Advances in Electronics and Measurements for Fishery Industry and Technological Investigations

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Abstract : Fishery technology is a multidisciplinary subject warranting integrated approach for its development coordinating a variety of biological and technological disciplines. The complex and hostile nature of the environment where the fishing technological investigations are carried out further necessitates the evaluation of the operational features of the dynamic systems as well as estimation of the physical, chemical, biological and mateorological values of the sea related to fishery resources. The recent developments in microelectronics and space exploration have made revolutionary changes in acoustic fish detection methods, precise navigation, safety in the sea and satellite remote sensing techniques for fishery forecasting. The efforts made in CIFT show the scope and utility of a series of electronic instruments for monitoring the performance of fishing gears, fishing crafts, water quality and the marine environmental parameters. The instruments developed in CIFT using fully indigenous technology are aimed at to make scientific studies on the multidisciplinary nature of the marine environment in relation to the fishing efforts so as to achieve sustainable exploitation of the resources and self reliance in the technology. The paper gives an account of the recent advancements in electronics along with the specific contributions made indigenously.

Introduction

The instrumentation as applicable to ocean sciences and fisheries started with improvised methods. The methods and practices have undergone many improvements over the years. The developments in semiconductor technology, sensor materials and large scale integration have revolutionised the concepts of data acquisition from marine environment and under water systems. The success in space explorations have further accelerated the progress through remote sensing from larger area of sea surface. CIFT identified the vast scope of electronics in marine investigations and carried out R & D works in certain limited area of fisheries technology. The basic technology developed include more than 3 dozens of sensors, electronics and controls with features and facilities to meet our requirements associated with data acquisition from under water trawl system, marine environment, fish processing factory, etc. Fisheries technology is an interdisciplinary subject requiring the contributions from different basic and applied subjects, belonging to physical, biological and chemical aspects. The type of data required for its development as well as commercial exploitation also is multidisciplinary. The instruments developed in CIFT with indigenous materials and technology can be classified into a few application groups namely fisheries hydrography, coastal engineering & aquaculture, behaviour studies of marine animals, fishing technology and fish processing technology.

Electronic Navigational Systems

The advances in semiconductor technology and large scale integration facilities associated with the success in space explorations resulted in the development of Global Positioning Systems (GPS) useful for all types of navigational requirements in sea, land and space. As the units have become very compact and low cost, it has become handy to fishing vessels with easy operation, not only for reaching to the potential fishing grounds but also to make safe navigation. The DGPS being introduced by Cochin Port is expected to make much more precise navigation with sub metre accuracy useful for survey and related marine construction works.

Satellite Communication Networks

The presence of artificial satellites have revolutionised communication facilities also in addition to their contribution for navigation. Global satellite communication facilities are now available and are being introduced all over the world. The following are some of the systems and the facilities associated with them.

Sat com : means satellite based communication

Standard A : The system where all 4 modes of communications are adopted namely A1, A2, A3 and A4, and applicable to telegraphy, telephony, telex and fax.

Standard B : Same as A with digital transmission.

Standard C : sends telex compulsorily

Standard M : All except fax and up to 9.6 kilo bauds / sec.

Standard P : Being introduced as next model with enhanced facilities.

EGC : Enhanced Group Calling facility - an added facility to communicate with a group of vessels.

Special Safety Systems

Several new radio transmission based safety systems have emerged recently consequent to the revolution in communication electronics for ensuring better safety in sea.

Floating beacons: These small floating units consisting of VHF transmitter and battery, transmits SOS message in the international distress frequency to alert other vessels or other stations on the distress condition. Such floating beacons can be used in sea going vessels or even in country crafts for their safety.

EPIRB: These Emergency Position Indicating Radio Beacons are much more advanced types giving further details of the beacon attached with the boat or ship, namely details of the boat and their location so that the search party can easily locate them.

SART: Search and Rescue Radar Transponder. These devices floating on sea communicate with marine radar equipment attached with fishing vessels, acting themselves as transponders.

SCRB: Selective Calling Ratio Buoys. This system can communicate with selected floating buoys at times of emergency at 28.5 MHz.

PLB : Personal Locator Beacon. This sytem is meant for communication within a ship or its surroundings. The transmitter fitted on crew at works transmits emergency messages which helps to locate and rescue them from the danger in time.

Immersat: This is an international satellite communication net work for facilitating different types of communications with participation of 74 countries. Immersat facilities are being used for all activities including emergency messages, rescue operations, weather forecasting, data transmission from instruments, etc.

Advances in Acoustic Systems

The acoustic fish detection and living resource survey systems have undergone several improvements during the last few years with the introduction of multifrequency transducers coupled with white line, TVG, Image expansion, P.P.I. display, etc. The echo integration facilities associated with computer processing net works have helped to classify the resources for different depths for estimating resource position. The sector scanning techniques using an array of transducers estimate the resources more precisely in large scale survey estimations.

Equipment for Aimed Trawling

Acoustic and other types of instruments and devices are being introduced from time to time for facilitating different fishing techniques particularly for aimed trawling, gill netting etc,. Trawling being the most complex and active fishing activity, detailed studies are needed correlating the functions of craft, gear, the fish resources and the environment. Many electronic instruments have been introduced for systematic studies in this area.

Some of the equipment used in larger trawlers are Net sonde for measuring the position of trawl net with a view to control the net to the depth where fish shoals are detected in fish finder; Trawl monitor/ Trawl eye/Net monitor which give details all around the net using more acoustic transducers directed to different directions; Scanmar system which gives other details including temperature and speed of the systems. The fish Reporting Systems/ Sonobuoy being introduced in some countries transmit information to the receiver stations on the availability of the fish shoals, based on the sound recorded using floating buoys.

Fishery Forecasting

There were several attempts in the past using telemetering buoys to acquire data from potential places in the sea for fishery forecasting based on environmental parameters. But acquiring data from large area had been the major constraints in this direction. The accuracy and reliability of the forecast depend on the simultaneous acquisition of the multi disciplinary data precisely.

Artificial satallites equipped with instruments to monitor earth resources including sea surface temperature (SST) have become useful these days. SST is able to be measured instantly from the satallites and SST being an important parameter, forecasts are being done regularly in many countries including India. These forecasts are expected to make better utility and perfection in the near future with the addition of other related parameters also.

Fascimile Receivers

Information gathered from several potential centres are being transmitted to the receiver in the vessel for making fascimile plots of the weather conditions. These informations are useful as general indication of weather conditions and to some extend for fishery forecasting.

Marine Surveillance

Every maritime state has taken up this on top priority for preventing large scale resource exploitations by mechanised crafts in the coastal waters for protecting the interests of the country crafts. Governments are finding it difficult to implement the policy in the absence of reliable technical measures to detect such crafts as well as decide their operational limits. These surveillance measures are also needed in connection with other activities such as smuggling, illegal immigrants and other criminals. Marine radars can detect the vessels to some extent and aerial photography also can do some help in this direction. Another promising field is infra red photography to locate such vessels in both day time as well as night. Recently a British Company has introduced such an equipment exclusively for this purpose.

Electronics for fishing technological investigations and resource based studies

Electronic instruments can play major role to evaluate the performance of craft, gear and the marine environment and make integrated studies for perfecting the harvesting practices and evolve measures for sustainable exploitation of the fishery resources. Here some of the major activities involved are : (1) performance evaluation of the underwater trawl system by monitoring the important hydrodynamic parameters, (2) performance evaluation of the craft system by monitoring speed of motion, towing resistance (total load), (3) environmental monitoring relevant to performance of gear, craft and the resource potential such as ocean current at different depths, water quality parameters, marine meteorological parameters, etc. Though many firms have introduced relevant instruments, many of these are unsuitable to our conditions and are generally very expensive.

Electronic Instruments Developed in CIFT

CIFT identified the need of electronics for routine fishing operations as well as testing and standardisation of fishing craft and fishing gear along with monitoring of the marine environment. The following is a brief list of instruments developed in CIFT using indigenous materials and technology.

Fisheries Hydrography

Instruments are needed for monitoring the environment in relation to fisheries resources. They include instruments for acquiring data directly from different depths of the ocean and also for laboratory type instruments where the collected water samples are analysed to estimate the contents including chemicals and heavy metals. The instruments developed in CIFT are designed to acquire the data directly from sea depths without the need of collection of water samples, which are quite laborious and time consuming. Direct measurements from ocean depths enables faster survey covering larger area with minimum time. Some of such equipments developed in CIFT are the following.

1. **SALINITY TEMPERATURE METER :** For direct measurement of water salinity and temperature from water depths upto 200 M.
2. **SALINITY TEMPERATURE DEPTH METER:** for measurement of salinity, temperature and depth directly from water depths up to 200 M.

3. **SALINITY TEMPERATURE RADIATION METER:** for direct measurement of salinity, temperature and radiation from depths up to 200 M.
4. **INSITU-TURBIDITY METER:** for measurement of turbidity directly from water depths up to 30 M in the range 0-1000 JTU.
5. **OCEAN CURRENT METER:** for measure of water current and its direction directly from depths upto 200 M.
6. **NET-FLOW METER AND INTEGRATOR:** to indicate flow rate of water inside plankton nets in the range 0-600 cms/sec. and its integratiion to indicate the total water flown through the net during a definite duration of survey, while assessing the fisheries productivity of an area.
7. **OCEAN TELE-LAB:** to monitor 5 important fishery hydrographic parameters simultaneously using a single underwater probe and consisting of their respective sensors namely, water salinity, water temperature, water current, current direction and depth of operation.
8. **SHIP-BORNE DATA ACQUISITION SYSTEM:** This is an equipment developed for acquiring ten channel data on marine meteorological parameters, water quality and performance of the ship. The data will be required for numerous activities connected with the marine environment and, living & non-living resources of the sea. The data acquired are water salinity, water temperature, speed for the vessel, air temperature, relative humidity, atmospheric pressure, solar radiation, wind, wind direction and ship's stability/sea roughness. The equipment has been developed in three models namely, model A - manual operation in small fishing/survey vessels, model B - attached with memory module for data collection in medium type vessels by automatic operation. Model C - attached with computer for operation in large vessels. The equipment was developed as a project sponsored by Dept. of Electronics, Govt. of India and is being commercialised by M/s. Keltron.

Coastal Engineering and Aquaculture

The numerous activities connected with coastal protection, coastal fishing including aquaculture require studies on the environment including ecological conditions along with the dynamic coastal processes. Some of the measurements needed in these lines are wave profile and its impact on the coast, water current measurements and tide measurements inorder to estimate the total water flux in backwaters, lagoons etc. Other water quality parameters including sediment settling and transportation are very important features. Some of the instruments developed in CIFT are the following.

1. **DIRECT READING CURRENT METER - WADING ROD TYPE :** for measurements in shallow waters.
2. **DIRECT READING CURRENT METER - SUSPENSION TYPE :** for measurements in deeper water upto 30 meters.
3. **TIDE TELEMETER :** for continuous monitoring of tidal variations along the coast and in backwaters, lagoons etc.

4. **SALINITY BRIDGE:** for quick and accurate estimation of water salinity and temperature of culture ponds.
5. **TIDE AND WAVE TELEMETERING SYSTEM:** for continuous measurement of tidal variations and wave profile along the coast.
6. **REMOTE SEDIMENT MONITOR:** for automatic estimation of sediment deposits under sea beds, rivers, backwaters, etc.
7. **AUTOMATIC SEDIMENTATION ANALYSER:** for quick and precise estimation of grain size distribution in marine sediment samples.

Behaviour Studies of Marine Animals

Instruments are needed to study the behaviour and response of different animals including fishes, barnacles, oysters, etc. to different environments which are created in controlled conditions. Such basic studies lead to major application fields in fisheries, marine biology and ecology with the ultimate aim of fishery forecasting. Some of the instruments developed in CIFT are the following.

1. **FISH ACTIVITY RECORDER:** for monitoring the activeness of fishes in an experimental fish tank and simulated with different levels of salinity, temp., pH, DO, nutrients, toxicity etc.
2. **BARNACLE CIRRI COUNTER:** the instrument counts the cirri beatings both qualitatively and quantitatively in response to the conditions created with different levels of salinity, temperatue, DO, pH, toxicty, pollutants, etc. The response of the animals sensed as measure of the no. of cirri beatings made and the instrument senses the same without making direct contact or disturbance to the animal.
3. **OYSTER ACTIVITY MONITOR :** the instrument monitors the micro shell movements of the animal without disturbing on its response to the simulated conditions in the tank.

Fishing Technology

Electronic instruments are needed in fishing technology for detection of fish shoals, survey of fishing ground, safe navigation, communication, etc., during routine commercial operations. Instruments are also needed for the better fishing practices by monitoring the performance of the ship/boat, the load conditions of the net and accessories, the speed of the boat, the performance of the underwater system, etc. While some of these namely speed log, warp load meter, trawl depth meter etc. are regularly used, others are required for occasional measurements and several investigations connected with fishing technology for further improvements of the system.

The following are the instruments developed in CIFT in this line, for facilitating systematic field investigations in fishing craft and gear technology.

1. **PORTABLE WARP LOAD METER:** to monitor the load of trawl nets inorder to assess its performance under water including its safe operation and is designed as a portable one for operation in different smaller vessels, in the range 0-1000 Kgs.
2. **SHIP-INSTALLED WARP LOAD METER:** for permanent installation in larger vessels and continuous monitoring of warp load of larger trawlers in the ranges of 0-2000, 5000 Kgs.

3. **BOLLARD PULL MONITOR:** for estimating the capacity of marine engines/boats in view of estimating its suitability and achieving better performance and efficiency of the complete system, in the ranges of 0-1000 and 3000 Kgs.
4. **TRAWL DEPTH METER:** to monitor the depth of operation of the trawl system especially during mid water operations, inorder to control the net to the depth where fishes are located (using Fish Finder). The equipment is used for many other investigations related to optimising fishing techniques and scope ratio estimations.
5. **SPEED AND DISTANCE LOG :** for monitoring the speed of motion as well as indicating the total distance travelled during trawling and other survey activities.
6. **CATCH LOAD MONITOR:** to indicate quantity of fish caught in the net while transferring the cod - end from water to the deck of the boat, in the range 0-500 or 1000 Kgs.
7. **UNDER WATER TENSION METER:** to indicate the load of the net alone instantaneously under water during trawling inorder to assess the proper performance of the trawl gear system and distribution of the load among the components. Range of measurement 0-500 and 1000 Kgs.
8. **SIDE WAY TILT METER:** to monitor the side way tilt of otter boards instantaneously during operation in the range ± 40°.
9. **Fore and aft tilt meter:** to indicate fore and aft tilt (pitch angle) of otter boards under water during operations in the range ± 40°.
10. **ANGLE OF ATTACK METER:** to indicate the angle of attack of otterboards under water during operation, in the range 0-90o.
11. **MESH DISTORTION TELEMETER :** to indicate the shapes of the meshes at different parts of trawl system during operation and estimate the distoritions in the range 0-25 cms.
12. **CATCH TELEMETER :** to indicate the catch of fish caught in the net during operation under water, as a measure of the resistance to motion of the cod end part due to accumulation of catch.
13. **FISHING LOG :** This composite equipment monitors 5 important parameters required during experimental and investigative fishing methods namely, warp load, boat speed, water temp., water salinity and air temperature.
14. **TRAWL GEAR TELEMETER :** This equipment is designed to indicate important parameters of the under water trawl gear system namely trawl depth, angle of attack, sideway tilt, fore and aft tilt, bollard pull and speed of the boat, simultaneously needed for experimental investigations in fishing gear technology.
15. **UNIVERSAL MARINE TELEMETER :** This wire telemetering type equipment monitors 15 channel data simultaneously on the performance of the fishing craft, underwater trawl system and the underwater environmental parameters so as to make integrated studies for achieving optimum design of the subsystems. The data is communicated from the net to meter through a single 3 - core cable.

Fish Processing Technology

These electronic instruments were developed in CIFT for ensuring quality during processing, making integrated watch keeping of cold storages and also facilitating new investigations in processing engineering, solar processing etc.

1. **FREEZER TEMP. MONITOR** : for continuous monitoring of the temp. inside cold storages and deep freezers in the range -50°C to +50°C with special features namely (i) mini sensor of size 2.5 mm dia, 10 mm length attached with 1 mm thin cable for measurements inside frozen blocks also, (2) wire telemetering measurements with long cable up to hundreds of meters (3) recorder output facility and digital display.

2. **MULTICHANNEL FREEZER TEMP. MONITOR & PRINTER** : for continuous and instantaneous measurements of cold storages, deep freezers etc. of larger processing complex using several sensors installed at remote and distant required locations. The instrument is available in different designs including automatic type with data printed in computer printer with time and details.

3. **BRINE CONCENTRATION METER:** to make continuous measurements of concentration of brine used in fish processing factories, in the ranges of 0-12%.

4. **SOLAR PROCESSING MONITOR:** for making continuous and simultaneous measurements of all important environmental and functional parameters of solar dehydration systems, namely solar energy, wind energy, relative humidity, air temp., water evaporation rate, moisture content of fish and weight loss of fish under drying, so as to make systematic studies on utilisation of solar energy and combined effect of environmental factors on materials under processing.

Environmental Data Acquisition Systems

Human interaction with environment has increased tremendously these days warranting the proper monitoring and assessment of the environment inorder to make sustainable development and exploitation. Here monitoring and analysis of the environment in an integrated manner is the systematic approach needed for appropriate decisions. Numerous multidisciplinary data are needed to be acquired directly from the environment. The nature of the data acquired and operational methods and constraints are quite different in open fields because of numerous constraints and hazards. CIFT has designed data acquisition systems complete with sensors with indigenous and appropriate technology for various applications. The sensors developed and compatible to the system in different models belong to air, water and soil extending its applications to aquaculture, ecological studies, coastal engineering, hydrometeorology, agroclimatology, water resources, etc. The systems are available in different channel nos. of 10 and 16, different sensors and different types of operation including automatic attached with memory module and computer. Some of the sensors developed for acquiring the data are water salinity, water temperature, water-current, water level, waves, sedimentation, water density, air-

temperature, relative humidity, water evaporation, solar radiation, atmospheric pressure, wind velocity, wind direction, soil tempe. and soil moisture. Some of the data acquisition systems based on this technology are:

1. **ENVIRONMENTAL DATA ACQUISITION SYSTEM - 16 CHANNELS :** designed for acquisition of data directly from open sites and needed for environmental studies connected with aquaculture, ecology and coastal zone management.
2. **AQUACULTURE SYSTEM MONITOR:** for monitoring the water quality and environmental parameters of different culture/breeding tanks of intensive aquaculture system.
3. **MARINE METEOROLOGICAL DATA ACQUISITION SYSTEM:** for coastal weather forecasting.
4. **AUTOMATIC WEATHER STATION:** for weather measurements needed for agriculture and other applications.

Conclusion

The precision and reliability of electronic marine instruments have improved considerably owing to the new technologies adopted. The users should be careful to select the type of instruments needed for the different occasions considering the facilities available for their installation and operation. The scientists, engineers and subject matter specialists should be kept abreast of the new measurement techniques and facilities inorder to make better understanding of the complex marine environment and its relation to living and non living resources. The respective educational institutions should include the subject of marine electronics in their curriculum giving thrust to the applied aspects. The new technologies developed should be brought to the attention of all concerned through training and necessary field demonstrations.