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The Environment Monitoring Automatic System with radio data communication

SUMMARY

The paper presents an automatic computer-aided system applicable to remote monitoring physical and chemical parameters of the water and air environment. The measurement data are transmitted by radio. The system was designed and tested by the authors' team of Faculty of Maritime Technology, Technical University of Szczecin.

The paper presented at IVth Symposium on Diving Technology, Gdynia, 13-14 October 1994

SYSTEM'S APPLICATION

The Environment Monitoring Automatic System (EMAS) is designed to monitor the water and atmospheric environment. The monitoring is performed by periodical measuring and recording of selected physical and chemical parameters of water and air. The system's configuration contains:

- ☐ Central Control Unit
- ☐ Cluster Control Centres
- ☐ Water and Atmospheric Stations

and enables to monitor any water and/or land area.

The system can detect exceedance of the set values of monitored parameters by the measured ones and activate alarms. The measurements realized by means of the entire measuring network can be carried out on demand (i.e. in any ordered time). The measurement data obtained in this way are transmitted to the Central Control Unit where they are processed to be used to support decision-making.

SYSTEM'S STRUCTURE

The EMAS consists of Clusters. Each Cluster consists of :

- Cluster Control Centre
- Checking Sub-centres where information is collected and processed
- unattended (service-free) Water and/or Atmospheric Stations

The Cluster is governed by System's Central Control Unit. The Checking Sub-centres are passive components of the system's structure. They only receive information without ability to interfere with operation of the system. The Cluster operates over the land or water area where distances between the Water and/or Atmospheric Stations do not exceed 15 km. (An actual distance limit depends on configuration of the ground and propagation conditions of radio waves in a given area). Theoretically, the number of Stations which belong to the same Cluster is unlimited.

COMMUNICATION SYSTEM

The radio communication system was chosen for data transmission after consideration of the peculiarities of System's operation, possible distribution of Stations over water and inland areas, level of alternative telephone links occupancy, costs of cable links installation and telephone lines renting.

The tree-type structure was chosen of communication between the Stations with the System's Central Control Unit considered as the trunk of the communication tree.

The Cluster Control Centres can communicate with the Central Control Unit in two ways: directly or by using frequency converters located inside the area of radio-link network. The Water and Atmospheric Stations operate as the measuring and sending stations as well as the transmitters of radio signals received from external stations. The suitable configuration of Cluster, in which any terminal Cluster Station is able to communicate with the Cluster Control Centre, is that which uses three or fewer Stations working as radio signal transmitters.

Thus the maximum distance between terminal Stations and the Cluster Control Centre is limited to 60 km.

The standard version of the Stations is suitable for 500 mW radio stations. The radio station is coupled with a computer by means of FSK modem which performs narrow-band modulation and converts digital signal to a double-tone signal. The available transmission speed is 1200 bauds.

CLUSTER CONTROL CENTRE

The Cluster Control Centre is designed to currently supervise the measuring Stations which belong to the Cluster, to acquire the measurement information, to process, visualize and transfer the measurement data to the Central Control Unit.

The IBM PC - type computer is used as the Centre hardware. The signal transmission/reception unit is connected with the computer by means of RS 232 connector. The unit consists of :

- radio station
- FSK modem
- energy supply system equipped with service-free accumulator.

The resident computer program is used to supervise and operate the System. It means that the computer can be used to execute other programs too. The software installed in the centre makes it possible to:

- ✧ lock/unlock Station's measurement cycle
- ✧ read out/set in the Station's astronomic clock
- ✧ set Station's measurement cycle parameters
- ✧ execute on-demand measurements
- ✧ read out current Station's configuration
- ✧ read out the number of measurement sessions performed by each Station, as well as date and execution time of the sessions
- ✧ read out packets of measurement data recorded during the sessions
- ✧ record and print measurement results
- ✧ reset Station's buffer memory
- ✧ configure network transmission routes.

An appropriate order given by System's operator is transferred through the RS connector to the signal transmission/reception unit and then, after being coded, sent by radio to the proper Station. The Station sends automatically the confirmation signal by radio if the order is executed.

CHECKING SUB-CENTRE

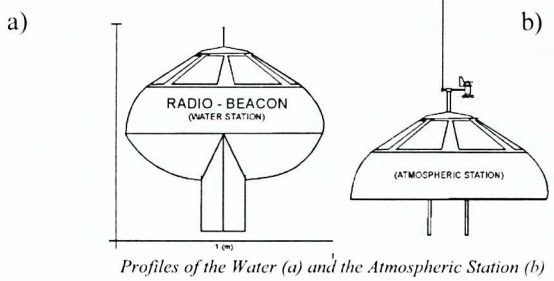
The Checking Sub-centre is designed to collect and process the information obtained from the measurement Stations. The Sub-centre consists of a PC computer and transmission/reception unit. The same operations as those attributed to the Cluster Control Centre can be executed by means of Sub-centre's software. However the operations which interfere with the System are not available from this level. The following operations can be executed from the Checking Sub-centre:

- ✸ readout of the Station's astronomic clock
- ✸ readout of the Station's measurement cycle parameters
- ✸ readout of packets of measurement data recorded during the sessions
- ✸ recording and printing of measurement results
- ✸ elaboration of the measurement results.

The Checking Sub-centre can be considered as a standard passive station which collects the measurement results obtained directly from the measurement Stations. It should be installed in such places where immediate access to the measurement results is necessary.

WATER AND ATMOSPHERIC STATIONS

The Water Stations (a kind of radio beacons) and Atmospheric Stations are designed to monitor the water or atmospheric environment, respectively.



Profiles of the Water (a) and the Atmospheric Station (b)

The monitoring is realized by measuring chosen physical and chemical parameters of a given medium and recording its results in the buffer memory.

The Stations are able to:

- ★ receive radio signals for re-programming the Station's operation algorithm
- ★ transmit radio signals which carry the information on values of the measured parameters
- ★ transfer radio signals to and from other Stations.

The Stations are composed of two parts: the dome and the base. Solar batteries are installed on the dome's „windows" (panels). Their total area is sufficient to supply the Station's devices with DC current of 1A at 14÷16 V. The antenna is located in the upper part of the dome.

Two waterproof compartments are provided inside the dome. The service-free accumulators are located in the first, external compartment. The second, internal one is equipped with the measurement devices and instruments, microcomputer module, radio station and accumulator charging unit.

The microcomputer module is based on a single-chip processor. Measuring 8 analog and 8 binary quantities and controlling 8 binary outputs can be executed under the supervision of the microcomputer module. The measurement results are stored in the memory buffer which can contain results from up to 1000 measurement sessions. Storing operations of measurement results and the parameters, which determine the processor operation algorithm, do not depend on any external energy supply source. The microcomputer is electrically separated from the measurement devices and instruments.

The Station's processor software enables to:

- control binary outputs
- set the real time clock
- read out the analog and binary outputs
- transfer measurement values to the buffer memory
- read out buffer memory content and transfer it, formed in data packets, by radio
- program measurement algorithms
- supervise measurement operations according to a current algorithm
- switch off the radio station in the case of the supply voltage drop below 10,5 V and
- switch on the radio station again when the accumulator is charged enough by the solar batteries
- execute on-demand measurement operations after receiving an appropriate command from the Centre.

The Water Station is made of the GRP. The station is given such a form to minimize influences of sea waves, water currents and icing. To avoid the risk of crushing, the Station can immerse under ice layer. The black colour of the upper part of the Station is provided to accelerate melting of the surrounding ice.

The underwater part of the Station contains the measuring probe, fitted with measuring sensors and instruments, and echo sounder transducer. It is protected by a basket equipped with an anchor, the sling device of which is fixed to the basket. The lower part of the Station can be filled with water or permanent ballast.

The main particulars of the Water Station are as follows:

- breadth	905 mm
- depth	1100 mm
- mass with permanent ballast	160 kg
- mass with water ballast	63 kg

The tested Water Stations are equipped with the instruments to measure the following five magnitudes:

- hydrogen ion concentration (pH) in water	5 to 10
- solubilized oxygen content in water	0 to 20 mg/l
- water specific conductance	0 to 1 S/m
- water temperature	-10 to +40°C
- water depth	0 to 100 m

The remaining channels can be used in the future to measure other quantities, if necessary.

The dome, if closed in the bottom part with a flat aluminium cover fitted with foundation fixture, can be used as the Atmospheric

Station. The anemometer for determining wind velocity and direction is located near the top of the dome. The bottom cover is fitted with a cable socket which enables to charge accumulators internally. The tested Atmospheric Stations are equipped with instruments to measure ambient temperature, wind velocity and direction. The remaining five free channels can be used to measure other quantities, if necessary.

RECAPITULATION

The ground tests of the System were carried out for 6 months in the area of the Technical University of Szczecin. The Atmospheric Stations were located on the roof of the Maritime Technology Faculty building as well as and in interior compartments. The design and checking works of the System's prototype have been performed since the end of 1991 year.

System's software and Water Station design were modified after the preliminary tests. The Station's weight was substantially reduced due to replacing the permanent ballast by water ballast. It made transporting the Station much easier. The tests confirmed that the System is highly reliable and complies with its design specifications.

Acknowledgements

The authors would like to thank the Environment Protection Department of the Province Administration Office in Szczecin for its support to authors' efforts to create the Environment Monitoring Automatic system. The thanks are also extended to Lech Tolkacz, Włodzimierz Chocianowicz and Marek Witkowski who contributed the authors' work.

Appraised by Andrzej Piegat, Assoc.Prof.,D.Sc.

Conferences

MANOEUVRABILITY '95

Under this heading an international symposium on the manouvrability of large ships sailing at low speed in restricted waters was held in Iława on 16÷19 October this year.

Such conditions frequently appear in port water regions where the manoeuvring of ships of several hundred thousand ton mass and more than 200 m long is a difficult and risky task. Large ships sailing in the a.m. conditions are characterized by a long stopping distance, several mile circulation radius and very high inertia forces; therefore, not only is vast experience needed in manoeuvring such ships in port basins but also thorough knowledge based on scientific research.

Efforts of many world research centres is focussed on this research field. The symposium in Iława served as a forum for presentation of the latest research results and exchange of experience gained.

It was very fortunate that many world-wide recognized marine research centres accepted invitation of symposium's organizers and 16 researchers from Great Britain, Australia, Belgium, France, the Netherlands, Japan, Germany, Russia and Ukraine together with 24 representatives of Polish universities and research institutes took part in the symposium.

22 papers (12 of which from abroad) were presented and discussed. The papers were devoted a.o. to the following topics:

- ship motion dynamics during manoeuvres
- hydrodynamic parameters identification based on sea trial test measurements
- influence of propulsion and steering system characteristics on ship manoeuvring performance
- influence of shallow water manoeuvres on marine environment
- analysis of ergonomic aspects of ship manoeuvre execution
- verification of mathematical models of ship manoeuvrability, based on model and sea trial test measurements
- simulation techniques in training of navigation officers and ability of simulators to model real conditions during manoeuvres
- loads acting on ship equipment due to hydrodynamic phenomena
- manoeuvrability of partly immersed floating structures

A vivid and interesting discussion followed the presentation witnessing actuality of the presented problems.

For instance, the authors from Maritime University of Szczecin have drawn attention to some aspects of port basins and waterways design from the point of view of ship manoeuvrability (basin area, depth, quay shape and structure versus minimum manoeuvre area, influence of flow field around ship, perturbance zone etc).

The papers of Warsash Maritime Centre, Great Britain, and of High School of Waterways Transport in St. Petersburg, Russia, provoked discussion on changes needed to be introduced to training simulators to cope with changeable technical and operational characteristics of new types of ships.

The paper of Maritime Academy in St.Petersburg on ergonomic criterion introduced to evaluation of ship manoeuvrability characteristics met vivid response of the audience. It was confirmed once more that the so called „ human factors " should not be omitted while predicting ship behaviour during manoeuvres.

The symposium was organized by Foundation for Safety of Navigation and Marine Environment Protection which has its research and training centre in Iława. The participants of the symposium were given an opportunity to be aquainted with the equipment, methods and techniques used in the centre in training courses for navigation officers both from Polish and foreign shipping companies.