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Use of Sensor Network for Real-time Monitoring Systems in Ships and Offshore Structures

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ABSTRACT

Monitoring systems typically employ many numbers of various sensors, with very complex wiring among them. Due to the complexity in wiring, maintenance and changing sensor configurations after they are installed, wireless sensors receive much interest, which are expected to provide more convenience. However, wireless communication in an environment composed of steel structures and many obstructions, as it is the case in ships and offshore platforms, is very difficult and often lead to short communication range or redundant systems to achieve the level of reliability required for monitoring systems. In this paper, wireless communication in steel structures is tested with emphasis on its expected performance on ships and offshore platforms, and recommendations for composing efficient sensor network are proposed. In addition to wireless communication, PLC (Power Line Communication) is also tested as a suitable complement to increase reliability of sensor network where wireless communication is limited without the complexity of conventional wired network.

KEY WORDS: Wireless sensor network; power line communication; monitoring system.

INTRODUCTION

Monitoring systems typically employ many numbers of various sensors, with very complex wiring among them. Some of these sensors form a network, in order to generate more intelligent information and to be managed more efficiently. Due to complexity in wiring maintenance and changing sensor configurations after they are installed, wireless sensors receive much interest, which are expected to provide more convenience.

Wireless sensor network (WSN) has received noticeable attention recently. WSN has the structure where several sensor networks are connected to an external network through a gateway. The sensor nodes send data to nearby sink node, where data from each node is accumulated and transmitted to a gateway. The data transferred from the gateway can also be transmitted using satellite communications, and wired or wireless networks. USN(Ubiquitous Sensor Network) technology has achieved significant growth because of Ad-Hoc network technology and standards of routing protocol. Especially, wireless communication technologies such as WLAN (wireless LAN), ZigBee and Bluetooth came into the spotlight in constructing efficient wireless networks. On the other hand, wireless communication has many limitations in being applied to vessels such as multi-pass or screen of radio wave due to the steel structure in a vessel because it mainly uses GHz frequency region. As these problems can reduce the reliability of data transmission or recognition, it is necessary to prepare backup plans such as variations in network topologies, addition of repeaters or relay antennas. Recently, a new communication technology RuBee (IEEE 1902.1) using low frequency below 450KHz is introduced and expected to give retailers and manufacturers an attractive alternative for many applications. Since it is less prone to be subjective of harsh environment composed of liquid and metal, it is expected to be more adequate to marine vessels. However, no product based on this protocol is yet available and the most widely used protocol up to now is Zigbee.

In this paper, wireless communication using Zigbee protocol in steel structures is tested with emphasis on its expected performance on ships and offshore platforms, and recommendations for composing efficient sensor network are proposed. The test was carried out both in small scale steel structured testbed and inside various compartments of a 3500t training ship. In addition to wireless communication, PLC (Power Line Communication) is also tested as a suitable complement to increase reliability of network where wireless communication is limited without the complexity of conventional wired network. The tests show promising results for application of sensor network to ships and offshore platforms. However, several issues are identified in deploying sensor network, especially in case of PLC, which depends much on the power system layout of the ship or platform. These issues are addressed with recommendations on how to deploy sensor network as the conclusion.

TESTBED EXPERIMENT

Testbed Setup

Testbed is composed of three steel containers as shown in Fig. 1. Except the container themselves, there are no other steel structures or equipments inside containers, which can be interpreted as an ideal condition for communication. Two of these containers have small windows and the other one has no window such that it can form a