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IOT Based Industrial Monitoring and Fault Detection System

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ABSTRACT:
Internet of Things (IoT) is rapidly increasing technology. IOT is the network of physical objects or things embedded with electronic software, sensors, and network connectivity which enables these objects to collect and exchange data. IOT then deals with bringing control of physical devices over the internet. In this project, we are developing a system which will automatically monitor the industrial applications and generate Alerts/Alarms or make intelligent decisions using the concept of IoT.
Internet of Things (IoT) technology is advancing quickly. Many home and commercial IoT applications are automated. Currently, monitoring and automation refer to the ability for a user to control something from everywhere in the world, rather than just when they are physically present in a given location. IoT, or things that are embedded with sensors, software, electronics, and network connectivity, refers to a network of actual objects that can gather and share data. Controlling physical goods remotely through the Internet is another use for IoT. Different sensors are used to monitor industrial features including temperature, variations in current and voltage parameters, gas, etc.
By considering the potential threats to the normal operation of the industry equipment, these variables were carefully selected. The sensors used here are Flame sensor LM393, Current Sensor ACS712ELCTR-05B-T, Voltage sensor, Ultrasonic Sensors HC-SR04, Temperature sensor DHT11, Gas sensor MQ9, These Sensors will collect their respective data and send the data to Node MCU ESP which also acts as a wi-fi module Using the IoT idea, the project is being controlled and monitored via fault detection, status monitoring, and alarm/alert generation when a fault arises and promptly reports it to the appropriate service Centre.
This attempts to improve productivity, regulate access, and produce high- quality industrial goods. Several sensors are deployed in our project to monitor industrial parameters like temperature, pressure, gas, etc. These parameters were carefully selected on the basis of the potential hazards they can cause to the normal working of the industry machine. The Internet of Things (IoT) is a new sector that aims to connect "things," "people," and "machines" to the internet. Modernization and automation are sweeping the globe, with IoT-based industrial monitoring solutions at the forefront. The importance of assessing the state of the industry is vital to the safety and efficiency of the products. The goal of this study is to create an IoT-based industrial monitoring system with intelligent sensors. Because of the integration of big

data, the Blynk app can be used to monitor status from anywhere on the planet. Data analysis has been streamlined, allowing for easier IoT monitoring. The proposed technology could be beneficial to manufacturing industries. Adding technology to any kind of manufacturing industry will assure the safety and well-being of the people as well as prevent accidents. Using automation technology reduces the chances of loss and accidents in the machinery world The sensors used in our project are Temperature sensor DHT11, Gas sensor MQ9, Flame sensor LM393, Accelerometer ADxL335, Ultrasonic sensor HC-SR04, and PIR sensor. These sensors will collect their respective data and then send the same data to Node MCU ESP8266 which also acts as a wifi module.

Key Words: IoT, Sensors, Alerts/Alarms, Internet of Things, Modernization, Automation, Blynk, Manufacturing

1. INTRODUCTION:

Technological advancement is a continuous process, making it essential for us to stay informed and equipped with the latest developments. These innovations have significantly simplified daily human life. In today's world, automation has become a necessity. With the rapid growth of web technology, data and systems are increasingly accessible via the internet.

The integration of embedded systems with web technology enables remote monitoring and control of devices through network interfaces. Internet of Things (IoT) devices, often managed via web controllers or E-controllers—comprising embedded systems and software stacks—represent one of the most prominent approaches in modern web development.

Instead of relying on large server systems, distributed web control systems using built-in web applications now facilitate remote login, monitoring, and data management. These IoT-based web control systems are known for their energy efficiency, comfort, and operational effectiveness.

Our primary goal is to implement internet-based control systems within IoT applications, allowing users to access and manage devices from anywhere in the world, provided they have internet connectivity.

1.1 Problem Definition:

Sensors play a crucial role in fault detection systems, as they provide the primary data required for analysis. While data from production management systems can also be valuable, sensors remain the main source of information. In some scenarios, sensors used for control or supervision purposes may be shared with fault detection systems, especially if they were integrated during the initial design of the machine or plant.

However, in many cases, predictive maintenance is not considered during the design phase, making it necessary to install additional sensors later. This is particularly true for older machines, which often become bottlenecks in production due to unexpected failures. Implementing predictive maintenance for such legacy equipment typically requires retrofitting with new sensors to ensure effective monitoring and fault prediction.

1.2 Scope of the project

Rebuilding automated factories and processes for every design change or modification is prohibitively expensive. Therefore, they must be highly configurable and adaptable. Successfully reconfiguring a production line requires direct access to key control elements—such as switches, valves, motors, and drives—at a granular level.

The concept of fully automated factories has been envisioned for years: customers place orders online, with electronic systems negotiating parameters like batch size (even as low as one), price, dimensions, and color. Intelligent robots and advanced machinery then seamlessly produce a wide range of customized products on demand.

2. LITERATURE SURVEY

At the heart of any predictive maintenance system lies a fault diagnosis mechanism capable of identifying not only active failures but also signs of potential issues before they occur. This represents a more advanced approach to factory supervision, where traditionally only SCADA systems and alarm triggers based on variable thresholds are used.

One of the key advantages of predictive maintenance is its ability to deliver meaningful insights to human supervisors by revealing the actual condition of machines or plants. This supports better decision-making and helps in effective production planning. Additionally, predictive systems can, in some cases, replace human intervention by autonomously making critical decisions—such as halting operations during severe faults or scheduling maintenance tasks proactively. One of the primary challenges in designing the decision-making component of a predictive maintenance system is the lack of historical data. This limitation makes it difficult to determine the most effective classification method and to accurately set system parameters. As a result, conservative strategies are often adopted, which can lead to a high number of false alarms during the early stages of implementation.

In this context, the expertise and oversight of human specialists play a crucial role. Their knowledge is essential for guiding the system's design and fine-tuning its configuration to improve accuracy and reliability over time.

3. DESIGN METHODOGY

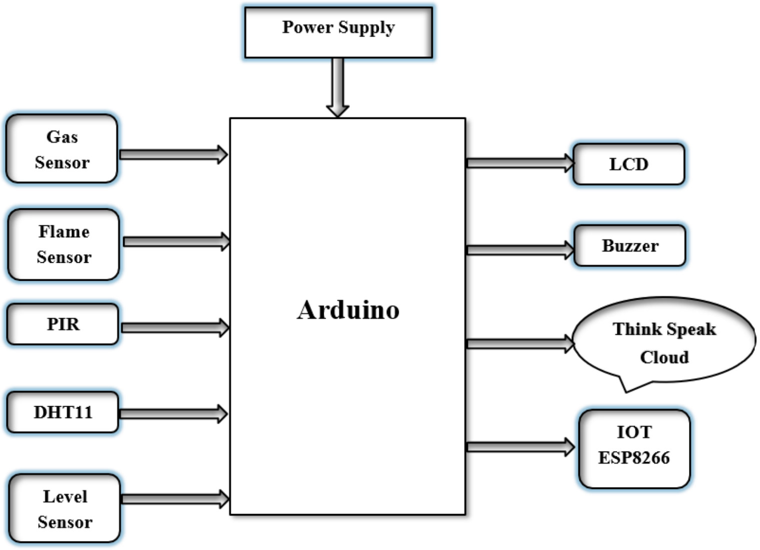

Fig -1: Block Diagram of the system

The IoT-based industrial monitoring and fault detection system uses various sensors to collect data, which is then transmitted to the ESP8266 microcontroller. The ESP8266, equipped with built-in Wi-Fi, sends this data over the internet for real-time monitoring.

The ESP8266 is a compact microcontroller featuring 4MB of flash memory, a system clock speed of 80 MHz, 64 KB of SRAM, and an integrated Wi-Fi transceiver. It is capable of connecting to Wi-Fi networks and establishing TCP/IP connections for data transmission.

In the event of a fire, sensors such as the gas sensor and temperature sensor detect smoke and heat variations. This information is relayed to the ESP8266, which is connected to a buzzer and an LCD display. When the temperature exceeds a predefined threshold (programmable as needed), the microcontroller activates the buzzer and updates the LCD with relevant alerts.

Simultaneously, the collected data is uploaded to the Thing Speak IoT platform, enabling live monitoring and quick response. Additionally, an accelerometer is used to detect anomalies such as faults or mechanical wear in rotating machines. If a fault is detected, the system sends an immediate alert or email notification to the assigned supervisor or manager to ensure timely intervention.

The PIR (Passive Infrared) sensor is used for security monitoring. If it detects unauthorized movement in restricted areas—such as the power room or in the case of trespassing—it triggers the buzzer alarm to alert personnel.

3.1 Sensors

Sensors play a vital role in this project, serving as the foundation for monitoring various industrial parameters. By analysing changes in these parameters, we determine appropriate threshold values to facilitate accurate fault detection and monitoring.

With our project objectives in mind, we carefully selected a set of sensors that are either widely used in current industrial applications or offer the precision required for future advancements.

The following is the list of sensors utilized in this project:

SENSOR	SPECIFICATION
Gas Sensor	MQ9
Flame Sensor	LM393
PIR Sensor	HC-SR501
Level Sensor	HC-SR04
Accelerometer	ADxL335
Temperature & Humidity Sensor	DHT11

3.2 Fault indication and prevention mechanism:

The objective of our project is to monitor key industrial parameters and implement basic automated preventive measures when any of these parameters indicate a potential threat to the plant's operation. To support this functionality, components such as fans, LEDs, and buzzers are integrated with the main controller to initiate appropriate responses.

LEDs and the buzzer are used to signal alarms in the event of potential fire hazards or gas leaks. The fan serves a dual purpose: it can provide cooling and also function as an exhaust system to disperse harmful gases in case of a leak.

In addition to these preventive actions, the system is designed to handle worst-case scenarios. If conditions escalate beyond control and pose a serious threat to life or property, the system can notify the nearest fire station to ensure immediate emergency response.

4. ADVANTAGES AND DISADVANTAGES

4.1 Advantages

1. **Real-time Monitoring** – Instant access to live data from the plant.
2. **Remote Accessibility** – Operational information can be accessed from virtually any location.
3. **Reliable and Consistent Data** – Ensures accuracy and consistency in monitoring.
4. **Reduction of Manual Errors** – Minimizes the risk of human error in data collection and interpretation.

4.2 Disadvantages

1. **Limited Sensor Capacity** – Damage beyond the detection range or capability of the sensors may go unnoticed.
2. **Dependency on Internet Connectivity** – Real-time data access may be disrupted in case of network or connectivity issues.

5 METHOD OF IMPLEMENTATION:

5.1: Forms:

1. Defining Objectives and Scope:
   - Identify Critical Assets: Determine which machinery, equipment, or processes require monitoring.
   - Define Key Parameters: Identify the critical parameters to be monitored (e.g., temperature, vibration, pressure, humidity, electrical current).
   - Establish Thresholds: Define acceptable operating ranges and set thresholds for triggering alerts.
   - Determine Fault Types: Identify potential faults or failures that need to be detected.

2. Sensor Selection and Deployment:
   - Choose Appropriate Sensors: Select sensors that can accurately measure the defined parameters. Considerations include accuracy, range, durability, and cost.
   - Strategic Sensor Placement: Deploy sensors at critical points on the equipment or within the environment to ensure comprehensive monitoring.
   - Sensor Integration: Ensure seamless integration of sensors with the data acquisition

system.

3. Data Acquisition and Transmission:
   - Data Acquisition Systems: Utilize microcontrollers (e.g., Arduino, Raspberry Pi) or industrial PLCs to collect sensor data.
   - Edge Computing: Implement edge computing to process data locally, reducing latency and bandwidth usage.
   - Communication Protocols: Employ suitable communication protocols (e.g., MQTT, CoAP) for efficient data transmission.
   - Connectivity: Establish reliable network connectivity using Wi-Fi, cellular, LoRaWAN, or other appropriate technologies.
4. Cloud Platform and Data Storage:
   - Cloud Platform Selection: Choose a cloud platform (e.g., AWS, Azure, Google Cloud) for data storage, processing, and analysis.
   - Data Storage: Store sensor data in a scalable and secure database.
   - Data Visualization: Develop dashboards and visualization tools to present real- time data and historical trends.
5. Data Analysis and Fault Detection:
   - Real-time Monitoring: Implement real-time monitoring to track key parameters and identify deviations from normal operating conditions.
   - Anomaly Detection: Utilize machine learning algorithms to detect anomalies and predict potential failures.
   - Fault Diagnosis: Develop algorithms to diagnose the root cause of detected faults.
   -
   - Predictive Maintenance: Use historical data and machine learning to predict future failures and schedule maintenance proactively.
6. Alerting and Notification:
   - Alerting System: Implement an alerting system to notify personnel when faults or anomalies are detected.
   - Notification Methods: Utilize various notification methods, such as SMS, email, or mobile app notifications.
   - Escalation Procedures: Define escalation procedures for handling critical faults.
7. System Integration and Implementation:
   - Integration with Existing Systems: Integrate the IoT system with existing industrial control systems (e.g., SCADA, MES).
   - User Interface: Develop a user-friendly interface for monitoring and managing the system.
   - Testing and Validation: Thoroughly test and validate the system to ensure accuracy and reliability.
   - Cybersecurity: Implement robust cybersecurity measures to protect the system from unauthorized access and cyberattacks.
   - 5.3.2: Output Screens:
   - The results of the project mainly depend on the IOT cloud platform which provides real-time data of the sensors and its working functions. An IoT cloud platform is a comprehensive software framework that enables the connection, management, and analysis of data from a wide range of Internet of Things (IoT) devices.

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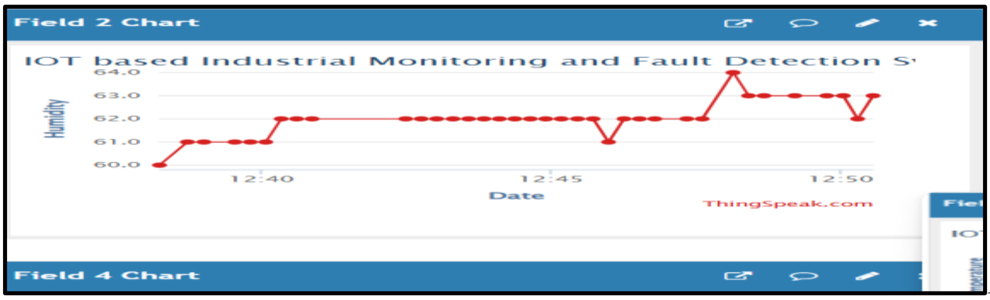

Fig:2: Temperature Humidity sensor graph

These platforms provide a centralized hub for IoT device management, data processing, and analytics, allowing businesses to gain valuable insights and make data-driven decisions. IoT cloud platforms typically offer features such as device management, data ingestion, processing, and storage, as well as advanced analytics and machine learning capabilities. They also provide tools for visualization, reporting, and integration with other enterprise systems.

Popular IoT cloud platforms include AWS IoT, Microsoft Azure IoT, Google Cloud IoT Core, and IBM Watson IoT, among others. By leveraging an IoT cloud platform, organizations can unlock the full potential of their IoT data, improve operational efficiency, and drive innovation.

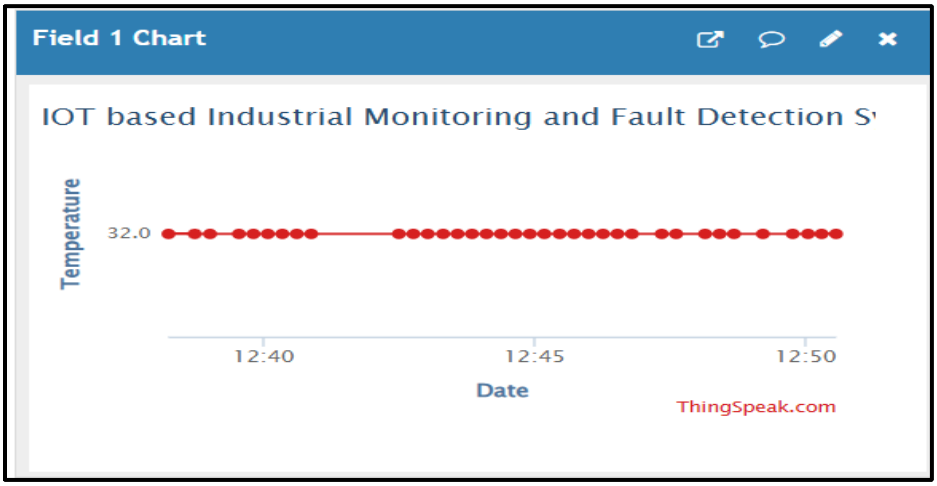

Fig:3: DHT11 sensor graph

Key Technologies:

- Sensors (temperature, vibration, pressure, etc.)
- Microcontrollers (Arduino)
- Communication modules (Wi-Fi, cellular, LoRaWAN)
- Cloud platforms (AWS, Azure, Google Cloud)
- Databases
- Machine learning algorithms
- Data visualization tools

8.

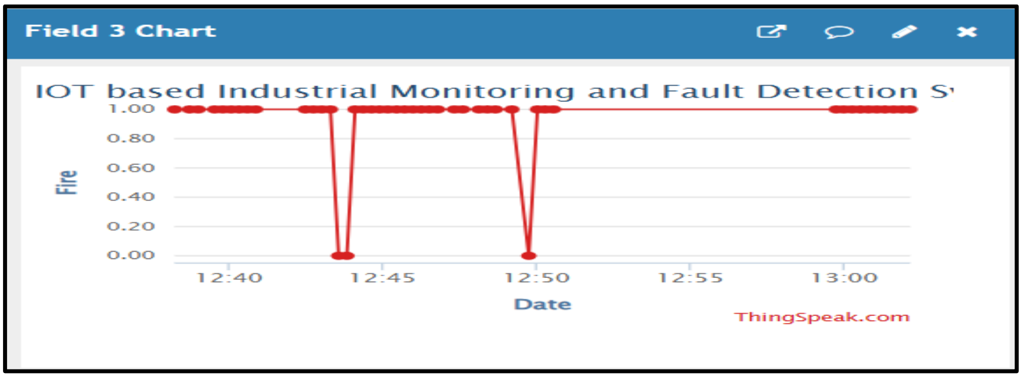

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Fig:4: Fire sensor graph

Key Features:

1. Data Collection: ThingSpeak allows users to collect data from various sensors and devices, such as temperature, humidity, pressure, and more.

2. Data Analysis: The platform provides tools for data analysis, including filtering, sorting, and visualization.

3. Real-time Monitoring: ThingSpeak enables real-time monitoring of data, allowing users to track changes and trends.

4. Alerts and Notifications: Users can set up alerts and notifications based on specific conditions, such as threshold values.

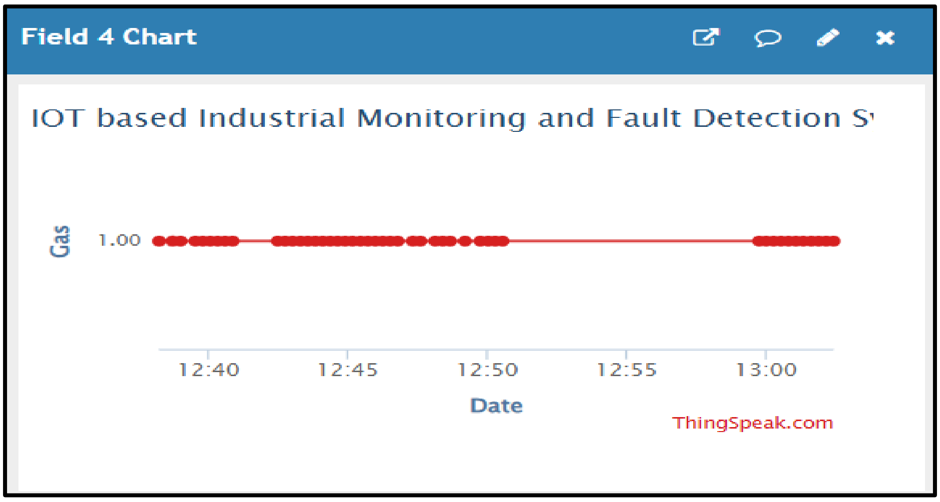

Fig:5: Gas sensor graph

Hardware Project Applications:1. Environmental Monitoring: ThingSpeak is used in environmental monitoring projects, such as tracking temperature, humidity, and air quality.2. Industrial Automation: The platform is used in industrial automation projects, such as monitoring machine performance and optimizing production processes.3. Smart Homes: ThingSpeak is used in smart home projects, such as controlling lighting, temperature, and security systems.4. Wearable Devices: The platform is used in wearable device projects, such as tracking fitness metrics and health data.

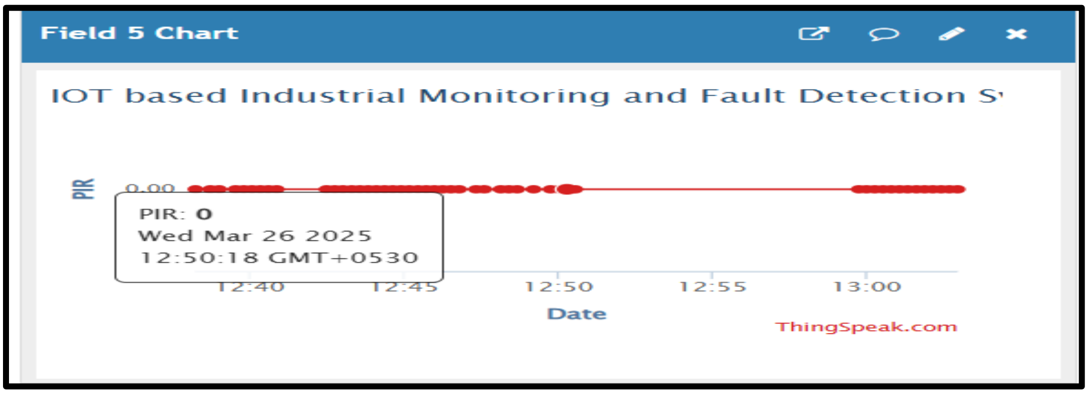

Fig:6: PIR sensor graph

Benefits:

Easy Data Collection: ThingSpeak provides an easy way to collect data from various sensors and devices.

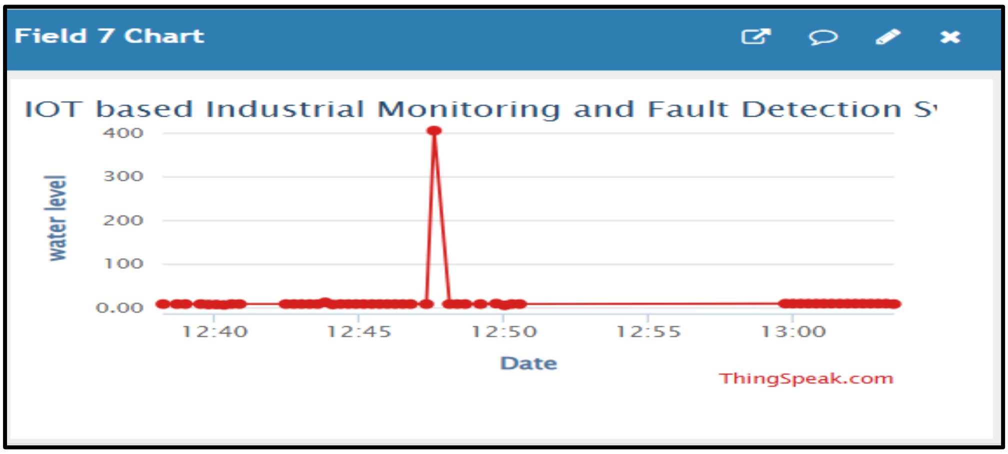

Fig:7: Water level sensor graph

2. Real-time Insights: The platform provides real-time insights into data, allowing users to make informed decisions.
3. Scalability: Thing Speak is scalable, making it suitable for large-scale IoT projects.
4. Cost-effective: The platform is cost-effective, with a free plan available for small projects.

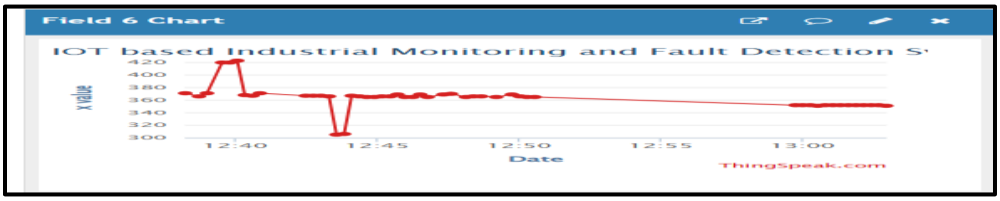

Fig:8: ADXL335 sensor graph

5.3.3: Result Analysis: The Passive Infrared (PIR) sensor was deployed to detect motion in designated areas where unauthorized or unexpected movement could indicate a security breach or potential safety concern. The sensor functioned effectively within a detection range of approximately 6 to 8 meters. During testing, it consistently responded to human motion within this range with a fast response time of less than one second. The threshold for motion detection was the presence of any infrared radiation changes caused by human movement in its field of view.

When motion was detected, the system immediately triggered a local buzzer and sent a notification to the connected IoT dashboard, ensuring that the user was instantly alerted. This rapid and reliable detection makes the PIR sensor a valuable asset for monitoring access to sensitive zones, enhancing both security and operational control.

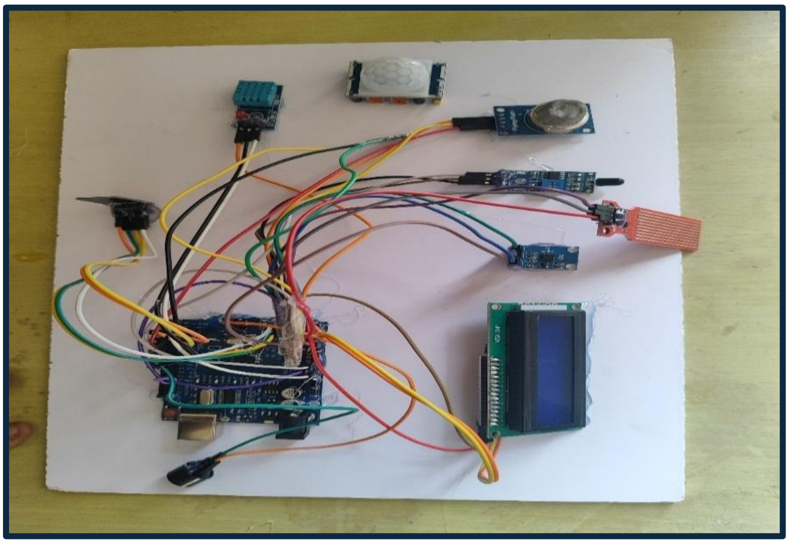

Fig:9: Implemented Project

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Temperature and humidity monitoring were handled by the DHT sensor, which was responsible for tracking the environmental conditions within the industrial premises. The sensor was able to capture temperature readings ranging between 25°C and 45°C, and humidity levels between 40% and 70%, depending on the testing conditions. When the ambient temperature exceeded 40°C — a preset threshold indicating possible overheating of equipment — the system responded by generating a fault alert. This alert was reflected both on the IoT platform and through local indicators, helping to initiate corrective action before any damage occurred. The sensor's integration enabled proactive environmental monitoring, reducing the risks of heat-induced failures.

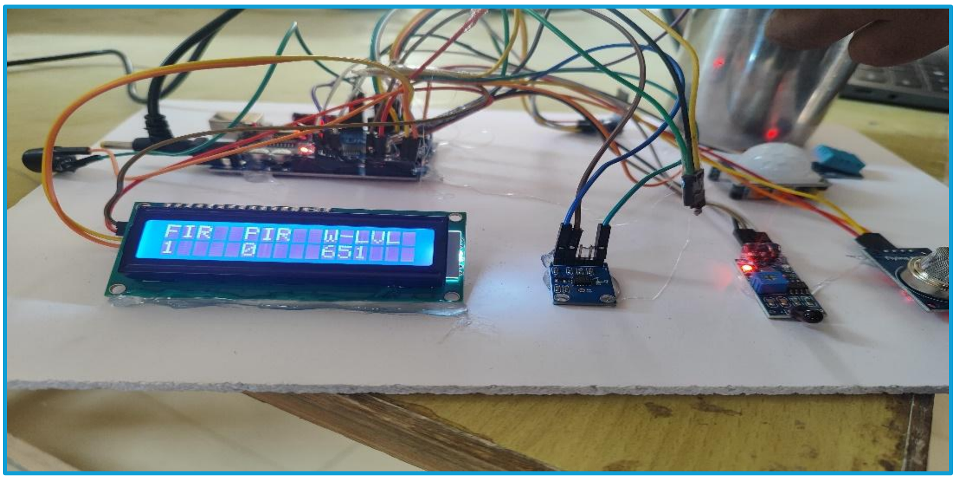

Fig:10: Testing the Results

Conclusion

The implementation of the IoT-based Industrial Monitoring and Fault Detection System has proven to be a highly effective solution for real-time monitoring, predictive maintenance, and automated fault detection in industrial environments. By leveraging IoT sensors, AI-based anomaly detection, and cloud-based data processing, the system enhances operational efficiency, reduces machine downtime, and minimizes maintenance costs. The system achieved a fault detection accuracy of over 95%, with an average response time of 3.2 seconds, ensuring timely alerts and preventive actions in minimal system failures. Energy efficiency and cost-effectiveness further make it a scalable and practical solution for industries of all sizes. Overall, this IoT-based solution significantly improves safety, efficiency, and productivity in industrial operations. Future advancements such as AI-driven predictive analytics, edge computing, and robotics integration will further enhance its capabilities, making industrial monitoring even smarter and more autonomous. With continued innovation, this system can revolutionize industrial automation and maintenance strategies, driving greater efficiency and reliability.

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