

ON THE INSTRUMENTED MONITORING OF UNDERSEA VEHICLES

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ABSTRACT

Undersea vehicles (such as ROVs) require a viable tool for monitoring a very cost-effective system developed systematically with a system presented into hierarchical domains of different time domain of the problem. An instrumented ROV is suggested on a conceptual level for implementation for oceanographic applications. Aspects governing the configuration and detailed design are presented.

relevant undersea vehicle data more cost-effectively, more reliably, independently of environmental conditions. A number of methods and systems are existing at present. Some reasons for their lack of success are:

- available functional failure detection methods,
- unreliable or vulnerable instrumentation (which cannot be repaired/replaced on-site),
- time-consuming, inefficient undersea data analysis routines.

The current state-of-art of detection/monitoring methods available for automation/ instrumentation is discussed in the paper.

INTRODUCTION

The need of making a thorough and accurate use of the marine environment resources require a full complement of manned and unmanned undersea vehicles. When personal senses are not available at the worksite in order to perform the task, the use of a ROV is justified. ROVs are particularly suitable for undersea work and monitoring tasks for the following

reasons: operational endurance, low maintenance & equipment costs, high performance ability in hazardous areas (without supporting personnel), and handling problems (smaller ROVs are lighter vehicle).

Information about the operational performance of undersea vehicle parts is obtained through a programmed system using divers, in combination with ROVs. Still there is a need for methods and systems which may collect

METHODOLOGY

The general parameters that are monitored and their tasks fall into four basic groups viz; navigation (visual, compass heading, depth and sonar); scientific instrumentation (video recorder, samplers, CTD, radiometer, coring devices & releasers) [2]; life support (cabin temperature, pressure, oxygen, CO₂ %); operational (ballast air supply, battery voltage, thruster function & electrical system) [3]. The operational constraints of such undersea system include system power requirements, propulsion system efficiency, power transmission voltages, heat losses [4], drags, handling equipment and vehicle power plant dimension.

An important consideration in achieving safe, reliable, long-term undersea operational system in a marine environment is the proper design, construction and routine monitoring of the performance. While no monitoring programme can guarantee that all

defects or degradation can be deleted in the undersea vehicle, it must provide sufficient information leading towards the implementation of routine maintenance programmes. This includes considerations indicating whether or not further inspection (or remedial, restorative measures) are needed.

More than 180 unmanned vehicles are in operation (in the world), about 90 operated by commercial companies, the rest being with research organisations, navy and universities. These undersea vehicles are capable of:

- inspection/observation,
- recovery of tools,
- cleaning, brushing & chipping,
- cutting cables,
- attach lines with ease, and
- connect hydraulic lines & valves.

The advantages are:

- real time data coverage,
- high endurance, and
- depth capabilities.

Monitoring of undersea vehicles require system development including selection & design of modules/sub-systems in various fields of technology [3] such as, materials, components, navigation.

* **Materials:** The continuing development of solid-state devices (VLSI) has opened new areas of undersea applications. These include μ P, multiplex systems, control and monitoring components: all of which may be made pressure-tolerant (& can be installed in lightweight, oil-filled pressure-compensated containers for operations to all depths in the sea. Electrical application is further strengthened by the development of the electro-chemistry, packaging and handling techniques required to provide safe high-energy-density batteries.

* **Components:** Advancement in the field of solid-state electronic components has brought-in major improvements in the packaging of undersea electronic systems. The basic characteristics of pressure-tolerant electronics (PTE) (electronics not protected from depth pressure) is an advantage. PTE systems use liquid-filled, pressure-equalised containers which provide unlimited freedom of choice in container size, shape and materials.

* **Sensors:** The acoustic, optical and magnetic sensors have contributed to the achievements of undersea vehicles. These provide a means to find the worksite, provide for inspection and

documentation of the characteristics of the site, and means to monitor & control the tools during operations.

* **Navigation:** The navigation sub-systems are an important part of undersea monitoring instrumentation since they provide the means of finding a precise location, and a means of returning to same work-site on repeated excursions.

MONITORING-MISSION

The goal of monitoring campaign is to assess the proper functioning of all the modules in the undersea vehicles: and to replace one or several failed modules on-board the vehicle.

a) **Instrumented Monitor:** is an un-manned monitoring vehicle which can perform:

- the rendezvous, and the docking with the operational vehicle,
- perform robotic operation (with servo-controlled arm),
- produce and transmit video-images during the grasp and the other operations.

These functions provide a wide range of in-situ capabilities. The important mission in monitoring requires great reliability. The monitoring vehicle shall also carry spare modules for whole servicing campaign.

b) **The operational vehicle:** is the vehicle which has been assigned specific tasks to perform in the undersea environment. This segment is assisted by ship-control whose main duties, beyond the classical function of control and localisation, are to yield to the proper monitoring, of the necessary parameters for navigation and retrieval, and sequences of orders for teleoperations.

In the context of oceanography, remote data acquisition instruments are available today. These instruments range from simple mechanical devices for seabed or water sampling, to sophisticated intelligent devices for monitoring and processing a number of ocean parameters. Equipments for remote control and undersea monitoring has a crucial reliability requirement. The application of growing importance is

monitoring of undersea vehicles, most crucial being the "status bring";
 sensor operations should be added to take up precisely the desired position requires:
 precision sensor;
 remote monitor function;
 reduction in the number of electrical connectors';
 detection/monitoring of hydraulic pressure and temperature;

ly, this indicates the necessity autonomous watch-dog actions (and detection of malfunction), monitoring of system parameters and indicate system conditions).

major objectives of developments of technological innovations are, (taking consideration the various environmental considerations):
 increase in flexibility,
 improvements in reliability,
 enhancement of safety factor,
 optimization in instrumentation,

ing to:
 development of new materials,
 development of new devices and facilities,
 development of new process techniques,
 development of new system, and
 development of new software.

following can be [6] briefly defined as the area involved:
 realization of highly intelligent monitoring system;
 intelligent robot (with self diagnosis and recovery functions;
 high precision production technology;
 intelligent micro-sensor with high sensitivity and reliability

1 indicates the activities involved in the process monitoring for undersea vehicle. A wide variety of methods are available to with scheduling and planning. will have to be re-run periodically because the conditions (undersea) inevitably change. Simulation is used to determine scheduling strategies and floor layout. In general, the technology of monitoring - including process and other hardware, software - is changing rapidly, a basic understanding of Systems Issues remain complete: these issues include scheduling, scheduling, and control of

work. These are complicated by randomness in the undersea environment, particularly due to instrument failures and uncertainty/variability in monitoring requirements.

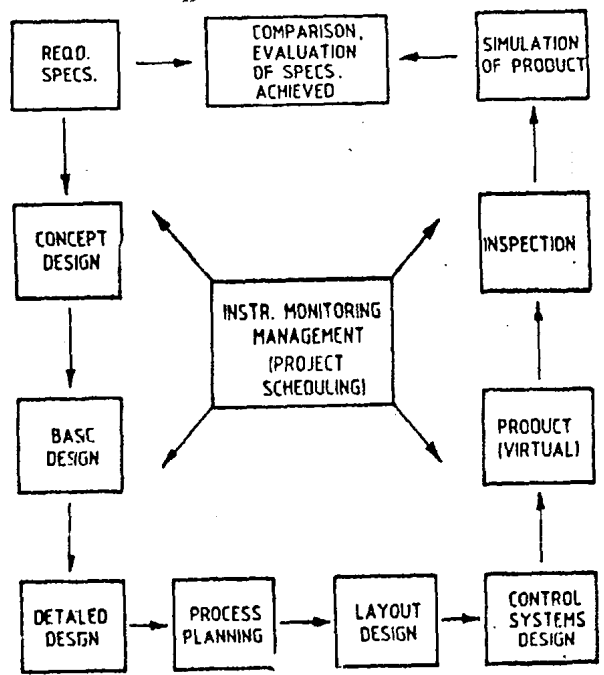


Fig. 1. INSTRUMENTED MONITORING CONCEPT

CONCLUSION

The main thrust of research in instrumented monitoring of undersea vehicles is complicated by the environment, particularly oriented towards mechanical failures and uncertainty, and variability in system requirements. In order to achieve the required number of operating status, it is certain that a microprocessor-based design will be required. Bearing in mind the need for high reliability of certain module functions a practical design concept is suggested, keeping in mind greater flexibility for future design changes and using 'off-the-shelf' components. The tasks suggested are (on priority commands under interrupt routine):

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

The continuous monitoring of information is especially important as the deployment of undersea vehicle progresses in the operational phase. It can also be pointed out that efficiency can be increased by :

- reducing operational times, and
- improving technological capability.

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REFERENCES

1. WILLIAMS JJE, "A High integrity subsea control and monitoring system." Cranfield Institute of Technology, USA. 1984.
2. Operational Guidelines for ROVs Report of the ROV Subcommittee of the Undersea Vehicles Comm. MTS, Washington DC, USA. 1984.
3. SIMON PETER A. Operational Consideration for a Scientist-Piloted Research Submersible. Proc. ROV'87 San Diego, CA, USA. p79-82.
4. NAYAK MR. On the operational aspects of Subsea Systems. Proc. ROV'87. San Diego, CA, USA p75-78.
5. Undersea Vehicles Directory: 1985, Busby Associates, Inc; Arlington, VA; USA.
6. IWATA K. Artificial Intelligence and CAD/CAM. Journ. of Japan Soc Prec. Engg. 49(10): 1448-1449, 1983.

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