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Ship information system: overview and research trends

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ABSTRACT: *Ship Information Systems (SISs) have been one of the main research focuses in ship design and become a multidisciplinary area. With these growing research trends, it is important to consolidate the latest knowledge and information to keep up with the research needs. In this paper, the SIS and its different forms are introduced and discussed. The beginning of this paper discusses the history and evolution of SIS. The next part of this paper focuses on different fields and research areas such as networking technology, information fusion, information decision, message display, ship control in real-time SISs. A Semi-Physical Simulation Platform (SPSIM) designed for SIS research and its running effect through a new Fuzzy-PID fusion algorithm are introduced in this paper then. A brief literature survey and possible future direction concerning each topic is included.*

KEY WORDS: Ship information system; Ship networking technology; Ship motion cooperative control; Semi-physical simulation platform.

INTRODUCTION

With the development of ship technology, the ship system tends to be integrated and distributed. Although different ships have different functions, all definitions found in literature for a Ship Information System (SIS) have one key feature in common. This defining feature is that SIS is composed by several independent subnets (sensor networks, display networks, etc.) and a total ship communication network which can exchange information (reference input, plant output, control input, etc.) among subnets and systems. (Fig. 1)

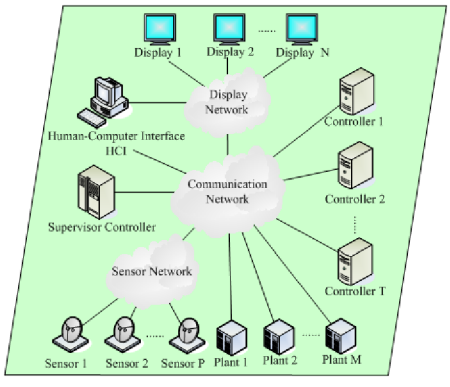

Fig. 1 Typical structure of SIS.

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Historically, electronic communication aboard ships used point-to-point wiring to exchange information. Due to the recent rapid increase in the number and type of shipboard electronic devices, wiring a ship had become a logistics nightmare. In this case, shipbuilders and vendors of marine electronics replaced old-style wiring with modern local area networks. Martin et al. summarized and analyzed some early naval data handling systems such as Shipboard Data Multiplex System (SDMS) and distributed switch system "SITACS", these systems can be treated as transitions to the SISs (Martin and Richard, 1984). Later Robert et al. developed a real-time messaging system for token ring networks (SHIPNET) which is currently operation in a shipboard environment (Simoncic et al., 1988). This system conforms to the IEEE802.2 LLC and 802.5 token ring standards and emerging SAFENET (Andersen et al., 1990) specification. SAFENET stands for "Survivable Adaptable Fiber optic Embedded NETwork". It is a real-time information transfer system jointly developed by industry and the U.S. Navy. SAFENET is a connectivity and flexibility system which allow for graceful evolution to fully distributed system architectures. Later, with the advent of networking technologies, supervisor controller systems are introduced into ship systems. C3I (Command, Control, Communication & Intelligence) systems is one of the most significant achievement in supervisor controller systems. And for this, Thomsett (1993) summarized some common C3I systems such as MHS and OSIS.

With the further development of SIS, it is mainly divided into three parts. Each part has different focus. The first focus is communication system, it provides ship system facilities required. RICE 10 is the Royal Navy's first digital internal communications system (Lister and Rosie, 1995). Within RICE 10, mainly broadcast and ship's alarms are totally integrated into the primary system. It uses nodes for routing which is also used in after systems, such as Ship System 2000 (Källberg and Stråhle, 2001). The second is display network, it works as a subnet for translation information to the displays. Gold and Suggs (1998) introduced a local area network which is used in Navy tactical display communication system. This system adopts central data buffer and fiber distributed data interface to exchange radar video signal. The last part is sensor network. Monitoring system (Staroswiecki et al., 2004) and navigation system (Murphy, 2004) are representative sensor networks in ship.

Later, with the development of ship intelligent, network scale gets a further extension. The ship control/monitoring systems (Integrated Bridge System, Standard Machinery Control System and Integrated Condition Assessment System, etc.) that are able to be linked together by the ship wide area networks and fiber-optic backbone as a smart ship which was introduced by Young and Gubbins (1997). Such technological advances make it possible to have a total real time control of ship (Geer, 1998). Recently, Raytheon Company's Total Ship Computing Environment (TSCE) is one of late-model SIS which is designed to connect all Zumwalt (DDG 1000) systems by creating a shipboard enterprise network that integrates all on-board systems.

SIS BASIC

The basic capabilities of any SISs are information acquisition (users / decision system / sensors), command (controllers / users), display (monitor / HCI), network, and control (actuators). In broader terms, SIS research is categorized into the following two parts.

1) Information transmission. Studying and researching on networks and communications to make them suitable for exchange information, communication type, redundant, etc.
2) Information processing. These deal more with ship system design over the SIS to optimization data collecting and publishing information such as information fusion, information decision, message display and ship control (Martins and Lobo, 2011).

SIS RESEARCH TOPICS AND TRENDS

SIS communication type and method

An information network is the backbone of the SIS. Reliability, ease of use, security and availability are the main issues while choosing the communication type.

The world's first operation packet switching network is ARPANET which is developed by the Advanced Research Projects Agency of the U.S. Department of Defense in 1969. And it can be also regarded as the predecessor of the Internet. Earlier SISs always used some similar networks such as SHIPNET. Later fieldbus technology is introduced in the SIS. It is a generic term which describes a modern industrial digital communication network intended to replace the existing 4-20mA (or 0-5V) analog signal standard. Controller Area Network-BUS (CAN Bus) is one of the commonest fieldbus, which is a serial asynchronous