

SOME ASPECTS ON THE KNOWLEDGE-BASED UNDERWATER SYSTEMS

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ABSTRACT

The consideration of various technical criteria leads to the evaluation of the main components in the life-cycle of underwater systems. The combination of intelligence and underwater technology has pushed the frontiers of oceanography to great heights. One of them being the development of knowledge-based expert systems. Extensive search of knowledge-base demands a comprehensive set of requirements, integrating diversified technologies into the intelligent system (that can be programmed, controlled and made easy to operate). These are discussed in the paper.

INTRODUCTION

Underwater systems have been increasing in complexity considering the environmental and operational aspects. The major areas shaping the current trends / 1 / in subsea control and monitoring are:

- improved instrumentation and control system sensitivity,
- acceptance of complex systems,
- rationalisation of control system design,
- provision of systems and components to satisfy environmental aspects.

The underwater system design programme can be conceptualised into the following phases:

- identification of the objectives,
- identification of the data to be collected,
- detailed system design, (including selection of sensors with proper resolution, accuracy and logistics)
- development of a knowledge-base,
- implementation of the design incorporating the Knowledge-base modifying wherever

necessary: for better flexibility.

Reviewing the system design methodology, one of the areas of immediate attention as observed are:

- simplification of interfaces,
- reduction in system complexity, (by modular design),
- improved control sensitivity.

The general approach to underwater system developments with self-powered remote applications will be discussed in more details in the paper.

METHODOLOGY

As more and more underwater systems become operational, monitoring of the knowledge-base is found necessary to:

- provide essential inputs to operational systems,
- monitor control parameters,
- monitor process parameters,
- validate control commands,
- meet statutory requirements.

Complex underwater systems generally have a design life about 20 years. To date no sensors are available to work for this length of time / 2 /. An alternative approach is to design sensors to be retrievable by a Remotely Operated Vehicle (ROV). Principal aspects of sensor design include:

- power and signal interfaces,
- process interfaces,
- sensor attachment and ROV interface

The primary design requirements (retrievable from a data base) are:

- size, weight, inertia, and sensor precision,
- sensor design attachments,
- manipulator operations,
- manipulative tools,
- actuators,
- sensor orientations, (horizl/vertl),
- sensor maintenance tasks.

field of oceanography, remote acquisition instruments have been available for many years / 3 / ranging from simple mechanical devices for water sampling, to sophisticated intelligent devices for sensing and processing a number of parameters. The basic system requirements are:

Underwater operational capability, back equipment, back communication link between back and underwater equipment (on-line or off-line).

High degree of interdependence between them. The knowledge systems integrate knowledge through rules and structures / 4 /. The knowledge management process for an underwater system leading to a proper decision is dependent entirely on our capabilities of the system and the available information in the data base. Functions of an electronic module

decode signals received from the sensors, and scan the appropriately monitored data in a modular fashion. The extent of modularity is relevant to the system reliability and maintenance. All the knowledge representation characteristics can be correlated during the definition of knowledge representation systems to reduce repetition. The type of knowledge is stored using a database based on a widely divergent hierarchical storage structure / 5 /.

Criteria determining the choice of system components are: availability of MILSPEC, range of peripheral devices, power dissipation, weight, and

vibration immunity, ambient temperature, operating RH (%), clock rate (MHz), propagation delay, switching speed, I/O characteristics, and power supply voltage;

In addition to: flexibility for future design changes, duty cycle, environmental factors, self test procedures, power up sequence.

The development phase includes the following procedures: material procurement, material inspection, PCB assembly and testing, integration, inspection, quality procedures.

For underwater system engineering there are no internationally accepted standards. New solutions have to be developed for interfaces which are specific to the subsea environment. Although good design will minimise the number of interfaces, there is always a pressure barrier requirement in an underwater environment and the need for integration. The identification of these design practice/procedure codes incorporating project execution requirements necessitates to satisfy the reliability and quality needs of a subsea system.

There are a number of methods available for calculating the behaviour of extremely pressurised systems such as /6/ :

- stress analysis,
- elastic stability,
- effect of shape imperfections,
- behaviour beyond elastic limit, and
- collapse pressure predictions.

Besides cost-effectiveness of fabrication, installation and maintenance, safety requirements represent important considerations in the design. Minimum requirements try to avoid:

- loss of human lives,
- pollution,
- economic losses.

The underwater knowledge based system supports

- the concept and feasibility design,
- assessment of system design,
- safety endorsement,
- detailed layouts effectively carried out on CAD system.

Wherever appropriate the programs could be interactive, and make extensive use of computer graphics to illustrate the models being worked on; to display results of analysis, and most important, to provide an interface with the user which encourages to provide correct data at each stage helping to highlight errors before they can lead to wrong results.

The knowledge-base consists of data/information on:

- system forms (of past designs),
- type systems (numerical data on past systems),
- weight and space scaling,
- equipment details,
- structural design,
- resistance and propulsion data,
- sea spectra,
- probabilistic/statistical rules for underwater systems.

CONCLUSION

The main thrust of research in the field of underwater systems design is complicated by the environment, oriented towards mechanical failures and uncertainty, and variability in system design. Bearing in mind the need for high reliability of certain functions some practical design aspects are presented, suggesting for greater flexibility for future design changes. Tasks, hence, suggested are:

- power-on initialisation,
- error detection/correction,
- monitor scan sequence,
- status feedback,
- self-test provision,
- power-down procedure.

The continuous monitoring of information is important as the deployment of underwater system progresses in the operational phase. Two factors which increase efficiency are:

- reduced operational time, and
- improved technological capability.

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