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(EDITORS: A press conference will be held at 2:30 p.m. Wednesday, April 16, at 149 Sidney St., Cambridge, Mass., where Navy and M.I.T. officials will describe and demonstrate the controls and displays developed for the Deep Submergence Rescue Vehicle. You are invited to cover the press conference and make photographs of the system. Navy hydronauts in training at M.I.T. will be present to simulate various phases of rescue missions using the M.I.T. system. Call Bob Byers, extension 2705, for assistance and information.)

The precision control and navigation system that will enable pilots of the Navy's Deep Submergence Rescue Vehicle (DSRV) to maneuver their craft with only an inch or two of error, despite the inhospitable environment of enormous ocean depths, was unveiled Wednesday (April 16).

The system, known as the integrated displays and controls (ICAD), was designed and developed by Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass., for the Navy's Deep Submergence Systems Project Office, Bethesda, Md., and was exhibited and described by M.I.T. and Navy officials at a press conference at the Laboratory.

The DSRV will be used to rescue crews trapped aboard distressed submarines bottomed at depths as great as 3,500 feet or more. What makes the control system so critical is that the DSRV pilots must be able to attach their craft to one of the hatches on a distressed submarine with an accuracy of plus or minus only one inch.

To do this, the M.I.T. system provides virtually instantaneous coordination between human pilots, sensing mechanisms (sonar, television and inertial instruments), displays and controls, the central data processing unit, a digital autopilot and maneuvering mechanisms (a rotable shroud around the DSRV main propeller, water jets and a system of five tanks that exchange mercury to redistribute mass and control pitch and roll).

The DSRV vessel is being built for the Navy by the Lockheed Missiles & Space Co., Sunnyvale, Calif. The M.I.T.-built control, navigation, computer, autopilot and display equipment is being delivered to the Navy for installation in the first DSRV.

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The overall M.I.T. system for DSRV represents a further extension of the Laboratory's application of the latest technological developments to complex control systems that require interaction between human operators and sophisticated hardware.

The Laboratory originally developed SINS (Submarine, or Ship, Inertial Navigation System) which is standard equipment aboard all U.S. nuclear-powered submarines and permits automatic navigation without the need of surfacing to make star or radio fixes. Thus nuclear subs may remain submerged for days and weeks, escaping enemy detection.

The Laboratory also designed and developed the fully automatic guidance system for the Navy's submarine-launched Polaris missile -- equally independent of externally-generated guidance data and thus impervious to jamming. Now under development at the Laboratory is the guidance system for the Poseidon missile.

Much of the technology developed in these earlier programs has found application in the Laboratory's DSRV control and navigation work.

On-board computer handling of statistical uncertainties in position and velocity measurements is one area in which DSRV design draws heavily on Apollo and earlier Laboratory projects. When a measurement uses several methods to obtain position and velocity data, the various measurements do not always agree precisely. Extensive research under the Apollo program and earlier Laboratory projects resulted in development of mathematical methods of handling these uncertainties with on-board computers, and this earlier work was a boon to DSRV workers.

The field of inertial instruments -- gyroscopes and accelerometers -- is another area in which DSRV designers reaped important benefits from earlier work on Apollo and other Laboratory projects. Indeed, the inertial navigator in the DSRV system owes much to the predecessor Apollo inertial measurement unit.

The DSRV and Apollo systems do exhibit marked differences, however, mostly dictated by differences in mission and operating environment.

For one thing, several factors combine to impose on the DSRV system a requirement for greater information handling capabilities over shorter time intervals. DSRV needs continuous position and velocity measurements. Space vehicles, whose trajectories are predictable according to the laws of mechanics, do not. Moreover, DSRV pilots will not have access to radio updates or celestial fixes as astronauts do. The DSRV central processor had to be designed and programmed to integrate doppler sonar data, inertial instrument data and submerged beacon signals to produce continuous position and velocity readings.

Tight vehicle control is another difference. DSRV will be buffeted by ocean currents. Its target submarine is likely to be tilted to one side or resting on an underwater slope, or both. As DSRV closes with its target, water will flow faster in the narrowing gap between them, setting up a suction effect. Even the mere turning of the DSRV propeller will produce cross coupling in the direction of thrust that will tend to throw the vehicle to one side.

Despite these and other effects, DSRV pilots will need a control accuracy of only plus or minus one inch at the moment of final coupling with the target. A rescue bell extending downward from the DSRV must be placed precisely over one of the hatches of the distressed sub.

Because of the enormous complexity of control, DSRV engineers designed a separate digital differential analyzer system to function as an automatic pilot. In Apolio, autopilot functions are carried out by the central processor.

Despite the technologically advanced character of the DSRV navigation and control system, however, human operators are essential. DSRV maneuvering -- particularly during hover and closure -- cannot be done entirely automatically and man must be involved.

The DSRV consists of three eight-foot spheres enclosed in a submarine-shaped outer structure. The forward sphere is the control station for a crew of two or three. Center and aft spheres are passenger compartments for rescued survivors. The bell-like skirt, only slightly larger than the largest hatch on a submarine, is mounted on the underside of the center sphere.

The M.I.T. system consists of a miniature inertial unit and a densely-packaged computer linked to sonars, displays and controls.

The inertial unit is an inertial navigator. The inner member is stabilized by three gyroscopes. Measuring the forces that act on the inner member -- and, hence, the magnitude and direction of the DSRV's acceleration -- are two accelerometers. The gyros and accelerometers are the smallest inertial components the Laboratory has ever developed for a guidance, navigation or control system.

The computer, employing integrated circuits, is packed into a volume of approximately 13 x 10 x 17 inches, weighs 70 pounds and consumes less than 250 watts of power. Yet, it embodies a general purpose computer, a digital differential analyzer, a stable precision oscillator for split-second timing, power supply circuitry, and a modular unit that transfers data into and out of the processor.

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Forward-searching horizontal and vertical sonars feed the system information about terrain and obstacles. Narrow beam sonars above and below feed in altitude and depth data. Doppler sonar yields ground speed when the DSRV is within 200 feet of the bottom.

High-precision short range sonar and a closed-circuit TV camera inside the rescue skirt aid in tight control during docking. Two modes of short-range sonar are provided -- one used from 150 to 15 feet from the target hatch, the other -- of still higher resolution -- used during the final closure.

All information is processed through the M.I.T. system and presented to the pilots on a battery of oscilloscopes which can be switched to focus on specific data -- as in docking -- or can integrate data and present generalized information position, speed and terrain features ahead.

Floodlights, viewports, an external manipulator to clear debris, and a grappling hook and winch aid final docking. A pressure gauge inside the skirt verifies a water-tight seal. Since modern subs are nuclear-powered, a radiation detection system warns if radioactive contamination is present.

DSRV will reach the site of a downed submarine by air lift, on board a surface craft, or by riding piggyback underwater on a mother sub. On site, the DSRV will first run a grid pattern until the bottomed sub is located precisely, then close carefully for docking and transfer of survivors.

The original engineering model of the ICAD built by the Laboratory in developing the system is now being used in training Navy hydronauts and operators who have been assigned as DSRV crews. Digital and analog computers simulate the performance of a complete DSRV in its operational environment. A closed circuit television system that views a four-foot moveable model of a distressed submarine -- mounted against a background painted to resemble the ocean floor -- enables the crews to carry out simulated search and rescue missions. There are presently 16 Navy crewmen in training at M.I.T. -- three officers and 13 enlisted men.

Laboratory director and founder is Professor Charles Stark Draper, whose early work with gyroscopic instruments enabled him to develop the first inertial guidance system in the U.S. Deputy Director of the Laboratory for Navy Programs is Forrest E. Houston, a co-inventor of SINS. DSRV director for the Laboratory is Brian Cuevas, formerly associated with Polaris test programs. He succeeded Aldo De Simone, formerly a principal engineer in the Polaris navigation system development, who left the Laboratory to enter private business.

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V. R. DeMarco, who formerly worked with SINS and Polaris Guidance developments, is designer of the DSRV computing systems; Dr. Pierre P. Dogan is designer of the ship control; Arthur Gulovsen, who also contributed to SINS development, is the designer of the inertial navigation subsystem; Bernard Murphy is in charge of the integrated controls and displays development. These hardware designers are supported by a computer programming team led by Norman Napier, who also helped develop the SINS.

Professors Martin A. Abkowitz, of the M.I.T. Department of Naval Architecture and Marine Engineering, and Jacob L. Meiry, of the Department of Aeronautics and Astronautics, serve as DSRV consultants to the Laboratory.

Captain W.M. Nicholson (USN) is head of the Navy's DSSP office. Mr. Joseph A. Cestone is head of the DSSP Sensors and Ship Control Branch which has responsibility for the ICAD.

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