Water Pumping Stations Remote Control System in Depression Areas Based GSM - 900 Cellular Communications System

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Abstract - **The article presents a remote control system for water pumping stations effected by means of a GSM cellular communications system. It displays a possibility of making use of a visualisation system in order to run research experiments. Characteristics of research at hand and issues to be solved have been outlined.**

Keywords - **automation, research experiment, melioration pumping station, GSM communications system, (depression-based) natural environment**

I. Introduction

Areas lying in the delta of the Vistula river as it enters the Baltic Sea are depression regions (Fig.1). Their agricultural and practical usage is extensively combined with proper operation of melioration systems, the main part of which are pumping stations. Water pumping companies in this area have to tackle growing operational costs. In particular it pertains to energy costs and on-going technical monitoring of the processes.

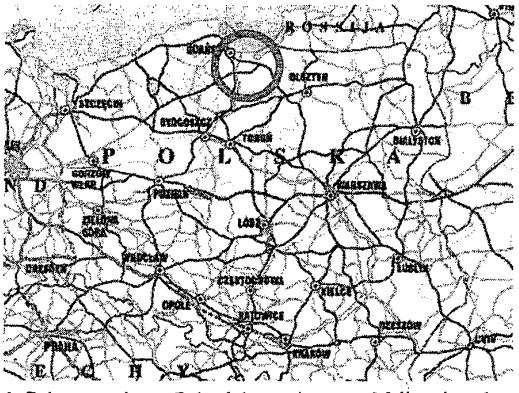

Fig.1. Zulawy – primary Poland depression area. Melioration plants in circle.

In order to try to solve the existing problems, the Electrotechnical Institute in Gdansk has implemented a monitoring system for pumping station operations, which rationalises the technical supervision and plays an important role in the anti-flood prevention system in the Zulawy area. Our experience helped to put together a new solution, which apart from the monitoring feature for water pumping stations enables to remotely control their operations. New system characteristics, apart from enhancing on-going supervision, help facilitate research experiments of identifying pumping station parameters for various operational conditions. A sample measurement object is energy consumption of a station understood as the volume of pumped water to active energy taken. The general structure of the pumping station remote control system is presented in Fig. 2. The system is made up of pumping stations equipped with programmable drivers (PLC), measurement converters and communications facilities (GSM).

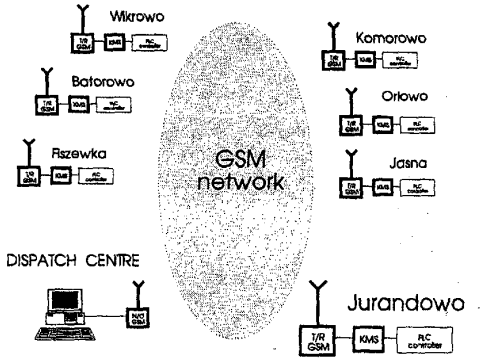

Fig.2. Data transmission system chart with names of pumping stations.

The system is run from the Dispatch Centre (CD) equipped with a stationary PC and a GSM client. Communication with individual parts of the system is based on data transmission (9600 bps), while data flow control is effected by means of software installed on a central computer and transmission modules (KMS) located in pumping stations.

II. Pumping Station

The source of data in the system are the automated pumping stations. Fig.3 shows a block diagram of a typical melioration unit. Its primary constituents are: an active power converter (4) installed at the input of frequency converter (1), a PLC driver (2), water level converters H_g (8) and H_d (9), a KMS parallel bus concentrator and a send/receive GSM terminal (5).

The pumping station driver collects data on water levels every 15 minutes, data on momentary power, energy consumption, operational time and other data to keep track of the unit progress. Apart from the functionality related to processing and acquisition of measurement data, the PLC driver provides a local control function for pump drives and auxiliary systems. Thanks to that and combining the frequency converter it is possible to flexibly regulate the pump performance levels. The PLC processes data to a format required by the superior information flow management system. The KMS coupling device helps to agree communications protocols between the driver and the superior dispatch centre. In the above example, the M1 or M20T modules of Siemens serve the purpose of a send/receive terminal.

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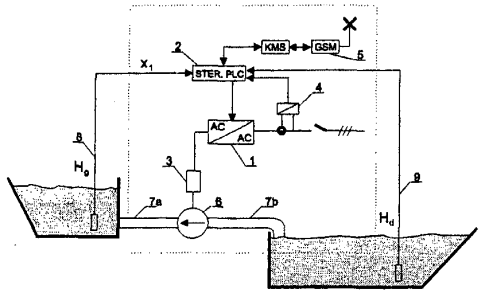

Fig.3. A measurement unit of a melioration plant at hand: 1-frequency converter, 2-programmable driver, 3-asynchroneous engine, 4-active power measurement converter, 5- GSM module, 6-pump, 7a-pressure pipe, 7b-suction pipe, 8 and 9-pressure converters.

III. Dispatch Centre

The dispatch centre is built around a PC connected to a GSM communications module. It operates on MS Windows-based software. In order to graphically depict the processes carried out in the pumping station a visualisation application based on Wonderware InTouch 7.0 software and DDE MODBUS Scada communications server were used.

The software features a set of maps and geological sections depicting the closest surroundings of the pumping station in the vicinity of Zulawy Elblaskie (to the east from the delta of the Vistula river) as well as a set of graphic objects outlining the basic constituent parts of the pumping station. The aim of the visualisation is to depict the on-going status of the pumping station that is water levels in melioration canals, number and speed of pumping engines and their time of operation.

In the WIZULA 6ex software, the operator running a remote research experiment in the Jurandowo pumping station is in position to monitor energy consumption, pump operations time, changes to water levels during pumping. The remote control of pumping station operations is effected via assignment of new parameters to maintain water levels in the inlet canal as well as via assignment performance values and effective pump operations time.

The screenshot in Fig. 4 displays control elements in the station accessible to the operator running a research experiment or monitoring the station operations. The buttons and text windows enable making flexible changes to the parameters. The graphic layout pertains to the actual technical pulpit in the station. Such an approach to data presentation helps the operator control the system from the Dispatch Centre.

Operators in the dispatch centre have an option of presenting the outcome in form of charts and tables both for the current data and database archives. Switching between software windows is effected by means of buttons placed on the right hand-side of the screen. Fig.5 shows a sample chart of water level runs in canals of the Jurandowo pumping station. The data collection period is 16th Nov 2001 to 22nd Nov 2001 and water levels are given in cms. The table to the right of the picture shows sample data registered every hour on 21st Nov 2001.

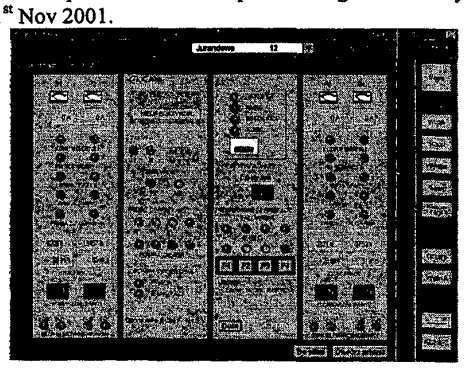

Fig. 4. Screenshot of operator pulpit in the dispatch centre (for the JURANDOWO pumping station)

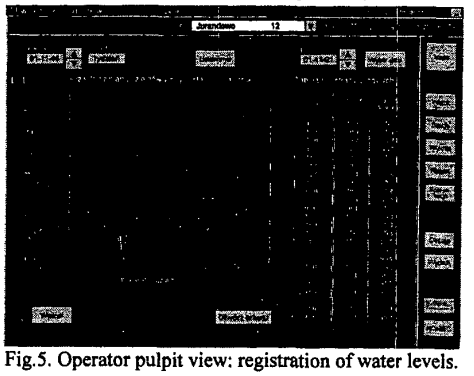

Fig.5. Operator pulpit view: registration of water levels.

An important characteristics of the system is the possibility of monitoring the data send and receive process. Fig. 6 shows a communications control screenshot. An update of the information available in the graphic screens requires the transmission to be initiated. Thanks to that window, the dispatcher can start up the communications with a chosen unit, monitor the transmission and specify data storage location on the hard disc. The operator can also access the parameters defining the quality of the transaction and status of blocks the system is made up of.

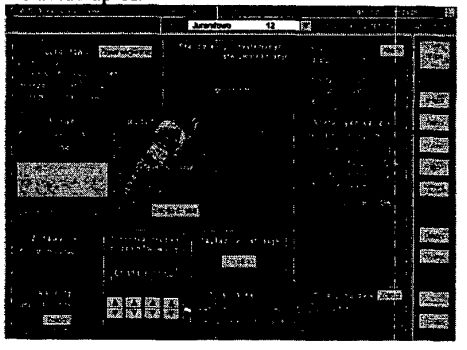

Fig. 6. Screenshot of data and archives transmission control

IV. CONCLUSIONS

The commercial GSM cellular communications system can be applied well to design wide remote control systems. With help of the above described system, it was possible to run an experiment in a scarcely accessible and remote melioration unit. As a result of remote assignment of parameters and unit monitoring, it was possible to register data otherwise usually difficult to obtain. The GSM-based remote control system can also be applied in on-going operations of pumping stations while at the same time reducing the operational costs of these facilities.

The application of the GSM technology to remote control requires fault-efficient connections. In a lot of cases one has to take into account the fact that the equipment is going to operate in an insufficient electromagnetic field. Additionally, the construction of melioration plants most often makes it impossible to apply antennae of a larger field. In order to enhance the quality of connections one would have to examine the impact on the change of propagation conditions on the water levels in such locations as Zalew Wislany and the Druzno Lake. The dynamics of these changes are high, which can affect the quality of radio connections. Similarly, the impact of frequent fogs and rains in this area needs to be accounted for. It seems worthwhile to carry out comparative testing of quality of connections for the available data transmission services (including the GPRS batch transmission). The results of these tests will be very useful at the stage of designing and assembling telemetric devices to measure water and rainfall levels.

ACKNOWLEDGEMENTS

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