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Study and Implementation of PLC and SCADA system for Lift Pumping Station Process Control

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Abstract:

Automation of process control fields was done using simple controller with minimal control over the process. The previous method can be called as semi-automated systems since direct human intervention was required in major phases. The use of programmable logic controller (PLC) changed the system and more automation of process was incorporated. Hence by this method the pumping station can be controlled for all its sequence of operations satisfying the predefined set of interlocks. A well designed Supervisory control system (SCADA) is implemented along the system which allows greater control and also provides the advantage of data acquisition for further analysis.

Keywords: User oriented programming; Permitives; Piping & Instrumentation diagram**;** Interlocks

1 Introduction

The programmable logic controller (PLC) is used as the basic controller for many process related activities. But the problem with the existing method of programming is that the developed program is mainly integrator oriented rather than user oriented. Hence with this system maintenance and troubleshooting of the process is tough and time consuming. Another huge factor is the level of control attained by automating a process which acts as the deciding factor in the overall efficiency of the system (Charles M Burt et.al.). By effective implementation of a SCADA system a high-end control system can be obtained. The principal advantage of using the SCADA system is its ability to store data which will be required for further analysis and improvisation. The methodological approach in implementing the system will yield a simple logical programmed with high control facility.

1.1 Understanding the process

The process requirements and sequence of operation should be understood clearly to design a high clarity system with effective modules. Generally to understand the process clearly its implementation data or control philosophy will be generated which acts as the guide for the entire system. The control philosophy contains all the requisites, permitives and interlocks to be satisfied and hence satisfying the logical nature of programming. Clear understanding also helps in effective implementation of the process with timely introduction of the required phase (Stuart Styles et.al). The main objective of understanding the process is to identify the key areas which require more attention to avoid failure rate of the system.

1.2 Need for Automation

Automating a process is generally considered as a method in which the existing units are replaced with highly sophisticated units with higher rate of output. But by simply changing the rate of output it need not get a higher efficient system. Hence need for automating a particular system should be based on identifying its major units and optimizing them according to the requirement with minimum investment. Thus necessity of automating a process control field becomes important since a high level control is required to obtain a highly efficient system.

1.3 Objective of Implementation of the system

The main objective of the system explained is to generate a simple logical controller programming with high security and control over the process related to lift irrigation pumping station. SCADA is designed in such a way that all the individual details pertaining to the pumps and valves are current and thus providing a live control system. The faceplates developed for individual units will have it corresponding commands with values fed from the feedback units attached with them.

2 System Structure

The main modules in the system include its structural arrangement, Controller programming unit, SCADA development unit etc. From the diagram given below (Fig.1) the blocks can be seen interconnected showing the dependency level with which the system works which helps in gaining a higher overall efficiency.

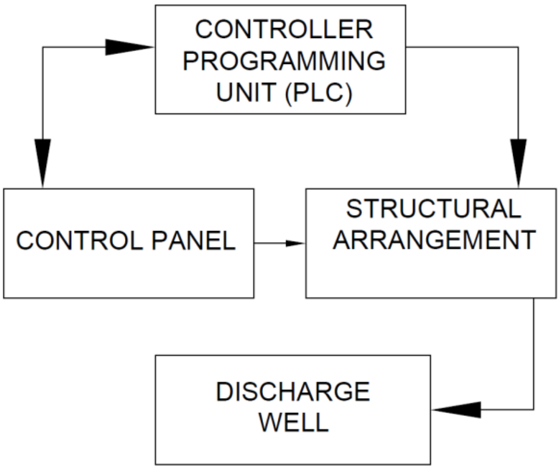

Fig.2 System Structure

2.1 Definition of blocks

- Controller Programming Unit: The PLC programming should contain all the requisites and at the same time should satisfy all the interlocks. The program is developed in more a user oriented which helps in troubleshooting if any error occurs.

- Structural arrangement: The initial graphical developed structural arrangement of the plant helps in better planning o the piping and instrumentation required for the system. Based on the initial observations the piping & Instrumentation diagram is generated which contains all the data relating the field instruments used and the piping characteristics.

- SCADA designing: SCADA designing is based on the actual field pump house structure. This gives a better understanding of the system architecture since is a graphical tool (Slavica Prvulović et.al.). The units included in the system will be assigned with each tag from the controller and based on the values given to the assigned tags the SCADA screen changes giving a visual indication of the change occurred.

3 Pattern of Implementation

The method based on which the step by step implementation of the system is important for such a highly dense interrelated process. It helps in a concurrent method of implementing the system which reduces the non-value added steps and thus reducing the wastage.

3.1 Programming Prerequisites

To generate a simple user oriented program all the prerequisites should be understood. The control philosophy developed gives a theoretical explanation of each process taking place in the system and gives an outline of the requisites to be satisfied by the controller. Since the philosophy is a theoretical document based on it a block logic diagram is developed which gives direct relationship of the actions to each unit implemented in the system. The figure shown below shows the block logic diagram (Fig.2) developed for a vertical turbine pump in the lift pumping station.

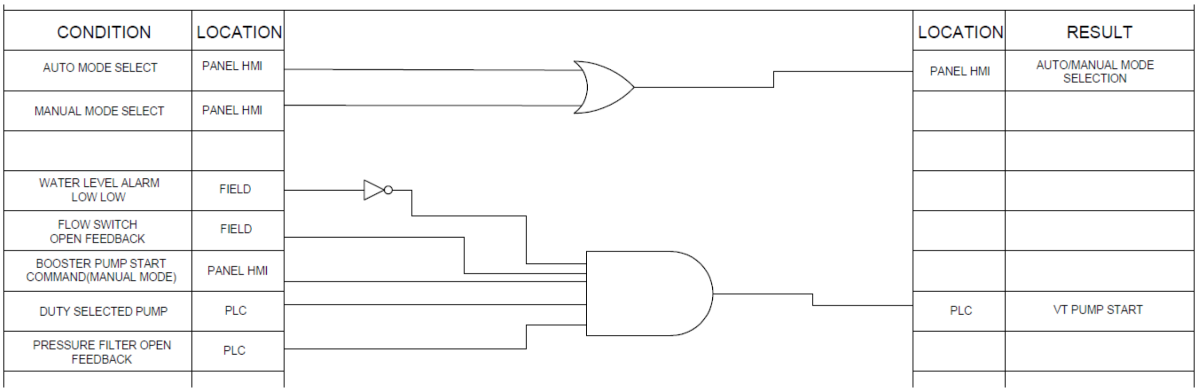

Fig. 2 Block Logic Diagram

3.2 Programming Concepts

Certain basic programming concepts are used for the process which helps in easy generation of the program especially for a big process control field where multiple numbers of units of similar types are present. The main type used is Add on Instruction (AOI) which is like a sub-routine in programming which can be called for any number of times (Ramleela Khare et.al). In logical programming such an AOI is generated with common features for multiple units which save time by avoiding repeated creation of programming steps. The diagram shown below (Fig.3) gives the AOI which have the same features with multiple numbers of instances.

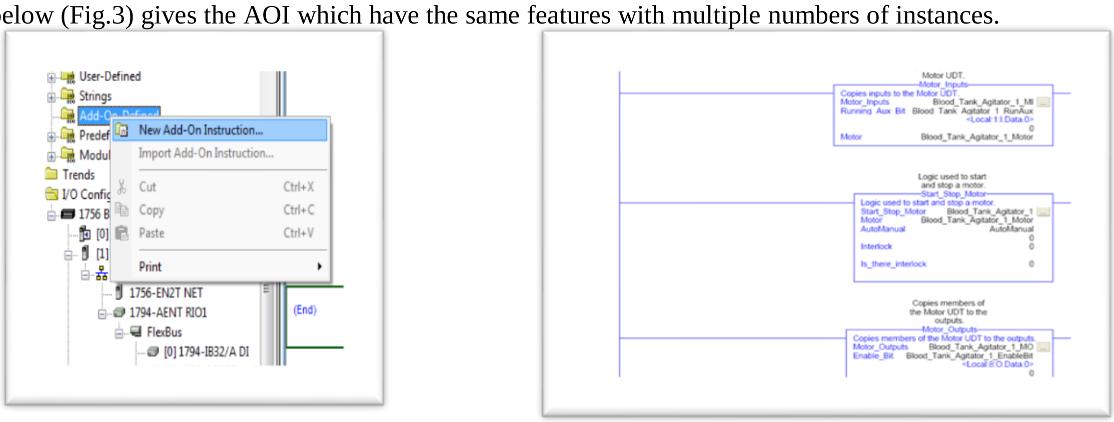

Fig. 3 (a) Creation of AOI (b) AOI for multiple pumps

Based on the requisites and using the concepts effectively a simple logical program can be generated which will be user oriented as well easy for troubleshooting.

3.3 Pump house structure

The pump house structure definition helps in understanding the location and interconnection sof the pumps with the instruments attached along with them Thus the structure is understood from the piping and instrumentation diagram which acts as an ancillary document supporting the creation of visually oriented SCADA screen.

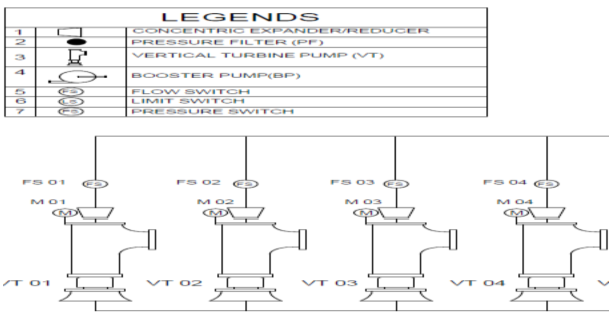

Fig. 4 Piping and Instrumentation Diagram

The above diagram (Fig.4) shows the piping pattern and the measuring instruments attached with them. The placement of pumps and connections to each unit are very important for generating a similar SCADA screen.

3.4 SCADA design

The supervisory unit acts as the main control unit with its added feature of data acquisition. An effective method of developing the SCADA system would act as a tool for continuous process improvement (Mike Sowers et.al.). The screens are developed mainly based on the piping and instrumentation diagram and thus a system similar to real one can be generated. The faceplates or pop-ups added along with each unit will give all the necessary details about that particular unit and would also contain the corresponding action commands relating to that particular unit. The SCADA system is integrated with the main controller and thus a interdependent system is generated.

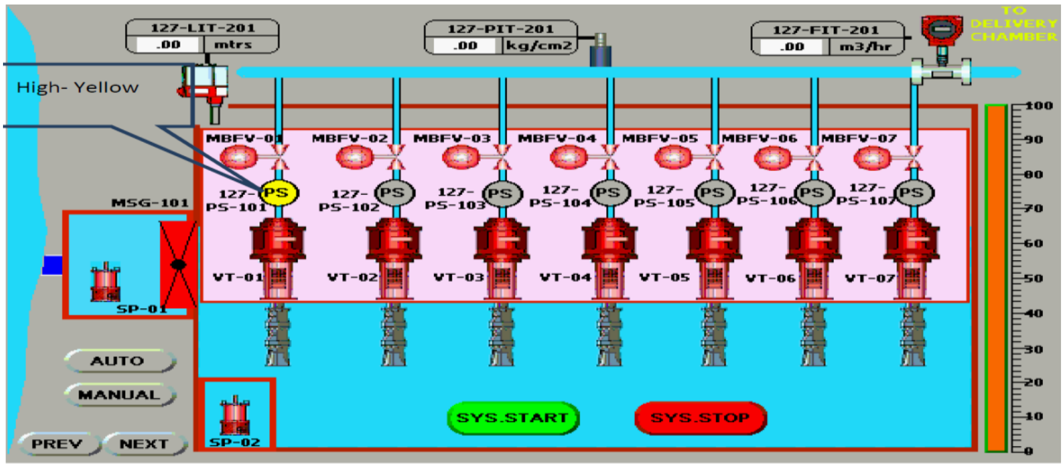

Fig.5 SCADA screen

The diagram shown above is the SCADA screen (Fig.5) developed for the process control activity. Data acquisition is mainly used as a recording system which can be utilised for future up-gradation and result analysis. Thus the added feature helps in avoiding for using a separate historian to collect the dat. The trend screen can be used in case live streaming of a particular data is required, though they are used only in conditions where critical values are to be maintained all the time.

4 Expected outcome

The expected outcome on successful implementation is to generate a simple user oriented program with a high level control over the process achieved through the use of SCADA. The efficiency level of the system can be increased by obtaining a greater control over it. The program is based on standard concepts which helps for easy understanding but with protective factors included to avoid discrepancy in utilising the simplicity provided.

Conclusion

PLC and SCADA on effective implementation to a process field yields highly efficient systems. The only hindrance of obtaining such a system is the method by which they are implemented. To show the system as a complex process the controller programming generally contains several unwanted rungs. These rungs will add programming time as well as becomes difficult for troubleshooting if a service personnel from other firms are attending the system Hence the developed system will be based on simple programming without compromising the security aspect and with a high end fool-proof control logic.

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