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Supervisory Control and Data Acquisition System (SCADA) in Construction Industries

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Abstract – SCADA technology provides a thorough understanding of the fundamental concepts and the practical issues of SCADA systems. Particular emphasis has been placed on the practical aspects of SCADA systems with a view to the future. SCADA technic is rarely used in construction field this paper is all about the SCADA technology used in construction industries like in RMC plant, HOT mix plant, Equipment's, irrigation districts, etc. The first 'SCADA' systems utilized data acquisition by means of panels of meters, lights and strip chart recorders. The operator manually operating various control knobs exercised supervisory control. These devices were and still are used to do supervisory control and data acquisition on plants, factories and power generating facilities. The sensors are connected directly to the meters, switches and lights on the panel. This technology in advance technology which is one time investment for mass construction. In PWD (Public Work Department) SCADA technology has been made compulsory for road construction.

Key Word: Data Acquisition, Information Display, Alarm Processing, Information Storage and Report, Quality Control

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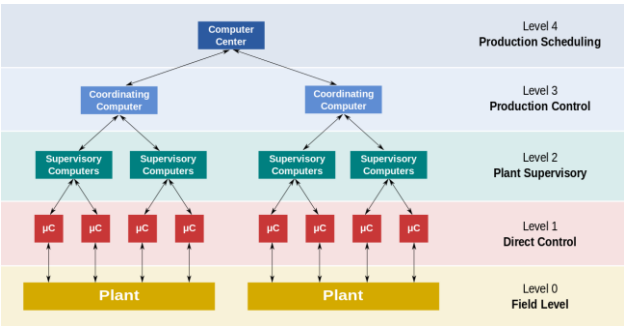
I. INTRODUCTION

A Supervisory Control and Data Acquisition (SCADA) system is a powerful tool which, when implemented properly in construction industries can lead to improved service to more effective operations and in some cases a reduction in costs (less labor, less energy, etc.). However, widespread adoption of SCADA and automation technologies remains a technical and financial challenge for most construction fields. In spite of many good hardware and software products available on the market now, putting all the pieces together requires specialized expertise. Nevertheless, by following some straightforward strategies and rules of good practice, combined with advanced control techniques, even very complex automation systems have been successfully implemented. These implementation steps are briefly outlined with a focus on lessons learned. Updated implementation costs for typical system components are given to aid in project planning, well as quality of the work taking place at other field remote location. This paper provides an overview of experience implementing SCADA systems. By investing in advanced communications and electronics technologies, construction industries are striving to benefit from reduced operations costs, improved system performance, and increased responsiveness from a management standpoint. In practice, many engineers face challenges in each step of the project-cycle that mean achieving these benefits is far from automatic.

In previous paper it was discussed about SCADA now we are implementing SCADA technology in construction industries to make the work easy and economical with the best quality. The below given diagram shows the how SCADA works from field;



Referring to the diagram,

Level 0 contains the field devices such as flow and temperature sensors, and final control elements, such as control valves.

Level 1 contains the industrialised input/output (I/O) modules, and their associated distributed electronic processors.

Level 2 contains the supervisory computers, which collate information from processor nodes on the system, and provide the operator control screens.

Level 3 is the production control level, which does not directly control the process, but is concerned with monitoring production and targets.

Level 4 is the production scheduling level.

Level 1 contains the programmable logic controllers (PLCs) or remote terminal units (RTUs).

Level 2 contains the SCADA software and computing platform. The SCADA software exists only at this supervisory level as control actions are performed automatically by RTUs or PLCs. SCADA control functions are usually restricted to basic overriding or supervisory level intervention. For example, a PLC may control the flow of cooling water through part of an industrial process to a set point level, but the SCADA system software will allow operators to change the set points for the flow. The SCADA also enables alarm conditions, such as loss of flow or high temperature, to be displayed and recorded. A feedback control loop is directly controlled by the RTU or PLC, but the SCADA software monitors the overall performance of the loop.

Levels 3 and 4 are not strictly process control in the traditional sense, but are where production control and scheduling takes place.

Data acquisition begins at the RTU or PLC level and includes instrumentation readings and equipment status reports that are communicated to level 2 SCADA as required. Data is then compiled and formatted in such a way that a control room operator using the HMI (Human Machine Interface) can make supervisory decisions to adjust or override normal RTU (PLC) controls. Data may also be fed to a historian, often built on a commodity database management system, to allow trending and other analytical auditing.

SCADA systems typically use a *tag database*, which contains data elements called *tags* or *points*, which relate to specific instrumentation or actuators within the process system according to such as the Piping and instrumentation diagram. Data is accumulated against these unique process control equipment.

SCADA technology consist of:

- Supervisory computers

This is the core of the SCADA system, gathering data on the process and sending control commands to the field connected devices. It refers to the computer and software responsible for communicating with the field connection controllers, which are RTUs, and software running on operator workstations. In smaller SCADA systems, the supervisory computer may be composed of a single PC.

- Remote terminal units

Remote terminal units, also known as (RTUs), connect to sensors and actuators in the process, and are networked to the supervisory computer system. RTUs are "intelligent I/O" and often have embedded control capabilities such as ladder logic in order to accomplish boolean logic operations.[4]

- Programmable logic controllers

Also known as PLCs, these are connected to sensors and actuators in the process, and are networked to the supervisory system in the same way as RTUs. PLCs have more sophisticated embedded control capabilities than RTUs, PLCs are often used in place of RTUs as field devices because they are more economical, versatile, flexible and configurable.

- Alarm handling

Important part of most SCADA implementations is alarm handling. The system monitors whether certain alarm conditions are satisfied, to determine when an alarm event has occurred. Once an alarm event has been detected, one or more actions are taken (such as the activation of one or more alarm indicators, and perhaps the generation of email or text messages so that management or remote SCADA operators are informed). In many cases, a SCADA operator may have to acknowledge the alarm event; this may deactivate some alarm indicators, whereas other indicators remain active until the alarm conditions are cleared.

Alarm conditions can be explicit—for example, an alarm point is a digital status point that has either the value NORMAL or ALARM that is calculated by a formula based on the values in other analogue and digital points—or implicit: the SCADA system might automatically monitor whether the value in an analogue point lies outside high and low- limit values associated with that point.

Examples of alarm indicators include a siren, a pop-up box on a screen, or a coloured or flashing area on a screen (that might act in a similar way to the

"fuel tank empty" light in a car); in each case, the role of the alarm indicator is to draw the operator's attention to the part of the system 'in alarm' so that appropriate action can be taken.

SCADA system is used in construction industries for quality control and easy work done with huge profit. The study utilizes three important research methods; first, the literature review was to find the use of SCADA in various fields.[1] Shruthi L S and Abhay Tawalare (June 2015) Department of Civil Engineering, VNIT Nagpur. He found that it Monitors and controls the processes. All the operations can be controlled from a single central location. Reduces the dependency on labour force in road construction. [2] Keith Stouffer ,Joe Falco, Karen Kent September 2006.It says that SCADA Transfer technology to field operations .Adapt a best-of-breed correlation engine to this environment.[3] Mr. Nilesh D. Chinchore, Prof. Pranay R. Khare June 2015 says that no Danger of Over compaction, Compaction Control on the Job, Easy to operate in construction equipment for road roller. .[4] Peter Fonus and Dale Barr October 2004 concluded that Widely used to monitor and controls. Transmit data from the field to the central master control unit.

II. METHODOLOGY

SCADA technology can be used in construction industries as this makes the work easy with less labour and the quality of work is maintained. As in this paper we have mentioned the technic used in various construction field, like hot mix pant, RMC plant, road roller ,etc. this gives good result in the particular field. Where the cost is maintained due to labor's. On RMC plant the only one person can handle the hole plant with help of SCADA and this further can be seen in the other office of engineer through internet, this this displays the quantity of concrete used in the concrete like cement, sand and aggregate and admixture. The final report also can be seen in this method so that if missed by the engineer the all data can be recorded and can be seen again.

Not only in RMC plant but also on site the work of JCB can be handled by using this equipment, like how much the excavation is done can be seen from the site to the office, the road roller movement kilometers can be seen in this technic thus the equipment's of construction are handled easily.

In HOT MIX Plant the various sand and the tar is been used the SCADA helps to take the amount of material like 6mm, 10mm12mm, aggregate in the container and the sprinklers the amount of tar in the mixer so that the asplat is prepared easily without the labours with perfect quantity and all this data is been seen through internet in the engineer‘s office and other head office too with the help of internet. This is AN advance technic and must be used in construction to make the work easy. The barriers occurred during the working can be easily detected without visiting the site or plant.

SCADA (Supervisory Control and Data Acquisition) is a system to automate industrial control and monitoring. SCADA includes field sensors, Programmable Logic Controllers (PLC) and Remote Telemetering Units (RTU). SCADA use can also be found in power generation, manufacturing automation, oil and gas exploration and utilities monitoring and control. SCADA can be used to monitor parameters such as temperature, pressure, flow rate, pH, etc. SCADA can set off alarms based on collected and observed data and remote access function can be enabled through a web based interface or specialized software on networked machines. With the advantage of high efficiency and excellent environment adaptability, SCADA is widely employed in a lot of industry fields. Although the SCADA is widely, there are still some shortcomings like data fusion and data mining on the data acquired from RTU. Regarding this problems, the Service-oriented architecture is introduced and a system constructing method is proposed which will improve the efficiency and reduce the labour cost. The case of electricity using ESB is employed to prove the validity of the method proposed.With the rapid development of information technology, People become more and more dependent on the automatic technology in some special industries like oil, electricity and chemistry. As a novel technology, SCADA is widely deployed in this field, which greatly reduce the manpower requirement and improve the efficiency at the same time.SCADA (supervisory control and data acquisition) is a type of industrial control system (ICS). Industrial control systems are computer controlled systems that monitor and control industrial processes that exist in the physical world.

Features:

- SCADA system comprises a PC, printer, UPS and SCADA software which enables the operator to perform all commands and control functions like take report, detect failures etc on the PC screen with animation support.
- The operator is also able to enter as many recipes as desired, can enter all customer and truck information into the system where production information is stored for one year.
- Remote servicing and maintenance is possible via Internet.

- SCADA system monitors overall performance of the plant and eliminate the need of manual data collection.

- Alarm and wide monitoring system enables the operator to quickly spot and address problem.

A. SCADA System:

SCADA technology has existed since the early sixties and there are now two other competing approaches possible – distributed control system and programmable logic controller. In addition there has been a growing trend to use smart instruments as a key component in all these systems. Distributed control system is another variant of SCADA where data acquisition and control functions are performed by a number of distributed microprocessor-based units situated near to the devices being controlled or the instrument from which data is being gathered. Distribution control system has evolved into systems providing very sophisticated analog control capability. A closely integrated set of operator interfaces (or man machine interfaces) is provided to allow for easy system configurations and operator control. The data highway is normally capable of fairly high speeds. Another variant of SCADA components widely used is the Programmable Logic Controller. These have replaced hardwired relays with a combination of ladder– logic software and solid state electronic input and output modules. They are often used in the implementation of a SCADA Remote Telemetry Units as they offer a standard hardware solution, which is very economically priced.

- Data Acquisition

The systems you need to monitor are much more complex than just one machine with one output. So SCADA system needs to monitor hundreds or thousands of sensors. Some sensors measure inputs into the system and some sensors measure. These are analog sensors, which can detect continuous changes in a current input. Analog sensors are used to track fluid levels in tanks, voltage levels in batteries, temperature and other factors that can be measured in a continuous range of input.

- Data Communication

In real life, you want to be able to monitor multiple systems from a central location, so a communications network is to transport all the data collected from the sensors. Early SCADA networks communicated over radio, modem or dedicated serial lines. Older SCADA systems depended on closed proprietary protocols, but today the trend is to open, standard protocols and protocol mediation. Therefore the remote telemetry unit (RTU) is needed to provide an interface between the sensors and the SCADA network.

- Data Presentation

The only display element in our model SCADA system is the light that comes on when the switch is activated. A real SCADA system reports to human operators over a specialized computer that is variously called a master station. The SCADA master station has several different functions. The master continuously monitors all sensors and alerts the operator when there is an “alarm” — that is, when a control factor is operating outside what is defined as its normal operation. An advanced SCADA master can add a great deal of intelligence and automation to your systems management, making your job much easier.

- Control

The human operator also has a button on his control panel. When he presses the button, it activates a switch on. Now let’s add the full computerized control of a SCADA master unit that controls the entire factory. You now have a control system that responds to inputs elsewhere in the system.

III. CASE STUDY

Location: PMC HOT MIX Plant, Yerwada, Pune.

SCADA System with sensor remotely monitors the hot mis plant. This system gives a warning when the equipment fails or process upsets,. Thequantity of agreggate, tar and the temperature can also be seen on remote location with the help of SCADA. The gates of the control panel would be able to view on SCADA system monitor at remote location.

Please refer below mentioned images for detailed view of SCADA system:

Figure1. HOT MIX material Details on Monitor

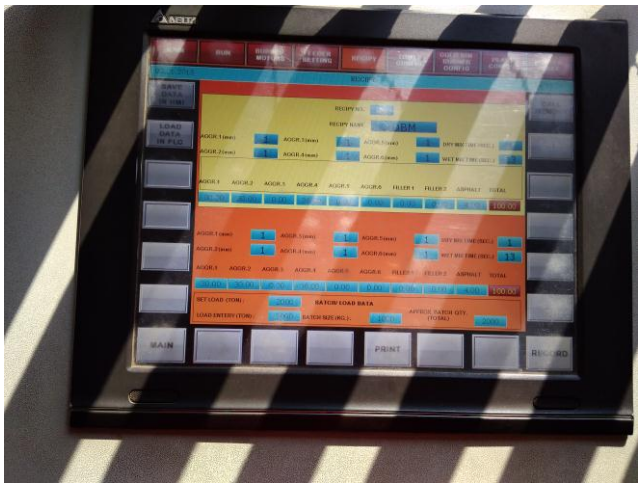


Figure2. Recipe of asphalt on screen

Figure3. SCADA Equipment

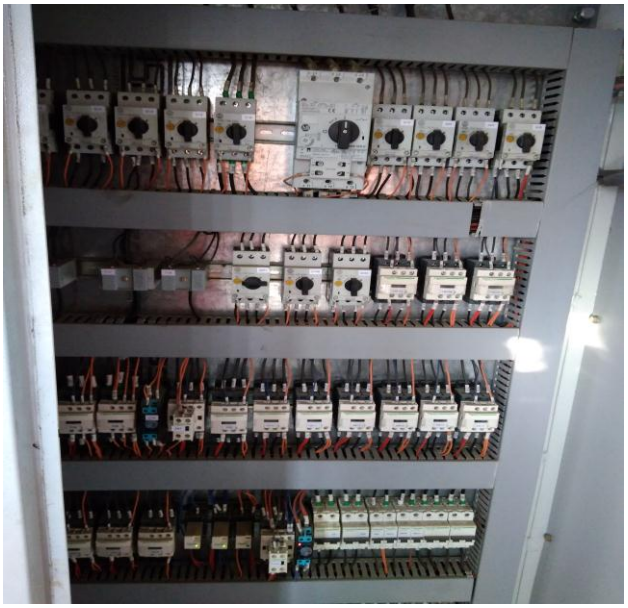


Figure4. SCADA Equipment control panel

Figure5. SCADA Equipment control panel

A. Advantages

- Continues monitoring process
- Real time control
- Automation and protection
- Remote Control & operation

B. FUNCTION OF SCADA

- Data calculation
- Information Display
- Alarm processing
- Data acquisition
- Supervisory control

These functions are performed by four kinds of SCADA components:

- Sensors and control relays that directly interface with the managed system.
- Remote telemetry units are small computerized units used in the field at specific sites and locations. These units work as local collection points for collecting reports from sensors and delivering commands to control relays.
- SCADA master units are larger computer consoles that work as the central processor for the SCADA system. Master units provide a human interface to the system and

automatically regulate the managed system in response to sensor inputs.

- Communications network that connects the SCADA master unit to the Remote Telemetry Units in the field.

IV. CONCLUSION

SCADA systems are a vital tool for keeping our society going. As electronics and communications have improved, so have the capabilities of SCADA systems. SCADA systems make controlling large and small processes easier for Operators in construction industries.

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