SMART GUARD: REVOLUTIONIZING INDUSTRIES WITH IOT BASED ENVIRONMENTAL OVERSIGHT AND POLLUTION MITIGATION

Project Reference No.: *47S_BE_3244*

***College : ****JSS Academy of Technical Education, Bengaluru*
***Branch : ****Department of Electronics & Instrumentation Engineering*
***Guide(s) : ****Mrs. Nagarathna N*
***Student(S) : ****Ms. Akshatha V*
Ms. Lekhana H G
Ms. Pushpavalli K

Keywords:

Actuators, IOT, LoRA communication, Sensors

Introduction:

India's industrial journey, stemming from the inception of its first cotton mill in 1854, has propelled its transition from underdevelopment to development. However, this progress has come at a cost, with industrial pollution emerging as a significant concern. The Central Pollution Control Board was established in 1974 to address this issue, but the impacts persist, spanning air, water, thermal, soil, and noise pollution. Industrial activities, from burning fossil fuels to improper waste disposal, emit harmful gases like CO2, methane, and nitrous oxide, posing threats to both human health and environmental stability. Additionally, the Industrial Revolution has historically led to adverse effects such as poor working conditions, inadequate nutrition, and hazardous environments. To combat these challenges, various technological solutions have been proposed, including automatic firing systems and surveillance mechanisms employing IoT, night vision, and robotics. However, key problems persist, including limited environmental monitoring, delayed hazard detection, inefficient safety protocols, fragmented communication, ineffective pollution mitigation, energy inefficiency, lack of scalability, and complex user interfaces. Addressing these issues demands comprehensive, adaptive, and user-friendly solutions to ensure sustainable industrial growth while safeguarding both human well-being and the environment.

Objectives:

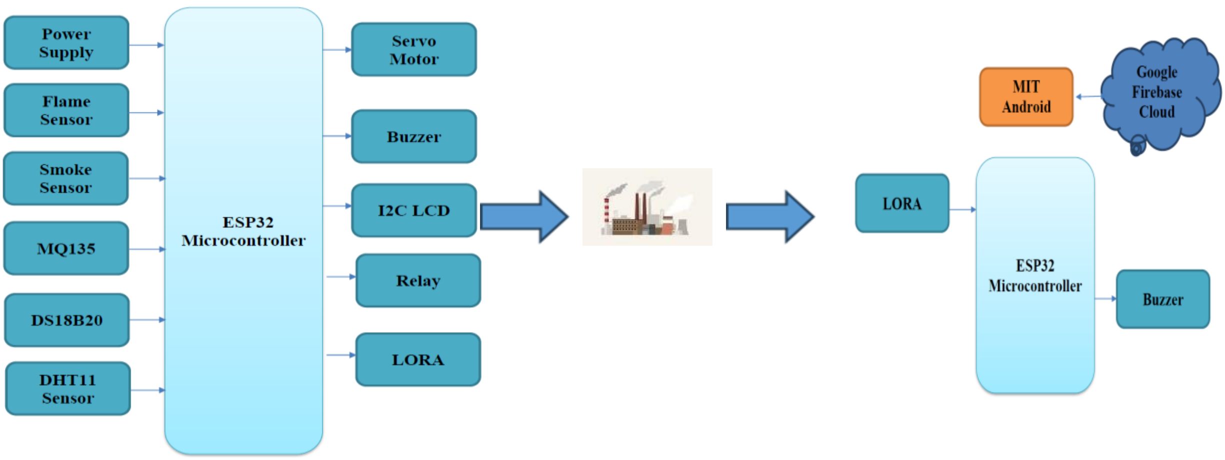
- This project will determine accurate air pollutants readings through sensor, which will then be compared to the limitations of pollution control board.
- Monitoring various parameters like funnel's temperature, surrounding humidity and temperature, flame and smoke which will alert and partially mitigate for prior safety of employers.
- Any discrepancies must be identified and communicated from industry to central hub about the hazard through LoRA communication.

Methodology:

Smart Guard utilizes IoT technology to monitor environmental conditions and mitigate pollution in industries. It relies on LoRa communication for seamless data transfer between sensor nodes and a central hub, powered by the ESP32 microcontroller. Key components include sensors like DHT11 for temperature/humidity, flame/smoke detectors, and MQ135 for air quality. DS18B20 monitors funnel temperature while actuators like servo motors and relays ensure safety measures.

Sensor nodes strategically placed collect data on temperature, humidity, air quality, and fire risks. LoRa facilitates wireless transmission to the central hub where the ESP32 processes and analyzes data. In response to threats, actuators intervene: servo motors for gas leaks, relays for pump/fan control. An LCD interface provides real-time data for easy monitoring and decision-making.

The system's functionality involves data collection from sensors, wireless transmission via LoRa, processing by the ESP32, and actuator response. Safety measures include gas leak prevention and fire incident control. The user-friendly LCD display ensures quick response to anomalies. The below block diagram is all about the representation of the functionality of the Smart Guard project. We have two main areas of the consideration. One is the transmitter part which is nodes are distributed in the area under monitor i.e. Industrial area where different parameters are measured. The other is the receiving end which is present in the central hub containing computer displaying the measured parameter's data. Google firebase cloud is used for data transfer and MIT invertor for data end where data is viewed either in android mobile or pc. LoRa is used for long distance data transfer where Wi-Fi connection is weak. ESP32 microcontroller is used which offers integrated Wi-Fi option.



BLOCK DIAGRAM OF TRANSMITTER

BLOCK DIAGRAM OF RECIEVER

Conclusion:

TEST CONDUCTED	OBTAINED RESULTS
Flame sensor - "Condition **1**''	Extinguisher pump **ON** LCD : "Flame detected" App notification : Alerting signal
MQ135 - When value >**200**	Servo motor **ON** LCD : "Pollutants detected" App notification : Alerting signal
DS18B20 – When value >**40**	Coolant **ON** LCD : Temperature Display
DHT11 - When temperature > **35**	Fan **ON** LCD : Temperature Display
MQ2(smoke) - When value >**1400**	Exhaust fan **ON** LCD : "Smoke detected"

Description of the innovation in the project

LoRa (Long Range) is a wireless communication technology designed for long-range communication between IoT (Internet of Things) devices. It operates on unlicensed radio bands and is characterized by its low power consumption, long-range capability (up to several kilometers), and ability to penetrate obstacles like walls and buildings. LoRa uses spread spectrum modulation techniques to achieve robust communication in noisy environments. It's commonly used for applications such as smart city infrastructure, industrial automation, agricultural monitoring, and environmental sensing.

MIT App Inventor is a cloud-based tool that allows users to create mobile applications for Android devices without needing to have prior programming experience. It provides a visual interface where users can drag and drop components to design the user interface and define the functionality of their app using a blocks-based programming language similar to Scratch. MIT App Inventor simplifies the app development process, making it accessible to a wide range of users, including students, educators, and hobbyists. It's commonly used in educational settings to teach basic programming concepts and app development skills.

Scope for future work:

1. Explore the integration of advanced sensors for real-time air quality monitoring, including volatile organic compounds (VOCs) and particulate matter (PM).
2. Investigate machine learning algorithms to predict environmental trends and detect anomalies for proactive pollution mitigation.

3. Develop a mobile application for stakeholders to access real-time environmental data and receive alerts on pollution levels.
4. Implement geospatial analysis to identify pollution hotspots and prioritize intervention efforts.
5. Enhance the scalability of the system to accommodate a larger network of IoT devices for broader environmental coverage.
6. Integrate weather forecasting data to better understand the impact of meteorological conditions on pollution dispersion.
7. Collaborate with regulatory agencies to ensure compliance with environmental regulations and standards.
8. Conduct field trials in different industries to validate the effectiveness of pollution mitigation strategies.
9. Investigate the use of block chain technology for secure and transparent data management in the environmental monitoring process.
10. Explore partnerships with research institutions to leverage cutting-edge technologies for environmental monitoring and mitigation.
11. Develop predictive maintenance algorithms to ensure the reliability and longevity of IoT devices deployed in the field.
12. Explore the use of drones for aerial monitoring of environmental parameters in hard-to-reach or hazardous areas.
13. Integrate smart grid technologies to optimize energy consumption and reduce carbon emissions in industrial facilities.
14. Investigate the use of smart sensors for monitoring water quality and implementing measures for water pollution prevention.
15. Develop a data visualization dashboard for stakeholders to analyze trends and make informed decisions on pollution management.
16. Explore the use of advanced communication protocols, such as 5G or satellite communication, to improve data transmission reliability and speed.
17. Implement multi-tiered security measures to protect sensitive environmental data from cyber threats and unauthorized access.
18. Conduct cost-benefit analysis studies to assess the economic impact of pollution mitigation measures implemented through the Smart Guard system.
19. Explore the potential for public-private partnerships to fund and scale up the deployment of the Smart Guard system in different industries and regions.
20. Investigate the use of renewable energy sources to power IoT devices, reducing the carbon footprint of the environmental monitoring infrastructure.