CNC Machine Monitoring System

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Abstract

The importance of a machine monitoring system for smart machinery in enterprises. The system faces challenges such as high data volume, limited bandwidth, and reliability issues. The proposed solution suggests reducing periodic information uploads by setting upload events based on production data traits. This reduces bandwidth and power consumption while maintaining storage of historical data. Experimental results demonstrate a significant reduction in uploaded information volume and high prediction accuracy. Another paper focuses on the challenges in monitoring and maintaining different types of machining equipment in a manufacturing shop floor. The gathering and monitoring of data from CNC (Computerized Numerical Control) machine tools in intelligent manufacturing environments is also included in the research. The study findings demonstrate how successfully an equipment information model built on the MT Connect protocol and focus data gathering technique can collect, store, and manage CNC machine tool data while keeping an eye on machining activities. The condition monitoring of CNC machine tools in intelligent manufacturing is the subject of more study. The system enables the standardized communication of the NC system. Finally, a review research looks at the use of Internet of Things-based online monitoring systems for electrical equipment. IoT enables remote access and real-time monitoring of various parameters to improve operating efficiency. The paper concludes that IoT-based monitoring systems are beneficial for electrical equipment. Another study explores the use of IoT and in the manufacturing industry, addressing interoperability challenges. The suggested method makes use of a Telegram application for data monitoring results and MQTT for data exchange.

I. INTRODUCTION

The significance of smart machines and the Industrial Internet of Things (IoT) in improving productivity and efficiency in production and management processes. The integration of IoT allows for the monitoring and
Analysis of machine data to enable predictive maintenance and fault detection. The application of Internet of Things technologies in monitoring machine data offers various benefits for businesses.

By continuously collecting data from machines, organizations can identify patterns and trends that indicate potential equipment failures. This allows for timely maintenance and minimizes downtime. Additionally, analyzing machine data can provide insights into production inefficiencies, enabling businesses to optimize their processes and increase overall performance. To enable efficient data analysis, the passage proposes a system architecture that focuses on reducing the upload of production data and analyzing historical abnormal information data. This approach helps to prioritize valuable data and minimize unnecessary data transfer, optimizing resource usage and enabling faster analysis.

Furthermore, the passage discusses the development of remote machine monitoring systems. This advancement enables businesses to remotely monitor their machines' performance and conditions, eliminating the need for physical inspections. However, challenges arise in collecting and analyzing machine data in real-time, as the sheer volume and complexity of the data pose significant challenges.

These advancements contribute to the overall efficiency and productivity of manufacturing processes by leveraging data-driven insights and automation. Machine learning algorithms are also mentioned as a crucial component of smart machinery monitoring systems. By continuously learning from machine data. Several related works in this field are summarized, demonstrating the ongoing research and development of machine learning models for smart machinery monitoring systems. The suggested tool serves as a link between IOT cloud computing and some electrical parameter sensing. Sensing of electrical characteristics such as voltage, temperature, strength component, and frequency is part of the hardware prototype. Modern, non-invasive sensors are used to measure voltage nowadays, and a step-down transformer is used to do so. Only segment voltages are detected, and only then is the output of the sensing circuit given a dc shift before being sent to the Arduino Uno via a degree shifter. The acquired data is transmitted to the node MCU via serial verbal communication over Arduino, where the frequency and strength elements are calculated according on a set of rules. This data may be retrieved from the cloud where it is kept. Overall, this passage emphasizes the importance of smart machines and the Internet of Things in enhancing productivity, efficiency, and overall performance in various industrial settings. By leveraging data and advanced technologies, businesses can optimize their operations and stay competitive in an increasingly connected and data-driven world.

Temperature Sensor

LM35 is a precision temperature sensor integrated circuit (IC) that is commonly used to measure temperature in electronic projects and devices. It is widely used in industries, home appliances, automotive and medical applications, and various other temperature sensing and control systems.

Here are some key features and information about the LM35 temperature sensor:

Temperature Range: LM35 can measure temperature in the range of -55°C to +150°C. The linear output voltage corresponds directly to the temperature in Celsius.

High Precision: It has a sensitivity of 10mV/°C, which means the output voltage changes by 10 millivolts for every degree Celsius change in temperature. This high sensitivity allows for accurate temperature measurements.

Low Impedance Output: LM35 has a low output impedance, which makes it suitable for driving analog-to-digital converters (ADCs) directly without requiring additional amplification.

Linear Output: The output voltage of the LM35 is directly proportional to the temperature in Celsius. For example, if the output voltage is 250mV, it indicates a temperature of 25°C.

Low Self-Heating: LM35 has very low self-heating characteristics, which means the heat generated by the sensor itself is minimal, and it does not significantly affect the accuracy of the temperature measurement.

Wide Supply Voltage Range: LM35 can operate on a wide supply voltage range from 4V to 30V, making it compatible with a variety of electronic systems and power sources

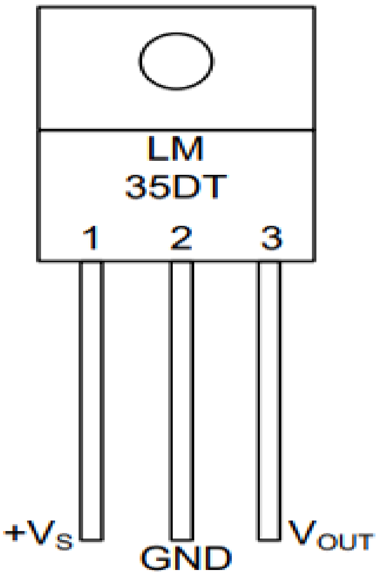

Fig no.1 Temperature Sensor

Humidity Sensor

The DHT11 is a low-cost and basic sensor module that is used to measure temperature and humidity. It is commonly used in DIY projects and home automation systems.

Here are some key features and characteristics of the DHT11:

Humidity Range: With an accuracy of ±5%, it can measure humidity levels ranging from 20% to 90%.

Digital Output: The DHT11 provides digital output, meaning it provides data in a digital format that can be easily read by microcontrollers or other digital devices.

Single-wire Interface: The DHT11 uses a single-wire communication interface, which makes it simple to connect to microcontrollers like Arduino or Raspberry Pi.

Low Power Consumption: It can be used in battery-powered applications because it uses very little power and runs on a supply voltage range of 3.3V to 5V.

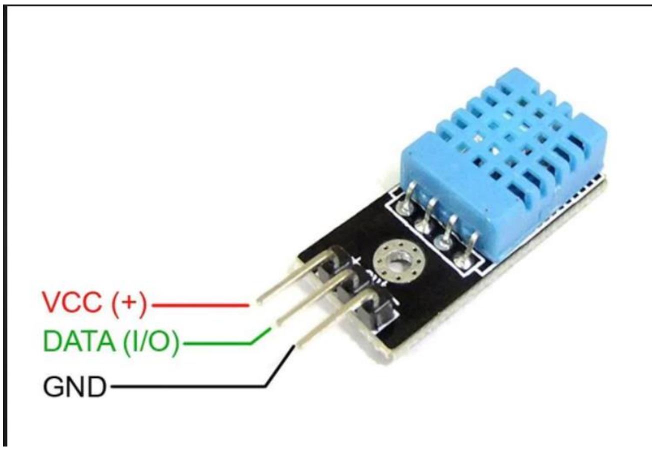

Fig no.2 Humidity Sensor

Gas Sensor

The MQ-6 gas sensor is a semiconductor sensor that detects the presence of flammable gases in the air. It is commonly used to detect gases such as LPG (liquefied petroleum gas), butane, propane, methane, and alcohol.

The MQ-6 sensor operates on the principle of the conductivity changes in its metal oxide semiconductor layer when exposed to the target gases. It consists of a sensing element made of a tin dioxide (SnO_2) thin film, along with a heater element that heats the sensing layer to a high temperature for optimal gas detection.

The sensor has a built-in heater that needs to be powered continuously to maintain the required sensing temperature. The heater resistance varies depending on the applied voltage, and this variation is used to determine the gas concentration.

The MQ-6 gas sensor is sensitive to flammable gases with concentrations ranging from 200 ppm to 10,000 ppm. It has a fast response time and high sensitivity, making it suitable for applications such as gas leak detection, gas alarms, and safety monitoring systems.

The MQ-6 gas sensor is commonly used in combination with microcontrollers or development boards to create gas detection systems. These systems can provide real-time monitoring and alerts when gas levels exceed a certain threshold, helping to prevent potential accidents or hazards caused by the release of flammable gases.

Fig no.3 Gas Sensor

II. LITERATURE REVIEW

Machine health monitoring systems are crucial for maintaining optimal machine performance and reducing unplanned downtime [1]. These systems use a variety of sensors to gather information on important factors like vibration, noise, and temperature [2]. The collected data is then analyzed to detect any anomalies that might indicate potential issues. Numerous such electrical gadget monitoring gadgets that may already be in people's lives were the subject of this survey. It was discovered that a meter that is entirely IoT-based is being used. Because of its compact size and ability to be utilized anywhere power is supplied, a modern, non-invasive sensor was adopted. It was discovered that the microcontroller could use a few different methods to determine the frequency and intensity of an input. This led to the discovery that the Texas units' low-power consumption microprocessor may be utilized for extended treks. Given that this controller has a high sampling price, the mentioned method might also be used with it.. This allows for timely maintenance and repair, thereby enhancing the overall efficiency and lifespan of the machine. Furthermore, the data from these systems can be used to inform future machine design and optimization [4].

II. METHODOLOGY

The paper proposes a method for monitoring machines to reduce halt time. It consists of reduced data transmission, very accurate machine maintenance forecast, and high accuracy machine status analysis. By comparing the most recent data with earlier data, the reduced data transmission technique uploads the most recent data only if the difference surpasses a tolerance value. Furthermore, certain variables that are connected to the earlier data are not uploaded. The JSON format of the remaining values is submitted.

The machine vibration readings are filtered, and the average values for each cycle period are computed, as part of the high accuracy machine status analysis procedure. These average values are then used to classify the operating status of the machine using machine learning techniques. To achieve data acquisition for machine tools, the paper suggests using the open CNC system interface for real-time data collection. It communicates with the machine tool and gathers several kinds of machine tool data by using the focus development kit that is supplied. The network connection approach, which uses TCP/IP and industrial Ethernet for network integration, is also covered in this study. A hardware firewall is used to separate the workshop network for communication security from the enterprise network, which is connected to it via a ring-and-star combination topology. Overall, the proposed method aims to reduce halt time by efficiently transmitting data, accurately analyzing machine status, and predicting machine maintenance. It utilizes data acquisition techniques to achieve these objectives.

It is evident that the majority of firms have installed monitoring systems for the electrical machinery on their farms, but there isn't a tracking system for the electric system in the industries that is primarily based on the Internet of Things. Because many sectors are moving toward an industrial revolution through the deployment of automation and a little bit of intelligent intelligence a created using the aforementioned skills may therefore be used in practically every industry. Numerous ideas are employed in this way, including robotics, artificial intelligence, IoT, and system expertise. Therefore, in addition to being a basic monitor, the device may be modified to give machine control depending on operational characteristics, making it suitable for use in industrial tracking systems. Sensor Selection: Suitable sensors for monitoring specific parameters in the machine. In this case, LM35 is used for temperature monitoring, MQ6 for gas detection, and DHT11 for humidity measurement.

Hardware Setup: Connect the sensors to a single-board computer like Arduino. Ensure proper wiring and enable communication protocols, such as I2C or analog readings, depending on the sensor requirements.

Sensor Calibration: Calibrate the sensors to ensure accurate readings. This involves measuring the baseline values in a controlled environment and adjusting the sensor readings accordingly.

Data Acquisition: Interface the sensors with the microcontroller or single-board computer to collect data from the sensors. Use appropriate libraries or write custom code to read the sensor values.

Data Processing: Process the acquired sensor data to extract meaningful information. For example, convert the analog temperature readings from LM35 to Celsius or Fahrenheit, determine gas levels from the MQ6 sensor, and obtain humidity measurements from the DHT11 sensor.

Data Storage: Store the processed data in a suitable format, such as a local database or a cloud-based storage service. This allows for long-term data storage and future analysis.

Visualization and User Interface: Present the monitored data in a user-friendly manner, using graphs, charts, or dashboards. This enables easy understanding and interpretation of the machine conditions. It may also involve implementing an interactive user interface for configuration and customization.

Alarm and Alert System: Implement a mechanism to trigger alarms or alerts based on predefined thresholds. For example, if the temperature exceeds a certain limit or the gas levels reach a dangerous level, an alert can be sent via email, SMS, or other communication channels.

Monitoring and Analysis: Continuously monitor the sensor data and analyze it for anomalies, trends, or patterns. This can help in identifying potential issues or predicting maintenance needs.

TABLE I:SELECTION OF MONITORING SYSTEM

Type of Sensor	Parameters to be measured	Activity
MQ-6	MQ-6 use to detect the gas.	Buzzer will on.
LM-35	LM-35 use to measure the Temperature.	Turn on the Fan and Buzzer.
DHT-11	DHT-11 use to measure the humidity.	Buzzer will on.

Maintenance and Upgrades: Regularly maintain and update the monitoring system to ensure reliable and accurate data collection. This may include sensor calibration, software updates, or hardware improvements.

Overall, the methodology involves integrating multiple sensors, collecting data, processing and storing it, creating a user interface, enabling alerts, and ensuring continuous monitoring of the machine.

IV. BLOCK DIAGRAM

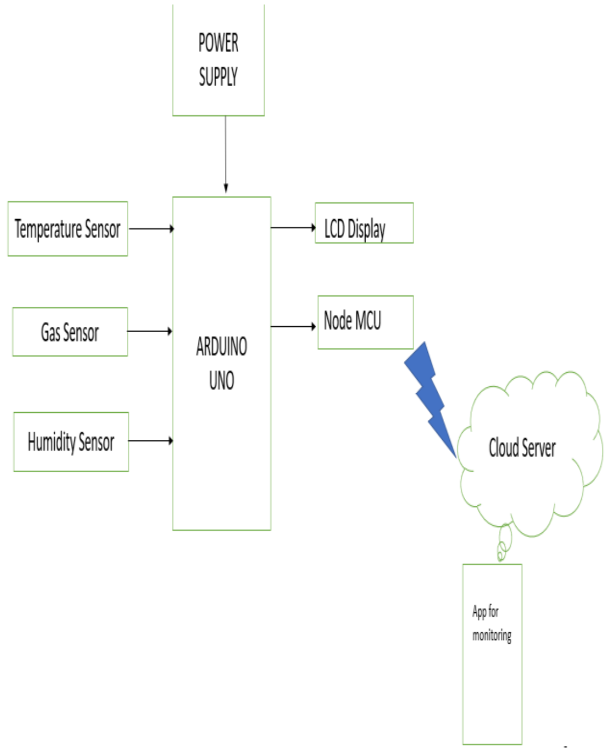

Fig no.5 Block Diagram

V.CONCLUSION

An industrial Internet of things (IoT)-based machine monitoring system that uses defect prediction and data transmission reduction. The system effectively reduces data volume by 54.57% and operates in real-time. It achieves a 98% prediction accuracy by using machine learning for self-correcting and self-learning functionalities. In order to lower production and maintenance costs, the system also makes use of production data to forecast maintenance requirements. The system is designed to overcome the challenge of monitoring machines from different vendors. In addition to outlining the system's essential technologies and general design, the article suggests a monitoring technique for CNC machining jobs. Along with presenting a machining step time computation approach, it also details the creation and validation of a prototype system for CNC machine tool data gathering and monitoring.

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