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DEVELOPMENT AND IMPLEMENTATION OF LOW COST IIOT GATEWAY WITH EDGE COMPUTING FEATURE FOR INDUSTRY 4.0

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Abstract - *Nowadays factory is moving rapidly towards industrialization and IOT. Because the world is moving to the Era of where robots and machines are doing all the jobs in the industry, for that to coordinate all the work systems these industries are moving towards IIOT which is also known as the Industrial Internet of Things. But the problem is that the small and medium scale industry is lacking the financial support to adopt this IIOT. To solve this problem, I have developed a system that is cost-efficient Compact, and specially made for small scale and medium scale industries by which they can keep track of their inventory, workflow, and production Rate. The way to do this is by taking the production data from the systems such as PLC, Smart Sensors, and Smart actuators and converting it into meaningful data by sending it to the Enterprises Recourse planning teal air an automated software which we can get an instantaneous update about the wages, production, predictive maintenance of the machine, inventory and delivery rate. With less cost and small modifications without changing the existing machines and controllers in the industries.*

Key Words: **Industrial Internet of things, Optimization, Preventive maintenance, smart sensors, and Actuators.**

1. INTRODUCTION

Currently, all industries are trying to adapt to the upcoming industrial revolution called industry 4.0 which is also called connecting organizing everting with the internet which is also called IIOT. It is a thing that supports prototyping, development, production, logistics, and supply. The main characteristics of industry 4.0 are that it supports vertical networking which is a digital-physical process that helps industries to detect and diagnose as well as shift the stock level in the market in the industries second is the Horizontal integration via a new generation of global value chain networks which is also a PDP process in which the system call record all the vents in the industries including Stocks, inventory, ware hosing, supply chain. Through-engineering across the entire value chain is in which all the processes in the industries are all crossed over with the each and v Increasing speed through exponential innovations. One of the columns of Industry 4.0 is making a progressively independent and exceedingly cognitive biological system. It depends on innovations such as machine learning, deep learning, progressed autonomy, and IoT to encourage accelerated productivity. Every process helps in determining the process and coordination of the system.

1.1 Objective

The objective is to develop a system that is cost-efficient and easily adaptable so that every industry can use it to make their industry connected to IIOT and to Develop a device that has both features of IIOT gateway and Edge computing with Creating a custom node for node-red that is compatible with Node-Red which is widely used in the industrial internet of things and integrate multiple communication type device and compute those data in the developed gateway. For taking data from a legacy device like PLC we used RS485, and ethernet for connecting through the protocol for its side I used normal internet for transferring data from IOT board to internet or mobile. In between that there is node-red which has multiple node libraries like Modbus, binary, MQTT, data converter, and a comparator which help in converting useless data into useful data.

1.2 Methodology

The process is to develop a complete Internet of things system for Industry which is outlined, and the steps are as follows:

1. Develop a device that has both features of IIOT gateway and Edge computing using low-cost single-chip computers like raspberry pi
2. . Create a custom node for node-red that is compatible with Node-Red which is widely used in the industrial internet of things.
3. Integrate multiple communication type devices and compute those data in the developed gateway and get useful data from the system in a dashboard format.

2. Impact of low-cost IOT solution

As per the study lots of small-scale industries scale industries are struggling to move towards the current industrial revolution that is industry 4.0 because of its high

cost and low exposure about how it helps to increase the efficiency of the industries and how it also protects the environment from overuse of raw materials and There are no devices that are cost-efficient and can acquire data from multiple protocols with a flexible integrating environment. Data acquisition IOT devices are too costly for small-scale industries to implement. This is due to the earlier stage of the industry 4.0 concept in the industrial revolution. To make this system adaptable we should have a cost-efficient system but we don't have it.

3.1 OPC-UA

OPC-UA stands for open platform communication unified architecture, this OPEC UA was created in the year 2008. it is an open-source communication protocol that is completely independent of the system and completely service-oriented. All the communication protocol COMS are mapped under UA protocol and it's independent of the type of platform that it is running even if it is a cloud-based or physically embedded architecture which is secure and encrypted with authentication and auditing features. It discovers the devices in every available local system. all data are displayed in a hierarchical format like folder and file format allowing for simple and complex structure. All data are based on access permission. All the data are gathered based on subscription-based events which are except for values. Clients can execute programs based on the method defined on the server. It supports various platforms like cloud-based servers, PLCs, and micro-controllers. And it works o every architecture Microsoft Windows, Apple OSX, Android, or any distribution of Linux. In the transportation of data, it uses ultra-fast OPC UA binary transportation library which is compatible if sending compatible JSON WebSocket library and MQTT in this it also supports session encryption. Where the message is transmitted through a secured layer that also has various encryption methods. These data are sent on sequential bases where it secures the messages from attacking, and the authentication of each client and server is validated through the x509 certificate. Every client and server have both user control like logic and certificate-based specific authentication.

3.2 MQTT

MQTT stands for Message Queue Telemetry Transport it is an OASIS standard messaging protocol for the Internet of Things it is designed for lightweight pub/sub protocol communication mainly for connection embedded and remote devices which are far from a tower which needs low power low-cost communication which has a small code footprint and a minimum network bandwidth it is used in a wide verity of fields such as automotive, manufacturing, telecommunications, oil and gas, etc. it is lightweight and efficient which is it can be used in a very small microcontroller. MQTT message headers are small to optimize network bandwidth.

3.3Modbus RTU

Modbus is an open serial protocol developed in the year 1979 by Modicon it is a master-slave architecture it is easy to use and is also reliable it uses rs485 communication as communication. It can transmit data up to km without any loss in data transitions due to its simplicity and the small cod footprint it is mostly used in remote sensors in transmitting data between the systems. The main application is building automation and industrial automation. Modbus RTU messages are simple 16-bit data structures with a CRC value in them and they also can handle floating points, tables, ASCII text, queues, and other unrelated data. This serial communication has the capability of interchanging data between a commercial SCADA and OPC server system. It is mostly rugged and two-wire communication so it is easy to use and integrate.

3.4Modbus TCP

Modbus TCP is an ethernet-based physical layer with a Modbus-based communication protocol. It uses an IP address as the client sender address with most of the sub mask as 255.255.255.0 with a port as 502. A Modbus TCP protocol consists of a piece of Modbus RTU communication with a special header, other than serial-based Modbus protocol like master or slave it uses client server-based protocol. The difference between this Modbus RTU and Modbus TCP is that it uses ethernet cable for communication and serial cable for Modbus RTU communication.

3.5NODE-RED

Node-red is browser-based programming software that is used to wire hardware devices and API and online services interestingly. It is flow-based programming like lab view apart from LabVIEW it is open-source whereas LabVIEW is an open-source language programming tool. It has a wide range of nodes that palette that can be deployed to its runtime in a single click. This JavaScript can be deployed with a plain text editor in it. It is made up of mode.js which takes advantage of its node.js event-driven, nonblocking, and co-existence model it can run on a low-cost system like the raspberry pi. every flow created can be converted into JSON format and can be exported and sent into other systems.

3.6 Software & Hardware Implementation

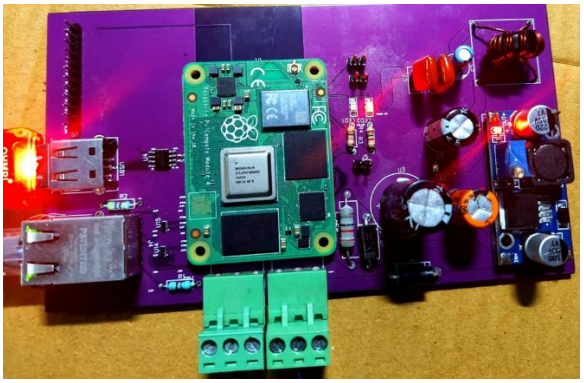

Fig -1: developed device

This device can be accessed through the web browser with the local IP address of 127.0.0.0:1880 and can be login through the default password after that we can use multiple nodes like MQTT mode MODBUS serial node, Modbus TCP node. And can be connected to the server Industrial protocols can be connected easily to these devices using ethernet and serial wires. After connecting it, it is turned on by using the power supply of 24V Through an ethernet cable or switch the device can be accessed through the web using the default IP address of the device. And the web portal can be logged in through the default username and password. In their it has a node-red interface for the device. There is lots of communication node for controlling the legacy devices through this device which is monitored and sent to the MQTT server.

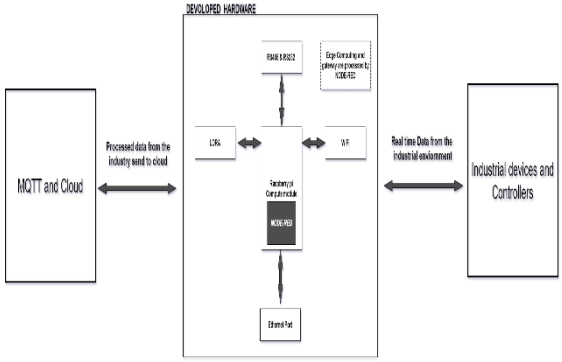

Fig -2: system architecture

First, the legacy device is connected through the IOT controller through supported communication like Modbus RTU, and Modbus ASCII the data communication between the plc and controller is carried through the node-red program after that the data from the plc is converted into useful and meaningful data and transferred to the app instantaneously through MQTT communication. In that, we can monitor a device remotely and can also control devices remotely.

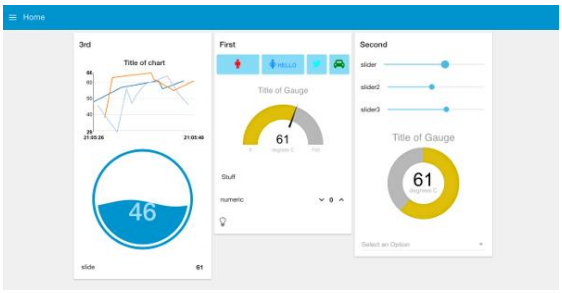

Fig -3: Developed dashboard

we have used Modbus RTU, Modbus ASCII, Modbus TCP, Profibus, Profinet, wifi, and ble4.0 for inhouse communication for IT communication we are going to adapt the M2M communication protocol like MQTT. For taking data from a legacy device like PLC we used RS485, and ethernet for connecting through the protocol for its side I used normal internet for transferring data from IOT board to internet or mobile. In between that there is node-red which has multiple node libraries like Modbus, binary, MQTT, data converter, and a comparator which help in converting useless data into useful data. By this, we can monitor industrial devices more effectively and cost-effectively. For example, if a production machine is making textile it is based on the worker efficiency if we motor and transfer those data into useful ones, we can calculate the production rate and salary.

4.Result

We have demonstrated that Node-RED can be used to quickly develop prototype IIoT applications. At the same time, we show that Node-RED has significant advantages in the field of data visualization and the MQTT protocol is over traditional industry solutions so far, because it is very easy to create business logic, which is a much more cost and time effective task using these technologies. Thanks to this, we can extend the interface to very simple, on-demand, monitor any sensor data, we find important. The use of these technologies enables rapid prototyping, letting the industry remain competitive despite rapid development. In this way, the combination of the two technologies with minimal development work allows the development and testing of prototypes or proof of concepts. Even though the cost of deploying IIoT can be much more positive in the long run, IIoT is designed to optimize industrial processes, leading to cost savings. A key element in this is the proper analysis and utilization of data since such systems provide the type of data that can be used to implement predictive maintenance, thereby maximizing machine availability. This is the area where research and prototype development have already started. So, we want to explore the horizontal and vertical scalability of the system, test multiple database systems for load-bearing and accessibility, examine system security issues and connect the system with predictive algorithms to see how we can get valuable data.

5. CONCLUSION

The product is developed to meet industrial requirements at a low cost. Due to its low-cost small-scale industry can also afford it. This device can easily be integrated with the existing industrial controller. Every industry can transform into industry 4.0 at Lower Cost. The programming method for this controller is totally through node-red so it is easy to adopt by everyone. By which we can monitor industrial devices more effectively and cost-effectively. For example, if a production machine is making textile it is based on worker efficiency if we motor and transfer those data into useful ones, we can calculate the production rate and salary and we showed that our approach accelerates application development in many ways: firstly by using low-code platforms such as Node-RED, where a lot of functionalities come from the Node-RED ecosystem itself. nodes such as CoAP, HTTP, etc. Moreover, we introduced application templates with reusable Recipes. Therefore, there is no need to develop an application from scratch.

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