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SMART ENVIRONMENT MONITORING SYSTEM

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Abstract: In the face of growing environmental and human health risks arising from air and sound pollution, and which is most the intense in most Indian cities, our new system provides an ideal compact solution. Through this article, one designs and develops an intelligent surveillance platform for the environment. All four sensors are very easily controlled and in a position of activating an alarm or taking some action. The temperature, humidity, air quality parameters i.e., CO, smoke, LPG using DHT11, MQ7, MQ13, and LM393 sensors are tracked. The alerts are visual with the help of LED indicators as well as an audible buzzer and LCD display instantly or in real-time. A message notification is sent when the parameters are beyond their threshold value, which provides substantial insight to make better decisions for a better world. The main purpose of this system is to improve and maintain the health of our cities for future generations.

Keywords: Raspberry Pi 3, LCD Display, MQ7, MQ135, DHT11, LM393, GSM Module, LED, Buzzer.

I. INTRODUCTION

Therefore, to-date, the smart environment monitoring system is of great importance. Several factors like deliberate gas discharge from industries, automobile use, and more have contributed to the rise in pollution. People need to be alerted against pollutions, and the smart monitoring system can help inform people how they can make all of it happen. The procedure can clarify people by protecting

1. **A cleaner world:** The importance of healthy environment; smart environment monitoring systems will alert people and form the population to take action against pollutions and discomfort. During the project, the CPU processing unit Raspberry Pi 3B has been used. for the purpose of collecting real - time data such as temperature, humidity, air quality and noise.
2. A set of sensors captures information from the environment. A DHT11 is a sensor that measures both temperature and humidity. To monitor air quality, both MQ7 (CO) and MQ135 (smoke/LPG) sensors will be employed while LM393 will be used to detect noise, another environmental aggravating factor.
3. The system gives an immediate feedback of the sensor data held in micro-controller via LEDs and buzzer. A green LED indicates any alerts for temperature/humidity and a red LED blinks for sound level independently. Similarly a buzzer sounds for any higher readings of the gases detected. This real-time output of the sensor data enables the authorities to take necessary actions.
4. Further SMS alerts are triggered via GSM900A module when the readings breach the automatic defined thresholds and sent to mobile number every thirty minutes.

Allowing people to respond to alerts, the system empowers individual citizens and authorities to take remedial action. Pollution can be reduced, climate change can be moderated and noise levels can be lowered. We get a better, healthier, more comfortable environment.

II. LITERATURE SURVEY

Further literature survey was also done to refer and follow the existing methodologies of implementation, also the traditional methods like air quality testing stations, noise meter measurement of levels etc., using ESP32, Arduino UNO, NODE-MCU(ESP8266), LPC2148 as a microcontroller in such environment monitoring systems.

1. “Air quality monitoring stations and sound level meters[1]”.

It currently represents the traditional method for the monitoring of the environment. In line with the question, they described a method used for monitoring the environment, taking air quality monitoring stations and sound level meters as an example. They stated that such methods are fixed locations that measure air pollutants and noise levels in the environment. However, while these methods are available and desirable, there are drawbacks to them, such as being expensive to distribute and maintain. The possibility that they fail to provide stable and real-time information within the environment is high, and they may not be widely distributed in an area.

2. “ESP32 sensor for smart air pollution monitoring system method [2]”.

ESP32 is one of the most widespread microcontrollers and it can be used for developing several devices of environmental monitoring. The paper has been presented a whole wireless solution under the form of hardware for data gathering and a mobile application for data consultation and notifications. The presented system is a system able to have a real-time control of IAQ using the powerful IOT architecture.

The proposed solution has some limitations like the iAir is a demonstration of concept that shall be experimentally validated in order to improve the level of calibration and accuracy of the system. The proposed solution can be regarded as a limited case since it is always possible to invent and design hardware and software improvements to adapt the system to specific cases or problems such as the supervision of the environmental conditions of a laboratory, a schoolroom, a residential home for old people or a hospital.

3. "Arduino UNO for IOT-based noise pollution monitoring systems [3]".

This figure shows the use of Arduino UNO Aduki boards. This is another microcontroller that can be used for most environmental monitoring projects. It's been well received in most engineering communities among hobbyists because of it isolated design. Arduino UNO is often the recommended choice for Beginners who want to use a microcontroller board for the first time as they are simple and easy to use.

Various research works has documented the use of Arduino UNO in noise pollution monitoring systems. IOT based air and sound pollution control system manages and monitors the air pollution and sound pollution, specified places on a cloud-based internet portal, Things speak.com. Things speak servers send data in numerical forms, which you can monitor on the LCD display unit you are using. While Arduino is not suitable for mass deployment, it may have limited memory and processing capacities when dealing with large data set.

4. "NODE-MCU (ESP8266) for embedded systems [4]".

This is an article on setting up a low-cost sustainable air quality monitoring system. Here, the benefits and limitations of using low-cost sensors (LCS) for Air Quality Monitoring (AQM) are presented along a step-by-step proposal to create a resilient AQM system using LCS. This might be helpful for developing countries, given the resource constraints in such countries. Nevertheless, as LCS-based technique was not as accurate as the existing traditional technique, the details about the development of LCS need to be updated. Field researchers do not have the capacity to gather all the materials and a non-exhaustive report was published on these LCS documents expressing the need for a report on the complete methodology for the set-up of air pollution monitoring unit using LCS. All the methods and techniques adopted by each researcher for LCS safety features could be consolidated into one frame work as a whole. This technical document would help to configure a better set-up of an Air Quality Monitor fast and understand its reliability.

III. BLOCK DIAGRAM

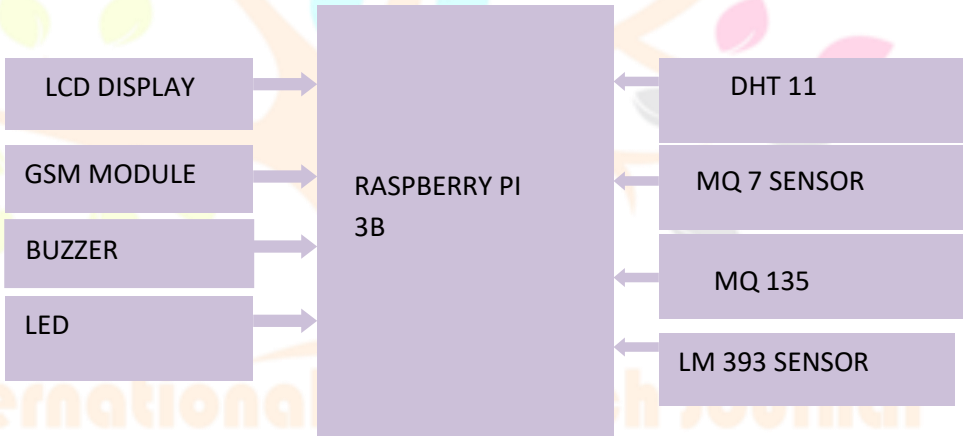

Fig.1 Block Diagram

IV. METHODOLOGY

This proposed system explains on how to create a smart environment monitoring system by using Raspberry Pi B module. An extension for this project is mentioned, which includes SMS alert system, DHT sensor. An overview of the methodology is stated below

Hardware Selection and Setup: The main part of this system is a Raspberry Pi 3B which has a basic processing and connectivity power. For environmental sensing, it uses environmental sensors attached to this Raspberry Pi. It contains a DHT11 which enables it to read the temperature and humidity and hence detects the environment of the range specified by the sensor. It uses MQ7 or MQ135 sensors which enables it to detect CO and smoke/LPG fumes in air to analyze the air quality and areas of concern. It has an LM393 sound sensor that checks the sound level to detect the noise level around the place it is to be used. This sound level is shown on an LCD module that uses a visual display to show real-time reading from the sensors.

For the different range of consideration among the sensors there will be different visual indicators provided. For the cases that are a matter of concern like temperature/humidity, separate LED indicators are attached that turns into a green color to warn about the occurrence. For the case of concerning gas levels, a buzzer will be provided that buzzes in case the gas levels cross the limits that are supposed to be within normal ranges. For remote notification in case the readings cross the preconfigured limits, an SMS module(GSM900A module) will provide the functionality that says you are in danger.

Sensor Calibration: Each of the sensor used, it will need to be calibrated. To do this, it will need to be exposed to known concentrations of the target gas or noise volume, and its output adjusted to match. In most cases, the manufacturer will provide instructions, or there'll be a site online that explains the process.

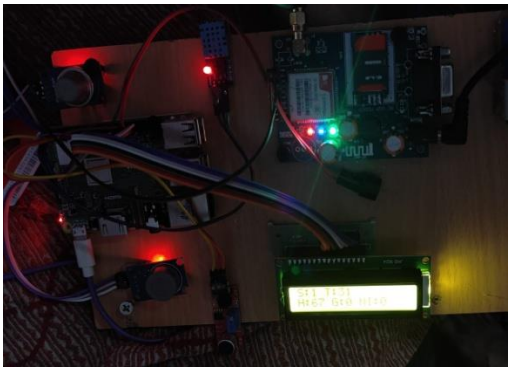

Fig.2 Implementation of Hardware

Software Development: The main programming language of Raspberry Pi is Python. Libraries such as 'RPi.GPIO' will interface with the linked sensors and actuators (LEDs, buzzer).The program will continuously read from the sensors, process the data and display the values on the LCD display. Threshold values will be set in the code for temperature, humidity, gas levels and noise. When the readings breach the threshold values, the program will trigger alerts by activating the LEDs and the buzzer (for instant warning) and SMS messages through the GSM module (for out of band notification).

System Integration and Testing: Once the hardware is assembled and the software is programmed, thorough testing is done. Crucially, this means simulating input from the environment – ensuring that the sensor readings, alert triggers and SMS-sending are all working properly. Tweaks to sensor calibration or code might be needed.

Deployment and Maintenance: The last one, of course, has to be dispatched to the designated location, plugged in, and the sensors configured for proper readings. The system must be monitored to make sure that it continues working and that the sensor framing is still correct, and it may need to be recalibrated at intervals.

Data Analysis: For instance, number counts from collected data provide useful information about environmental conditions. Tri-state and Single-site monitoring of air quality, noise level and temperature over time informs our decisions about the management and remediation of pollutants.

Following each step should help assemble a complete and user-friendly smart environment monitoring system.

V. RESULTS

The main objective of this project for which it is developed is to make the people aware about the inhaling pollution due to which it causes and what are the reasons. The alert mechanism is constantly running, raising alerts if environmental conditions go outside user-set thresholds. If the temperature gets above 40°C, the humidity above 85%, if smoke is detected, or if the system thinks it hears nothing for more than 4 minutes, the system will raise an alert. Once an alert is raised, a buzzer is sounded to provide an audio cue, and SMS with the user's chosen text will be sent via the Raspberry Pi's serial port to a pre-programmed mobile number.

Moreover, we integrate the system with a GSM module, so that the sensing data will be stated in a form of an SMS alert. Once the values enter threshold limits, an alert notification will be shown to respective mobiles through a SMS. The below figure show the results displaying on LCD Display. From the fig.1, S indicates sound level, T for temperature, H for humidity, G for smoke, NI for CO. Here the temperature and humidity are recorded as 31 ^{0}Cand 67%. Whenever the values breach the threshold values the remaining sensors display readings as 1(high).

Fig.3 Output at LCD interface in hardware level

Finally, for making a reliable view of data as well as an LCD Display, we integrated a buzzer which gets activated for MQ&, MQ135 sensor when it attains threshold value, led. From fig.3, it is an SMS received by GSM module since the LM393 sensor sensed the noise value exceeding the threshold.

Hence it sent an SMS alert as shown in fig.3. The SMS sent by GSM shows the values detected by all the sensors. It indicates that noise level as high, hence it sent alert along with the term "sound detected".

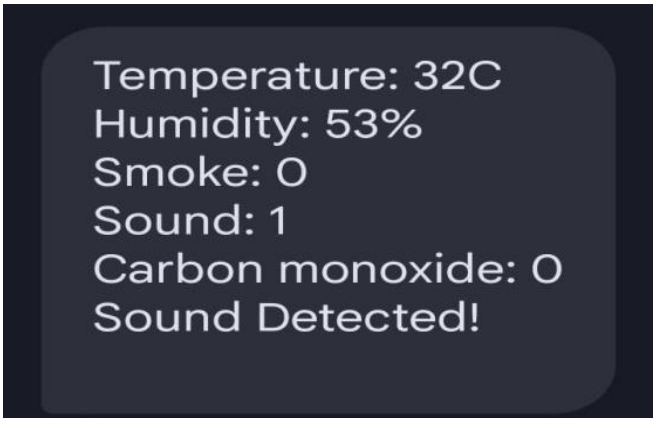

Fig.4 Output at mobile sent by GSM module

We as a team implemented an environmental monitoring system inspired by Raspberry Pi, which is a small computer sensor capable of recording temperature, humidity, smoke, sound, and carbon monoxide levels. This system is expected to monitor the environmental conditions in real-time and raise an alarm when specific threshold values are exceeded.

To facilitate the local monitoring a 16x2 LCD was selected, which is interfaced with the Raspberry Pi and provides a user-friendly human-machine interface which displays the real-time operational data from the sensors and the overall system status. After switching ON the operation, the main screen will show the current temperature, humidity, smoke levels; the sound levels; and the carbon monoxide levels followed by a main menu which offers six choices such as system reset, environment and other status, system information, the current alerts, enable/disable the alerts, and exit. After choosing certain reaction based on the system settings when a 'Normal' or 'Priority' alert event is generated, a relevant alert message will be displayed on the LCD to notify the user of that particular abnormal situation. The testing showed that the system for environmental monitoring works in a strong manner, detecting correctly the readings of the sensors and sending warnings if there were changes in the environmental conditions.

Combining multiple sensors and the alert mechanism, the system for monitoring environmental concerns works effectively to detection the risks for the environment.

Future Enhancements: Although the current version is a fairly good basis for environmental monitoring, there are many areas where it can be enhanced, such as by:

1. Integration of new sensors or other environmental parameters (eg, air quality, light intensity, motion, etc).
2. Add feature to log historical sensor data for analysis and trend determination.
3. Enhancement of the alerting mechanism to support customizable threshold settings and multi-channel notification options.
4. System: Develop a web dashboard or mobile application to remotely monitor and control the environmental monitoring system.

Therefore, a developed environmental monitoring system can demonstrate how easily Raspberry Pi can be used to construct an inexpensive and flexible system for monitoring and controlling the environment. As time goes by, we believe this system has a lot potential in many aspects to use home automation, industrial monitoring system, as well as help various environmental researches.

Discussions:

We successfully monitored air quality, Temperature and Humidity, Sound level by using Raspberry PI 3B and when the readings were out of threshold range then we got an SMS alert through the GSM 900A Module

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