Implementation of Automated Urban Drinking Water Supply and Leakage Identification System

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Abstract— There is a huge difference between the demand and supply of the water across all the villages, cities and states in India. Therefore, there is need of system which not only supplies the water but also reduces the leakage, theft, wastage of the water efficiently. This can be achieved by making the supply system automated by connecting the supply system to Programmable Logic Control and Supervisory Control and Data Acquisition System. It minimizes the human error and also reduces the supply cost of the government. The idea is based on the PLC and SCADA which is the advance technology being used by the industries.

Keywords — *water leakage, water demand, supply, Programmable logic control (PLC), Supervisory Control and Data Acquisition (SCADA) , Human error.*

I. INTRODUCTION

In current scenario the water has been essential resource of the life. Particularly in the cities or urban areas where there is dependency of the people on the stored water, in that case conservation of water is very much essential. Also due to various environmental factors the water cycle functionality has also been affected. Hence there is problem of water scarcity at many places. The cities are not getting enough rain to store it and utilize it for further use.

Hence there is a need of the system which can supply the water effectively in the urban areas. Also there is wastage of water due to human negligence, fault in the pipe, bursting in the pipe, or illegal connections. These problems can be eliminated by using an advanced system like PLC and SCADA. This will not only supply the water effectively but also protect the leakage as well [1]-[2].

II. REVIEW OF CURRENT TECHNOLOGIES

The current technologies which has been used till now

- Wireless Sensor Networks (WSN) Layer:

The WSN consist of number of sensors. RFID readers, cameras M2M terminals and the data may be collected by any device from the environment. RFID is most used WSN node, which consist of one reader and several tags, the tags are used to identify the objects by a unique Identifier which helps these objects to get integrated with the internet.

- The Internet of Things (IoT) :

IoT is a noble concept that is rapidly evolved in the last few years. IoT refers to the world wide networks of interconnected object addressed uniquely based on standard communication protocol. Objects included in IoT are not only sophisticated device or electronic such as mobile phones, but they also comprise of object such as clothing, paper, book, etc. These objects working as sensors or actuators are able to communicate with each other in order to reach a common goal.

IoT is the environment to implement all smart sensor technologies. It is assume to be a midpoint between WSN and cloud computing.

- Cloud Computing :

Cloud Computing is the delivery of on demand computing resources from the application to the data center over the internet. The application layer in IoT needs storage surface to backup the data in data base to provide the analytical service to evaluate the received data . Cloud Computing provides the important services such as storage and data analytic tools [3]-[4].

III. METHODOLOGY

The SCADA system has one or many PC main-station(s) that controls one or more PLC's implemented into the pumping stations or located in control panels. The block diagram of the water distribution system is shown in figure 1.
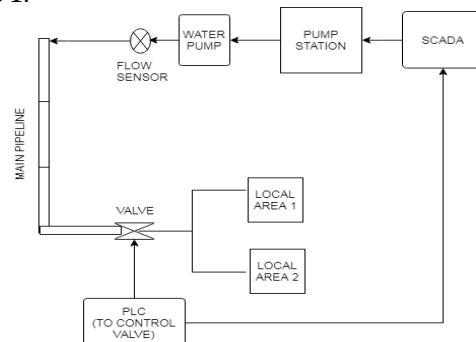

Fig.1 Water Distribution System

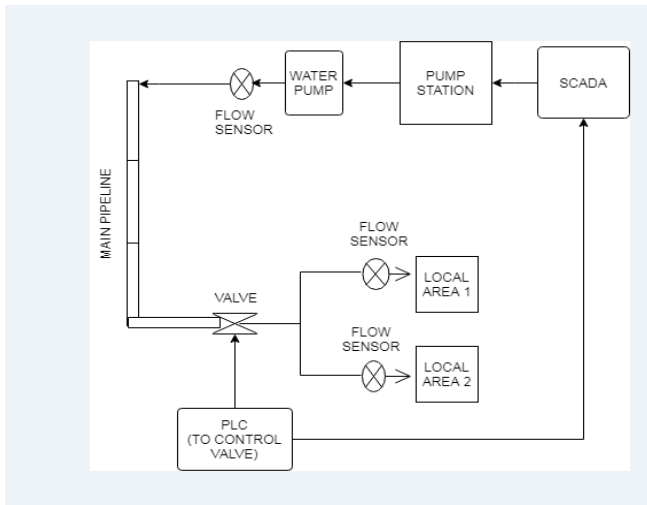The block diagram of leakage identification system is shown in figure 2

Fig.2 Leakage Identification system

The PLC(s) controls the technical process directly whereas the CDU user interface HMI, the modification of the data is done by the central PC, Fig. 3.Implementation of an intelligent control system. This supports effective functionality and the reduction in the cost is achieved by effective system and also reduces water loss. The online supervision of the water distribution system is realized by the central PC as well as the remote control of the actuators installed into the most important points of the system. As per the need of flow in the water distribution system the pressure and sensors are used at the station or measuring points throughout the network. These devices are connected to the RTU which helps in transmitting the data to the central PC or station to monitor the system at real time basis. The RTU provides the acquired data from the sensors by the help of modules, and also ensures that the primary signal and wireless data communication is attached to the dispatching unit.
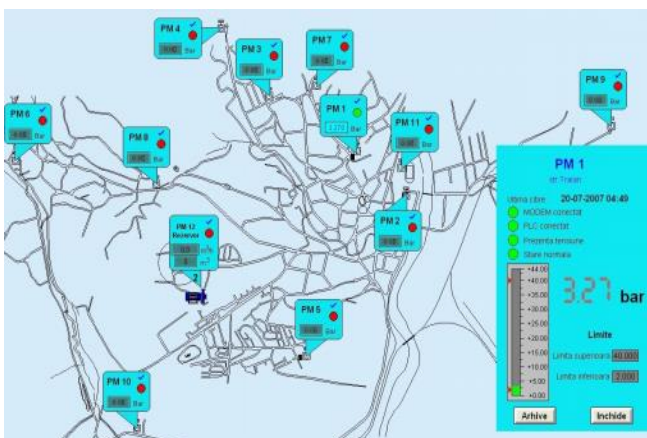

Fig. 3 Dispatching unit main user interface

The SCADA system connected to the dispatching unit helps in managing the communication of data with RTUs and PLCs and it also stores the received data from the measuring point and from the pumping stations and helps the operator to perform the advance functions such as controlling the flow, etc. Fig. 4
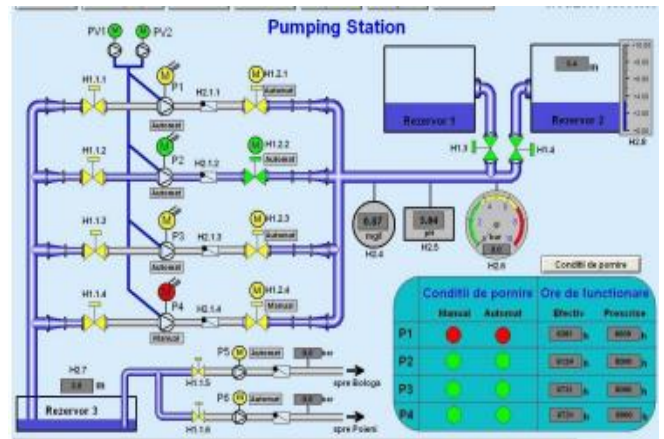

Fig..4 Technological parameters of the pumping station

The data collected from the remote localities or site from the pumping station and the reservoir through the PLC are transmitted to the dispatching unit computer installed at the specific location. SCADA application program designed especially for the water management is been combined by the computer software system. In order to supervise the pressure at some point and to monitor the correct functioning of the system , the program emulates the operator console HMI and the technological user interfaces "Fig. 5".
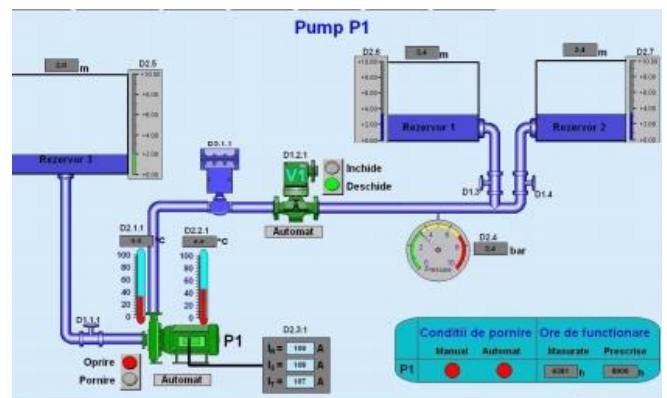

Fig.5 Remote control of the pumping station and storage reservoirs GUI

Related to the operator requested parameters, the dispatching unit SCADA system elaborates daily, monthly, yearly diagrams, tables and reports. For future reference the software stores the obtained data and saves it in specific database. The SCADA is protected from the false use by three level of security in order to help the operator to protect the system from wrong access.

- Low level involves no ID code – The operator is authorized to read or print data reports and select the actual user interface, using the menu driven selection.

- Authorization similar to the lowest level but in addition offer the access to proceed the alarm/events acknowledgement, to elaborate the on/off command for the pumping units, open/close for the electric operated valves, selection of functional regime automatic/manual, remote set up of controller set-points and PID parameters and modification of the technological parameters limits,

The on line support for the management of the process events, generates alarms, triggers the signals status change, support the operator maneuvers, elaborates the time controlled procedures is being offered by the SCADA system, Fig.6. It is possible to define and select the class events to be recorded or retrieved.
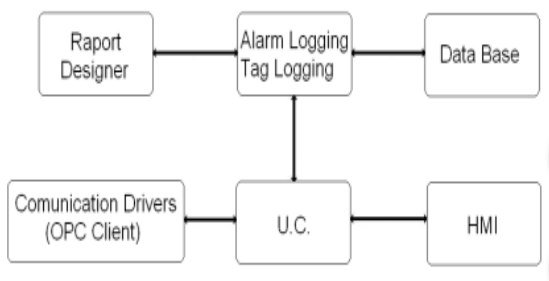

Fig.6 SCADA system application software structure

The event shown above are the graphical symbols on user interface announce by the changes on the process images that a certain functional condition is fulfilled.

Within programmable time the alarms are remembered in the SCADA dispatching system and stored in FIFO stack arranged according to priority and occurring time of event. It is possible to utilize the alarm list either individually or in group. The already used alarms are eliminated from the alarm line and are forwarded to the alarm list. The alarms are maintained active on the alarm list until they are fixed. Alarms are displayed in the graphical process image by their color change with an alarm identification attachment as a text message. The alarm list is updated dynamically. It is possible to assign or change the alarm priorities to all the selected alarms according to the supervision schedule. The alarm list for display or print follows the sorting criteria imposed by the operator. The operator may change alarm settings for parameter limits under normal operation. All the acknowledged alarms are recorded in the SCADA database accompanied by the time stamp and the operator name. The transitory alarms must also be acknowledged. The SCADA system process the information regarding the operation status of all electrical engines, pumps and electric actuators; valves, the selected functioning regime; the actual position of all remote operated valves and equipment; the operation time and number of starts for all electrical drives. Actual operation status report is online updated in a graphical process user interface on the dispatching console including operation status.

As digital values in field areas coordinated with the process symbol images and their associated graphical curves, analogue measurements and calculations are displayed the operator can display the dynamic curves (trend diagrams) or retrieve the recorded data and display them as historical curves. The dispatching unit operator may print out the curves or tables on the graphic printer.

The analogue parameter configuration programming interface includes extended features for additional limit, for alarms definition related to out of the range upper and lower level limits, local controllers PID parameters and process set points.

The process technological parameters, analogue data acquisition measurements, digital input/output monitored signals and the results of mathematical/algorithm equations are recorded in a SQL database. The data can be exported to different software platforms, enabling the possibility of carrying out future mathematical and statistical computation of both automatically and manual acquired data [5]-[6].

IV. RESULT
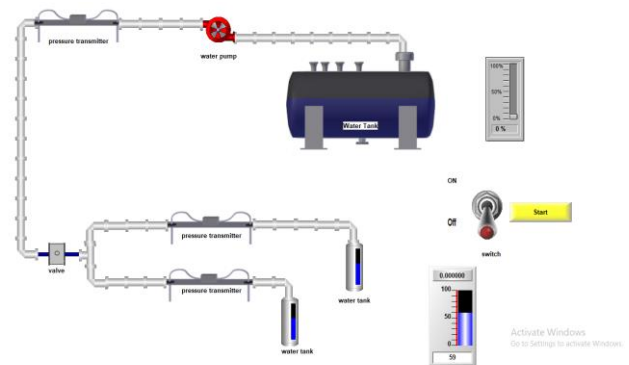
The proposed architechure for water management system is monitored and controlled by the SCADA. The water supply can be turned ON or OFF depending on the needs and user demand. Also depending on the reference pressure if the pressure of the pipe goes beyond specified tolerence level then the system will give an alarm about the leakage in the pipeline. Depending on the situation (leakage) the SCADA will turn OFF the supply and hence leakage can be reduced.

V. CONCLUSION

The proposed software model for SCADA is as follows:

The overall supervision and efficient monitoring of the equipment and the management of water flow according to

the user demand, the available volume of water in the reservoir based on the capacity. Measuring the data provided by the SCADA and then managing accordingly.

Monitoring the pressure using the pressure sensor and correlating it with the expected pressure. Monitoring the leakage in the pipelines by observing the pressure which is expected at the output. The real time operator alarm information triggered by any equipment failure in the distribution system, Optimization of the maintenance cost and reduction of the human involvement. Complete analysis of the data and online computing and monitoring of the system.

VI. REFERENCES

[1] G. Badea, "Instalatii sanitare", Editura RISOPRINT, Cluj Napoca, 2005

[2] G. Badea, "Instalatii de alimentare cu apa, canalizare, sanitare si de gaze", Litografia Universitatii Tehnice, Cluj Napoca, 1982,

[3] Westermo Handbook 5.0, "Industrial Data Communication; Industrial Ethernet", 2007,

[4] Yadav, A. B., & Shukla, P. S. (2011). Augmentation to water supply scheme using PLC & SCADA. 2011

[5] Sithole, B., Rimer, S., Ouahada, K., Mikeka, C., & Pinifolo, J. (2016). Smart water leakage detection and metering device. 2016 IST-Africa Week Conference.

[6] Ntambi, F., Kruger, C. P., Silva, B. J., & Hancke, G. P. (2015). Design of a water management system. AFRICON 2015.