9. Electric and electronic systems

9.1 Automatic control

9.1.1 Joystick operating device
Joystick control system, which controls several actuators with one joystick lever such as main propulsion machines, rudders and etc, is recently installed on many domestic tankers and ferries for labor saving during arriving and leaving pier. Also research, survey and working vessels are required capability of precise position keeping during long period and maneuverability along predetermined course at constant speed. Position keeping control system with GPS or hydro acoustic position reference system, which measure ship position, is necessary to joystick control system for the above type of vessels. Mitsubishi Heavy Industry, Ltd. has deliver joystick control system and position keeping control system matched with any purpose and type of vessels, which are developed according to long term accumulation of ship motion characteristic data in shipyard, to ocean survey vessel, fishing survey vessel, working vessel, domestic tanker and ferry. Figure 1 shows Mitsubishi Heavy Industry's maneuvering system.

![Figure 1](image_url)

9.1.2 In-ship LAN system
It is important subject for high technology vessel such as survey and research vessels to use data collected from observation system onboard efficiently. One of effective usages of data must be joint ownership of any information onboard by ship’s LAN system.

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Ship's LAN system developed by Mitsubishi Heavy Industry centrally manages data collected from navigation system in the system under UTC time. The system has many functions based on know-how derived by building many special ships, which are preparation for navigation data in the system to research instrumentation and display of navigation information.

The system can prepare many functions applying to Internet technology, so that external personal computers carried by researcher from outside are easily connected to the system. Ship's LAN system can be a common platform for utilizing several information onboard commonly. As a result, Ship's LAN system can prepare more feasible network platform onboard.

However it is no meaning for ships isolated from outside if maintenance of the system becomes more complicated due to feasibility of the system.

Mitsubishi Heavy Industry prepares a platform for ship crews to be capable to recover the system by constructing network based on personal computers when the system has trouble.

E-mail is used for joint ownership with outside of ship and general information is collected through Internet.

Figure 2 shows example of ship’s LAN system.

Figure 2
9.1.3 Other automatic controls
Terasaki Electric co., Ltd. had developed WE300 oriented to compact size and cost save for bulk and medium tanker and WE21 oriented to total monitoring and control system for high graded ship such as large container vessel and tanker. Both systems have been used onboard.

Wire sharing data transmission system is applied to these system to assemble field data each module in the system including power unit are dual system and applied to hot-standby.
Start and stop of auxiliary machine, open and close of valve, stand-by sequence for main engine, start and stop of generator, automatic control of bilge plant, automatic control of ballast system and etc are controlled by programmable sequence function inside the system. LCD display (or CRT), keyboard, trackball, touch panel are prepared as man-machine interface.

[Keisuke Murata]

9.2 Electronics

9.2.1 VDR (Voyage Data Recorder)
Installation of VDR is compulsory for all passenger ships and cargo ships of 3,000 gross tons or more engaging in international voyages built 1 July 2002 or later, in accordance with the overall revised Convention of SOLAS (Safety Of Life At Sea) 2000 Chapter X, and also will gradually be compulsory for existing ships retroactively.

VDR is a recording system to store in memory and maintain such information concerning an incident at navigation as position, movement, physical status, command and control of a vessel including crew’s voice over the period leading up to, and following, an incident having an impact thereon. VDR is able to continuously maintain sequential records of pre-selected data items relating to the status and output of the ship’s equipment and command and control of the ship. VDR is used so that the cause of incident is investigated and measures are taken to counter recurring by means that final recording medium (capsule) should be recovered and the maintained data in capsule is replayed after the incident. This information is for use during any subsequent investigation to identify the cause(s) of the incident. To permit subsequent analysis of factors surrounding an incident, the method of recording should ensure that the various data items can be co-related in date and time during playback on suitable equipment and should be such that the timing of all recorded data items can be derived on playback with a resolution sufficient to reconstruct the history of an incident in detail. VDR is designed and constructed in accordance with international standards (IEC61996) acceptable to the International Maritime Organization (IMO), and complied with the requirements of for data security and continuity of operation. To be brief, VDR is equivalent to both of flight recorder and voice recorder for airplanes.

9.2.1.1 Constitution of VDR
VDR in marine use consists of following two components.
(1) Main processing unit
(2) Final recording medium (capsule)

Main processing unit is a permanent facility in ship including terminal board to collect information from many sensors, interfaces, signal converters etc. As for final recording medium, there are two types, one is floating type and the other is fixed type on ship. Each is manufactured on the different specifications from each other as required.

9.2.1.2 Data to be recorded
Following data shall be recorded by the requirements of Convention.
(1) Date and time
(2) Ship’s position
(3) Ship’s speed
(4) Heading
(5) Bridge audio
(6) Communications audio
(7) Radar data
(8) Echo sounder
(9) Main alarms
(10) Rudder order and response
(11) Engine order and response
(12) Hull openings (doors) status
(13) Watertight and fire door status
(14) Accelerations and hull stresses (where fitted with)
(15) Wind speed and direction (where fitted with)

9.2.2 AIS (Automatic Identification System)
As in the case of VDR, installation of AIS is compulsory for all passenger ships and cargo ships more than 300 gross tons engaging in international voyages built 1 July 2002 or later, in accordance with revised Convention of SOLAS 2000, and also will gradually be compulsory for existing ships retroactively. The Universal Shipborne Automatic Identification System (AIS) is a newly developed system to improve the safety of navigation. AIS communicates navigation data such as ship’s name, position, course, speed, etc. between ships, ships and coast stations on VHF channels using TDMA techniques and such information can be displayed on each panel.

9.2.2.1 General system constitution of marine use AIS device
AIS consists of following function blocks in general.
(1) VHF antenna
(2) Antenna changing/dividing unit
(3) TDMA/DSC transmitting unit
(4) TDMA receiving unit (Dual line)
(5) DSC receiving unit
(6) GPS antenna
(7) GPS receiving unit
(8) Control unit
(9) Display unit (including operating unit)
As main navigation data from outside, following inputs are necessary.
(10) GPS receiving signal (ship’s position, course over ground, speed over ground)
(11) Gyro signal (heading, rate of turn)
To begin with, AIS was developed from a need to know in advance the intended course of the other ship who was going to take after this, in such a navigation as the collision incident to ships around at sea will be probable, just like car turning indicator. And so AIS system was proposed to utilize DSC (Digital Selective Calling) of VHF band telecommunication that was popularly utilized for GMDSS distress alert, because almost ships were already provided with it. It was considered practical to let other ships around know the movement of the ship. This is the type of broadcasting and can communicate with automatic transmitting and receiving device to other ships around and near-by land stations and further can assist identification of the ship by simplified information exchange (without hand operation), can support following the targets and can provide information useful to collision avoidance.

[Shigeru Nakama]
9.3 Electric

As topics of marine electric technology in 2002, diesel-electric propulsion vessel and pod propulsion system were introduced, especially adoption of diesel-electric propulsion system to merchant vessels was highlighted. The diesel-electric propulsion system has been in the past adopted to special types of vessel such as large passenger vessel, working vessel, research vessel, etc., however expansion in the future to merchant vessel is expected, from viewpoints of maneuverability, space-wise and also from recent interest to environment problem.

9.3.1 Double acting tanker “TEMPERA”
Afra-max type tanker “TEMPERA” built at Sumitomo Heavy Industries, Ltd. is operated by electric driven pod propulsion unit with azimuthing installed at stern of the vessel and is designed to sail with bow ahead in open water and to navigate stern first in ice sea conditions utilizing bow propeller effect, and is introduced to have excellent ice sea maneuverability.
The vessel is a diesel-electric propulsion vessel with one set of electric driven pod propeller, and 4 sets of main generators are installed to supply to propulsion electric motor, high voltage (6,600 V) and low voltage (440/230 V) equipment. Bus bars of high and low voltage distribution system are divided into two sections for redundancy of power supply.
Electric driven pod propeller consists of pod with built-in electric propulsion motor and fixed pitch propeller, and fitted to the hull body with strut. Electric propulsion motor is 16,000kW rated output and dual windings type stator coil to avoid tripping motor due to failure of one winding of stator coil. Deck machinery, ballast pumps, cargo pumps, and stripping pumps installed in this vessel are of electric motor driven type to consume electric power effectively.

9.3.2 Coastal chemical tanker “Sensho”
It is introduced that Nakatani Shipbuilding Co. delivered coastal chemical tanker with electric driven propeller for the first new-building in Japan. 2 sets of pod propeller which are of L type propulsion system with controllable pitch propeller (CPP), are installed at stern of the vessel and are driven by constant speed motor installed in steering gear room through vertical shaft and gearing. Outline arrangement of the system is shown in Figure 9.3.1.

Figure 9.3.1 Arrangement of propulsion system

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3 sets of main diesel generators are provided, supplying electrical power to propulsion system during navigation and also to bow thruster, and to 6 sets of deep well type cargo pumps and other cargo handling equipment.

Considering to the fact that the vessel is a coastal vessel operated by small number of crew, maintenance works of electrical equipment can be carried out onboard by installing constant speed electric motor in steering gear room. Accordingly, maintenance works for electronic devices for control such as inverter, etc. are reduced compared with pod propelling system containing variable speed motor as used for passenger vessels.

The vessel is provided with land base machinery monitoring system utilizing data communication through INMARSAT, and it is possible to monitor always from land necessary conditions of engine during operation.

9.3.3 Others

Drug suction dredger and oil recovery vessel “Hakusan” built at Ishikawajima-Harima Heavy Industries Co., Ltd. is an diesel-electric propulsion vessel provided with controllable pitch propeller type azimuth thruster with nozzle. This vessel can turn at the point and run sideways together with bow thruster, and has excellent maneuverability during dredging in narrow channel. Further, motor speed for dredging pump and recycling pump is controlled with inverter to be capable of optimum operation during dredging work.

The motor of pod type electric driven propeller by Siemens AG adopts permanent excited synchronous motor. Standard permanent magnets are arranged on the rotor of this motor and take place of conventional excitation windings. And no external forced cooling system is necessary for inside of pod and cooling of internal stator coil is achieved by the surrounded sea water only. Thus this system designed small and compact body.

Pod type electric driven propulsion system is under development also in Japan. Kawasaki Heavy Industries, Ltd. has been developing azimuthing pod type propelling system “Podpeller” adopting smallest class induction motor in the world. (It was announce in March 2003.) The motor for driving propeller is installed in the pod, and speed of motors for propeller driving and azimuthing is controlled with inverter.

[Tetsuro Kajita]