INSTRUMENTATION FOR HYDROLOGICAL INVESTIGATIONS SCOPE, PROBLEMS AND DEVELOPMENT

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ABSTRACT

Preservation and sustainable exploitation of water are the prime concern of every country and especially ours since we suffer from frequent droughts as well as floods. Every activity leading to sustainable exploitation of water and other natural resources warrants monitoring of the resources alongwith the associated environment. Instrumentation is the essential and direct step towards the systematic evaluation of the environment including resources.

INTERDISCIPLINARY NATURE

The instruments required for hydrological measurements in an open environment with applications in agriculture, irrigation etc., are highly interdisciplinary in nature, involving different aspects of physics namely hydraulics, mechanics, electro-optics, hydrodynamics, electro-chemistry etc., in addition to electronics and instrumentation. This nature of the subject poses problems to scientists as well as manufacturers. The successful development of the system needs the support and expertise of different disciplines. In the absence of such multidisciplinary expertise, the designers concentrate on selected aspects only and leave the system incomplete. The multidisciplinary aspect mostly appears in the design of sensors rather than in electronics.

Field Operated Applications

The hydrological instruments are to be operated mostly at remote sites and therefore they have to be designed with features and facilities suiting site conditions. Some of the features are: rugged designs of the sensors to withstand rough handling and rendering easy instal-

lation, sensors suitable for withstanding all types of water including growth of biological organisms in coastal zones, low power requirements, high portability, and easy operation by unskilled persons. Some of the important field operated applications are:

1. Water discharge through canals/rivers.
2. Water discharge through pipe lines.
3. Water level variations in rivers, estuaries, and reservoirs.
4. Tide variation along the coast and open sea.
5. Wave profile along the coast and open sea.
6. Soil moisture measurements at different depths and locations.
7. Water current measurements in rivers and canals.
8. Water current and direction measurements in oceans.
9. Sediment transportation and sediment analysis.
10. Infiltration and water conservation properties of soils.

SENSORS FORM THE MOST IMPORTANT PART

Electronic instruments applicaBLE FOR ENVIRONMENTAL SCIENCES in general have three essential parts, namely (1) sensor, (2) electronics for signal conditioning and signal processing, and (3) data display. Of these different aspects, the sensor is the most important one as it picks up the basic information and is exposed to all the hostile environments of temperature, pressure, humidity, hydrodynamic forces, silt etc. The total reliability of the system is decided by the sensor and the addition of sophisticated parts namely microprocessors or computers etc., does not help to improve the quality of the data, though they help to improve other functional features and data processing.

STANDARDISATION OF INSTRUMENTS

Standardisation is required to ensure proper procedures and quality of data gathered. The standardisation can be done in two different aspects, namely (1) ensure procedures and quality of a particular design of instrument, or (2) fixing the essential requirements to achieve the final performance and accuracy of data. Most of our standards applicable to hydrological instruments are based on the former aspect, where

a particular design or product is kept as the standard. Newer or better techniques cannot be accommodated in this case. Following this standard is relevant only when that particular design of the equipment is produced. In the latter case, any technique could be accommodated, provided it follows certain essential requirements. Adoption of case (2) is needed to accommodate improvements and new developments. In fact, such standards are not followed in the case of imported equipment, as they work on different principles and designs.

DATA STORAGE AND TRANSMISSION SYSTEMS

These aspects are very important for hydrological instruments as they are mostly operated at remote sites and the data acquired has to be stored in suitable devices or transmitted to a central place. Many of the conventional devices namely recorder, printer, cassette data logger etc., are too delicate for a hostile environment and also they consume much power which is difficult to be provided at such places. The latest in this series is the solid state memory module which involves microprocessor controls, stores the data after conversion to the digital form. These devices using VLSI technology are now available with extremely low power requirements and hence can be attached with instruments at remote sites for continuous operation for a few months. The data stored are retrieved through computers. The memory module designed by CIFT, Kochi has flexible facilities in order to acquire data from instruments of single or several channels, thus avoiding the need for dedicated types.

The data transmission is done normally in VHF, and HF bands directly to the receiving stations. A larger network namely ARGOS has been introduced as common facilities for global data communication using satellites. There are interface cards available in the market to transfer data from instruments directly to IBM compatible computers utilising the facilities of computers for storage as well as processing and later printing with real time.

DATA ACQUISITION SYSTEMS AND INTEGRATED MEASUREMENTS

Many of the hydrological investigations need integrated measurements for better analysis of the complex environment taking into account

maximum parameters which are directly and indirectly related. They have become important these days with increased efforts for evaluation of the impact of water related and other developmental projects on the environment. Data has to be acquired from larger areas in most cases, either using sensors capable of sensing the signals from distances using long cables or with wireless transmission. Such sensors can simplify the whole process to some extent as they do not need the electronics along with them. As far as hydrological measurements are concerned, conventional data loggers are not suitable as the latter types are compatible with only a few usual sensors. Most of the hydrological parameters need special sensors matching the site and special signal conditioners to them. It is most desireable in this case the designers and manufacturers keep certain standards of uniform output of 0-5 V as far possible so that their insturments can be attached to existing computers, memory modules, data transmission systems etc., using standard interfaces. The data acquisition systems introduced by CIFT for applications in ocean, coastal, agricultural and hydrological applications have followed this standard.

NEWER PRINCIPLES AND TECHNIQUES PROVIDE BETTER TOOLS

The research, survey and investigation methodologies adopted and practiced in different scientific disciplines change from time to time based on the instrumentation facilities available. Many new techniques are being introduced in hydrological survey and investigation practices. Such newer techniques and facilities have to be propagated systematically following procedures involving theoretical discussions, field demonstrations and long term operations, and comparison with other types. Satellite remote sensing techniques introduced recently have played a major role in hydrological survey and analysis of larger areas mostly giving surface details with limited accuracies.

Most of the developments of recent instrumentation are limited to signal processing and system operational control through microprocessors and computers. New principles rarely appear in the design of sensors which sense the basic information and decide the total accuracy. Many of the known principles are also getting improved, incorporating electronic signal conditioning and processing techniques for better performance and operational convenience.

New techniques introduced in sensors or electronics are meant for achieving better accuracy, operational convenience etc. Some of the new cases introduced by CIFT for hydrometeorological applications are:

1. Discharge measurements in canals using flow and discharge monitor employing contactless electro-inductive overflow level sensor.
2. Discharge measurements through large pipe lines using flow and discharge monitor using filting type flow sensor suitable for all types of water.
3. Hydrometeorological data acquisition system of 16 channels suitable for use at remote sites, attached with a memory module.
4. Water level telemeter for use in rivers and reservoirs with pressure sensors of different ranges.
5. Remote operated soil moisture meter capable of making continuous long term measurements from different locations simultaneously.
6. Automatic sedimentation analyser for analysis of sediment samples employing Stroke's Law.
7. Remote sediment monitor for direct measurements from water depths.
8. Thermohygometer with remote operated sensors.
9. Solar radiation monitor and integrator with facility to totalise the incidental radiation.

The Indian Council of Agricultural Research has entrusted CIFT with a project on Development and Applications of Electronics for Agricultural Investigations with the thrust given to irrigation and drainage engineering. As per this new programme, research institutes interested and desirous of using these new instruments developed at the CIFT can get associated with the project. CIFT will supply instruments to them along with training, demonstrations, field operations etc., in order to carry out more effective investigations in hydrology and the related environment.