Design and Implementation of a Real-Time Dashboard for the Industry using IoT

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***Abstract*—This paper proposes a design and implementation of a real-time dashboard for industry using IoT to monitor the moment, temperature, gas level, acceleration rate, and distance is monitored remotely and can be sent to the processing unit for analysis to take necessary actions under the abnormal for better reliability and efficiency. Where physical quantity is converted to digital data for future use. The wireless sensor is responsible for the effective data collection of the described parameters The real-time data is updated to the cloud automatically, in case of emergencies the decision is done based on these existing data and also based on real-time data. This data can be accessed anywhere in the world through a WiFi connection. A real-time dashboard is created in the Blynk and Arduino IOT cloud where the data are converted into visual data where user understanding level will be high. ESP8266 WiFi module is acting as a bridge between the sensor and dashboard data display in the dashboard. ESPressif system WiFi microchip with built-in TCP/IP networking software is used to create Operational Dashboard.**

Keywords—Internet of Things(IoT), ESP8266 Node MCU, CLOUD Platform, Operational Dashboard.

I. INTRODUCTION

The Internet of Things (IoT) refers to the extension and use of the Internet of Things in industrial sectors and applications It enables industries and enterprises to have good efficiency and reliability in their operation. Industrial operations have become critical nowadays as evolution takes place in the industry the maintenance of systems becomes difficult so a combination of information technology and operational technology enhances the operation more reliably and effectively.

The Internet of Things (IoT) comprises ever-growing technologies that can be used for connecting, controlling, and managing intelligent objects connected to the Internet through an Internet protocol (IP) address. The US Intelligence Council predicts that by 2025, IoT devices may be present in every field. As reported by Statista global expenditure in 2023 is expected to be $ 1 trillion, with IOT infrastructure in the manufacturing sector expected to reach $400 billion.

A basic IoT device made up of a WiFi-based sensor connected to the internet is placed in a circuit board. There's a wide range of devices available. These devices are manufactured by different companies. For prototyping a microprocessor device like ESPRESSIF ESP32, STMicroelectronics B-U5851-IOT02A Discovery kit, or STMicroelectronics B-L4s5i-IOT Discovery kit these boards have inbuilt sensors such as temperature and accelerometer sensors.

The IOT Device SDK and IOT Hub support common communication protocols such as HTTP, MQTT, AND AMQP. IoT devices have different characteristics when compared to other clients such as browsers and mobile apps. The device SDKs help to address the challenges of connecting devices securely and reliably to cloud services. IoT Devices are often embedded systems with no human operator and can be deployed in remote locations, where physical access is expensive. It requires limited power and processing resources. May need to use proprietary, custom, or industry-specific application protocols.

The industrial monitoring system deals with wireless IIOT sensor data enabling Organizations to forecast and warn personnel when a machine will require maintenance. This IIOT use case avoids costly breakdowns and unnecessarily expensive repairs. Energy optimization is also one of the valuable cases for industrial IOT monitoring systems. cone ting industrial machines, HVAC systems, and other things consume a lot of energy but the Internet of Things can help to cut off energy use.

Dashboard represents our physical world many data sources are purely digital like financial stock prices, and the Internet of Things utilizes input/output devices and sensors from our physical world to display insights from an environment or its systems. IoT Dashboards populated with graphs, charts, control switches, maps and tables, and countless other widgets are the digital tools we use to visualize and display data coming from the physical world to our computers. IoT dashboards can be accessed simply with a URL and any standard browser or mobile application anywhere in the world.

II. RELATED WORKS

Integration of IIOT (Industrial Internet of Things) tools and the exploitation of their positive benefits are becoming a main factor in the industry more research has been conducted in

different areas and more papers are published in the following, let us examine in detail the results of the study and predictive results

Katalin ferencz and Jozsef Domokos, in Rapid prototyping of IoT application for industry [1] say that Developed their prototype using Node-Red Iot application using combined cycle power plant (CCPP) data the system has high complexity because the Node-Red Is an open source javascript based system developed. The main disadvantage is that the process they developed for the monitoring web page is bitting complex because SQL databases one is not easy to adopt.[1]

Sudharani Potturi, and Dr.Rajashekar P.Mandi, in a conference Paper on Critical Survey on IoT-based Monitoring and control of Induction Motor [3] explains IOT application in different fields like Industrial Motors, Agriculture Motors, and IoT for Motor in Electric Vehicles. The Web page is created
But the survey is not transparent the applications explain in different fields whether the application is on a web page or in the form of links.[3].

III INDUSTRY AND IOT

The Encouraged by an inspiring message delivered by the prime minister at the recent WEF Davos conference stating Industry 4.0 is not about Robots it is about humans[7]. The Past industrial revolution of the 18th, 19th, and 20th centuries from steam to electricity to computing, all in a direct manner towards improving efficiency and speed of the processes in which humans were involved. The industries were transforming.
Until the start of the 4th Industrial Revolution, the industry was characterized by strict and rigid standards that provided a sense of security[6].

Machines play an important role in the industry 3.0 revolution every sector is getting digitized so there is a need for updation in the industries. In Industry 3.0 legacy machines are in use, To update the machines some advanced tools are used. The Internet of Things is one of those technologies. IoT devices collect large amounts of data that can analyze to optimize production, and machine utilization and predict the need to replace a component, called predictive maintenance. Manufacturers can increase productivity and efficiency with customized digital solutions.

IoT devices communicate with other devices that can share or get the data even from the legacy machine. To update the machines the Internet of Things is combined with
Automation to make the machine more reliable and effective.

The industrial application lies in two broad categories one is a monitoring system and another one is a control system both

processes need large amounts of data. IOT collect data for these process in the industry.

If we go with PLC for controlling and monitoring it needs additional data storage. Certain space is required for setting up the PLC. Though is an effective one it cant be implemented in medium-scale industries and also in small-scale industries.

If the cloud space is bought once it is used for storing, also for running applications, and Processes information. Cloud platforms have multiple uses. The cloud server is a virtual server that makes computing resources accessible to multiple users over a network through the internet. cloud server hosted and delivered by a cloud computing service. Cloud servers depend on the demand of the user and have broad access to the network. Top cloud vendors are Amazon web services, Microsoft Azure, Google Cloud Platform, IBM Cloud, and Oracle Cloud.

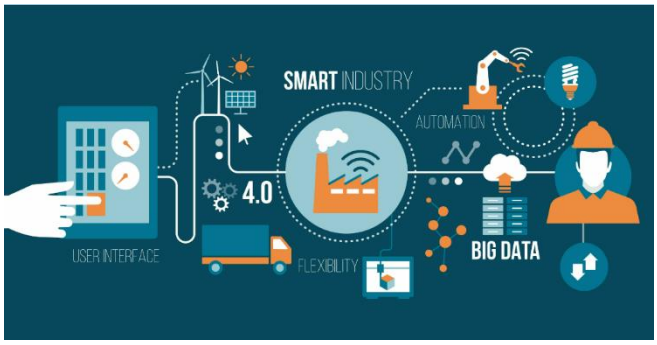

Fig 1. IoT in Industry

Smart devices /machines are accurate, their use reduces human. contact and error which increase quality and safety[1]. Machines are taking up space in production, that is, they take on tasks that can be reprogrammed, machines can do. The human factor is displaced from the production lines, great accuracy is achieved and the role of people in factories is changed. As a result, you will need more office workers than line.

An important feature is a cost-effective implementation[1]. Product design has the problem of learning the various licenses and complicated software that may not need in the design phase.

According to the design free software is available in the market based on the dashboards and microcontroller software is used.

The complicated part of the dashboard implementation is the integration of sensors. Each sensor possesses a different register value and each sensor have particular libraries. Depending on the microcontroller the software should get integrated with the cloud platform. Some inbuilt widgets will be available or customization can be done. the voice assistant intimates the change in data and intimates during the abnormal condition that occurs inside the industry. These dashboards will be displayed on the LCD or a PC monitor in the center of the industry. The parameters get updated automatically real-time data variation will be in the display and widgets make the user understand the data easily.

IV. PROPOSED SYSTEM FUNCTIONAL OVERVIEW

Fig 1 displays the system hardware of the proposed system IoT-based real-time dashboard for analyzing the industrial parameter. The system hardware is used to collect the physical data for monitoring the parameters. As illustrated in Fig 1, the temperature sensor(DHT11), Distance sensor(HC-SR04), Gas sensor (MQ2), PIR sensor, and Acceleration sensor(ADXL345) are employed to monitor the external environment, and the data is stored through ESP8266 NodeMcu WiFi module. The data get stored in the corresponding register that is connected to the microcontroller. The cloud platform uses the stored data from the NodeMCU board and analyzes them in the database. Depending on the sensor connected to the microcontroller the memory space and register to get utilized based on that and corresponding data get stored and the future gets accessed. WiFi module connects the microcontroller to the cloud platform. The voice assistant gets connected with the third-party board for intimation.

A . Sensors

Sensors are employed to detect events or measure changes in the environment [1]. Sensors have been powered by high-speed and low-cost electronic circuits which increases quality, reliability, and economically efficient products[8]. The DHT11 is used to measure temperature and humidity. Distance sensor(H-SR04) measures the distance of the object or the position of the object. PIR sensor detects the objects' presence by moment. Gas sensor(MQ2) measures the gas level inside the industry and also the gas level in the chemical industry and others. The Acceleration sensor (ADXL345) measures the acceleration rate of a machine. Raw data is sensed by the sensor and sent to the input ports of the ESP8266 module and automatically updated in the cloud.

B . ESP8266 NodeMCU Module

The ESP8266 module is a cost-effective board with complete networking software with an inbuilt TCP/IP ESPressif system WiFi Microchip i.e. inbuilt transmitter and receiver module. The NodeMCU module is an open IOT device with 4MB storage capacity and a hardware development environment that is built around inexpensive [1]. ESP stands for Encapsulating Security Payload protocol within IPsec for providing authentication, integrity, and confidential network packets.

C. Relay Module

The relay module is a high-voltage switch used to connect the industrial light loads for control and also for protection purposes. the supply voltage for the single-channel relay module is 3.75v to 6v. relay active current is around 70mA. Maximum contact voltage is 250VAC or 30VDC. The maximum relay current is 10A. Dual channel relay module, Four channel relay module, and 8channel relay module are present depending on whether the usage channel gets increased or decreased.

D. Cloud Platform

The Cloud platform allows developers to write applications that run in the cloud. The Cloud platform is in three types Public cloud, Private cloud, and Hybrid cloud in these industries can conveniently use the Cloud. Even AI(Artificial Intelligent applications can work efficiently in the cloud platform [9]. The Real-time data and stored data are placed in the cloud for analyzing the process and also for monitoring the situation.

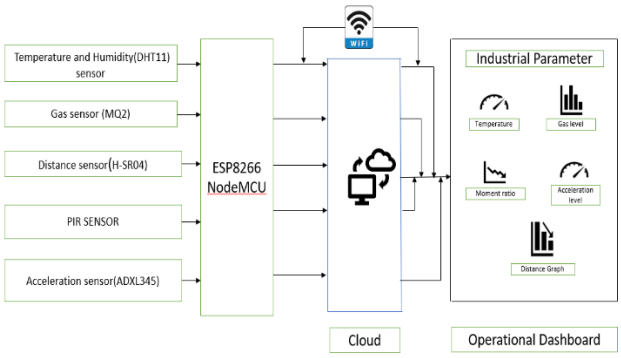

Fig 2. IoT-based real-time dashboard.

ESP8266 NodeMCU module is a third-party board to the Arduino IDE. IDE is an open source used to write or upload A computer program to the NodeMCU board. In general, Arduino 1.8.5 is used to design the code for the integrity of the sensor. The language employed here is basic C programming to code the sensor. Each sensor possesses a separate library to connect the microcontroller.

In Microcontroller each sensor is connected to analog pins and the out will be in the digital pin that is displayed in Fig 2. That digital pin is connected to the digital pin of the sensor and that data is uploaded to the Cloud through Arduino IDE. After the execution of the code Cloud platform personal credential will

be given a password or secret key to only access with login credentials. that should be incorporated into the code. IoT devices communicate through WiFi so the WiFi username and WiFi password are also incorporated in the code.

After the installation cloud libraries in the Arduino IDE Driver should be installed to connect the Arduino IDE code with the cloud account. A separate demonstration page will be opened where widgets can be assigned according to the measuring level. One time setting up all those things is enough The dashboard will predict and analyze the data.

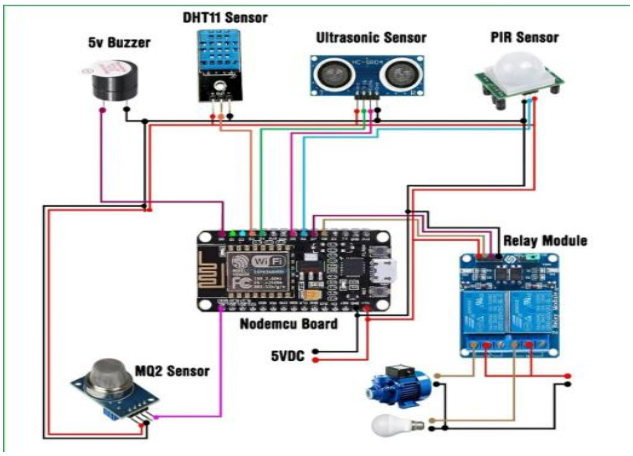

Fig 3. Proposed Circuit

E. Types of Cloud

The operating system and hardware of a server in an internet-based data center are known as a cloud platform. Compute facilities, such as servers, databases, storage, analytics, networking, applications, and intelligence are rented by businesses. Businesses do not need to invest in data centers they pay for services. there are three different types of cloud platforms [10].

PUBLIC CLOUD – Third-party providers that distribute computing services over the Internet are known as public cloud platforms. Some of the best providers are AWS, Microsoft Azure, Alibaba, and IBM Bluemix[10].

PRIVATE CLOUD - A private cloud is always hosted by the on-site data center. A private cloud is always owned by one corporation or a single group buys the cloud for their private storage. user authentication can access only within the organization.

HYBRID CLOUD – The Cloud architecture that possesses both the characteristics of public and private cloud that's called Hybrid Cloud. Data and programs are easily migrated from one to the other. This Cloud makes it more flexible while improving the infrastructure, security, and enforcement

Organizations can use a cloud platform to develop cloud-native software, test and build them, and store, back up, and Recover data. Total details of the organization stored in the cloud that they owned[10].

V. ESP8266 ARCHITECTURE

Features of ESP8266 Low cost, compact, and powerful Wi-Fi Module Power Supply: +3.3V only Current Consumption: 100mA I/O Voltage: 3.6V (max) I/O source current: 12mA (max). Built-in low-power 32-bit MCU at 80MHz,512kB Flash Memory. Can be used as Station or Access Point or both combined Supports Deep sleep (<10uA). Supports serial communication and hence compatible with many developments

platforms like Arduino. Can be programmed using Arduino IDE or AT-commands or Lua Script[11].

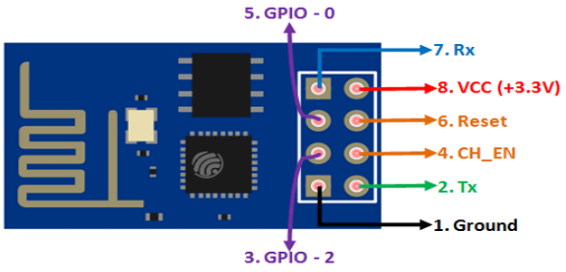

Fig 4. Pin Configuration of Wi-Fi module

Ground – connected to the ground of the circuit. TX GPIO-1 is connected to the RX pin of programmer/uc to upload the program and alternatively used as the Input/output pin when not used as TX.

GPIO-2 general purpose Input/Output pin. CH_EN IS Chip enable is inactive high. GPIO-0 it's a flash general-purpose input/output pin and is alternatively used as a serial programming module. Reset it reset the module i.e. it repeats the process after the reset. RX GPIO-3 general purpose as input/output pin and alternatively used as RX pin.Vcc cone ted to +3.3V only.

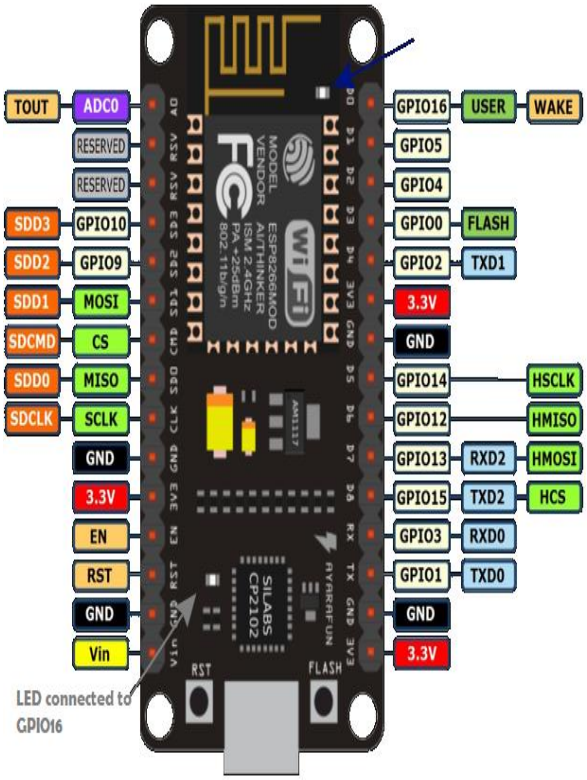

Fig 5. Pin configuration of ESP8266 module

All ESP8266 variants have an ESP8266 core processor and a Tensilica L106 32-bit microcontroller unit. This is a low-cost, high-performance, low-power consumption, easy-to-program, wireless SoC(System-On-Chip). It provides capabilities for 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose input/output (13 GPIO), Inter-Integrated Circuit (I²C), analog-to-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI),

I²S interfaces with DMA (sharing pins with GPIO), UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM).

It has a built-in programmer and a voltage regulator, that allows flashing and powering the device via micro-USB. The system operates at 3.3V[12].

The ESP8266 can set up WIFI connections. At a high level, Wi-Fi can participate in TCP/IP connections over a wireless link. ESP works on the TCP/IP protocol or the UDP protocol.

Real-time data with minimal cost the estimation is illustrated In Table 1.

TABLE 1

COST ESTIMATION OF THE PROJECT

s.no	Components	Quantity	Cost
1	ESP8266WiFi module	1	390
2	Distance sensor (H-SR04)	1	115
3	PIR Sensor	1	200
4	Gas sensor (MQ2)	1	210
5	Temperature & Humidity(DHT11)	1	210
6	Relay Module (Dual Channel Relay)	1	110
7	others		292
			1,527

Updating machines will be easy through the Internet of Things and the implementation cost will be minimum. Medium Scale and small-scale industries can also participate in the Industry 4.0 revolution by updating their legacy machines using the Internet of Things and automation.

Fig 3 displays the hardware setup it doesn't require any space to install. Just attach the machine fetch the code to the sensor and the microcontroller send the signal through virtual a pin. Fig 4 represents the Real-time dashboard that represents the data periodically. A free cloud platform is used for monitoring purposes

VI RESULT.

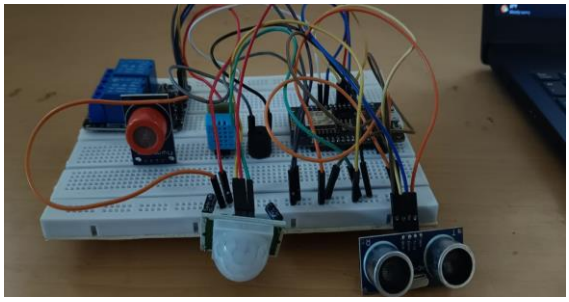

Fig 6. Hardware Setup

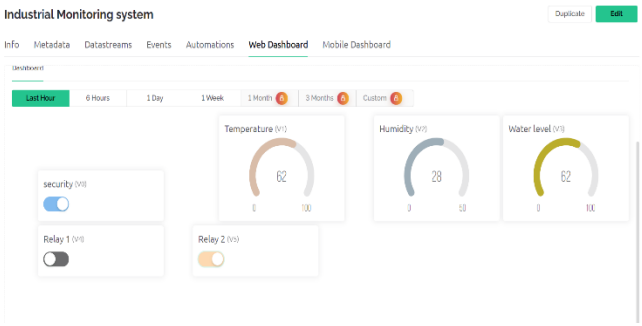

Fig 7. Real-time Dashboard in Cloud Platform

The data sensed by the sensor and difference is collected every minute or every hour. The deviation is shown in Fig 7. The data collected in the cloud is used for future analysis and to make the best outcome.

V. CONCLUSION.

The paper gives the solution to improve the legacy machines and maintain the economy of the industry high. It monitors and maintains the data in the same place where is get executed. Different types of Dashboards are available the dashboard implemented here is an Operational Dashboard it maintains the storage data and also the analyzing data in abnormal conditions. From the future perspective, the highly digitized environment seeks more information this paper going to be a key player it's going to be part of the digital twin technology. The Digital twin in every industry comes true with the help of real-time data. the combination of these technology enriches the industry and focus on Industry 5.0.

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