Canal Water Management Through Computerised Supervisory Control and Data Acquisition System

Dr B Kumar, *Fellow*

R M Patnaik, *Fellow*

R Kumar, *Member*

To and fro movement of information of water availability condition of canal and demand in time from top to bottom and vice versa can save every precious drop of water from being unutilised. This timely and efficient management of canal operation by top and low levels of authority through supervisory control and data acquisition system (SCADA) becomes easy and within control if the system is blended with information technology. This paper presents a supervisor's view for sustainable management of canal water.

Keywords : Canal; Supervisory control and data acquisition system (SCADA); Remote terminal unit (RTU)

INTRODUCTION

Need of Irrigation

Starting from irrigation by flooding in the Indus valley civilisation to irrigation by canal systems in the Mauryan period and commercialization of irrigation water in the British regime the importance of irrigation in the present days has grown tremendously. The importance of irrigation has increased due to the necessity to feed every person of the world through the available culturable land. Thus agriculture cannot move a pace without the help of irrigation.

Objectives of Irrigation Projects

The main objective of any irrigation system is to deliver water at the scheduled place at the scheduled time. Hence, crop system is necessary for scheduling of demand. When the scheduling has been fixed, the next objective is the operation of the delivery system with minimum loss. To meet these objectives vast employment is generated through the government as well as farmers and NGOs.

EXISTING SYSTEM OF CANAL OPERATION

Operational concepts and operational methods are two different things. The first deals with the location of the priorities on which the control structure is to be based. It controls the water depth, discharge, volume, level, demand etc. The second one, *ie*, operational method is a combination of methods for greater compatibility of the canal operation.

Techniques Involved in Operation

The following operational methods may be employed in the canal system:-

1. Constant downstream depth	The pivot point is located at the downstream end of the canal pool
2. Constant upstream depth	The pivot point is located at the upstream end of the canal pool
3. Constant volume	The pivot point is located near the midpoint of the canal pool.
4. Controlled volume	The pivot point can move within the canal pool.

NECESSITY OF CANAL OPERATION

The term control in the context of canal operation means to create and achieve the required hydraulic results within the canal territory. It involves persons, equipments and structures to follow a unified system. Local manual control and local automatic control uses more human power but loses control when the flow of information is blocked due to various reasons and the decision making body delays the supply of water at opportune time as well as at appropriate place. Naturally the ultimate users are at loss. Therefore, a central location or control centre or master station is needed for monitoring and control and also for delivery of decisions in conjunction with the necessity of the users. It is here that the role of supervisory control and data acquisition system (SCADA) for optimization of water resources plays an important role.

SCADA becomes more useful when it is linked with the computer system.

Duty Performance

The basic duties to be performed are as follow:-

(i) Types of crops and their water requirement of different fields within the canal command.

(ii) Water levels and discharge position of headwork main canal, branch canal and distributaries.

(iii) Gate positions

(iv) Flow and pump status

(v) Collection of data of each station and its transfer to master station

(vi) Storage/Retrieval/Analysis and decision making at master station

(vii) Transfer of decisions from master station to substations and remote stations

(viii) Implementation status to master station

Dr B Kumar is with Regional Institute of Technology, Jamshedpur ; R M Patnaik is with Gridco, Bhubaneswar 751 022 and R Kumar is with Central Design Organisation, Water Resources Department, Patna.

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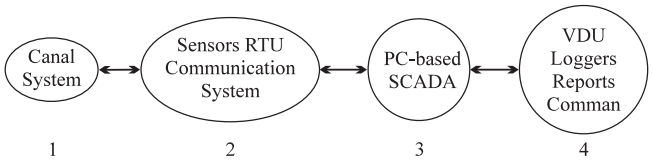
SYSTEM CONFIGURATION

The computer based SCADA system requires four major subsystems:-

1. Data Acquisition Subsystem
2. Data Processing Subsystem
3. Software Subsystem
4. Man-Machine Interface Subsystem



The supervisory control method requires equipment for data collection, communication/transfer and control/analysis/ management. Each remote site requires a remote terminal unit (RTU). The RTU collects data, communicates with control centre and controls the remote site leased on the information received from the control centre. A communication system is required between each RTU and control centre, to allow two-way communication and for monitoring and control. In addition to communication equipment, the control centre will need equipment for monitoring, computing and controlling.

Data Acquisition Subsystem

Sensors are employed at various canal sites to measure water levels, flow characteristics and gate positions. There are different types of sensors, but depending on the volume and type of data the best-suited one is selected. The selected sensors should be compatible to software and computer of the system. Different types of sensors consist of water level sensors, floats, bubblers, ultrasonic sensors, pressure sensors, flow rate sensors, ultrasonic flow meters, flumes and weirs control gate openings etc. Data collected are transmitted to canal control centre through communication link.

The Communication System may be:

(i) Single Channel VHF Radio

(ii) Single Channel UHF Radio

(iii) Metallic Cable (4 to 100 pair)

(iv) Fiber optic Cable (2 to 8 pair)

The selection of communication link depends on (a) Location of the control centre, (b) number of remote terminal units, (c) number of data points at each RTU, (d) data acquisition scan time and data update rate, (e) control output requirements of each RTU, (f) reliability requirements of water system, (g) communication channel configuration, and (g) the cost of communication system.

Data Processing Subsystem

The data processing at the canal control centre requires four Pentium IV Computers. The incoming data are received by two PCs from the RTUs via data concentrator telemetry interface unit. A watchdog monitors the status of each computer and controls the changeover switch between the two PCs. If one PC fails to operate, another one automatically takes over. One Pentium IV is used as a server and another one as a stand-by. The stand-by computer can be used as off-time simulator and analyser.

Table 1 Functional requirements at different centres

CCC	SCC	RTU
Off-take Data Bank	Off-take Bank	Farmers Data Bank
Water requirement at each opening/gate	Water requirement at each opening/gate	Water Account of each farm
Water Account of each main/branch/ distributary system	Water account of each off-take/distributary canal	Rotational water delivery schedule
Macro scheduling of water	Macro scheduling of water	Agro-meteorological Data Bank
Gate Operation Data	Gate Operation	Micro scheduling of each village/season
Billing		Water level/Gate Position/Discharge/ Flow
		Billing

Software Subsystem

The requirements of software at different control centres such as canal control centre (CCC), sub control centre (SCC), and remote terminal unit (RTU) vary and hence the selection depends upon the functions at these sites (Table 1).

Man-Machine Interface Subsystem

One of the most important tasks of the canal control centre is the clear and comprehensible display of the canal process parameters. This is provided with a man-machine interface consisting of

(i) Canal process single line diagrams

(ii) Tabular data display

(iii) Graphs

(iv) Bar charts

(v) Data entry forms

(vi) Billing

CONCLUSION

The adoption of SCADA system is no doubt a costly one but the continuous saving of manpower, establishment cost and minimisation of named misuse will be advantageous for the government and ultimately the beneficiaries, *ie*, the farmers. Mere prophesing that water is an economic source will not help, rather steps to exhibit it, as an economic source is necessary. The equality and equity in water distribution is sure to be achieved by the SCADA system.

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