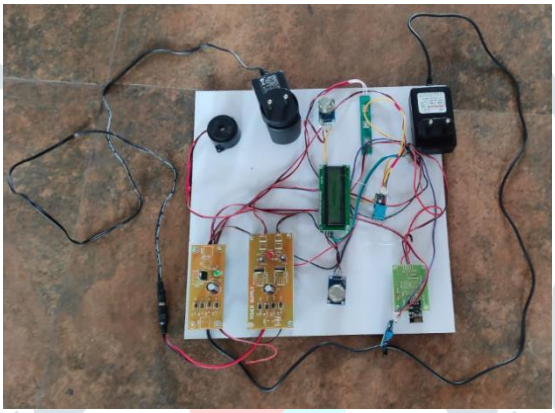

Fig 9.2: Underground sewage monitoring device

9.1 Hardware Output

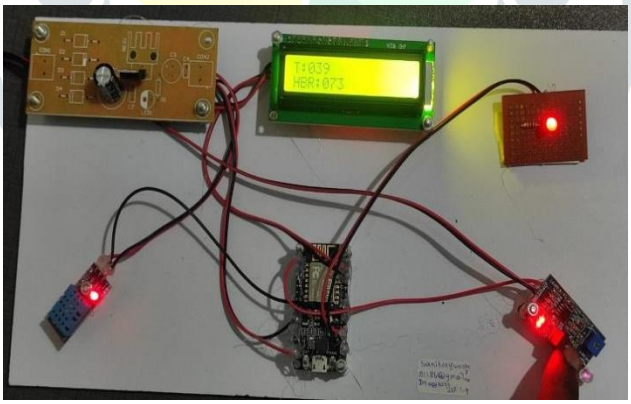

Fig 9.3: IoT health device displaying temperature and heart beat rate

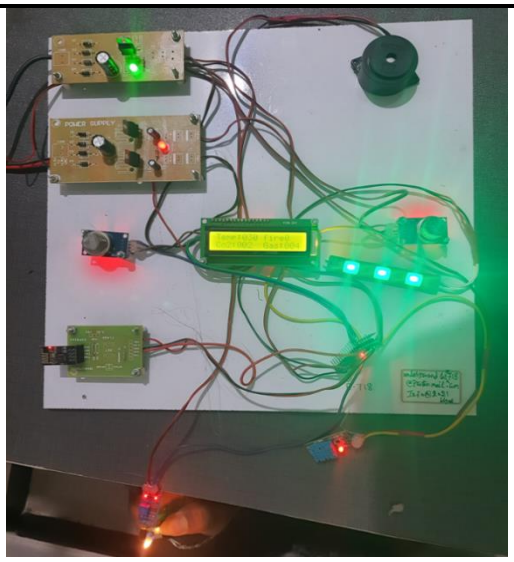

Fig 9.4: IoT based safety monitoring system of underground sanitation workers

The image describes that if there is fire or any leakage of gas like methane, carbon monoxide, butane, CO_2, etc., the buzzer gets activated by indicating LED light and the values will be sent through the third-party application-Blynk.

9.2 Software Output

An IoT system is equipped with the sensor, which communicates through Wi-Fi. The data which are gathered by the sensor are processed, based on the processed data and then the desirable action is performed. The user can view the values of the various parameters mentioned via third-party application. The network of the sensor, data processing and a user interface are the some important of the IoT system.

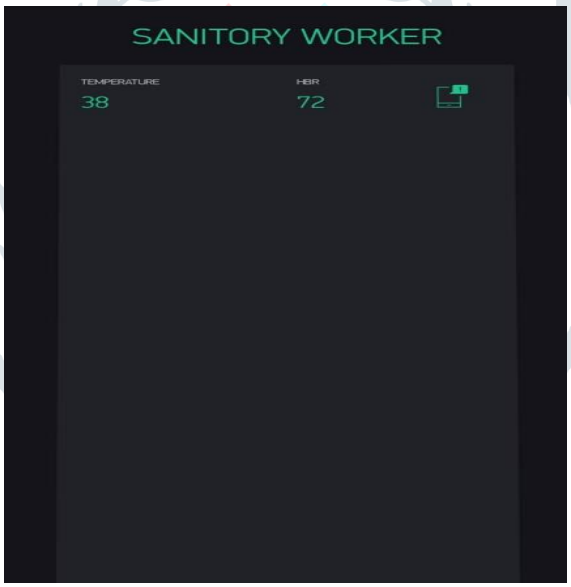

Fig 9.5: Temperature and Heart beat rate of sanitary worker

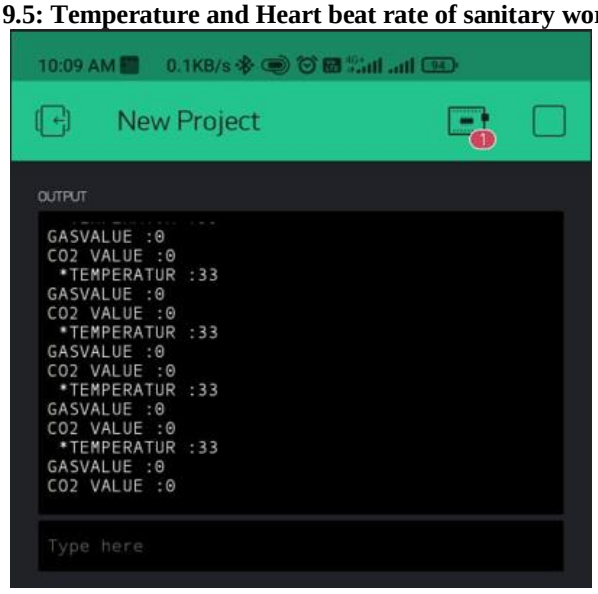

Figure 9.6: Temperature, Co_2 and gas values in the underground environment

X. Conclusion and Future Work

This paper suggests an approach to achieve portable camera-based text reading system. By using integration of image processing, speech processing it is possible to develop cost effective and user-friendly real-time application. Combination of OCR and CRNN overcomes drawback of individual and gives better result which successfully recognizes text image and convert it into speech for blind person. This proposed system presents the development of the work by implementing OCR and pyttsx3 using for Blind People, considering OCR and TTS stages, to create an application that was gradually improved and refined over the work. An analysis was made regarding the OCR and TTS technologies that were used in the development of the application, in order to know the methods behind those, and to understand in greater detail the mechanisms that perform optical character recognition on images and speech synthesis of texts. The work consisted of the construction of an application composed by several parts, integrating the system of image capture by the web camera, which is used by an OCR framework for recognition of its text, which is then synthesized through a process of TTS. Optimizations carried out for improving outcomes resulted in a more efficient application, capable of responding to the challenge set by the theme of the work a camera that reads texts for the blind.

Through translation tools, one converts the text to the desired language and then again by using the TTS speech recognition tool can convert that changed text into audio. This idea will tend to anew technology that involves neuron based visual system which can give information directly to damaged neurons in mind in disabled people.

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