Wireless Scada for Monitoring Load Conditions of Transformer and Temperature Control in Remote Plant

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Abstract— *The main aim of the paper is to process the real time data acquisition wirelessly under supervisory control for small and large scale remote industrial environment. In large industrial establishments many processes go on, therefore it is essential to monitor all the processes and control the factors affecting them. Adapting a technology like WIRELESS SCADA (Supervisory Control and Data Acquisition) one can achieve the above mentioned objective effectively, and thus saving a lot of manpower. For achieving this real-time scenario, a temperature & transformer logging system for a remote plant operation is taken. Here temperature sensors & voltage sensors are duly interfaced to the 8051 microcontroller. Data collected from the temperature sensors & voltage sensors are constantly sent over 2.4 GHz transmitter wirelessly to the microcontroller which is then received at the matched 2.4 GHz USB type receiver connected to a PC / Laptop. One can set parameters like set point, low limit and high limit on the computer screen. When the temperature & voltage of sensors goes beyond set point the microcontroller sends a command to the corresponding relay. The heaters (shown as lamps) connected through relay contacts (corresponding to their sensors) are turned OFF (or ON in vice versa). Hence, processes at hazardous areas can be controlled with more accuracy and better safety using SCADA. Adapting such a technology will save both money and time.*

Keywords— SCADA, Zigbee, Embedded systems, Temperature sensors, transformer.

I. INTRODUCTION

Supervisory **C**ontrol **a**nd **D**ata **A**cquisition., A SCADA system is a common process automation system which is used to gather data from sensors and instruments located at remote sites and to transmit and display this data at a central site for control or monitoring purposes. The collected data is usually viewed on one or more SCADA Host computers located at the central or master site. Wireless SCADA is required in those applications when wire line communications to the remote site is prohibitively expensive or it is too time consuming to construct. In particular types of industry such as power stations, Oil & Gas or Water & Wastewater, wireless SCADA is often the only solution due to the remoteness of the sites [1] –[3].

1.1 Supervisory Control and Data Acquisition System

The supervisory control and data acquisition (SCADA) system is generally considered a necessary part of monitoring and control for large processes, including oil and gas production, paper manufacturing, and power generation. The system often consists of hardware architecture and a software package. From the hardware perspective, the system mainly includes remote terminal units (RTUs) and master terminal units (MTUs). The core part of a RTU is a programmable logic controller (PLC), such as a micro-processor or single-board computer. RTUs are responsible for acquiring remote data from sensors or other data sources and implementing control strategies. MTUs are in charge of handling data processing and human-machine interaction The RTUs are connected to MTUs with SCADA system communication channels [1]-[3].

The software package contains scripts running on PLCs, programs and databases on MTUs, as well as graphical user interface (GUI) for human-machine interaction. The software package should be designed to satisfy all kinds of customized needs and to achieve pre defined functionalities. The software package contains scripts running on PLCs, programs and databases on MTUs, as well as graphical user interface (GUI) for human-machine interaction. The software package should be designed to satisfy all kinds of customized needs and to achieve pre defined functionalities.

1.2 Zigbee

Zigbee is the most popular industry wireless mesh networking standard for connecting sensors, instrumentation and control systems. ZigBee, a specification for communication in a wireless personal area network (WPAN), has been called the "Internet of things." Theoretically, your ZigBee-enabled coffee maker can communicate with your ZigBee-enabled toaster. ZigBee is an open, global, packet-based protocol designed to provide an easy-to-use architecture for secure, reliable, low power wireless networks. ZigBee and IEEE 802.15.4 are low data rate wireless networking standards that can eliminate the

costly and damage prone wiring in industrial control applications. Flow or process control equipment can be place anywhere and still communicate with the rest of the system. It can also be moved, since the network doesn't care about the physical location of a sensor, pump or valve. The ZigBee RF4CE standard enhances the IEEE 802.15.4 standard by providing a simple networking layer and standard application profiles that can be used to create interoperable multi-vendor consumer electronic solutions. The benefits of this technology go far beyond, Zigbee applications include: Home and office automation Industrial automation Medical monitoring Low-power sensors HVAC control plus many other control and monitoring uses

1.3 Wireless Communication

All wireless communication systems have the following components: Transmitter Receiver Antennas Path between the transmitter and the receiver In short, the transmitter feeds a signal of encoded data modulated into RF waves into the antenna. The antenna radiates the signal through the air where it is picked up by the antenna of the receiver. The receiver demodulates the RF waves back into the encoded data stream sent by the transmitter [3]-[4]

1.4 Transmitter & Receiver

The power output of the transmitter and the sensitivity of the receiver are determining factors of the signal strength and its range. Other factors include any obstacles in the communication path that cause interference with the signal. The higher the transmitter's output power, the longer the range of its signal. On the other side, the receiver's sensitivity determines the minimum power needed for the radio to reliably receive the signal. These values are described using dB/m, a relative measurement that compares two signals with 1 mill watt used as the reference signal. A large negative dB/m number means higher receiver sensitivity A real world SCADA system can monitor and control hundreds to hundreds of thousands of I/O points. A typical power station wireless SCADA application would be to monitor the varies parameters like transformer voltages in each phases ,current in each phases,& also can monitor temperature and also can control the parameters. Almost all the Industrial Data Acquisition and control systems today use connection oriented concepts for interfaces. However, the variety of physical shapes and functional commands that each cable or wire based system has also raises numerous problems: the difficulties in locating the particular area affected by the industrial parameter, the complexity in operation of the system, the maintenance issue and so on. The control of sensitive industrial parameters by using SCADA-based wireless technology has gained significant industry and academic attention lately for the usability benefits and convenience that it offers users. The control of the temperature of a room containing chemicals and toxic gases the existing research has failed to provide a flexible solution for controlling such conditions by connection oriented systems. They have used cables and bulky equipment which require large amount of space, high degree of the maintenance and are easily detoriated by moisture and excessive heat. Additionally ,the Data acquisition and control techniques used so far have imposed considerable computational burden and have not provided a consistent and accurate results expected by the employees and their industries. Data Acquisition and Control Systems have gained much larger importance in the Industrial field because of the rapid Technological advancement and Security reasons. Whether it is an Industrial workshop, Defense go-down or experimental lab of the power plant accurate monitoring of the parameters is the need of the day. It could be the temperature, humidity, gas or light detecting sensor waiting for our command to provide us with information about the measured parameter of the particular area where they are installed. Advantage of the system is that the engineer or worker not only can obtain accurate data about the industrial parameters in remote area, but also there is no need to be physical present over there. The amount of computation required to process the data detected by sensors is much greater than that of the mechanical devices. Many of those approaches have been implemented to focus in detection of the single parameter such as temperature, gas, humidity or light by dedicating the entire system to only one parameters.

II. EXISTING METHODS

The utilization of GPS module, GSM module and the stepper motor in the design will increases the cost of the design which makes the design an uneconomical one. Incorporation and controlling of the stepper motor is a bit costly compared to dc motors.GPS requires a special module to be incorporated in the design which is very costly and we does not require to track the exact position of the train. So the usage of the GPS module in the circuit is an uneconomical one.GSM also requires a specific module to be installed in the design which is also a costly one. The main disadvantage is it depends up on the operator signal for the communication. So the GSM module is uneconomical, If the complexity of the circuit increases then the controlling of parameters is also becomes more difficult. By using GPS, GSM, RTU & MTU the design becomes more complex [1]-[3]. The main difficulties are: Generally in GPS and GSM technology the dependence on the nature is more and hence the control of parameters will become more difficult. To control and monitor the parameters, you must constantly turn

on and off the coils. The controller simply energizes the relay coils in a certain pattern and the relay will operate accordingly. At any given time the computer will know the parameters of the plant the number of parameters given can be tracked.

2.1 Mobile phone based SCADA for industrial automation:

The term supervisory control and data acquisition SCADA was first introduced in the 1960s at Bonneville Power Administration and was first published in the PICA Power Industry Computer Applications Conference Proceedings. The SCADA system is used for monitoring and controlling of industrial processes from remote areas. The need to monitor the process and possibly control the operation of industrial systems from virtually anywhere is becoming an important issue. However, with different types of platforms used in present SCADA systems, incompatibility has become the main obstacle 1. Other problems include cost, security, accessibility, system integration, data integrity, and consistency 2.Many companies are considering SCADA systems to provide access to real time data display, alarming, trending, and reporting from remote equipment by using different communication media such as Internet, private leased line PLL, dial-up connection, satellite, and radio modem. Recent technological advances have made location transparency achievable through the Internet at a relatively low cost and acceptable level of security. Some of the potentially valuable developments are Intranet and Extranet. Nowadays, improvements in the visual interface of the SCADA GUI Graphical User Interface have fairly high resolution graphical animations [5]-[7]. In spite of all these improvements, a need has emerged to access system information instead of controlling it from specific control centers.

SCADA systems have been opened to the world via the Internet to meet this requirement [5]- [6] . Despite all these improvements, the SCADA system needs a computer connected to the Internet. Recently there has been a growing trend towards personal computers and work stations becoming “portable” and “mobile.” This has led to a big expansion of wireless networking, which is getting advanced in terms of technology and usage and penetration 3.SCADA software usually exists in a computer, which carries out tasks of supervision and management of alarms, as well as data processing and process control. The communication is made by means of special buses or LAN networks. All these tools are executed normally in real time, and are designed to give the plant operator the possibility of supervising and controlling of these processes. SCADA systems require both hardware and software for their successful execution. User designed control parameters, graphical system diagrams, trend charts, alarm screens, and programmable control logic are some of the features of the software program for the SCADA systems. This paper discusses the use of mobile phone as a client for an industrial SCADA automation system [1]-[2] . An experimental prototype crane system is monitored by a mobile phone in a sample SCADA application. An attempt is made to provide some insight into design considerations for wireless mobile phone based automation as used in modern SCADA automation systems. It is emphasized that with some basic knowledge of design considerations, it is easier to take the right automation approach and choose the right equipment for the task considered. Test results have indicated that the mobile-based SCADA integration using the general packet radio service GPRS or wireless application protocol WAP transfer scheme could enhance the performance of the crane in a day without causing an increase in the response times of SCADA functions [7]. As distance to remote sites increases, it becomes more difficult to access them. In this case, SCADA becomes a better alternative to an operator or repairman visiting the site for adjustments and inspections. Distance and remoteness are two major factors for implementing.

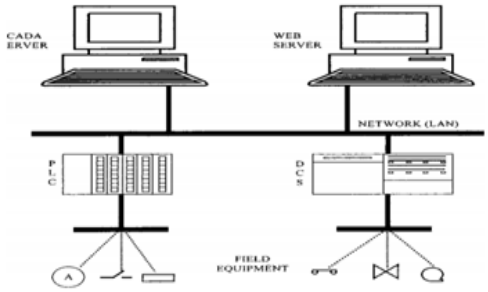

FIG:1. CONVENTIONAL SCADA SYSTEM COMPONENTS

2.2 Design of the mobile phone based SCADA system

External data communication and integration from various information sources such as control centers, power plants, and substations have become a necessity. As more and more real-time information is being desired by many customers and vendors, existing information management systems cannot satisfy the new challenges. Distributed SCADA has already

become the trend of the future industrial automation system development. In operation of the mobile phone based application, SCADA software in the server is operated first. Afterwards, the SCADA controlling program SCP, which realizes the process of sending data to the server side program SSP, is operated. Then, it transfers the data reading from the SCADA database to the Web page designated, where the ASP active server page is responsible for setting up the connection between the mobile phone [5] and the SCADA system.

FIG2. MOBILE PHONE GUI SPECIFICATIONS

The simple quantities of data received by the ASP, sending from SCP found in the Web server, is stored in the ASP. This information reaches the ASP by means of GPRS or WAP after JAP in the mobile phone and this information is saved in the JAP database. Analyzing the data in this database, the JAP turns it into a value diagram, bar graph, text message, and various graph animations, which can easily be understood by the operator. As long as the program in the mobile phone operates, data between the mobile phone and SCADA system are automatically exchanged [3]-[4].

III. PROPOSED SYSTEM

3.1 Wireless SCADA for Monitoring the Load conditions of Transformer and Temperature control in Remote Plant

Generally in small scale industries it is difficult to place the SCADA. Because of high expensive. But we need to monitor the parameters of the plant. But in practical case it is not possible. So there are lot of damages happened in the past especially at these small scale industries due to lack of monitoring. In order to prevent these damages the entire system should be automatic. In that way we planned to design a new model to monitor and control the parameters of transformer and also for a remote plant. There is also another problem that due to human errors while monitoring the parameters of remote plant.

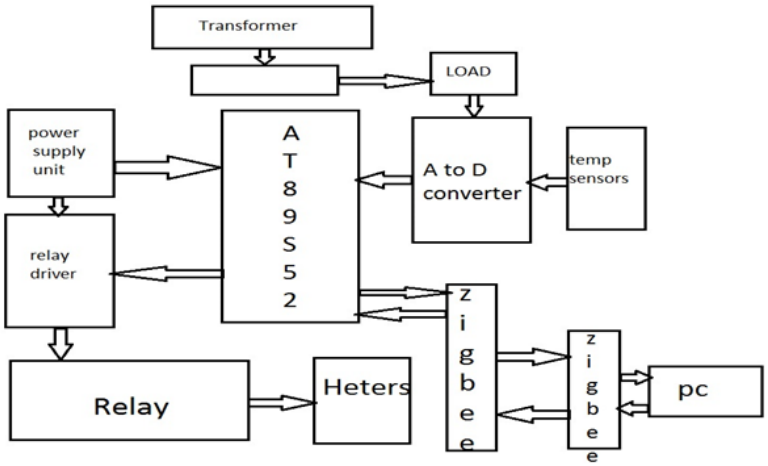

FIG 3. BLOCK DIAGRAM OF WIRELESS SCADA FOR MONITORING LOAD CONDITIONS OF TRANSFORMER AND TEMPERATURE CONTROL IN THE REMOTE PLANT

3.2 Circuit Complexity

Simplicity in any circuit improves the circuit performance and gives accurate as well as desired output. Complexity of the circuit will disturb the output performance of the circuit. The usage of the GPS and GSM modules and stepper motor in the above circuits will increases the complexity of the circuit.GPS (Global Positioning System) is a technology which finds the latitude and longitude position of the desired object. By using this technology we can find the exact location of the specific train. This technology can be utilized in the circuit by incorporating the GPS module in the circuit. The main disadvantage in

using this module is it depends upon the satellite and it consumes more power and it is not completely automatic, it is partially automatic. GSM (Global System for Mobile Communication) is another available technology in the market. It can be utilized by installing GSM module in the circuit. It operates with mobile signal and text messages. The main disadvantage in this module is it depends on the operator signal for the operation.

3.3 ZIGBEE

ZigBee is the most popular industry wireless mesh networking standard for connecting sensors, instrumentation and control systems. ZigBee, a specification for communication in a wireless personal area network (WPAN), has been called the "Internet of things." Theoretically, your ZigBee-enabled coffee maker can communicate with your ZigBee-enabled toaster. ZigBee is an open, global, packet-based protocol designed to provide an easy-to-use architecture for secure, reliable, low power wireless networks. ZigBee and IEEE 802.15.4 are low data rate wireless networking standards that can eliminate the costly and damage prone wiring in industrial control applications. Flow or process control equipment can be place anywhere and still communicate with the rest of the system. It can also be moved, since the network doesn't care about the physical location of a sensor.

3.4 Temperature Sensors

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Ê Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centi-grade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm^{1}$¤4ÊC at room temperature and $\pm^{3}$¤4ÊC over a full −55 to +150ÊC temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1ÊC in still air. The LM35 is rated to operate over a −55Ê to +150ÊC temperature range, while the LM35C is rated for a −40Ê to +110ÊC range (−10Ê with improved accuracy). The LM35 series is available pack aged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also avail-able in an 8-lead surface mount small outline package and a plastic TO-220 package.

3.5 Automatic Load Control

As come to automatic load control, if the temperature of the plant as to be increased then we has to turn on the cooling fans to cool the plant and get to a normal temperature. if the temperature of the plant as to be decreased, it has to be increased by turn on the heaters by using relay contacts. By this way we can control the automatic load.

3.6 Features of Microcontroller (8052)

8 Kbytes of In-System Reprogrammable Flash Memory.

Endurance: 1,000 Write/Erase Cycles.

Fully Static Operation: 0 Hz to 24 MHz

Three-Level Program Memory Lock.

256 x 8-Bit Internal RAM.

32 Programmable I/O Lines.

Three 16-Bit Timer/Counters.

Eight vector two level Interrupt Sources.

Programmable Serial Channel.

Low Power Idle and Power Down Modes.

In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The Power down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset [5]-[6].

3.7 Sensors

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing. Motion sensors in various systems including home security lights, automatic doors and bathroom fixtures typically send out some type of energy, such as microwaves, ultrasonic waves or light beams and detect when the flow of energy is interrupted by something entering its path.

3.8 Relay Driver

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote- control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and automation systems. Highly sophisticated relays are utilized to protect electric power systems against trouble and power blackouts as well as to regulate and control the generation and distribution of power. In the home, relays are used in refrigerators, washing machines and dishwashers, and heating and air-conditioning controls. Although relays are generally associated with electrical circuitry, there are many other types, such as pneu- matic and hydraulic. Input may be electrical and output directly mechanical, or vice versa.

3.9 RELAY

A **relay** is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

3.10 RF MOUDLE

An RF Module is a small electronic circuit which is used to receive or transmit waves on one of a number of carrier frequencies. RF Modules are often used in consumer applications including wireless alarm systems, garage door openers, industrial remote controls, wireless home automation systems and smart sensor applications. Due to RF modules not requiring line-of-sight operation, they are often used instead of infrared remote controls. A module is a self-contained component of a system, which has a well defined interface to the other components. An RF module is a functional integration of semiconductor devices.

3.11 LOAD

An **electrical load** is an electrical component or portion of a circuit that consumes electric power this is opposed to a power source, such as a battery or generator, which produces power. In electric power circuits examples of loads are appliances and lights. The term may also refer to the power consumed by a circuit.

The term is used more broadly in electronics for a device connected to a signal source, whether or not it consumes power. If an electric circuit has an output port, a pair of terminals that produces an electrical signal, the circuit connected to this terminal (or its input impedance) is the *load*. For example, if a CD player is connected to an amplifier, the CD player is the source and the amplifier is the load.

Load affects the performance of circuits with respect tooutput voltages or currents, such as in sensors, voltage sources, and amplifiers. Mains power outlets provide an easy example: they supply power at constant voltage, with electrical appliances connected to the power circuit collectively making up the load. When a high-power appliance switches on, it dramatically reduces the load impedance.

IV. RESULTS

Hence by using zigbee we made the prototype of wireless SCADA for monitoring the load conditions and temperature in a remote plant which uses RF technology for data collection in remote plant through zigbee which is connected to PC for monitor the parameters of the remote plant and transformer load conditions.

FIG 3: MONITORING THE TEMPERATURES OF DIFFERENT ZONES IN REMOTE PLANT

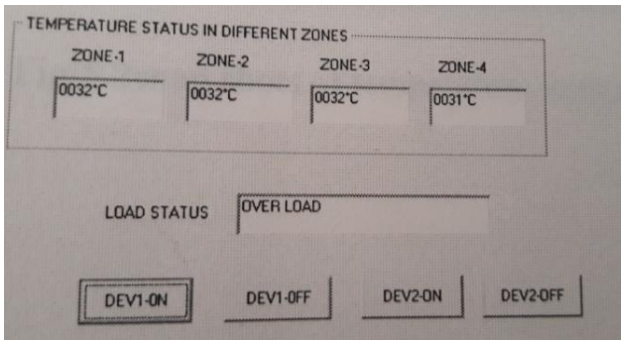

FIG 4: OVERLOAD CONDITION OF TRANSFORMER AND MONITORING THE TEMPERATURES OF DIFFERENT ZONES IN REMOTE PLANT

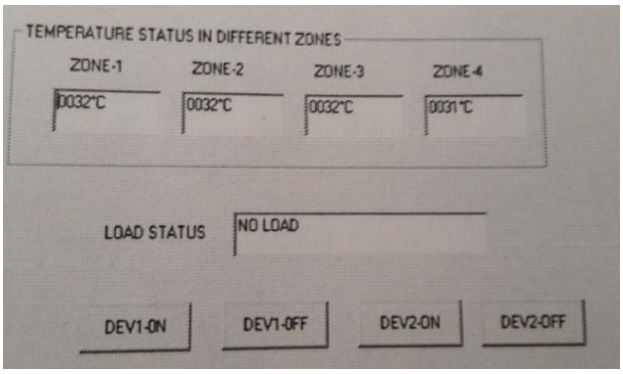

FIG 5: NO-LOAD CONDITION OF TRANSFORMER AND MONITORING THE TEMPERATURES OF DIFFERENT ZONES IN REMOTE PLANT

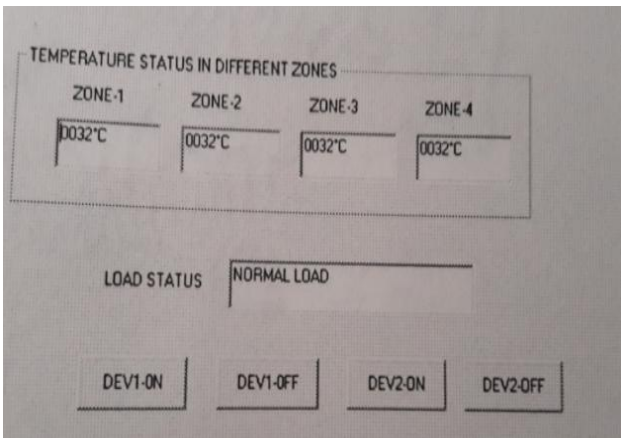

FIG 6: NORMAL -LOAD CONDITION OF TRANSFORMER AND MONITORING THE TEMPERATURES OF DIFFERENT ZONES IN REMOTE PLANT

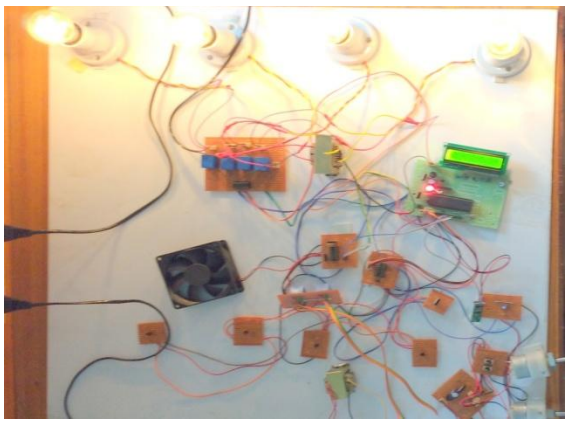

FIG 7: OVERVIEW OF HARDWARE MODULE

V. CONCLUSION & FUTURE SCOPE

The importance of monitoring and controlling Industrial parameters lies in building efficient SCADA based wireless technology. Its applications range from providing security through intrusion detection to measuring important parameters such as Temperature, Light Intensity etc. in future Data can be sent in a bi-directional way. The ultimate goal of this project is to develop a technology to aid in the further development of bi-directional communication between a PC and a remote robot. A user should be able to send data in a full duplex mode i.e. transmit and receive simultaneously. Data can be broadcasted. Broadcasted data can be sent which will enable data to reach multiple recipients. We can use SCADA to manage any kind of equipment. Typically, SCADA systems are used to automate complex industrial processes where human control is impractical — systems where there are more control factors, and more fast-moving control factors, than human beings can comfortably manage**.**

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