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Underwater vehicles technology in Poland

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Abstract

The paper deals with a classification of underwater remotely operated vehicles. Several Polish designs and really working vehicle systems are described. Fields of vehicles application are presented as well.

1 Introduction

Research and underwater operations are one of the fields of human activities which widen possibilities to gain natural resources of all kinds. The last 20 years of the offshore industry history shows the vast development of technical facilities for the penetration of the abyss, and among those manned as well as unmanned underwater vehicles play a key role. The paper outlines the fields of interest of two Polish research centers i.e. Technical University of Gdańsk and Technical University of Szczecin, and their output.

2 Classification of vehicles used in underwater reseach and typical configuration of ROV system

There are three groups of underwater vehicles which are the most significant from among numerous technical means used to penetrate the subaquatic space, namely:

- manned vehicles and capsules,
- unmanned vehicles,
- hybrid vessels of different design and configuration made for different purposes (features common for both a/m groups).

Unmanned vehicles are no doubt the most frequent and remotely operated vehicles (ROVs) are consequently the most common.

The configuration of ROV system depends mainly on the size and equipment of the system. The typical configuration is shown in fig.1.

In the Low Cost ROV system a vehicle is directly attached to the control station without any additional indirect links. Such a combination assures mobility and easy application.

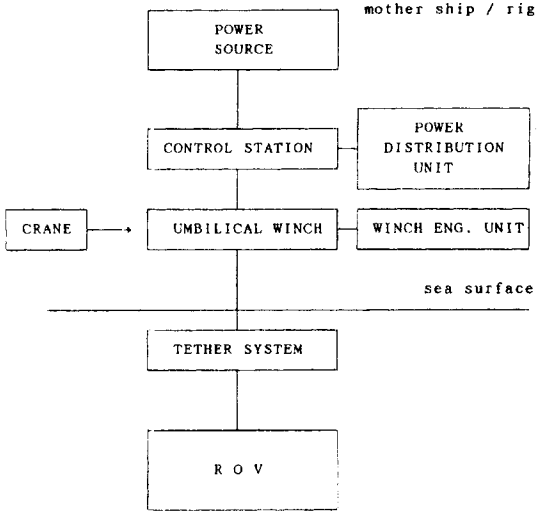


Fig.1. Arrangement of the typical ROV system.

3 Experience and output of Polish research centers

The first two designs of manned vehicles were developed in Poland still in the seventies.

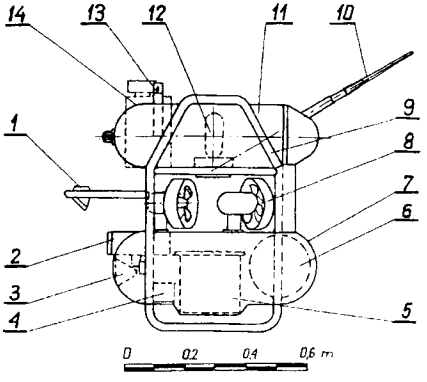
First at The Technical University of Gdańsk the prototype of aquaplane CZAPLA was built. The vehicle designated for observation tasks in shallow waters had been tested in a towing tank and sea conditions. Then GRZEŚ two-man submersible developed from 1974 to 1980 was an example of interesting idea of underwater vehicle used for fishing gear observation; Rowiński & Narewski [7]. It had been tested in the Baltic Sea and applied to some initial observation tasks.

In 1990 a very successful design of a LC ROV called KORAL-100 was developed, fig.2. It was a vehicle designated for observation and used for some underwater operations, e.g. at the oil rig of Petrobaltic Company.

Another vehicle designed those days was called HOLONUR and its purpose was towing a diver.

In the 80s several projects of manned vehicles were prepared at The Navy Academy, Gdynia.

Design works had been carried also at The Technical University of Szczecin. At The Ocean and Ship Technology Institute, former Ship Research Institute, a project of underwater observation vehicle PAO-100 was prepared in



1 - underwater light
2 - photo camera
3 - strobe lamp
4 - camera tilt unit
5 - power transformer
6 - electric circuits transformer
7 - covers
8 - lateral thrusters
9 - mounting frame
10 - neutrally buoyant umbilical
11 - computer container
12 - vertical thruster
13 - xenon flashing light
14 - obstacle avoidance sonar

Fig.2. KORAL-100 ROV general arrangement, Technical University of Gdańsk.

1988. In 1990 another project of the NPG lock-out type submersible for two operators and three divers was undertaken as well; Bednarski & Graczyk [1].

The main field of interest, however, were remotely operated vehicles. The experimental underwater device called AITS of a simple design was made at The Institute of Informatics and Naval Automation, former Chair of Automation and Systems Technique, in 1985; Piegat [6]. Its task was to investigate motion control systems.

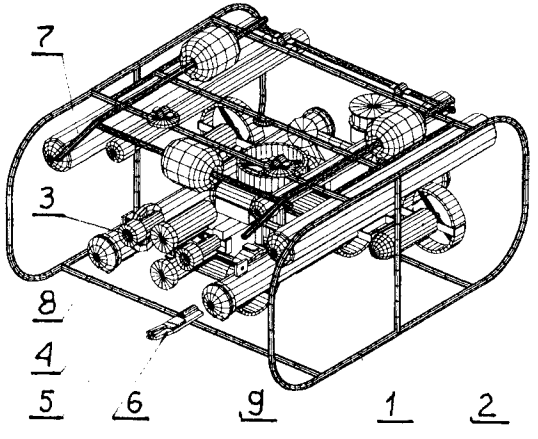
In 1988 the prototype of an inspection ROV called MUNA-400 was worked out (Orłowska, Skórski & Matejski [5]). It was a torpedo-like machine developing high speed and equipped with a tv camera.

At The Ocean and Ship Technology Institute the project of NUR ROV was carried from 1986 to 1990; Graczyk [2]. The vehicle was a sophisticated device for underwater tasks performed with or without diver co-operation, serving a set of underwater hydraulic tools. The documentation was prepared, a 1:2 scale model was built and tested at The Naval Hydrodynamics Center of Gdańsk, the vehicle behaviour was investigated on a ground of experiments and computer simulations. A number of subassemblies and subunits were built but due to the lack of financing the research and further investigation were stopped.

The co-operation with PPU SUBMAR, Gdynia, resulted in a TUM LC

ROV design - a vehicle designated for monitoring and observation which was equipped with tv and photo cameras. It could be applied in NPG submersible as an additional equipment for operators and divers carried by the submersible to penetrate wrecks and other underwater objects.

In 1991 and 1992 the Underwater Monitoring System (SMP, Polish name) was developed with the use of KRAB LC ROV, fig.3 - a vehicle designed with the participation of PPU SUBMAR and manufactured in co-operation with Hydrobotics Eng. Inc., a Canadian company; Graczyk & Skrzymowski [3]. The UMS is being developed and as Technical Objects Detecting System will be used for underwater inspection and search, as well as for monitoring aquatic habitat, and its instrumentation will be used to measure physical and chemical parameters of water; Matejski, Graczyk & Skórski [4].



1 - frame	4 - b&w TV camera	7 - buoyancy unit
2 - thruster	5 - color TV camera	8 - electronics
3 - light	6 - manipulator	9 - sensors vessel

Fig.3. KRAB-2 LC ROV - a carrier of equipment and apparatus, Technical University of Szczecin.

Table 1, below, lists designs and structures of ROV made at Polish research centers.

4 Fields of ROV application

Remotely operated vehicles are applied in ocean and inland engineering activities covered by the fields as follows:

- marine resources development: hydrocarbons, minerals, bio-resources, energy, water;
- transportation: ships, cables, pipelines;

Tab.1. Designs and structures of ROV made at Polish research centers

Vehicle --------- Year	Diving deph [m]	Vehicle mass [kg]	Speed max. [m/s]	Equipment
AITS 1985	10	144	0.2	lighting, tv camera
MUNA 1988	400	500	3.0	lights, tv camera
NUR 1989 model	300	7200	1.5	lights, tv camera, manipulator, jaws clamp, winch, welding unit, hydraulic tools package
KORAL-100 1990 KORAL-400	100 400	90	1.5	lights, tv camera, photo camera, strobe lamp, xenon flashing lamp, sonar
KORAL AT 1994	400	60		lights, tv camera, echo sounder; optional: tv cameras, wide angle tv camera manipulator, photo camera, sonar, transponder, ultrasonic thickness gauge, corrosion potential sensor
KRAB-1 1991 KRAB-2 1994	150 150	62 72	1.5 1.5	lights, 2 tv cameras, one-function manipulator, water samples device, research equipment to measure: temperature, pH, conductivity, oxygen contents

- exploration & survey: data acquisition, scientific exploration;
- environmental protection - pollution control, erosion & siltation control, controlled waste disposal, security;
- coastal & nearshore development: ports & harbours, shipyards structures, plants, terminals, reclama tion, recreation;
- inland transport: inspection and monitoring of quays, wet docks, fairways;
- hydrotechnics: inspection and monitoring of water dams and flooded structures;
- mining industry: inspection of flooded gangways and pit shafts, rescue operations;
- inland rescue: inspection of wrecks and emergency areas, monitoring of diving teams;
- assistance and support of special operations performed by the army, policy, rescue teams.

In a number of cases ROVs supersede divers. There are two main advantages of ROV application i.e.:

- it cuts on cost and economizes on expenditure by shortening the research time compared to traditional methods such as diving with its limited number of operations and expensive auxiliaries;
- it replaces a diver in hazardous spaces.

5 Summary

The growth and development process of submersible vehicles, especially ROVs, is rapid. The latest achievements of engineering are used to design ROV systems. The designs made in Polish research centers illustrate and reflect the modern trends of maritime engineering. Control and operation systems were developed, subunits and components were manufactured but international co-operation seems to be essential to apply high-tech instrumentation supplied by the most advanced companies and institutions. The instrumentation and equipment concerned include vision apparatus, manipulators and navigation equipment.

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