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Development of IoT Based Industrial Automation SCADA System

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Abstract—The term "Supervisory Control and Data Acquisition" is abbreviated as SCADA. Basically, SCADA systems are utilized in industry to automate processes. Process automation includes both controlling and acquiring data. This study presents an Internet of Things (IoT)-based SCADA system for a remote BTS station utilizing an Arduino IoT Cloud and ESP32. In order to measure important parameters of interest, temperature, gas, float (fluid level), are programmed. Using a Wi-Fi network communication channel, data is processed and parsed before being sent to the Arduino IoT Cloud. On the Arduino IoT Cloud, a dashboard with widgets is built to track and manage the system. In addition, a mobile application is put into use to facilitate remote control and monitoring. Without physically visiting the site, the plant manager may check the status of a parameter and operate industrial equipment as needed through the app. As a result, this technology lessens the need for regular industry monitoring and the associated maintenance costs. As a result, this technology improves the Plant's performance and production.

Keywords-SCADA, Android Smart phone, Wi-Fi module, RF module, Aduino Uno, Sensors, Remote monitoring system, ESP32 Microcontroller, IoT, Arduino IoT Cloud.

I. Introduction

SCADA is a system with the main goal of controlling and monitoring field equipment, most of which are situated in very distant and remote areas. For the automation of industrial processes, SCADA is a process control system that is extensively utilized in many kinds of industries. The complexity of monitoring and controlling plants is removed by a well-designed SCADA system. It is a system that saves time and money by doing away with the need for staff to visit each location individually to check, gather data, or make modifications. With the use of SCADA systems, which have computers, controllers, actuators, networks, and interfaces, processes may be controlled automatically, and data analysis is made possible through data collecting. The SCADA system has several uses in industrial automation, including signal detection, control, user interface, administration, and networking. Knowing the basics of the project makes it simpler to pick the best automation technique and the appropriate machinery for the job at hand. Data collection, network data communication, data presentation, and monitoring and control are the four main tasks that data collecting, network data communication, data presentation, and human machine interface (HMI) software undertake. The fourth generation SCADA architecture, or Internet of Things (IoT) setup, is the foundation of this system. IoT SCADA offers a number of benefits, such as remote assessment and control, real-time monitoring and notifications, data sharing,data manipulation, and presentation, system optimizing, trend analytics, flexibility, and higher productivity. The supervisory control and data acquisition system is extensively used in industrial process automation due to the rapid advancement in technology and software development.It offers a dependable and effective solution to keep an eye on and manage the manufacturing processes.Wide-ranging industrial automation applications for the SCADA system include signal detection, control, human machine interaction,management, and networking. It is underlined that choosing the appropriate automation strategy and piece of equipment for the work at hand is easily implemented with a basic understanding of design concerns.

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II. LITERATURE SURVEY

These days, due to the impact that information has on both our personal and professional lives, it is essential to have constant, fast access to it.to lower overhead expenses and boost productivity and efficiency. We give an introduction to the supervisory control and data acquisition system, define the Internet of Things, and discuss how the industry can take advantage of IIoT to increase system integration potential for better automation and optimization.

The main purpose of Supervisory Control and Data Acquisition (SCADA) is to monitor and control field devices, which are typically found in isolated and difficult-to-reach locations.

The limitations of the current proprietary SCADA system are suggested to be addressed by an open source, IoT-based SCADA system.This idea was illustrated with a prototype circuit. Three sensors that can read analog current, voltage, temperature, and humidity values are connected.Information transmitted via WiFi to the Arduino IoT Cloud for dashboard-based monitoring and control.A mobile app that allows for global remote monitoring from any location. Despite being a prototype, the cost and power consumption are incredibly low[1].This paper[2] has developed a low-cost SCADA system for industry automation that has both digital and analog input and output.The SCADA system that has been configured effectively uses SCADA to represent the data.SCADA is used to keep an eye on and manage the process parameters specific to the application.This paper[3] successfully proposed a model that integrates a mobile phone with Android functionality as a supervisory controller into a SCADA system. A Bluetooth base station is used to monitor and control plant data, negating the need for additional hardware for communication. Wireless communication is more practical and efficient in industrial automation, which lowers the complexity of the plant's processes. The most popular communication protocol in industrial automation is Bluetooth or Wi-Fi-based Android SCADA.This paper[4] describes an advanced setup of a mini thermal power plant in a laboratory using the Lab VIEW supervisory control (DSC) module and data logging.

This hardware can be integrated into any standard MOD bus to enable SCADA systems, and it can be used for automation in any industry since it communicates over the standard MOD bus protocol.The hybrid wind-PV power system's Web-SCADA implementation is described in this study[5].

Using a web browser, one may remotely monitor electrical characteristics like current, voltage, and power as well as environmental factors like wind speed, sun irradiation, and PV temperature over the Internet. Additionally, a web-based SCADA is used to let users monitor and manage the system online. This work builds on our earlier research, which used software to mimic a hybrid power plant.In order to support a microgrid that uses a hybrid renewable energy system (HRES), this study describes the design and implementation of a low-cost Supervisory Control and Data Acquisition system based on a Web interface[6].The created low-cost SCADA runs on a microgrid that has a battery bank for energy storage, a solar array, a wind turbine, and a biomass gasification facility. This paper[7-8]demonstrates applying Reliance SCADA and Arduino Uno on a small photovoltaic (PV) power system to monitor the PV current, voltage, and battery, as well as efficiency. The designed system uses low-cost sensors, an Arduino Uno microcontroller, and free Reliance SCADA software. The Arduino Uno microcontroller collects data from sensors and communicates with a computer through a USB cable. Uno has been programmed to transmit data to Reliance SCADA on PC.

III. DESIGN & MODELLING OF SYSTEM

A. Working and Block diagram

Different kinds of sensors (temperature sensor, gas sensor, float level sensor) are used which is controlled by microcontroller (ESP32) and Blynk Cloud as an app which is connected through user's phone and also through the desktop.

Block diagram of Automation Based SCADA system is shown in Fig.1 & 2 In this system LED lights are also connected from two 2-relay modules as output when any undesired event occurs. Although, the monitoring parameters the information generates through within seconds to the user's phone by the notification of the app.

The LED No. 1 light will glow as our output when the burner turns on, begins to heat, and the temperature rises above 70°C, as indicated by the temperature sensor. We receive a notification alert on our phone through the Blynk app. Similar to this, when the fluid level reaches a predetermined limit—which is determined by the float level sensor—we receive a notification alert on the Blynk app on our phone, allowing us to control it. In addition, LED number three in the model glows.

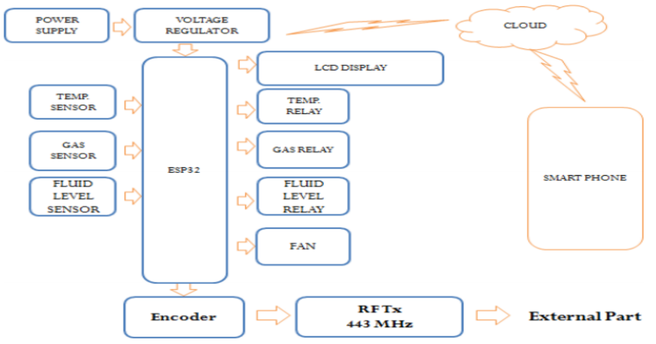

Fig.1 Block Diagram of Automation Based SCADA System

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Due to heating the fluid in the container turns into gaseous vapors which is detected by MQ135 Gas Sensor used thus we get a notification alert on blynk app in mobile phone and we could control it by our phone also LED no.2 glows in the model.Also with help of RF module it will gives alert by buzzer and LCD display when any event occurred. So that due to some reasons or negligence if operator of IoT SCADA system unable to control the equipment's even after any event happened then someone any other person from industry can operate the system manually as RF module is offline based system and gives alert through buzzer.

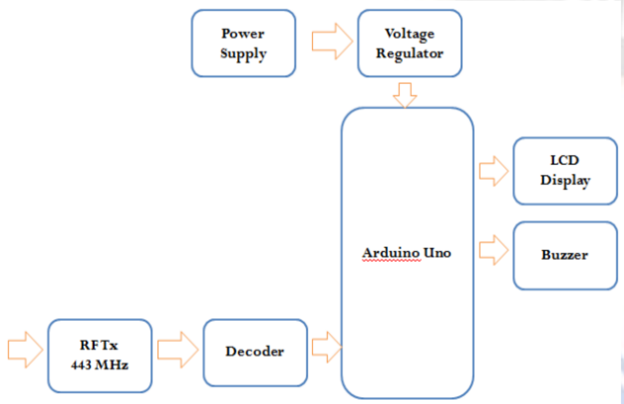

Fig.2 Block Diagram of External Part of IOT Based Automation SCADA System

B. Circuit diagram

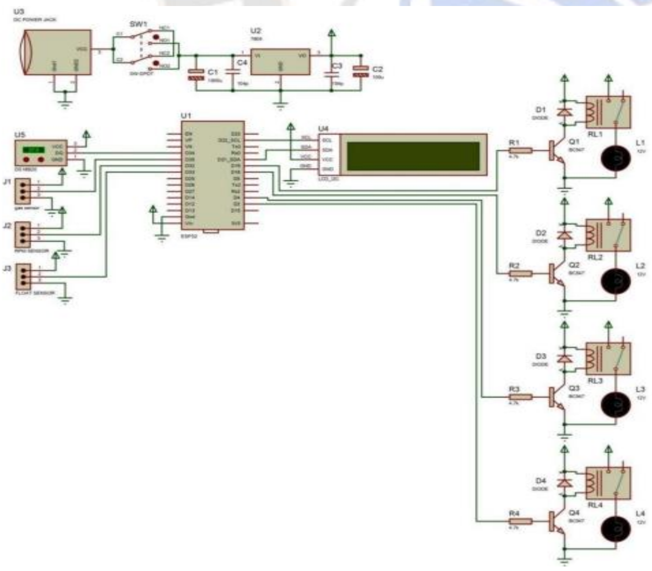

Fig.3 Circuit diagram of IOT based SCADA System

C. Methodology

The Internet of Things (IoT) setup serves as the system's foundation. The prototype serves as the plant or process, the Field Instrument Devices (FIDs) serve as the sensors, the ESP32 microcontroller serves as the remote terminal unit (RTU), the Arduino IoT Cloud serves as the master terminal unit (MTU), and Wi-Fi serves as the communication channel. The parts required to carry out this project are all easily accessible, open source, and inexpensive in comparison to comparable systems. A board containing three sensors temperature, gas, and fluid sensors—is used to design and build a circuit. The microcontroller's Wi-Fi capability is used to establish a connection with the Arduino IoT Cloud. To track and manage the many variables of interest, dashboards are developed in the cloud. So the user is able to control the industrial devices. When any event happen the user gets notification via Blynk Cloud. And also ESP-32 connect with external message display devices to meaning event. And generate alert sound by buzzer when any event happened and also the lights in relay will glow. Secondary device also connected via RF module 443 MHz.

IV. Results

In order to facilitate data exchange and transmission to the cloud server and mobile application, the sensors are utilized for the hardware implementation. The authorized user can quickly ascertain the system's status with his smartphone because the server updates the data in real-time. The supervisory system gathers process data and sends out commands to regulate it.

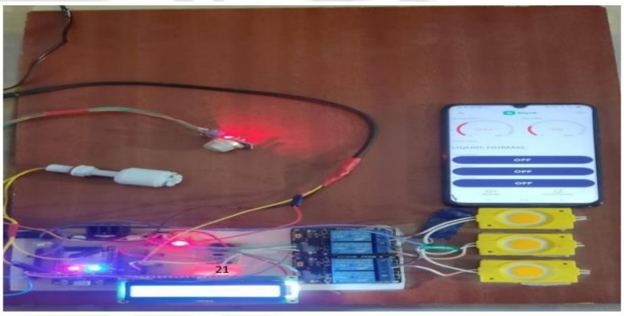

Fig 4. Hardware of the IOT based Industrial Automation based SCADA system

Most importantly, in the event that something unexpected occurs, the system will instantly send information and a signal alarm to the user's phone (for example, if the water level rises over the desired level). Here, we used a range of sensors (such as gas, temperature, and float level sensors) that are controlled by an ESP32 microcontroller and linked to the user's phone via the Blynk Cloud app. As an additional output when any event occurred, here in this system three LED lights are attached along with two 2-relay modules. However, as shown in the figures 5(a) & (b) below, the app's notification sends the monitoring parameters' information directly to the user's phone in a matter of seconds.

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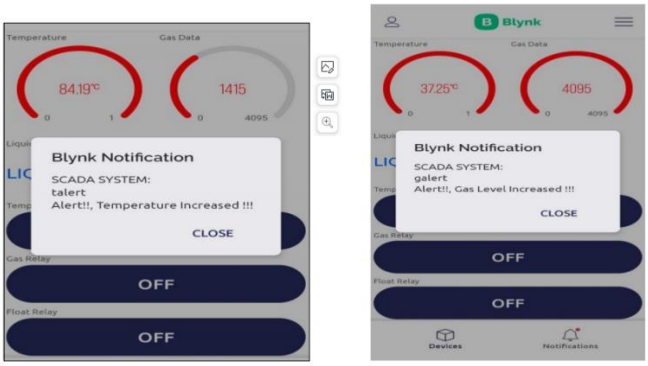

Fig.5(a). Notification when temperature increases.
Fig 5(b). Notification when gas increases.

Fig.6. When water level is controlled LED no.3 glows as output.

Fig.7. When gas is controlled LED no.2 glows as output.

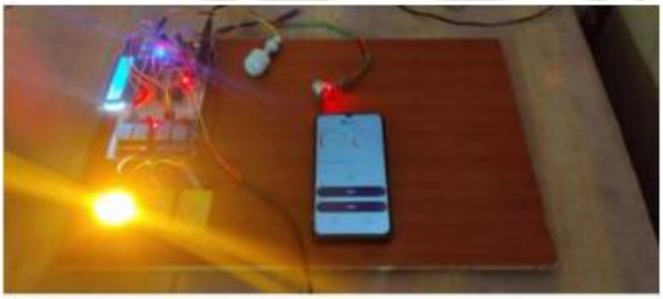

Fig.8. When temperature is controlled the LED no.1 glows as output.

RF module shown in figure 9 will provide notification of any events via buzzer and LCD display. Because the RF module is an offline-based system that provides alerts through a buzzer, if the operator of the IoT SCADA system is unable to operate the equipment due to some factors or negligence even after an event has occurred, another person from the industry can manually operate the system.

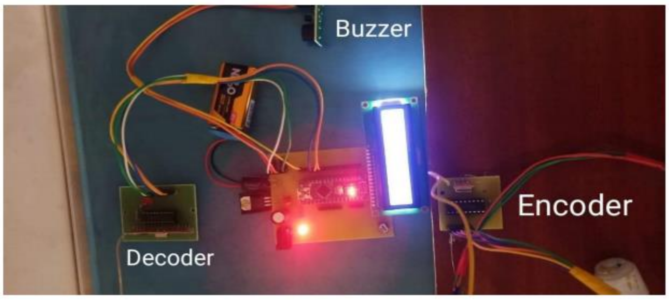

Fig.9 RF Module when any event occurred buzzer sounds and data visible on the screen.

Fig.10 Controlling of the Motor /Fan

V. CONCLUSION

As a result, utilizing the newly emerging technology of the internet of things, we created a system for monitoring and regulating the industrial environment. Compared to other systems, this method provides an efficient solution. In this system, we gather data from the sensor and make it accessible to the user at any time from a distance. Once we can check the temperature on a website, we can also adjust it online. As result, it will become a very affordable and effective method. Any safety and control system can be transformed into a smart, intelligent device with the aid of this device. With the help of various connected sensors and internet connectivity, the trial operation of the proposed prototype was made clear. A system that is planned has two benefits. First, we can display and allow access to our smart appliances from everywhere thanks to IoT connectivity, which will unquestionably show more user appropriateness, competence, and protection. Second, as a real-time monitoring system, all data are recorded in the cloud-server in accordance with sensor information. The user may assess all of the evidence as a result. This gadget can be enhanced in the future with a variety of functions and elements as we can use this technology to create not only an industrial but also an innovative city where every aspect of navigation is autonomous and controlled by a phone. This study offers a remarkable SCADA system with IoT design.Additionally, with the aid of the RF module, it will provide notification of any events via buzzer and LCD display. Because the RF module is an offline-based system that provides alerts through a buzzer, if the operator of the IoT SCADA system is unable to operate the equipment due to some factors or negligence even after an event has occurred,

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Rashmi Keote was born in India in 1979. She did B.E. in 2000 from Priyadarshini College of Engineering, Nagpur and M.Tech in 2010 in Electronics Engg., form Yeshwantrao Chavan college of engineering, Nagpur.India. She has completed Ph.D from Rashtrasant Tukdoji Maharaj Nagpur university in 2021.Her area of research interests is in VLSI Design .Rashmi Keote is currently working as Assistant Professor in Yeshwantrao Chavan College of Engineering since 2008. She has published total 14 research papers in international journals and international conference paper till date.

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P.T. Karule was born in India and persued his B. E. (Electronics and Power) from Govt. College of Engineering, Amravati. in 1986, M.Tech. (Electronics Engineering) from VNIT, Nagpur in 1992 and Ph.D. in the area of Medical Image Processing & Neural Network from Amravati University in 2010. He has

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25 years of teaching experience. His area of expertise is microprocessors and embedded system At present he is Professor in Department of Electronics Engineering of YCCE and also looking after administrative work of autonomous YCCE as Registrar. Earlier he was Head of Department of ECE, YCCE; during his tenure he started the popular activity of workshop series for students on current technologies with hands-on practice in summer & winter vacation to enhance the employability. He had also worked as Dean Industry Institute Interaction; YCCE He had Published 51 research papers in various international journals & international and national conferences. He received Best Paper Award at PSG college of Engineering.

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