An Experimental Study of RFID Adoption for Maritime Activities

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***Abstract*—Recently, Radio Frequency Identification (RFID) system is adopted to identify various objects in our real life. Key advantages of RFID system are to identify objects without physical contact, and to write arbitrary information into the tags. We believe that these advantages can improve safety and efficiency of maritime activities. However, RFID adoption of maritime activities has not been considered in previous works. It is not cleared whether a generic RFID system can be adopted for maritime activities because the system is assumed to use in a stable environment such as indoors. In this paper, we investigate the feasibility of adoption of a generic RFID system for maritime activities. For our motivation, we evaluate the performance of RFID system on the sea by measuring Receive Signal Strength Indicator (RSSI) of RFID system between ships.**

***Index Terms*—Radiofrequency identification; RFID tags; Marine safety; Marine accidents.**

I. Introduction

Radio Frequency Identification (RFID) system is adopted to identify objects such as passengers in public transportation system [1], products in stock management [2] and vehicles in container terminals [3]. Generic RFID system consists of three functional components, which are RFID tag, RFID reader and data processor. In contrast to 2-dimentional barcodes such as matrix codes, RFID system uses wireless radio waves to identify objects without physical contact or line of sight between readers and tags. A RFID tag can store some of arbitrary information including the ID information. Each object can be uniquely identified by attaching a distinct tag, and multiple tags can be read at the same time. RFID tag is mainly categorized into two types; active and passive. The passive type tags do not need the electric power to operate and are comparatively cheaper than the active type. In contrast, the active type tags have longer communication range than the passive ones. In [4], authors considered an efficient container management by using a generic RFID technology with passive-type tags. Moreover, authors in [5] proposed a fisher boat tracking system by combination of RFID system and Global Positioning System (GPS).

These advantages of RFID system mentioned above may improve maritime safety and efficiency of maritime activities. For example, there are lots of aquafarming rafts in maritime area, and these rafts are managed by fisheries cooperative associations. Generally, the holder information of a raft is displayed on a physical label attached directly on each raft. To investigate the holder of the raft, we need to transfer from a ship to the raft on the sea. If the label can be replaced by a RFID tag, we can obtain the holder information from a ship that is away from the label without transferring to the raft. This system can apply not only to aquafarming rafts but also ships, and can decrease the opportunities to transfer to rafts or ships. As a result, accidents on the sea can be reduced.

Furthermore, RFID system can be applied to investigation of flotsams. Since the introduction cost of passive-type RFID tag is comparatively low, we can manage many flotsams uniquely and continuously by attaching a passive-type tag to each flotsam even if there are a number of objects that should be managed. In particular, a massive number of flotsams were generated by the Great East Japan Earthquake, which occurred in March 11th, 2011. A lot of rescue teams, including the Coast Guard officers, the Self-Defense Forces and volunteers, have searched the flotsams to find survivors. However, the flotsams generated by the earthquake are too many to search efficiently, and the same flotsam has been checked many times by different rescue teams. If we attach a RFID tag, in which the search information is stored, to flotsam already checked, the efficiency of search may be improved.

However, RFID adoption of maritime scenes and activities has not been considered in previous works. It is not cleared whether a generic RFID system can be adopted for maritime activities because the system is assumed to use in a stable environment. In this paper, we investigate the feasibility of adoption of generic RFID system for maritime activities. For our motivation, we evaluate the performance of RFID system on the sea by measuring Received Signal Strength Indicator (RSSI) of RFID system between ships or boats.

The paper is organized as follows: The details of our experiment and measurement settings are shown in Section II. The results of our experiment are denoted in Section III. Finally, we conclude this paper in Section IV.

II. Overview of our experiment

Here, we describe the RFID system we adopted in this experiment, and show how we measure the RSSI to evaluate the availability of RFID system.

A. RFID system

We use a generic RFID system so that a lot of people can adopt the system easily. Our reader/writer device is MITSUBISHI RF-RW311, and the antenna is MITSUBISHI RF-ATCP012. The device and the antenna are connecting via a coaxial cable. The specifications of these devices are shown in Table I. We can obtain the value of RSSI from the laptop connected to the reader. We prepare two passive tags to measure RSSI from the antenna; Omni-ID Ultra and AD-380iL. Omni-ID tag has long read ranges of up to $35\,\mathrm{m}$, and AD-380iL is a label-type tag with ranges of up to $5\,\mathrm{m}$ that can attach on various materials such as ID cards.

TABLE I: SPECIFICATIONS OF RFID TAGS

(a) Omni-ID Ultra

Frequency	860 ∼ 960 MHz
IC	Alien Higgs H3
Standards	EPC C1 G2
Dimensions	210 mm × 110 mm

(b) AD-380iL

Frequency	860 ∼ 960 MHz
IC	NXP UCODE G2iL
Standards	EPC C1 G2
Dimensions	50 mm × 30 mm

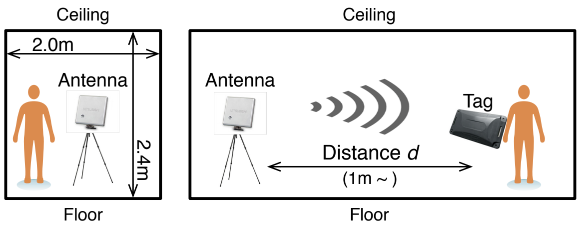


Fig. 1: Measurement environment in indoor corridor

B. Measurement environment

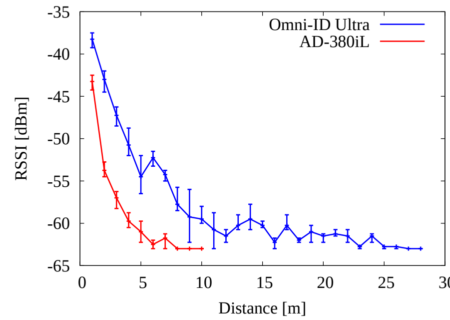
To establish a measurement system for experiments on the sea, we measured RSSI of RFID system tentatively in three cases; *indoor open space*, *indoor corridor*, and *outdoor open space*. As an example of our measurement environment, Figure 1 shows the measurement environment in the indoor corridor. We measure RSSI between the antenna and the tag with changing the distance to show the availability of RFID system. In addition to the value of RSSI, we also check whether the tag can be identified correctly in each distance. To clarify impacts of the distance and environmental factors on performance of RFID system, we mainly focused on the value of RSSI in this paper. We plan to take these systems on board, and measure RSSI between the antenna and the tag that placed on another ship on the sea.

III. PRELIMINARY RESULTS

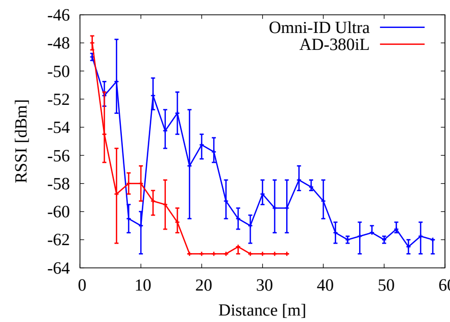
Our RFID system can identify the tag until the value of RSSI is $-63\,\mathrm{dBm}$. Figure 2 shows the variations of RSSI measured in each environment. The horizontal axes are the distance d between the antenna and the tag, the vertical ones are the value of RSSI. As seen in Figures 2a and 2c, the values of RSSI decrease in a monotone manner. By using Omni-ID tag, we can obtain the tag ID up to $28\,\mathrm{m}$ at indoor open space, $24\,\mathrm{m}$ at outdoor open space. In case of AD-380iL, the maximum distance at indoor open space is $10\,\mathrm{m}$, and the one at outdoor is $4\,\mathrm{m}$. Moreover, the result in indoor corridor shows that Omni-ID tag has longer ranges of up to $60\,\mathrm{m}$. We consider that this is caused by the reflected wave from the ceiling, the wall, and the floor because the corridor is a closed space shown in Figure 1. Our preliminary results show that the performance of RFID system is obviously affected from the surrounding environment. Thus, we should perform measurement experiments on the sea.

IV. CONCLUSION

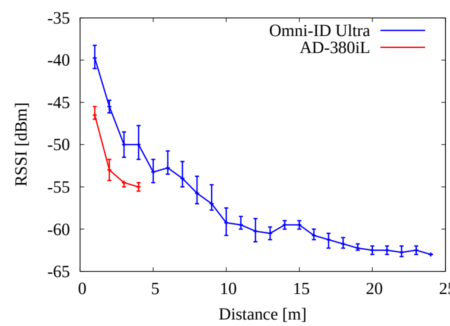
We have performed some experiments of measuring RSSI of a generic RFID system in indoors and outdoors on the ground. As a result, the performance of RFID system is obviously affected from the surrounding environment. Now, we plan to perform measurement experiments on the sea in near future.



(a) Indoor open space



(b) Indoor corridor



(c) Outdoor open space

Fig. 2: Variation of RSSI

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