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Automation of Water Pumping Station with Retrofitting Using PLC and SCADA Systems

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ABSTRACT: Enormous growth of residential areas has lead to over demand of water to fulfill daily activities and the increasing population and thus the wide expansion of urban residential areas have increased the need of proper distribution of water. Without water nothing happens in any kind of environment. Hence Water management is a matter of high priority in India and those responsible for major operations of water distribution need to be educated in this endeavour. Automation provides optimized solution to all problems of distribution of water and maintenance of the related equipment. Here similarly the Intermediate Boosting Pumping Station (IBPS) at H.D. Kote road Mysuru which pumps the processed water from Kabini River to the city overhead tanks also need to be automated. Hence the automation company CORE4 ENGINEERS at Kuvempunagar Mysuru, taken the project of automation of IBPS with retrofitting using PLC and SCADA systems. In this paper firstly automation is done taking feedback and control of one motor pump in pumping station with Retrofitting using PLC and SCADA systems and then integration of all the 3 motor pumps in pumping station using PLC and SCADA systems.

KEYWORDS: Retrofitting, Control Panel, Pump Priority Runtime, PLC and SCADA.

INTRODUCTION

The increasing population and thus the wide expansion of urban residential areas have increased the need of proper distribution of water. Establishing pumping stations is one of the most common ways of providing water from rivers. In normal days there is a rapid development in urban residential area, whereas in case of water distribution system they are using conventional method, which is not automated. Water management is a matter of high priority in India and those responsible for major operations of water distribution need to be educated in this endeavour. The best way to improve the water distribution system is by using industrial PLC and SCADA system. Automation provides optimized solution to all problems of distribution of water and maintenance of the related equipment.

The Intermediate boosting pumping station (IBPS) at H.D. Kote road, Mysuru which is connected to Kabini River pumping station presently using traditional method is not automated. Hence in this project the automation of this station is to be carried out. This automation is done using Retrofitting with PLC and SCADA systems. Retrofitting refers to the addition of new technology or features to older systems. Since 70% of water is supplied from here, the conventional method does not provide the proper distribution of water. Hence the automation of this plant fulfils the proper distribution of water. As already there is conventional method is there for distribution, the control panels are electronic ones, the replacement of entire panels with PLC panels is time consuming and uneconomical, hence the automation of this plant with retrofitting using PLC and SCADA is feasible and economical.

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II. LITERATURE REVIEW

Ramleela Khare, Dr Filipe Rodrigues E Melo[1] in their paper **"**Automation Of Water Distribution Plant" proposed optimized solution to all problems of distribution of water and maintenance of the related equipment and suggests low cost new equipment and system of operation and new techniques for reliable and efficient management of this technology in totality. The entire network including a standby generator has features of SCADA (Supervisory Control and Data Acquisition) automation to control and monitor water supply and in case of power failures to maintain continuity of power supply.

T. Baranidharan, A.Chinnadurai, R.M.Gowri, J. Karthikeyan[4] in their paper "automated water distribution system using PLC and SCADA" proposed automated water distribution system is to distribute the municipal water equally to all street pipe lines, so that everyone will get the equal amount of water. The set point is fixed for each pipe line. The water from the storage tank is measured with the help of level sensor. This system consists of PLC and SCADA. PLC is used to control the distribution of water. The overall system is connected to PLC with the help of RS-232 cable. PLC gives the signal to the solenoid valve according to the set point written in the program.

Karma Gyatsho Bhutia, Deepak Rasaily, Aarfin Ashraf[8] in their paper "PLC Based Automated Water Level Control system" proposed the automatic water level control using *float sensors*. The float sensor detects the level of water in the main tank. It will sense the low and high level of water in the water tank. If the water level is low, the motor will pump the water and after reaching high level it will stop the pump.

PROBLEM FORMULAION

- The automation of water supply plants in [1][2][3][4][5][6][7][8] explained about the automation of plants with PLC and SCADA, i.e., all the control panels are completely PLC ones replacing entirely those in traditional methods, which is more costlier and time consuming. In the present work the retrofitting is used in which the feedbacks is taken from the available electronic panels to PLC and SCADA unit and are controlled with it.
- Automation Of Water Distribution Plant in [1], the author explained about automation of plant even with water treatment, but the author only used as water level sensors but does not give any details of which type.
- All the water distribution plants are automated using PLC and SCADA in [2][3][4][6][7], but does not explain about the runtime priority control for the motor pumps, and in[5] the flow rate control with centrifugal pumps is explained and in[7] pumping of water according to water level but not does not discussed anything about priority control, but it is brought out in the present work.
- PLC and SCADA Based Automation in Testing of Water and Drinking Water Supplying Unit[3] ,the author used GSM module ,but with GSM module only the message about plant updates to higher authorities (AEE,AE) can be sent but cannot control from that in regard of any faults. The AEE can control from the place where he is using SCADA communication. This is taken for the future works.

III. PROPOSED METHODOLOGY

In this chapter the block diagram of the water supply system from Kabini River, present system and proposed system are explained. The advantages of the proposed compared to present system are brought out. The ratings of the equipments are specified.

Block Diagrams

Automation of water pumping station is proposed with retrofitting using PLC and SCADA systems. The block diagram of water supply system, present methodology for water pumping and the proposed system for water pumping are shown in figs 1, 2, 3 respectively.

The Water Supply System:

The fig 1 shows the block diagram of water supply system from Kabini riverThe pumping station at Kabini River pumps the water to water processing station where the water is processed for drinking purposes.

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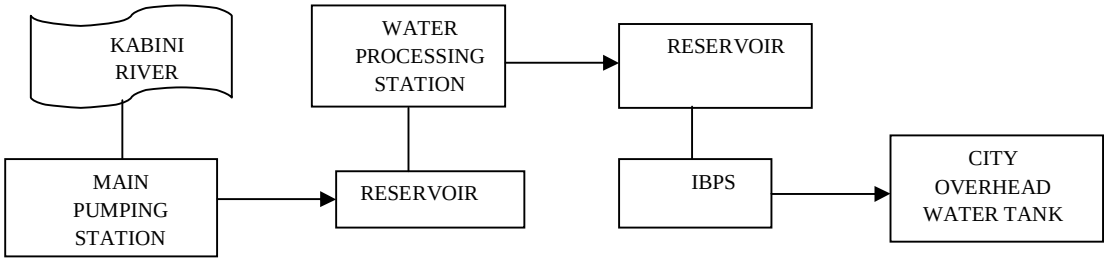

Fig 1 Block diagram of water supply system

This processing station has a reservoir to store the water in case the pumping from Kabini pump station may vary. From this processing station water is pumped to IBPS (intermediate boosting pumping station) H.D.Kote road, Mysuru where the automation is done in this project. Here also reservoir is there from which the water is pumped to the overhead tanks in the city.

Present Methodology for Water Pumping Station

The fig 2 shows the block diagram of conventional operation of the water pumping station where manual operation is there. All the panels and the soft starters are electronic ones.

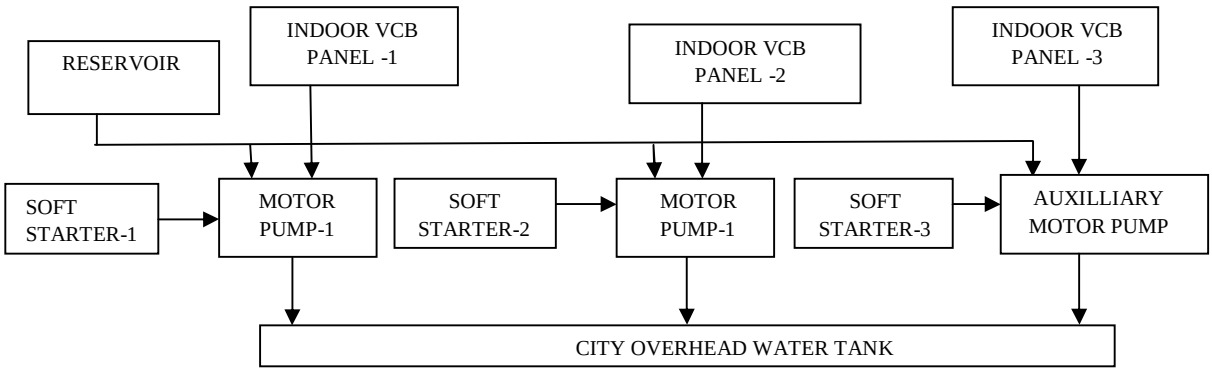

Fig 2 Block diagram of present methodology for water pumping station

This station is presently having manual operation and maintenance. This IBPS station is to be automated.

Block Diagram of the Proposed System:

The fig 3 shows the block diagram of automated IBPS with retrofitting. In the above block diagram the highlighted (coloured) portion indicates the automation for the system, in which the feedback from the mechanical system is taken to the PLC and then controlled using PLC and SCADA.

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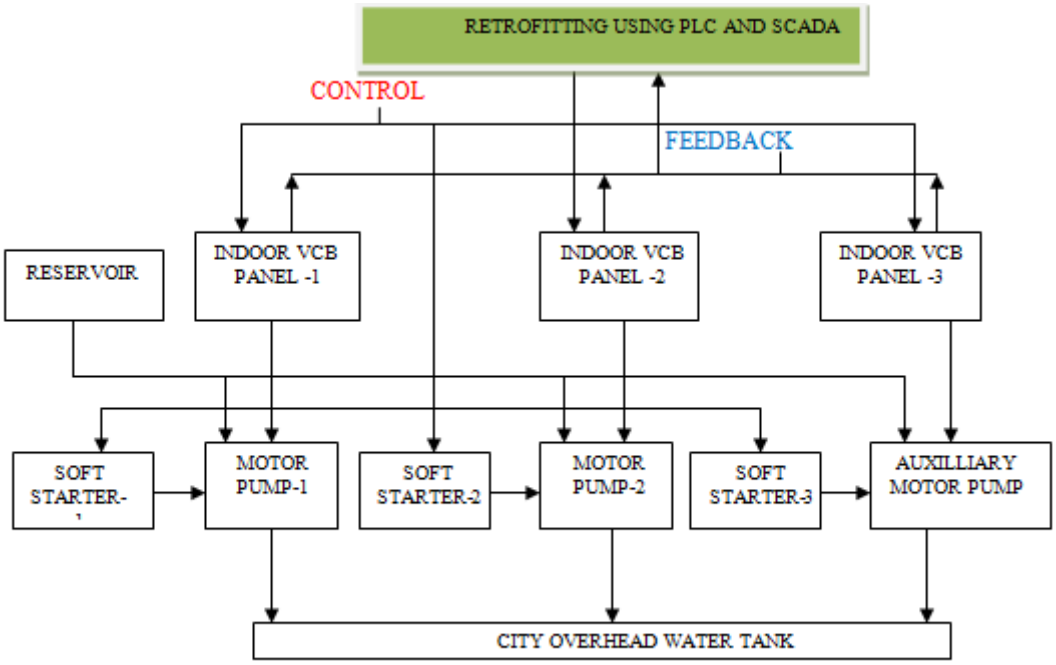

Fig 3 Block diagram of proposed methodology for water pumping station

The working with retrofitting is, primarily when the automation system is turned on, all inputs will be read by PLC and according to the program holds the respective output until the start command is given from SCADA. When command is received by SCADA, the respective pumps depending on its work time schedule will be turned on giving its visual status on the SCADA obtained through feedback loop of each pumps. If any of the protection parameters mentioned above is faulty, system generates the alarm indication like light, buzzer and respective faulty region will be displayed on SCADA screen for easy troubleshoot.
The motor which had run for less time period initially is preferred for next sequence of running.

IV. CONTROL PANEL AND ITS COMPONENTS

CONTROL PANEL

Control panel is a cabinet which contains electrical components to control the motors and equipments. As shown in the block diagram for retrofitting using PLC and SCADA (fig 3.3) the *control panel* is required. Hence the control panel is designed and wired accordingly.

Design of Control Panel

Electrical Circuit
The electrical circuit of control panel is shown in fig 4.

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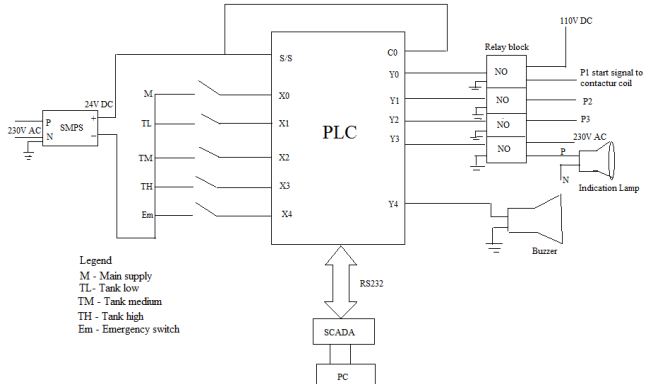

Fig 4 Electrical circuit for control panel connections

The electrical connections are as shown above according to which control panel is designed and programming is done. The 230v AC input is converted to 24v as required by PLC by SMPS and connections accordingly are as shown. The inputs of PLC are given with main and emergency switch for on off purpose, the tank levels “low, medium, high” with sensors (magnetic float sensor) and the outputs are connected to respective motor pumps with relay switches. The entire panel is connected to SCADA system for monitoring.

Mechanical specifications of the control panel used –

- Size: 220mm x 250mm , height- 160mm, 1mm thickness
- Material: Mild steel

The components used in this control panel –

- PLC
- SMPS
- Terminal connectors
- Connecting cables
- Lugs

Electrical specifications –

- PLC – Delta DVP SS2 series
- SMPS – 24V, 4.25A
- Terminal connectors – 36pc 12 way terminal block strip, 5A
- Connecting cables – Tin coated copper wire, 0.5mm
- Lugs – Pin type and “U” type

Fig 5 Overall Control Panel

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Programming Flowchart

Flow chart shown in fig 6 explains the automation process.

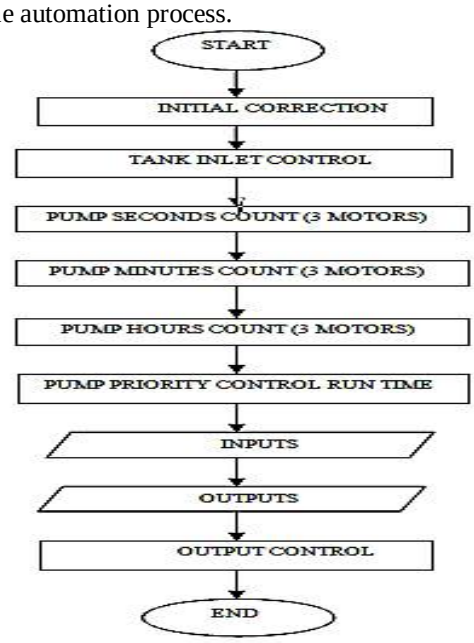

Fig 6 Programming Flowchart

V. RESULTS AND DISCUSSIONS

The main objectives of the project was "taking feedback and control of one motor pump in pumping station for automation with Retrofitting using PLC and SCADA systems" and " Integration of all the 3 motor pumps in pumping station using PLC and SCADA systems".

Primarily when the automation system is turned on, all inputs will be read by PLC and according to the program holds the respective output until the start command is given from SCADA. When command is received by SCADA, the respective pumps depending on its work time schedule will be turned on giving its visual status on the SCADA obtained through feedback loop of each pumps.

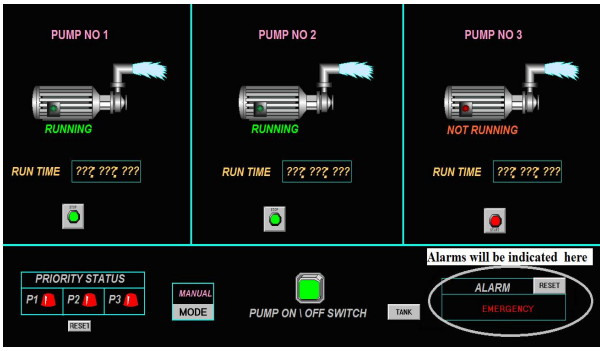

Fig 7 Fault indications by SCADA

Fig 8 Simulation by SCADA when system is turned ON

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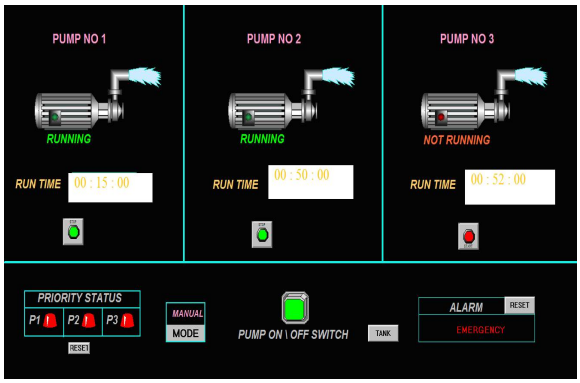

Fig 9 Indication of status of Motor Pumps by SCADA

PROPOSED METHOD	WITH AUTOMATION USING RETROFITTING
Complete manual maintenance	Automation with PLC and SCADA
No reliability	Most reliable
Unable to detect the cause in case of faults	Faults detected and automatically corrected(fig 5.3)
No real time information	Real time information by SCADA(fig 5.5)
Time consuming and Human errors	Time saving
No information of motor pump run status	Motor Pump runs according to previous run time

Table 1 Comparison For Present And Proposed System

In fig 9 for the first motor pump previous runtime is 15 minutes, for second motor pump previous runtime is 50 minutes and for third motor pump previous runtime is 52 minutes as shown. As the third motor pump had run for maximum time compared to first and second motor pump, hence when the system is turned ON the first and second motor pump will be running and the third one will be at rest until the runtime of first and second motor exceeds the runtime of the third motor.

With the above table 1 the automation is the best optimised solution for water pumping and distribution.The automation of the water pumping station is successfully done.

VI. CONCLUSION AND FUTURE SCOPE

Enormous growth of developing world has lead to huge need of water. The automation of the water pumping station eliminates all the problems associated with manual operations. The complete information and the status of the motor pumps can be obtained by SCADA system. This also provides proper distribution of water.The automation of station is done successfully but this can be improved by making control of the stations by SCADA systems i.e. the whole station can be controlled by the nodal officers from the place where they are using SCADA communication. GSM module can be used to provide the station updates to the nodal officers. Development of the android application and linking it to the water pumping station for control increases the efficiency of automation.

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BIOGRAPHY

Shakunthala graduated from P.D.A college of engineering Gulbarga, pursuing post graduation from The National Institute of Engineering Mysuru.

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