Development of a Real-Time IoT -Based Power Monitoring System for The substation of Petrochemical Facilities

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Abstract: Petrochemical industry not only consumes a large amount of electricity every year but also requires high-quality power supplies. Any unexpected power failure could shut down the entire production line and cause significant financial loss. Meanwhile, due to the large electricity consumption and intensive power demand, in-house cogeneration plants have been equipped for most petrochemical facilities. Thus, any power interruption or disturbance between a petrochemical facility and inter connected power grids could affect both sides of the power systems. Therefore, having high power quality becomes one ofthe most critical parts for petrochemical facilities. To avoid unexpected power failure and to provide a better understanding of the power system at petrochemical facilities, a fast, precise and reliable power monitoring system is required. A novel Real- IOT -Based Power Monitoring system is developed in this Project for a power substation at the petrochemical facility. Besides the data collecting with event triggering mechanism and measurement data recording functions, Sub synchronous Oscillation (SSO) detection application is also developed in this system. This monitoring system could provide precise data to help engineers with insightful analysis of the electric system to prevent a power failure, and it also could help system operators to have a better understanding of the system operation characteristics.

I. INTRODUCTION

Monitoring and control has made huge and vast advances in industrial application for quite sometimes now, helping out in technological improvement in sensing and computation with breakthrough in the underlying principles and mathematics.

Nowadays embedded processors, sensors, and networking hardware are becoming increasingly complex, intelligent and autonomous system for monitoring and control. In Industrial network control system for example strong interest in wireless solutions is driving the development of this technology as a potential replacement for current generation of wired industrial network. More and more real world industrial applications require accurately monitoring shock, vibration, noise, strain, temperature and other physical signals in remote or inaccessible locations such as runways, mines and wind turbines.

The petrochemical industry continues to be impacted by the globalization and integration of the world economy. Basic chemicals and plastics are the key building blocks for manufacture of a wide variety of durable and nondurable consumer goods. Considering the items we encounter every day—the clothes we wear, construction materials used to build our homes and offices, a variety of household appliances and electronic equipment, food and beverage packaging, and many products used in various modes of transportation—chemical and plastic materials provide the fundamental building blocks that enable the manufacture of the vast majority of these goods. Demand for chemicals and plastics is driven by global economic conditions, which are directly linked to demand for consumer goods.

The present day challenges demands technologieswith high data speed like the Enhanced Data rates for GSMEvolution(EDGE) incorporated, which can deliver three times fasterbit rate ratio comparing to GPRS in given time is what this workrecommends Whereas Industrial Internet of Things (IoT) is the best way of connecting industrial machineries and sensors, to each other, over the internet, allowing the authorized user of the industry to use information from these connected devices to process the obtained data in a useful way. IoT-connected applications typically support data acquisition, aggregation, analysis, and visualization. The IoT architecture includes latest technologies such as computers, intelligent devices, wired and wireless communication and cloud computin. Previously Bluetooth and RF (Radio Frequency) technologies were used to control and monitor the industrial applications but were limited to short distance. The operator had to be in the range of the Bluetooth connectivity or in the Radio Frequency area.

II. RELATED WORKS

Hong Yang et al. [1] proposes an application method of IMC interface system based on X3D technology. It use existing IMC software and hardware environment as anterior foundation, and extend control terminal to three-dimensional interaction interface in virtual reality technology. Aimed at bad ability of modeling in X3D criterion, a suit of multi-agent model of IMC interface system under X3D is proposed. Aimed at the exchange of data and command between interface system in X3D and anterior IMC environment, based on standard OPC technology, a universal frame for remote monitor and control application in X3D is proposed. Based on above works, the HMI system based on X3D is constructed.

Thomas et al [3] presents a methodology to monitor the changes due to corrosion damages on industrial plants by using Unmanned Aerial Vehicle (UAV) images. First, a couple of images acquired at two different times is considered and aligned to each other through a geometric transformation. Then, the possible changes are highlighted in both images by exploiting a simple automatic thresholding technique based on the assumption that damages have usually different aspects with respect to the surrounding structures. At the end, the images are compared to obtain an estimation of the damage growth.

Furuya et al [5] describe a WWW browser-based monitoring system (WBMS) for industrial plants. The WBMS is an integrated system connected with control LANs and an intranet. The authors show a system architecture based on an organizational security policy, and show some typical system requirements. They then describe two implementation approaches using Java technology, one is a graphical user interface (GUI) development and the other is about data acquisition and management at the client site.

Goulão et al [6] et presents a new data logger system to monitor the parameters of processes of industrial cooling systems. It results from a straight cooperation between academia and industry in applied research and development. The prototype built and tested fulfills all the requisites and functionalities expected for the system, and allows local and remote data access.

Shulong Wang et al [7] proposed a novel IoT access architecture based on field programmable gate array (FPGA) and system on chip (SoC), which can provide a unified access to the IoT for a wide variety of low-speed and high-speed devices with associated extendibility and configurability.

III. PROPOSED METHODOLOGY

A novel Real- IOT -Based Power Monitoring system is developed in this Project for a power substation at the petrochemical facility. Internet of Things (IoT) is rapidly increasing technology because today's world is internet world. IoT is combination of communication system and embedded system which is used to connect hardware devices to the network or internet. IoT is used for transmission and reception of data. These systems are used to monitor industrial applications by implementing industry standard protocols using IoT.

Besides the data collecting with event triggering mechanism and measurement data recording functions, Sub synchronous Oscillation (SSO) detection application is also developed in this system.

We are using a microcontroller(Atmega) to make the necessary commands. We are monitoring 3 parameters – Voltage, Temperature and current value in the petrochemical industries. Respective sensors for the different parameters are used to obtain their values. Voltage sensor, Temperature sensor(LM35) and current sensor. Once the values are obtained, it is given to the microcontroller. The microcontroller compares the obtained values with the predefined safe values so that it does not exceeds the safe values. If the obtained value exceeds the safe value, the application (for example a motor) is turned off (in case if voltage exceeds the safe value) or the application (for example a cooling fan) is turned on (if temperature exceeds the safe values). Thus, controlling is done automatically. We are also using a GSM module which transmits the data periodically to the cloud from which user can extract the data which can be updated through the IOT. The above block diagram represents the block diagram for IoT based petrochemical industrial automation.

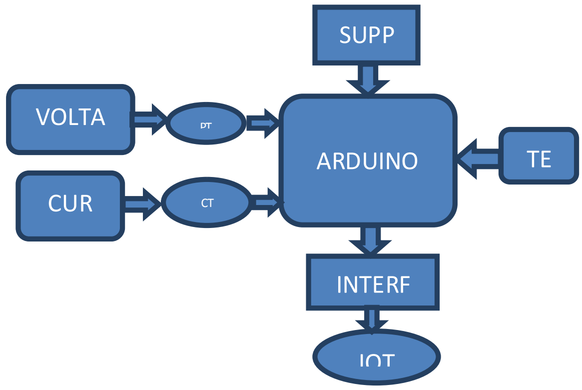

Fig.1 Proposed Block Diagram

IV. HARDWARE SPECIFICATIONS

Power Supply:

DC power supply part consist of ac supply of 230v is step down using transformer, bridge rectifier converts ac signal to dc & regulator is used to produce constant dc voltage.

Arduino Controller:

Arduino is a microcontroller or it can be called as tool for making computers that can sense and control more of the physical and real world than your desktop computer. It's physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects have the tendency to standalone, or they can be helped by the software section running on your computer. The boards can be assembled by hand or purchased preassembled from the market, it is available very easily. The arduino IDE is the software platform which can be downloaded for free. The Arduino programming language is an implementation of Wiring and defining the devices used, a similar physical computing platform, which is based on the Processing multimedia programming environment.

Relay Driver:

Relay Driver is used for drive the relay. ULN2003A IC is used as driver.

Relay:

Relays are switching devices. Switching devices are the heart of industrial electronic systems. When a relay is energized or activated, contacts are made or broken. They are used to control ac or dc power.

Potential Transformer:

The potential transformer works along the same principle of other transformers. It converts voltages from high to low. It will take the thousands of volts behind power transmission systems and step the voltage down to something that meters can handle. These transformers work for single and three phase systems, and are attached at a point where it is convenient to measure the voltage.

Voltage measurement:

The load voltage is measured by using a potential transformer. The load voltage is stepped down to a low value by using a potential transformer. The output of the potential transformer is connected to an variable resistor. The variable resistor reduces the voltage to a required level.

Temperature Sensor:

The temperature sensor is used to sense the temperature level. Thermistor is used to sense the temperature level.

Amplifier:

An amplifier is a circuit which can produce an output voltage, which is the product of input voltage with a value called voltage gain.

Current Transformer:

A current transformer (CT) is a measurement device designed to provide a current in its secondary coil proportional to the current flowing in its primary. Current transformers are commonly used in metering and protective relaying in the electrical power industry where they facilitate the safe measurement of large currents, often in the presence of high voltages. The current transformer safely isolates measurement and control circuitry from the high voltages typically present on the circuit being measured.

Current measuring circuit:

The current drawn by the load is measured by using current transformer. The primary of the current transformer is connected in series with the load. A resistance of suitable value is connected across the secondary of the current transformer. Here the current is converted into voltage. Now the voltage drop across the resistor is applied to variable resistor which reduces the voltage to a required level.

V. SIMULATION RESULTS

To implement our methodology in the simulation, we are going for the proteus ISIS schematic software tool. The Proteus Isis' circuit was implemented as in the below figure.

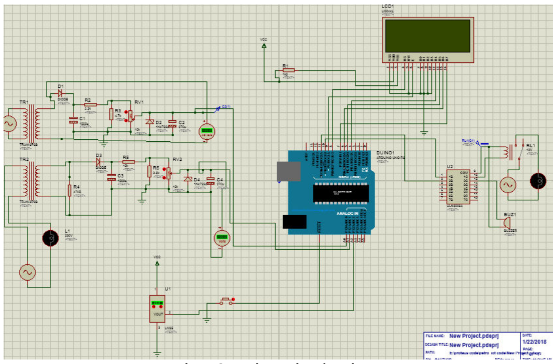

Fig. 2. circuit design

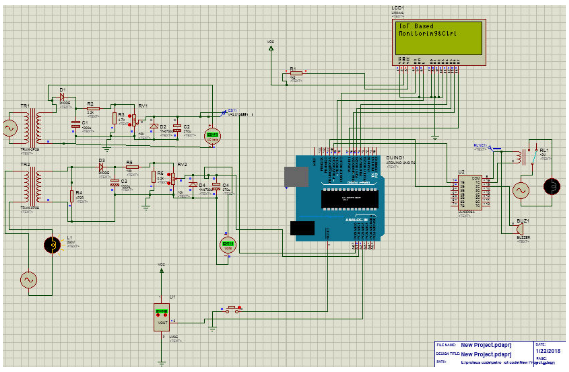

Fig. 3. simulation result

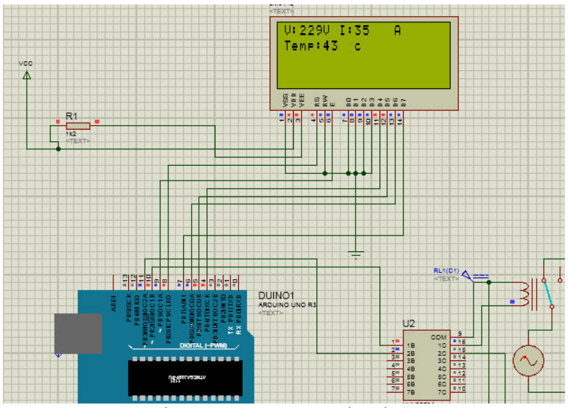

Fig. 4. system monitoring

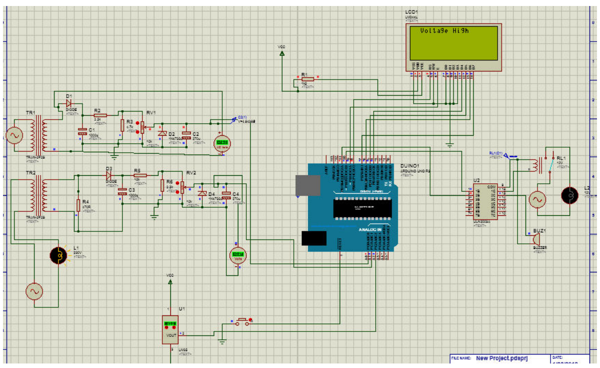

Fig. 5. high voltage indication

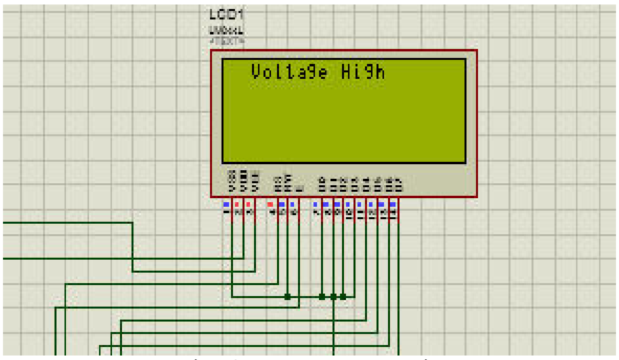

Fig. 6. measurement unit

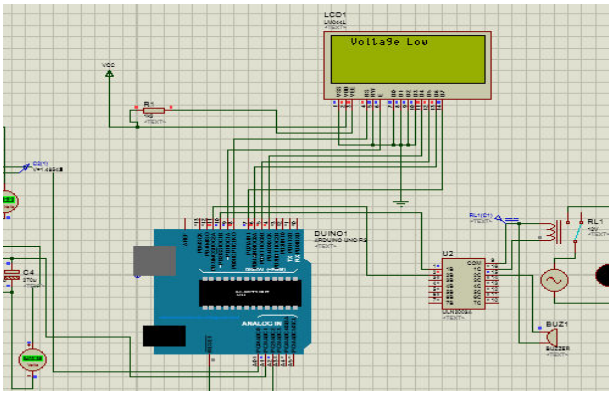

Fig. 7. low voltage indication

VI. CONCLUSION

In this paper, a real-time web-based power monitoring system with IOT is developed for the power substations at petrochemical facilities. Utilization of the arduino -based platform controllers enhanced the data acquisition speed and system computing power significantly to provide real-time data precisely. By applying this monitoring system, all the necessary data can be recorded based on the fault identification and over voltage range for further analysis, and engineers and system operators can have a much better understanding of the power system operations inside of petrochemical facilities. Therefore, the reliability of power system of these facilities can be improved by applying this real-time web-based power monitoring system.

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