REAL-TIME HYDROMETEOROLOGICAL NETWORK WITH TELEMETRY SYSTEM FOR RIVER KOLAB

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ABSTRACT

Real-time Hydrometeorological Network with Telemetry System (HMNTS) is a vital system for water management in river catchment areas. A complete hydrometeorological network with appropriate hardware for remote stations, telemetry link, master control centre and software for water management and database management are essential for effective upstream water management. It is used for flood-forecasting, reservoir regulation and other upstream water management applications. This chapter describes such a hydrometeorological network designed by HACE Ltd. New Delhi to be installed in the Kolab catchment area in Koraput district of Orissa.

The Kolab river basin drains a substantial portion of the southern interior of Orissa. It is a vital part of the Orissa agricultural system. Intelligent management of the Kolab Basin requires accurate current knowledge of flows in the river and the ability to forecast future flows. Such management requires a modern real-time hydromet data collection system coupled to state-of-the-art system models.

1. INTRODUCTION

A Real-time hydrometeorological network consists of:

1. Hydrometeorological equipment with sensors
2. Real-time hydrometeorological data acquisition and satcom transmitting system
3. Remote station computer terminal with keyboard and printer
4. Satcom communication central station equipment with front-end computer

5. Master computer system
6. Software supports for database management system and water management system
7. Standby equipment, special tools, accessories and spares.

The system can be broadly classified into two parts namely:

a) Remote Stations (Field Stations)

b) Master Control Centre Equipment

2. SYSTEM DESCRIPTION

2.1 Remote Stations

The real-time hydrometeorological network system has various types of remote stations. These include:

1. Meteorological Stations: (MS)–for meteorological and hydrological parameters.
2. Hydrological Observation Stations: (HS)–primarily for hydrological parameters.
3. Project Stations: (PS)–for meteorological and hydrological parameters with nodal telemetry stations and local data processing.

The network comprises of a combination of MS, HS and PS stations depending on the river characteristics and user requirements.

A typical remote station consists of:

* Basic station hardware, including them mast, housing and all mounting hardware
* Sensors depending on remote station type.
* Data acquisition module with computing unit, communication controller and power supply.

The basic station hardware is designed to meet all the stringent requirements of this application. The tower is made from corrosion resistant materials and is configured normally in three sizes, viz 10, 20 and 30 metres. The housing is made to NEMA–4 standards and has adequate capacity to house the data logger, computing unit, power supply and the batteries.

The sensors used are all mil-grade, designed to work continuosly in a harsh environment. The primary sensors used in the system are water-level and rainfall, while the secondary sensors used are wind speed, wind direction, temperature, relative humidity, solar radiation, evaporation etc. These sensors, which have been designed and manufactured in-house use state-of-the-art techniques. Details of individual sensors can be obtained from the author.

The data acquisition module consists of a data logger with a computing unit, a communication controller and a power supply built in a NEMA-enclosure. The data logger is specifically designed to handle hydromet data from primary and secondary sensors. The computing unit manipulates the observed data and forms derivatives if any. It then generates a DCP-message ready for transmission over the telemetry link. The data acquisition module also has a communication controller, interface and the transreceiver for the telemetry system. The choice of telemetry depends on the user, the site of installation and topography etc. For Kolab, VHF radio is chosen as the best option. A power supply unit consisting of a solar module with a charger and battery is also included. All this is housed in a NEMA–4 enclosure and mounted on the base of the tower in the remote station.

2.2 Master Control Centre

There are 13 general requirements which must be met by the computer system at the Master Control Centre (MCC). These requirements range from data acquisition to statistical calculations and flow modelling.

a) Data Acquisition

The ultimate system can handle up to 250 remote stations. The data acquisition is done by a purpose-built data-logger. It is connected to a dual-processor minicomputer. The computer is equipped with the UNIX operating system and HACE's DMS hydromet database management system.

b) Primary and Secondary Data Processing

The DMS database management system is integrated with the communications system. DMS is specifically designed to process real-time hydromet data and can handle all of the primary and secondary processing requirements.

c) Location Specific Information

The DMC stores all required information for a real-time hydromet system in easily accessible form. A system master configuration utility keeps general information such as site names, processing control and quality limits. A rating table secondary database is an integral part of the system. Users can define additional secondary databases and couple them to the main system. The secondary databases can be used for such items as cross section information and other model-related data.

d) Model Calibration

The system hydrologists will calibrate rainfall and runoff as well as flow models. The proposed system will make use of modes developed in-house for the purpose.

e) Periodic Reports and Flow Model Input

The DMC database software allows the user to develop custom menus which allow specific users to generate reports of interest. The UNIX operating system allows easy setup of batch jobs which run on a schedule to prepare input time series for model runs.

f) Model Files

All rainfall/runoff and flow models depend on time-series input files. These files are normally required to be composed of synoptic data values at uniform time intervals.

g) Prime Series and Statistical Models

Long-term statistics are vital for systems management and future planning. The DMS system supports automatic archiving of statistics on a daily basis. A scheduled process reads the entire contents of the daily files once per day and can perform user-programmable statistical analysis using such functions as *MEAN, MINIMUM, MAXIMUM, DAILY CHANGE* and others. One or more statistics on any parameter can be stored in the yearly ARCHIVE database. The contents of both ARCHIVES and the daily files are available for the input to statistical models.

h) Benefit Sharing and Accounting

The data systems frequently provide information to large numbers of

groups of users who depend on the information for resource sharing. The system can easily be set up to allow limited-access dial-in for users who wish to see specific portions of the data. The built-in user-definable menu system allows each user to see as much or as little of the system as he needs.

i) Physical Process Models

As indicated earlier, the proposed system will be equipped with the rainfall/runoff model, backwater calculations, reservoir operations models, and dynamic unsteady flow models.

j) Electronic Mail

Electronic mail is an integral part of the system. Any user with a valid account and password can send and receive mail messages.

k) Public Data Network

The master computer which will be provided, is equipped with a large number of spare serial ports and a built-in 2-line synchronous I/O interface. The additional serial ports can be configured for dial-in access. The synchronous interface can be used to tie the system to a packet switching network for wide area access to the data.

l) Simulation Models and Graphical Presentations

The DMS database system has built-in graphics in the interactive programs. Users can log on any of the high-resolution colour graphics terminals being provided and quickly view current data historical data or model input/output.

m) One Year of On-Line Data

As indicated earlier in this section, there is no built-in limit to the number of daily files which can be kept on line. A housekeeping procedure limits the number of files according to a user-suitable parameter. One year of on-line data is easily within the capacity of the disks proposed with the system.

2.3 Communication System

The communication system should perform four major functions:

i) Data transfer from remote stations to MCC
ii) Message transfer to and from PS and HS stations and MCC

iii) Transfer of interrogation commands from MCC to remote stations and transfe of remote station data in response to MCC

iv) E-Mail between RS to RS through MCC

The communication system includes a network of rugged terminals linked to MCC through a radio segment. Storage and display of data and related functions are achieved by the front-end computer.

2.4 Main Computer System Hardware Requirements and Specifications

The system is to be composed of:

- CPU
- Disk drives
- Cartridge tape drive
- Floppy disk drives
- Magnetic tape drive
- Communication line support
- System terminals
- Printer
- Digitizer
- Plotter

Central Processing Units

The minimum specifications for the CPU system are:

- 32-bit word length
- Support for hardware floating point calculations
- Error checking and correction for main memory
- Two CPUs in parallel, each of which have:
  - 8 or more MB of memory
  - 10 mips processing power
  - Cache memory of 32k or greater

Disk Drives

The system requires the following disk drives:

- At least one year of data on line
- Two units of equal capacity
- I Gb minimum capacity each drive
- Two spindles and two controllers

Communication Line Support

The specifications for the asynchronous lines are:

- Adequate number to support the peripherals and communications with the telemetry, and
- 50 percent redundancy for growth.

The specifications for the synchronous lines are:

- Adequate provision of synchronous lines for connecting the system to other computer systems, and
- At least one port to support CCITT (1984) recommendations X.25, X.3, X.28, X.29 and X.121.

2.5 Software Support for Data Base Management System and Water Management System

The objective of the Kolab project is management of the river basin for effective use of water resources. In order to meet the objective the communications system must be interfaced to a database management system and subsequently to hydrologic models. The hydrologic models will provide the necessary information for management decision making.

The database management system must be capable of processing the incoming information from the communication network in real time. This real-time processing includes quality control, conversion of data to user units, conversion of river stage to discharge, and update of input to the water management system.

The water management system must be capable of representing the

complete hydrology of the Kolab Basin. A coupled network of rainfall/ runoff, streamflow and reservoir routing models must be constructed. The model network must be stable, accurate, and easy to manage so that the best possible decisions on use of water are made.

In addition to real-time data management and modelling requirements it is necessary to deal with general hydrometeorological and management information. The system must be capable of storing long-term statistics and also be capable of handling information on users, water requirements, regulations, and all other aspects of water management and policy.

3. CONCLUSIONS

Real-time hydrometeorological network with telemetry system (HMNTS) use state-of-the-art techniques in sensor and data acquisition, communication and computers technology and software applications. These systems, require large capital outlay. Application of these requires adequate training. Nevertheless, they are extremely useful for optimum and efficient use of water resources, and can help save invaluable life and property.

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