Development of design technique for the performance improvement of ConTracer

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***Abstract*— CSD is the typical device to ensure container security based on active RFID. The requirement for CSD has been provoked by the U.S department of home security(DHS). It is designed to be mounted inside the container to sense the status of the container door. ConTracer is the CSD which is developed by ICC of Dong-A university in Korea. It has major features sensing door status as well as the inside conditions of container such as temperature, humidity, and shock power. ConTracer uses 2.45GHz frequencies for RFID. This paper focuses on container door sensing technique. For performance improvement ConTracer, We propose efficient design method using reed sensors and provide the containers door test results.**

***Keywords*— ConTracer; Container Security Device(CSD); Advanced Conveyance Security Device(ACSD); Active RFID; eSeal**

I. INTRODUCTION

Active RFID(Radio Frequency Identification) has longer recognition distance compare to passive RFID and easy to apply to metal material which makes it easy to utilize in port and inland logistics transportation management system and container security area.

According to the statistic data[1] from Drewry in 2008, total global container port freight volume is 586,930,000 TEU(Twenty Feet Equivalent Unit). North America port freight volume is 49,670,000 TEU, and the U.S reinforced its logistics security system in omnidirectional way to fundamentally block the terror threat against its country by establishing DHS (Department of Homeland Security) which generalizes safety and security jobs, and series of Maritime Security Act, SAFE Port Act, 9.11 Anti-Terrorism Implementing Recommendation Law. Especially, it signed the law which requires security device, which is recognized by US Customs Office and which can confirm that the container door is not opened during transportation, shall be mounted to all the containers into the country from 2012. In addition to the U.S, EU reinforced logistics security by establishing 'Shipping and Port Facility Security Regulation' which mandates even the International Maritime Organization (IMO) Recommendations of ISPS(International Code for the Security of Ships and of Port Facilities) Code. Also, it continues efforts to reinforce logistics security by legislating the logistics security regulation which is focused to World Customs Organization's (WCO) SAFE Framework, the business security system, and by establishing and operating import freight search system.

This is current trend of advanced countries around the U.S and Europe that they expand investment for related R&D such as developing electronic seal system, smart container technology and standardization as well as market promotion to reinforce security measures while preventing the obstruction in logistics flow.

The representative electronic security devices for freight container are eSeal(Electronic Seal) with Active RFID technology, and CSD (Container Security Device).

eSeal is mounted to the freight container's door. It senses abnormal opening of the container door and inform it to the reader close-by, and maintain its history.

CSD senses freight loss, theft and intrusion into the container when mounted inside the container. There is no standard for CSD as of now, and U.S DHS issued technology specification which is required by Customs & Border Protection(CBP) [2]. According to this specification, foreign companies such as GE centred Commerce Guard and Savi from the U.S and CIMC from China are progressing R&D activities. But there is no product developed to compete with foreign products up to now in severe competition situation by many other foreign companies.

Therefore, this research surveyed electronic security device development direction, and compared the CSD device developed by this research with other company's products which meet DHS CBP requirement specification. [3], [4]. The CSD device developed by this research is named ConTracer. Establish CSD system using the ConTracer, and implemented it to container freight between Korea and China to evaluate the system performance for validating the reliability of this research [5].

This paper is composed as follows. Related Research in Chapter II surveys development trend of electronic security device, compare and analyse container security products. Chapter III explains ConTracer and CSD system using

ConTracer. and evaluates the performance of container door sensing. Chapter IV gives conclusion.

II. Related Research

This chapter surveys development trend of electronic security device, compare and analyze container security products developed by other companies and ConTracer developed in this research.

Figure 1 shows the development trend of Seal used in containers. One or more traditional bolt barrier "Seal" of plastic or metal "Seal" has been used as door hasp mechanism has been used since the early period of container freight logistics. With development of IT technology and emphasized importance of container security since 2000, eSeal is developed which is mounted to the container door and senses abnormal opening of container door using active RFID technology.

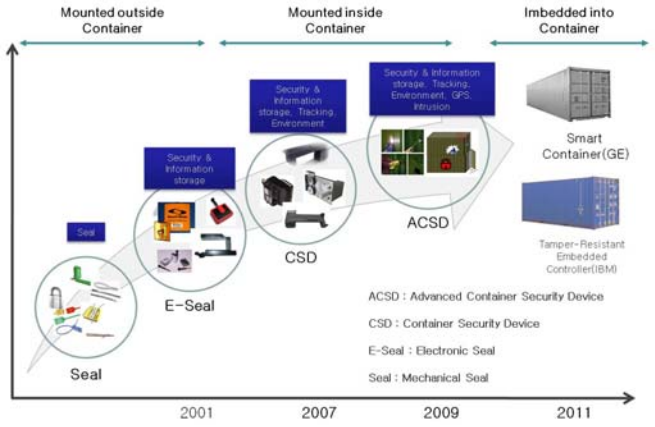


Figure 1. Trend of Container Security Device

But eSeal is mounted outside container door, has disadvantage that it is fragile and is not reusable.

CSD development became serious according to the CSD requirement document published by US DHS in 2007 which is mounted inside container to detect illegal opening of container door, and can be reused. Currently, ACSD(Advanced Container Security Device) is under developing which is advanced version of CSD, and enables container inside monitoring and illegal immigrants monitoring as well as illegal door opening. Future evolution will be intelligent container with embedded ACSD instead of mounting it to the container.

Device characteristics of ST-675 from Savi and CSD from GE Security are developed current container security device. These two devices can be utilized in container security related area such as CSI and SAFE Port Act, C-TPAT, 10+2 Regulation of U.S DHS. The Savi ST-675 is an active RFID container security tag with intrusion and environmental sensors.

The ST-675's sensor arm detects the open/closed state of the shipping container door, and the intrusion light sensor monitors the amount of light entering the container.

These intrusion sensors detect potential theft or tampering. The temperature, humidity and shock sensors monitor environmental conditions to prevent spoilage and damage to goods. The ST-675's unique C-clamp door-mount design places the sensitive RFID components inside the shipping container.

Only the low profile, external antenna casing is on the outside of the container, which significantly reduces the risk of tag damage during the loading, unloading and transportation of shipping containers.

The CommerceGuard CSD is built to be affordable and engineered to be secure and trustworthy. It is located inside the container for protection from tamper attempts, from being dislodged or knocked off, and from the harsh maritime environment.

Data communications are coded with AES 128-bit encryption technology, the same technology that secures international banking transactions. The CSD communicates at the 2.4GHz frequency, globally available without special governmental licensing. It is reusable, with a long battery life, allowing the cost of hardware to be amortized over several years.

III. ConTracer Introduction

ConTracer which is developed by this research is developed to comply with U.S DHS's CSD. It uses frequency of 2.4GHz. 2.4GHz adapts O-QPSK modulation. It has less than 3.6mW output with more than 100m recognition distance between reader and tag. It is mounted between container wall and door using magnet, senses container door opening using micro-switch. It is equipped with temperature, humidity and shock sensor to detect the container status during transportation and provide history. ConTracer is mounted inside the container, has less risk of damage, reusable and has long recognition distance of more than 120m. ConTracer solution established using ConTracer which is developed in this research. This ConTracer System complies with U.S DHS's CBP requirements. And the system used 2.4GHz frequency, fixed type Reader which performs RF communication frequency, Control Program which manages Reader, and DCP(Data Coordination Point) which stores information received from ConTracer.

3.1 Introduction of ConTracer

Figure 2 shows each part of ConTracer components developed in this research. It is composed of reed-sensor to detect container door, Main Board Mounting for temperature, humidity and shock sensor, and 2.4GHz RF Module Mounting.

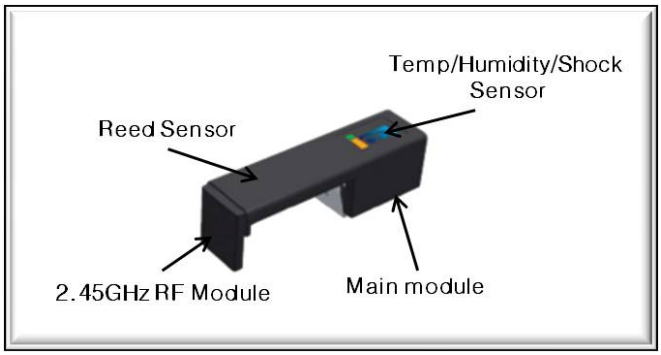


Figure 2. Description of ConTracer



Figure 3. ConTracer Mounting Location

ConTracer developed in this research is designed and manufactured to fit to all Dry containers which complies with DHS requirements and ISO 668[6] Standard. As seen in Figure 3, it is mounted in the gap between container wall and door at proper height using fixing magnet. Figure 4 shows door status sensing method based on DHS RFI.

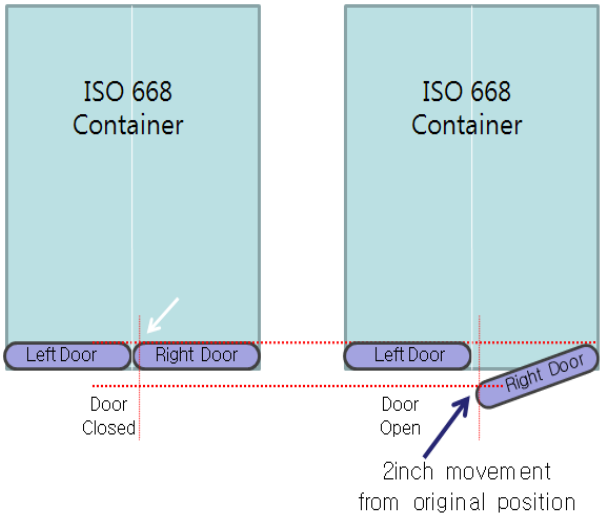


Figure 4. Door Status Sensing Requirements

3.2 Container Door Opening Detection by ConTracer

ConTracer is mounted at the gap between container door wall and door, mounted using fixing magnet. It detects container door opening within 2 seconds by pressing micro-switch using the slider attached to wall when the door opened more than 2 inch. The accuracy of door opening detection is above 95%, and it is designed to operate in severe port environments specification in ISO 10374[7] standard. When ConTracer is attached to container door, Principle of operating ConTracer shows figure 5.

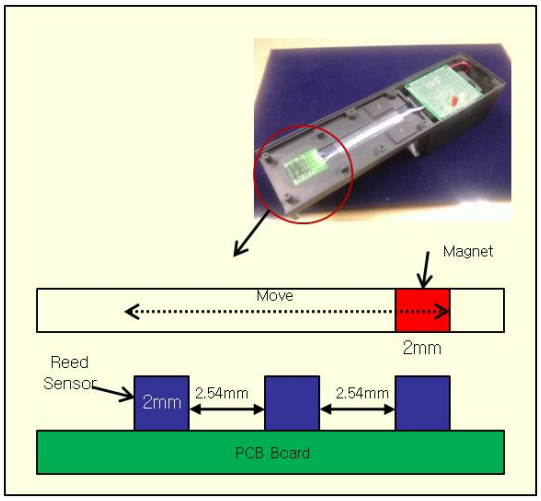


Figure 5. Principle of Detecting Door Opening by ConTracer

Container door Sensing test was performed to group the manufactures. The following results were obtained : It was found from the result that developed sensing design meets with CSD RFI Requirements.

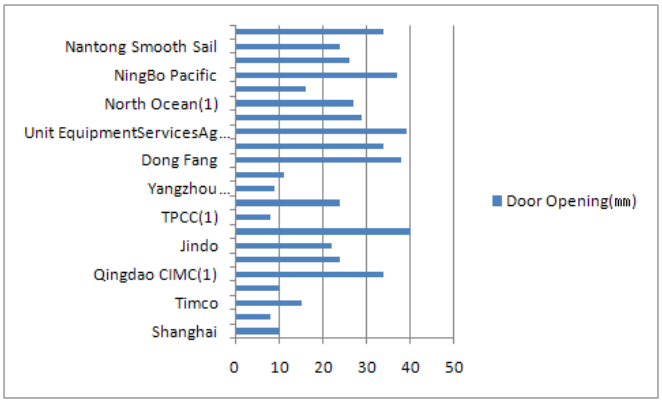


Figure 6. Door Sensing results of container manufactures

IV. CONCLUSIONS

This paper introduced the development stages of container security device, and investigated container security devices whose design and manufacturing are based on Active RFID. It also introduced ConTracer which is developed in this research and complies with CSD requirements published by the U.S

Department of Homeland Security(DHS). ConTracer is mounted at the gap between container wall and door using magnet. It detects door opening using reed sensor, equipped with temperature/ humidity/ shock sensors to detect transportation status of container and provide its history.

In summary, this paper focuses on container door sensing technique. For performance improvement ConTracer, We propose efficient design method using reed sensors and provide the containers door test results.

Future projects would be ConTracer mounting location to solve recognition instability problem when the container is filled with steel freight, DCP interlocking problem for data transmission to server, RF performance environment interference of ConTracer in steel structure which were found from the international demonstration service results. Also, we will take performance evaluation through domestic and international demonstration service between Korea and China.

ACKNOWLEDGMENT

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