Development of web-based scada like application using Arduino platform

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Abstract- Basically SCADA stands for Supervisory Control And Data Acquisition Systems. Nowadays SCADA systems are used for Home automation, Greenhouse automation, E-agriculture,Power generation and distribution etc. These SCADA applications include Level Monitoring, Light and Climate Control, Security and Surveillance, control and manage spatially separated utility sites and Control of Shutters and 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 and Displacement control. This system can not only perform these industrial applications but also proposes a 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 inter organizational data/equipments in industries via internet, it also overcome the problem of weak encryption used by the SCADA.Arduino Platform is the new technology used for supervisory control purpose. Alarm handling, Access Control, Automation , Logging, Archiving, Report generation, Interfaces to hardware and software etc are some features provided by the application. In future this system using .NET platform may replace the whole SCADA solution.

Keywords : SCADA, .Net, Arduino Platform, Set points, Supervisory Control, real time data

I. *INTRODUCTION*

Introduction traditionally the managers of water/waste-water, chemical industries, power generation and distribution cells need to collect accurate information from remote assets such as pumps, tanks and booster stations. Traditionally, this information is collected manually by collecting the chart recordings. This might be done monthly, weekly or daily, depending on available staffing. 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. Nowadays these types of applications are controlled by using Supervisory Control and Data Acquisition (SCADA) system. This article examines the use of .NET interface in SCADA applications, means a real time control system is developed by using the .NET interface which can perform all the data repository and controlling function in a better manner than a SCADA system, at very low cost as that of the SCADA. 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. 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.

II .SECURITY ISSUES OF SCADA

- It is a very bulky system, it requires a large maintenance.
- It is heavier and very expensive.
- It requires more power and having weak encryption.
- The SCADA system is more complicated than the sensor to panel type.
- Different operating skills are required, such as system analysts and programmer.
- With thousands of sensors there is still a lot of wire to deal with.
- The operator can see only as far as the PLC.
- Because SCADA systems use leased telephone lines, twisted pair cable, microwave radio, and spread spectrum techniques.

How does the .NET interface overcome these problems?

Installation of visual basic software is as simple as mounting the device, also it consumes less power than that of the SCADA system , plugging in the network cable and using a patch cord to connect to the server, USB port of the PC/LAPTOP, or production equipment cell to be protected.

Using the Internet capability of the production control console, with a password protected login, the security device can be set up and enabled in moments from a template on the device manufacturer's website. The utilization of asymmetric key encryption is suggested. It can provide security to the data that is transmitted from the SCADA master and the remote assets. 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. Our proposed Scheme can increase the security of the System.

III. PROGRAMMER'S DESIGN

The basic concept was to create a system which can perform like supervisory control and data acquisition system for monitoring and controlling the Industrial equipments. This system implements two ways for application remote monitoring and command, the first is based on SMS/call functionalities provided by GPRS network and the second one is accomplished by using a web page interfaces provided when using a web server. Following are some functions provided by the system:

- Flexible and open architecture
- Alarm Handling
- Access Control
- Automation
- Logging,Archiving
- Report Generation

IV. INTERFACES TO HARDWARE AND SOFTWARE

Two different types of control are implemented in the system to control the application as follows:

The key characteristic of control is to interfere or to modify the process. This control function or the interference to the process is introduced by an organization of parts (including operators in manual control) that, when connected together is called the **Control System**. Depending on whether a human body (the operator) is physically involved in the control system, they are divided into Manual Control and Automatic Control.

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A. Manual Control

Here manual control means the user should give the control inputs without the use of any automatic controller. For this experimental set up user can manually check for the temperature set point,or water level indicator or humidity. After that operator will take the decision and action manually wheather to turn on the fan or open the windows etc.

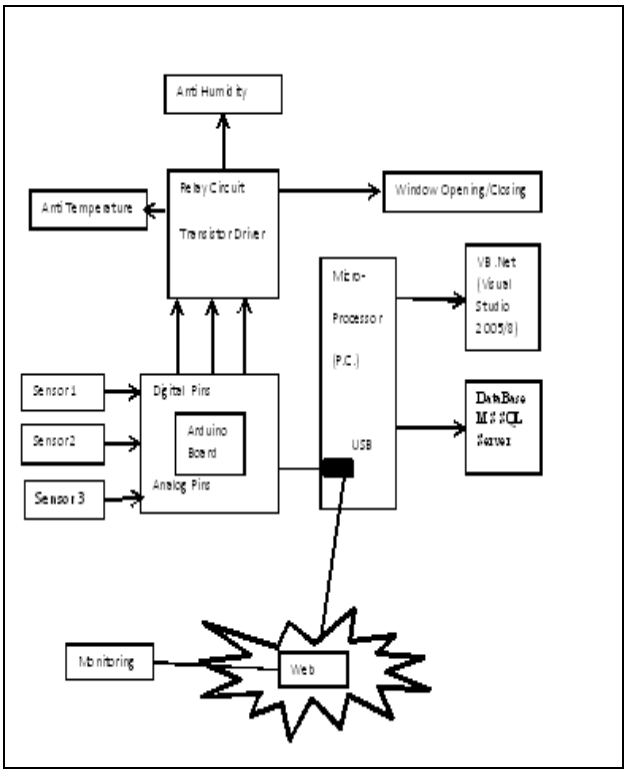

Fig 1: Block Diagram of System

B. Automatic Control ON/OFF Control Systems

In many applications, it is not enough to be able to measure a quantity. Often you want to control a quantity. Either you want the quantity (for example, temperature) to stay constant at some fixed value (like you expect when you set the wall thermostat) or you want to make the quantity vary in some predetermined fashion (for example, making an antenna point to a satellite as it crosses from horizon to horizon). Consider what you need to do to control a quantity. We'll use temperature as an example, but it could be any physical quantity.

• First, if you are trying to control a temperature, you need to know what the temperature is.

• Thus, the first thing you have to do to control a quantity (temperature) is to measure that quantity to see what value it has.

• Secondly, after you measure the temperature, you have to compare the measured temperature with the temperature you want to have - otherwise known as the desired temperature. Is it too high? Is it too low? How much higher (lower) is it compared to what you want?

• Finally, after you have compared where you are at (i.e. measured the temperature) and compared it with what you want (i.e. the desired temperature) you should take control action. There are numerous ways you can control a variable. Some of the ways that you can control a variable include the following.

• You can turn a controller ON or OFF. For example, the wall thermostat measures a room temperature and compares it to a

set temperature (the desired temperature). Then, if the temperature is too high, the thermostat turns the furnace/heater OFF. If the temperature is too low, the thermostat turns the furnace/heater ON.

Hardware of a Control System

Examining the automatic control system, it is found that it contains the following hardware.

- **Sensor** - a piece of equipment to measure system variables. It serves as the signal source in automatic control. These will be discussed at length in a later module.
- **Controller** - a piece of equipment to perform the functions of comparison and computation. The actions that a controller can take will be discussed at length in a later module.
- **Control Element** - a piece of equipment to perform the control action or to exert direct influence on the process. This element receives signals from the controller and performs some type of operation on the process. Generally the control element is simply a control valve.

V. MATHEMATICAL MODEL

When you build a control system it is helpful to have a picture of how the signals are produced and affect things in your system. Control system designers usually use a block diagram to show how signals flow in a control system. Here is a block diagram of a typical control system.

Interpreting this block diagram, we have the following.

The output of the system is y(t).

• The output is measured and fed back to be compared with the input, u(t).

• The result of the comparison is an error signal,

$$e(t) = u(t) - y(t)$$

• The error signal is multiplied by a constant, K, to produce the control effort, c(t).

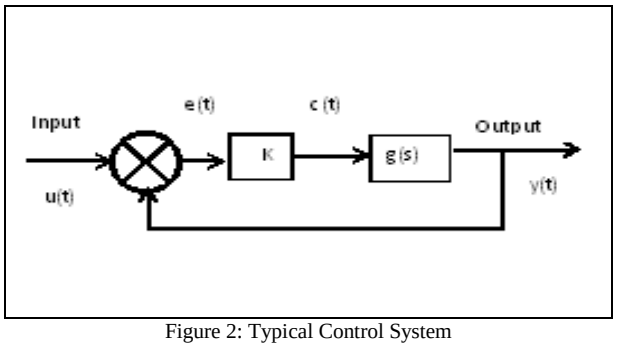

Figure 2: Typical Control System

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• The result of the comparison is an error signal,

$$e(t) = u(t) - y(t)$$

• The error signal is multiplied by a constant, K, to produce the control effort, c(t).

• K is referred to as the proportional gain.

• The control effort, c(t), is applied to the system.

• The system is represented here with a transfer function, G(s).

• Using a transfer function representation is done to remind us that the system will have dynamics, and

that applying a control effort will not result in an immediate response in the output.

Rather, we have to wait for the system to respond to the input. Systems that monitor and control critical infrastructures have special application demands and configurations. They may communicate using different protocols and diverse transmission media. For example, protocols that are popular on systems used by power grid plants may not be useful in oil and gas industry, which uses different protocols. Even though there is some work proposing new forms of communication, most SCADA services act in a client and server fashion. Field services receive requests from MTUs and sensors. HMI servers receive requests from HMI clients. Historians (relational or proprietary databases) receive requests from HMI servers and MTUs. Therefore, there exists a strong interdependency between these services. A service failure may cascade into the failure of other services and sometimes result in the failure of the entire system. That is why it is important to evaluate SCADA survivability using a service oriented approach. As mentioned earlier, survivability is about essential services. Therefore, services are classified into two types: essential and normal . In this paper services are classified manually by system experts. Services are the basic entity for the survivability evaluation of a SCADA system. To avoid misinterpretations about services and systems we provide two definitions that are important to a clear understanding of the relationship between them.

Definition 1. A system consists of a set of services communicating with each other and providing functionalities to internal and external clients, where the internal clients are other services within the system.

Definition 2. A service is a software that provides a functionality consumed by other entities (services or clients) of the system. Services can have a variety of states that describe different levels of operability (e.g. Normal, Compromised, Acceptable, Unacceptable, and so forth).

SCADA systems can be highly dynamic, and services capacity to respond to their clients may change over time, as the volume of requests and data exchanged changes. Service states and their related behavior also changes over time. To evaluate these changes and consequently calculate service survivability, the behavior of services is classified in two states: acceptable, and unacceptable. Consequently, any service in the system can only be in one of these two possible states. To determine if a given service is in one of the two states, a measurement needs to take place. A measurement according to a metric or a set of metrics determines the state of a service.

acceptable (a) - An acceptable state is a state in which the system is within the operating parameters defined as proper

operational environment. In such a state, all operations are being performed normally and there are no reported errors.

Unacceptable (u)- An unacceptable state is a state where the service is not behaving under the requirements defined as acceptable. Such behavior may be provoked by any undesired event. However as stated earlier, the metrics and the holistic survivability concept focus mainly on malicious attacks.

VI. OVERVIEW OF THE WEB ENVIRONMENT

The Internet is a public, cooperative, and self-sustaining facility accessible to hundreds of millions of people worldwide. Since information and knowledge transfer is critical for the success and continuous enhancement of any product it is imperative to keep abreast with technological innovations. A data repository, over the World Wide Web, is one such innovations used for information sharing and updating. With the introduction of the. NET technology, by the Microsoft Inc., the whole Internet technology is looking forward towards an era of integrating and unifying different language platforms into one single framework.[6] This project elaborates on the use of .NET technology in developing a data repository. It is an experimentation to learn and adopt this technology into admission procedure methods. This project should be very helpful for the all students when they want to take admission from any remote location. Internet technology has revolutionized the whole world in its methods of information sharing. In this new era of combined education and collective learning, the learning still seems to be incomplete if there is no one single platform or framework through which information is shared.

VII . .NET FRAMEWORK

The .NET Framework is the infrastructure for the new Microsoft .NET Platform. 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 Script (The Microsoft version of JavaScript). Microsoft's Visual Studio.NET is a common development environment for the new .NET Framework.

WHICH IS BETTER: MOBILE PHONE OR GSM / GPRS MODEM?

In general, a GSM/GPRS modem is recommended for use with a computer to send and receive messages. This is because some mobile phones have certain limitations comparing to GSM/GPRS modems. Some of the limitations are described below:

• The basic difference between these types of networks is that the GSM net-work addresses all devices on the network by a phone number. On the GPRS/EDGE network, all devices are addressable via an IP address, making data communications easy.

• Some mobile phone models (example: Ericsson R380) cannot be used with a computer to receive concatenated SMS messages.

• A concatenated SMS message is a message that contains more than 140 bytes. (A normal SMS message can only contain at most 140 bytes.) Concatenated SMS works like this: the sender's mobile device breaks a message longer than 140 bytes into smaller parts. Each of these parts are then fitted in a sin- gle SMS message and sent to the recipient. When these SMS messages reach the destination, the recipient's mobile device will combine them back to one message.

VIII. OVERVIEW OF ARDUINO PLATFORM

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

Open source hardware platform shares much of the principles and approach of free and open-source software. In particular, if the people wants to study the hardware to understand how it works, make changes to it, and share those changes. to facilitate this, all of the original design files (eagle cad) for the arduino hardware are released. these files are licensed under a creative commons attribution share-alike license, which allows for both personal and commercial derivative works, as long as they credit arduino and release their designs under the same license.

The Arduino software is also open-source. The source code for the Java environment is released under the GPL and the C/C++ microcontroller libraries are under the LGPL.

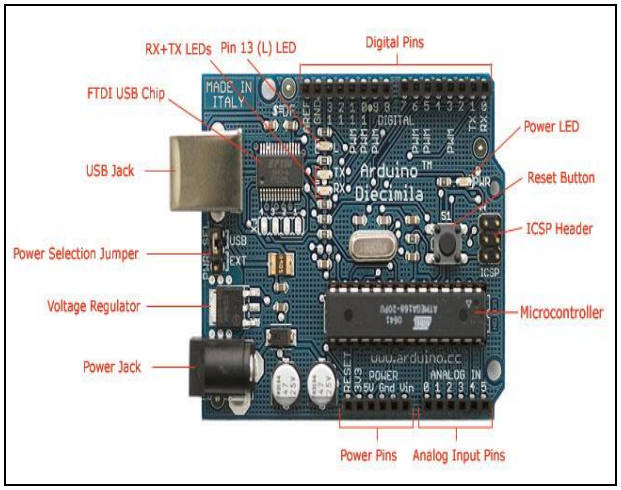

Fig 3: Arduino Board

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino Programming Language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software running on a computer.

IX. RESULTS

Sensors collect the real time environmental parameters from the field. It will provide this information to Controller circuitry. Controller will then depending on set points provided in the program, generate controlling action which will turn on the driver circuitry. Driver circuit consist of relays and transistors. Both can act as switches for firing the action. Relays are electromechanical switches and transistors are solid state switches. That is, Relays actually perform the mechanical action by making and breaking the contacts. Transistors are solid state switches in which current flows due to the motion of electrons. Set points can be defined based on particular environmental conditions. If the related environmental parameter will crosses the value of set point, automatically trigger is fired. Microcontroller will detect cross over of set point and we will take necessary control action. For example set point given for the temperature is 50 degree Celsius. Temperature sensor will continuously provide the values to the controller. If temperature exceeds 50 degree celcius,controller trigger the driver circuitry to take necessary action. In this case, the action may be switching on the fan to control the room temperature.

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