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IoT-Based Automatic Generator Control System for Industry

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Abstract: ***IOT Based Industrial Automation is an industrial automation system mainly focusing on Remote Monitoring and Control of the Industrial Machines of an organization. This system helps to build a budget friendly system take its first steps into the smaller mainly mechanical industries. It uses a blend of embedded systems with a web interface to allow the monitoring and remote control of the equipment. IOT Based Industrial Automation allows the users to control machinery over a secure local network there-by avoiding having to send personnel in risky environments and that is just the tip of the iceberg of advantages the system brings with it. The system has been designed to be as general in application as possible; this is to allow the system to be modified according to whichever industry and machinery it needs to be used for. In the use of generator sets, one should manually on and off the generator sets. So it is necessary to automate the generators.***

Keywords: Industrial Automation, embedded systems, control machinery, generator

1. Introduction

In manufacturing industries, many processes are running simultaneously for a complex production system. For the completion of any industrial product, many processes and parameters are needed to be monitored continuously. Most of the times processes are as serious, especially in the chemical industries, it is very harmful to a worker to supervise the system because of high temperatures, hazardous chemicals, and other toxic elements [1]. Automation system online makes user to operate the system even when user is not in vicinity of the automation system [2]. Automation field is yet to become a niche in India. The current lack of automation in the industry especially ones dealing with heavy mechanical machinery forces the working crews to interact with machines in highly risky environment. The machinery deals with hundreds or even thousands of parameters in terms of pressure, voltage, temperatures etc. Just adding the ability to control these machines remotely reduces the risks for the working crews. If production is to continue during power failures, the back-up power system capabilities must be able to supply power at peak building electrical load, possibly for extended amounts of time. Generators and electrical distribution equipment must be maintained on a schedule determined by manufacturers. Industrial automation processes use control systems like computers or robots to monitor and handle processes and machines. Automation in the industrial workplace provides the advantages of improving productivity and quality while reducing errors and waste, increasing safety, and adding flexibility to the manufacturing process.

Automotive control of Industry appliances

The problem currently is the lack of IT infrastructure in core mechanical industries. And the existing systems employed by the bigger industries are just too expensive for the smaller industries to implement. Another problem caused due to the lack of this infrastructure is the increased risk for the individuals working closely with these machineries. A third problem is the loss of advantage having an IT infrastructure would give these smaller industries. Usage tracking, control automation, security & fine tuning of machinery parameters for best output are just some of the applications. Currently there exist in industries huge machineries which needs are logically controlled using PLC. These PLC are controlled either by pre-programming or dynamically by the user over MODBUS protocol.

2. Related Work

1) "Embedded System Based Industrial Power Plant Boiler Automation Using GSM Technology "T. Karuppiah1, V. Sivasankaran, Dr. Azha. Periasamy, Dr. S. Muruganand. This paper describes to improve the usage of machinery in power plants, resulting in the safety of workers and improvement in resource management.
2) "Real-Time remote monitoring and operation of Industrial Devices using IoT and Cloud "H. S. Raju, Sanath Shenoy. In this paper authors have explained proven ways to utilize the capabilities of Cloud and IoT to control the device and analyze the data generated by them.

3) "IOT based Industrial Automation ", Sanyuta Swami, Priyanka Nalawade, Sayali Jadhav, Prof N. C. Yadav have proposed efficient industry automation system that allows user to efficiently control industry appliances/machines over the internet.
4) "Smart Emergency Generator Monitoring System through IoT using IEC 61850 ", Hyun Sung Lim, In Ho Ryu and Jun Ho Bang have proposed a system that can supply smart service to users with IoT technology and predict generator fault and reduce the accident.
5) "Migration of Legacy Industrial Automation Systems in the context of Industry 4. O– A comparative study ", Labib M. Zawra have presented a comparative study of different migration strategies of old automation systems".
6) "A Review on Robotic Process Automation-The future of Business Organizations ", Mr. Wasique Ali Ansari. This paper outlines the progress of AI in the field of automation. The usage of appliances and machinery being optimized to perfection using Machine Learning based AI neural networks, which will allow them to be used better and better every day while improving the usage of resources used to run them.

IoT in Industrial Applications

Recent advances in information, communication and networking technologies have led to the emergence of Internet of Things (IoT). It is a network of ubiquitous devices or things that are capable of computation and communication over the Internet. Internet of Things (IoT) is the internetwork of physical objects or "things" that are embedded with software and sensors to collect and send data between them and central severs with no or minimum human intervention. IoT helps in remotely controlling and accessing these things along an existing infrastructure. This creates opportunity for integration of the physical world and the computer-based systems, which results in improved efficiency, accuracy and economic benefit. One of the wide area of application is manufacturing or industry domain where IoT could be used for predictive maintenance, statistical analysis, near real-time energy optimization, enhanced safety measurements for workers in an industry environment. The term used for IoT in industry domain is termed as Industrial Internet of Things (IIoT) [4], which refers to utilizing the features of IoT in industrial plants, for enhancing and easing the traditional manufacturing processes. The main aim of this paper is to implement a generator automation system using PLC to overcome the manual operation of switch on and switch off of generator and digitalize the industries.

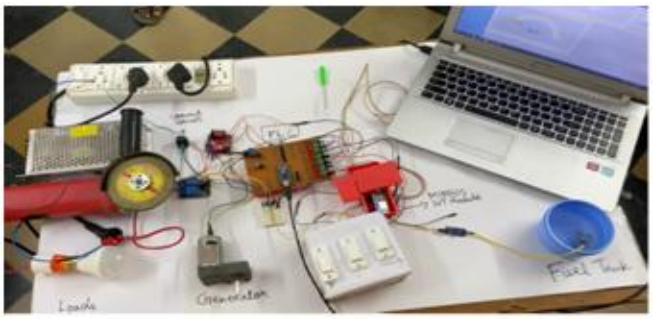
3. Experimental Description

a) Hardware Setup

The **ESP8266** is a low-cost Wi-Fi microchip, with built-in TCP/IP networking software, and microcontroller capability. This small module allows microcontrollers to connect to a Wi-Fi network. We can host small webpages without any external controller. The current consumption is significant for battery-based projects to increase the lifetime of the project. In common the NODEMCU is based on the ESP8266 microprocessor have a very low current consumption between 15 µA and 400 mA which can be further decreased with the deep sleep mode activated to 0.5 µA.

The system designed here is a budget friendly alternative which along with monitoring also offers control and smart management through data analysis. The embedded system translates the system data into input. The back-end of the web interface can understand and translate for the front-end.

Demo SetUp using dummy devices



b) Technologies Used:

- **Arduino programmed using Embedded C (**Arduino, 2021) The software for the system runs on a Node MCU which hosts an Ad Hoc network to which the employees connect in order to gain access to the machines connected to the system. The board is programmed using the Arduino IDE which uses a form of C Language that has been tweaked for this exact purpose.
- **Programmable Logic Controller:** A Programmable Logic Controller (PLC) forms the interface between the Machinery and the Node MCU. The PLC combined with the Node MCU forms the brains of the System. The PLC uses modular components that make up the hard logic necessary to send and retrieve data to the other controlling devices and sensors of the system.

4. Hardware Description

a) System Design

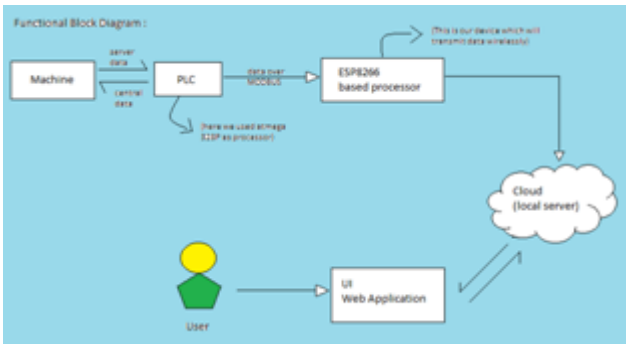
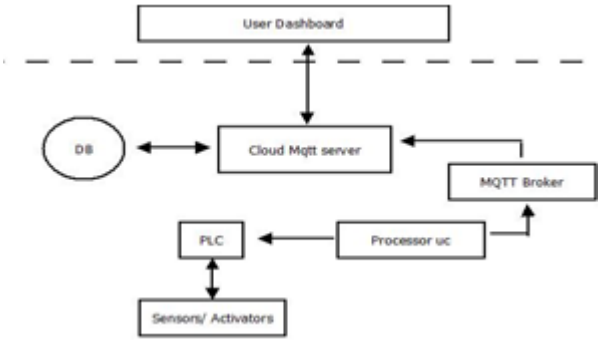


Figure 4.1: System Design

The system proposed here is a budget friendly alternative which along with monitoring also offers control and smart management through data analysis. The retrofitting requirements have been differentiated into Hardware, Communication, and Cloud.

b) System Architecture



5. Methodology

Technologies can be divided into 2 parts: The web interface and the Embedded system.

5.1. Web Inteface

The web interface is the part that provides the front-end. The control interface for the system makes use of the following technologies

5.1.1. HTML

Hypertext Markup Language (HTML) is the standard markup language for documents designed to be displayed in a web browser. It forms the bones of the web page which is then improved upon using the next tools. It was used for that exact purpose in the project.

5.1.2. CSS

Cascading Style Sheets (CSS) is a style sheet language used for describing the presentation of a document written in a markup language such as HTML. CSS is used for styling the pages making them more presentable

5.1.3. JS (Wikimedia Foundation, 2021)

JavaScript is high-level, often just-in-time compiled, and multi-paradigm. JS has been used in the project to improve the interface as well as for part of the back end that handles the user authentication as well as the passing of the information to the Node MCU in relevant formats.

5.2. Embedded System

The embedded system translates the system data into input the back-end of the web interface can understand and translate for the front-end. It uses the following technologies

5.2.1. Arduino programmed using Embedded C (Arduino, 2021)

The software for the system runs on a Node MCU which hosts an Ad Hoc network to which the employees connect in order to gain access to the machines connected to the system. The board is programmed using the Arduino IDE which uses a form of C Language that has been tweaked for this exact purpose.

5.2.2. Programmable Logic Controller

Programmable Logic Controller (PLC) forms the interface between the Machinery and the Node MCU. The PLC combined with the Node MCU forms the brains of the System. The PLC uses modular components that make up the hard logic necessary to send and retrieve data to the other controlling devices and sensors of the system. The PLC provided several advantages over earlier automation systems. It tolerated the industrial environment better than computers and was more reliable, compact and required less maintenance than relay systems. A wooden board is used for the structure of prototype which contains a platform and different components are placed in which fluid level and the load on generator are being controlled through PLC. System allows for the machinery to be connected to a Wireless LAN network. The machine data is collected using a PLC controller. These PLC are controlled either by pre-programming or dynamically by the user over MODBUS protocol. MODBUS is a communication protocol based on master/slave or client/server architecture [4]. The primary purpose of the protocol is facilitating reliable, fast communication between automation and field devices.

PLC Components used:

ESP8266 CONTROLLER WIFI CHIP: Allows the system to communicate wirelessly.

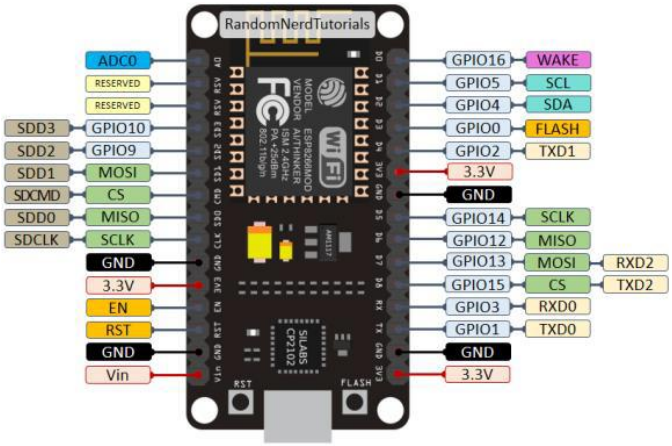


Figure 3.2.1: ESP8266 Pin Placement

Electrical Relay: The electrical relay does exactly what a switch does but instead of a human flipping the switch it will use a low voltage input current to find out when to flip the switch.

- **Capacitors:** Stores a predefined amount of current with focus on rapid release of the stored electricity
- **Resistors:** Provides resistance of a set amount where necessary.
- **Current sensor:** Is used to get a reading from the boiler. The reading is then used to control the pressure either manually or automatically.
- **Humidity sensor:** is used to check for the fuel level for the fuel tank.
- **Atmega 328P as PLC processor:** The brain of the brain. This is the processor for the onboard logic for the PLC.

6. Working

When there is no electricity generator automatically starts working starts working and it is programmed in such a way

that it should adapt itself to the output load that is being exerted on it. If generator has less output, then it rotates at a lower speed to provide lesser output and if the load on it is more it rotates at a higher speed to generate more output power. Power is calculated using current sensor and this data is sent to PLC. PLC also gets the input of fuel tank status and the output power load. When the fuel is below20%, an SMS will be sent to the admin informing that the fuel has been reached a minimum level. Output of PLC is showcased on the dashboard of the web browser from where the admins can access the data and they can control the machinery. All these control process are achieved by using a PLC microcontroller, sensors and different interfacing circuits.

7. Results

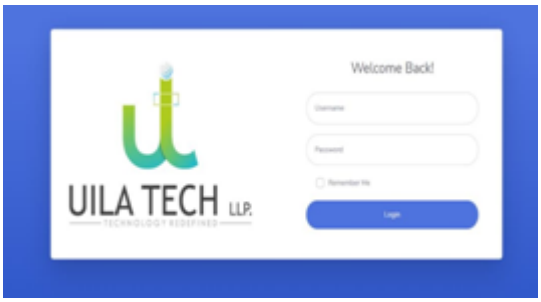


Figure 6.1: Login Screen

Above figure depicts the user interface design.

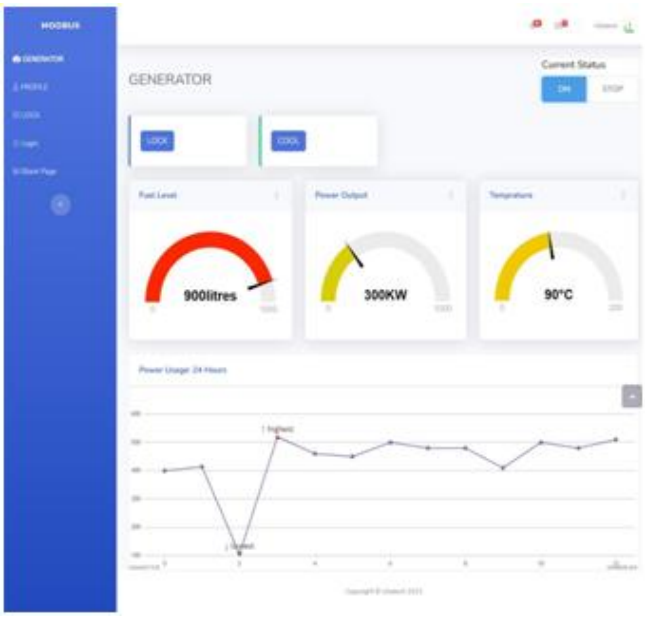


Figure 6.2: Control Page (Generator)

Above figure depicts the current status of Generator, Fuel tank status power output and the temperature.

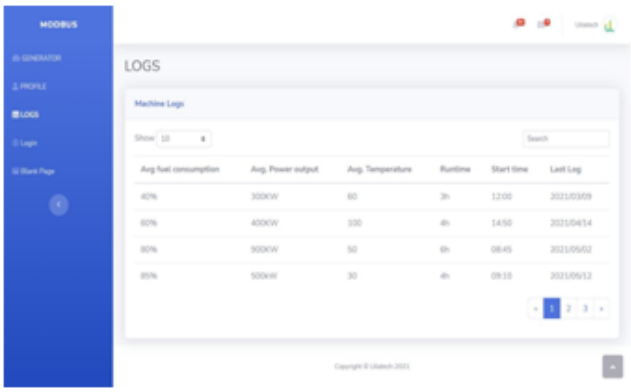


Figure 6.4: Activity Logs

Above figure shows the average fuel consumption, power output, temperature, run time, start time and last log.

8. Conclusion

To consider the necessities and demand of the industrial sector, there has been given significance attraction to generator automation system which is done in this paper by using PLC. Similar systems can be developed to automate various industry machines and the processes. It can be concluded that this industrial automation system can be applied to every industry to control various machineries far away from the industry. The system can be designed with medium cost instruments and locally available which makes it an easily obtainable product for the people of any level with electronic device.

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