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DEVELOPMENT OF SCADA LIKE APPLICATION USING ARDUINO WITH .NET INTERFACE

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Abstract- Nowadays SCADA systems are used for Home automation, Greenhouse automation, E-agriculture etc. Basically these SCADA applications include Level Monitoring, Light & Climate Control, Security & Surveillance, control and manage spatially separated utility sites and Control of Shutters & Doors and so on. With the arrival of new hardware and software technologies here a system is proposed which can perform the similar SCADA applications at lower cost and lower maintenances. This paper proposes a viable solution for SCADA like applications which include Water level monitoring, Oil level monitoring & Displacement control by using a microcontroller board and .NET interfacing. This system can not only perform these industrial applications but also proposes fine web based solution to access all these acquired data and equipments. Here a remote based application is used which will allow the user to access the data/equipments in industries via internet, it also overcome the problem of weak encryption used by the SCADA. In future this system using .NET platform may replace these SCADA solutions.

Keywords- SCADA, .NET, Web-Based, Remote, Encryption.

I. INTRODUCTION

Traditionally some managers are required to collect accurate information for monitoring and controlling the equipments from remote assets such as pumps, tanks & booster stations of water/waste water, oil facilities etc. Conventionally this information is collected manually by collecting the recordings of the data. While manual collection of this data is the norm, plants want to move to an automated process using a central station for all monitoring and control, which can reduce or eliminate the need for manual data collections [1]. However, techno-logical developments in the supervisory systems now make it possible to access process systems on the Internet [2]. Nowadays these types of applications are controlled by using Supervisory Control and Data Acquisition (SCADA) system. This system can not only perform these industrial/SCADA applications but also proposes a fine web based solution to access all these acquired data and equipments. This is all performed automatically. An alarm is also used here to sound in a predetermined fashion.

A SCADA System usually consists of the following subsystems:

1. A Human-Machine Interface or HMI is the apparatus which presents process data to a human operator and through which the human operator monitors and controls the process.
- 2) A supervisory (computer) system, gathering (acquiring) data on the process and sending commands (control) to the process.
- 3) Remote Terminal Units (RTUs) connecting to sensors in the process, converting sensor signals to digital data and sending digital data to the supervisory system.

A. Security issues of SCADA

- i. It is a very bulky system, it requires a large maintenance.
- ii. It is heavier and very expensive.
- iii. It requires more power and having weak encryption.
- iv. The SCADA system is more complicated than the sensor to panel type.
- v. The operator can see only as far as the PLC [3].

Because SCADA systems use leased telephone lines, twisted pair cable, microwave radio, and spread spectrum techniques, they have many of the same security vulnerabilities.

B. How does the .Net Interface Along with an Arduino Board Overcome these Problems?

Installation of visual basic 2005 software is as simple as mounting the device. It offers multiple language support. It uses encryption for better security and consumes less power than that of the SCADA system. Also it is simple to use & requires less maintenance. It overcomes the security vulnerabilities of the SCADA system as the .NET interface doesn't need any type of complex cabling. The Arduino IDE is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development.

II. APPLICATION ARCHITECTURE

The block diagram of the proposed system is shown in figure 1. The basic concept is to develop a system

which can perform remote monitoring or controlling functions like the most widely used system in automation industries "The SCADA system". Here an arduino board is used which is the heart of this system. An arduino board is nothing but a kit which is comprised of an atmega 8 bit μ c chip with inbuilt USB 8-bit FIFO IC means an FTDI driver that is serial/parallel interface converter, power supply and ADC. The arduino board performs both monitoring & controlling action of the system.

Arduino hardware is programmed using a Wiring-based language (syntax and libraries), similar to C++ with some slight simplifications and modifications, and a Processing-based integrated development environment [4]. The Arduino IDE comes with a C/C++ library called "Wiring" (from the project of the same name), which makes many common input/output operations much easier. Arduino programs are written in C/C++, although users only need define two functions to make a run able program:

- setup() – a function run once at the start of a program that can initialize settings
- loop() – a function called repeatedly until the board powers off

A web server is designed using .NET interface on the USB Port of the laptop/PC. The web server is used to monitor the controlling action and restore all the information in the database. Here we are considering three real time applications: (1) Water level monitoring (2) Oil level monitoring & (3) Displacement control.

The Oil and water both have some different properties like water is a polar substance while oil is a non polar. The arduino board is programmed here as per the requirement of the application which performs both controlling monitoring action for water & oil level and only monitoring action in case of the misalignment of the equipments a windows based programming is done. The web server can monitor all the three applications at a time. When the Oil/Water level will go below the set point the μ c performs its monitoring and controlling functions and the solenoid valve start feeding oil/water and when the Oil/water level will go above the set point the μ c performs its monitoring and controlling functions and the solenoid valve stops feeding oil/water. Similarly in case of the displacement control whenever there will be a misalignment of one equipment with the other equipment it will give the information to the user by using the GPRS module, it will send a message to the one user or the multiple user. Because of the widely coverage, the GSM/3G networks can be used for implementation of telematics applications including automotive, home automation and also E-Agriculture domains [7]. GPRS is a packet-switched technology that is an extension of GSM. (GSM is a circuit-

switched technology.) A key advantage of GPRS over GSM is that GPRS has a higher data transmission speed. GPRS can be used as the bearer of SMS.

Fig. 1 Block Diagram of the proposed system

This system is totally a self adaptive feedback control system. An alarm also sounds when the oil/water level and a misalignment will occur that is nothing but an audio message. Hence we can say that this system have a supervisory property (Monitoring) as well as the data acquisition property (Data Repository) with a controlling function like an SCADA system. The developed system is much cheaper than that of the SCADA and also this system consumes less power. This project offers a low cost solution for the automation industries to be used in various automation domains like E-Agriculture, Home/Building automation and so on. A Username and password protection i.e. a log in process is also added here to permit the access to the system for only the authorized users. Once a system is connected to the internet, it is not impossible for other internet users to have access to the system that is why encryption is very important [5].

III. CIRCUIT DIAGRAM OF THE PROPOSED SYSTEM

A. Automatic Control (Self adaptive control system)

In so many applications, it's not sufficient to be only able to measure the quantity. Many times we need to control the quantity. Either we need the quantity (water/oil level) to remain constant at some fixed value (i.e. set point) or we need to vary the quantity at some predetermined level. Adaptive control is the control method used by the controller which must adapt to a controlled system with parameters (e.g. when an aircraft flies its mass decreases gradually due to fuel consumption then that time a control action is needed that adapts itself to such changing conditions).

Fig. 2 Circuit Diagram of the proposed system

In this system we are trying to control the level of oil/water. First thing we have to do to control the level is to find the value of oil/water level to see at what level they are. After that we have to compare these measured values with the desired value i.e. the set point. Is it higher/lower than the desired value? If yes, then how much? At last after comparing measured values to desired values, we should take the self adaptive control action.

B. Arduino Board

Arduino is nothing but an open source single board microcontroller which is designed to make the process of using electronics in multidisciplinary projects more accessible.

IV. OVERVIEW OF THE .NET INTERFACING

With the advent of computers, learning through computer-based environments (hypermedia tools, Web-based educational support, simulation environments, etc.) has dramatically increased [6]. In order to access the Internet remotely with a secure connection that is platform and device-independent the .NET framework provides an effective and ideal solution by using the concept of web services. The applications of web services provide a safe and secure connection at one end and the process or operation at the other end of the connection. The design of inbuilt web environment will be performed using web services in the .NET framework. The pages were designed using ASP.NET with SQL server as the back end. Web services were then consumed from a different server into this server. The pages were integrated together and were hosted on the web as shown in figure 3.

Fig. 3 Web page

A web server is a software tool, which manages (hosts) web pages and makes them available to browsers, either through a local network or through the Internet. Physically web servers and the client machines can be on same machine or separated miles apart. However this does not make any difference in terms of access. There are many web servers available in the market today. Apache, IIS (Internet Information Services), Enterprise Server by IPlanet are a few examples. ASP.NET runs on IIS network. The pages are created using VB.NET in ASP.NET as the front end. Since it is server side scripting, the code is compiled on the IIS, the web server for .NET. The VB code and the ASP code are embedded in a single page. Before the actual coding, all the required name spaces and libraries required for the code are called in using an import statement. These pages are referred as web forms in .NET terminology. All web forms have the extension of .ASPX.

The .NET Framework is a common environment for building, deploying, and running Web applications and Web Services. The .NET Framework contains a common language runtime and common class libraries – like ADO .NET, ASP .NET and Windows Forms - to provide advanced standard services that can be integrated into a variety of computer systems. The .NET Framework provides a feature-rich application environment, simplified development and easy integration between a numbers of different development languages. The .NET Framework is language neutral. Currently it supports C++, C#, Visual Basic, and JScript (The Microsoft version of JavaScript). Microsoft's Visual Studio.NET is a common development environment for the new .NET Framework.

A Microsoft server-side Web technology ASP.NET takes an object-oriented programming approach to Web page execution. Every element in an ASP.NET

page is treated as an object and run on the server. An ASP.NET page gets compiled into an intermediate language by a .NET Common Language Runtime-compliant compiler. Then a JIT compiler turns the intermediate code to native machine code, and that machine code is eventually run on the processor. Because the code is run straight from the processor, pages load much faster. For most purposes, ASP.Net pages can be thought of just like normal HTML pages that have certain marked up for special consideration. When .Net is installed, the local IIS web server is automatically configured to look out for files with the extension '.aspx' and to use the ASP.NET module to handle them.

V. CONCLUSION AND FUTURE WORK

This system has a supervisory property (Monitoring) as well as the data acquisition property (Data Repository) like an SCADA system. The developed system is much cheaper than that of the SCADA and also this system consumes less power. This project offers a low cost solution for the automation industries to be used in various automation domains like E-Agriculture, Home/Building automation and so on. This system can not only perform these industrial applications but also proposes fine windows based solution to access all these acquired data and equipments. Here a remote based application is used which will allow the user to access the industrial data/equipments in industries via internet, it also overcome the problem of weak encryption used by

the SCADA. This system is fully user-friendly and very cost effective with good flexibility. In future this system using .NET platform may replace many SCADA solutions.

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