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Container Monitoring System

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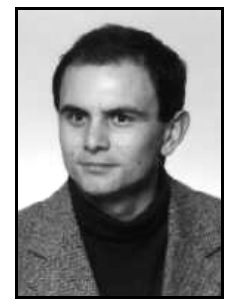

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Abstract

In the following paper the architecture of the planned container monitoring system in Polish harbours: Gdansk and Gdynia, the concept of the smart container module (SCM) and its main operational features are presented.

Keywords: cargo monitoring, security systems.

System Monitorowania Ładunków Kontenerowych

Streszczenie

W pracy przedstawiono koncepcję systemu monitorowania kontenerów przewożonych drogą morską. Scharakteryzowano główne cechy oraz przedstawiono modułowo-warstwowy schemat funkcjonalny. Ponadto opisano założenia funkcjonalno-użytkowe dotyczące Inteligentnego Modułu Kontenerowego (SCM), będącego podstawowym elementem składowym systemu. Przedstawiono również główne zadania projektowe związane z realizacją projektu

Słowa kluczowe: monitoring ładunków, systemy bezpieczeństwa.

1. Introduction

Every year, more than 350 million containers are freighted by ships all over the world and the container traffic is one of the most dynamically developing branches of maritime transport. Unfortunately less then 2% of containers are under strict supervision, and there is a possibility to follow container's route from loading point to its destination. Limited knowledge about container's content creates a gap for illegal and terrorist activities. Therefore, to resolve the container harbours security problems, the automatic monitoring system of container's contents and the smart container module for monitoring and measurements are needed. The permanent monitoring of each container via satellite systems is a very important part of maritime security and should be implemented in the near future.

2. The monitoring system concept

The concept of the monitoring system is based on the wireless radio transmissions of the information data from every container box located onboard of a ship to the security data base. To obtain this information, each container freighted by a ship should be equipped with the smart container module. The large number of container boxes onboard of a ship forces necessity of implementation specialized ship wireless network connected to a ship controller with ship's data base. On demand, all containers should send required data to the controller which stores them in a ship data base. In predetermined time intervals when at sea and at the entrance to the harbour a ship's transponder transmits important data to the local or global security data base. Transmission to the local (port) security data base would be done via land wireless systems networks (VHF/UHF) and transmission to the global data base, for example to the Long Range Identification and Tracking system (LRIT) [4], would be made via satellites networks. It is obvious that the cooperation between the port security system and the global security system (i.e. LRIT) should be arranged. The cooperation between homeland security systems of several harbours in one country is also advisable. On Figure 1, the concept of a container monitoring system is presented.

Ship's environment is unique and very difficult for radio transmissions. The radio transmission onboard of a ship requires application of a system resistant to the different electromagnetic interferences and providing reliable communication over bad radio channels, for example spread spectrum system i.e. Direct Sequence Code Division Multiple Access DS-CDMA [3]. The CDMA system allows multiple use of the allocated radio spectrum by deliberately spreading the spectrum occupied by each user (smart container module) with high-speed code word unique to that user (container). The spectrum spreading technique in DS-CDMA is achieved by multiplying the narrowband information (user data) by much wider spreading signal which is usually a pseudo random noise sequence, and the transmitted signal is modulated by a waveform which is not related to the transmitted information. This feature of the CDMA makes

possible easy container identification by different spreading sequences assigned to each container box and the modulating waveform determines the final bandwidth of the transmitted signal. At the receiver the original user data may be recovered by correlating the demodulated waveform with the original spreading code. All other signals remain fully spread and are not subject to demodulation. It could be concluded that deliberate spreading of the spectrum of a signal is wasteful. However, spreading the signal bandwidth by some factor lowers the signal power spectral density by the same factor.

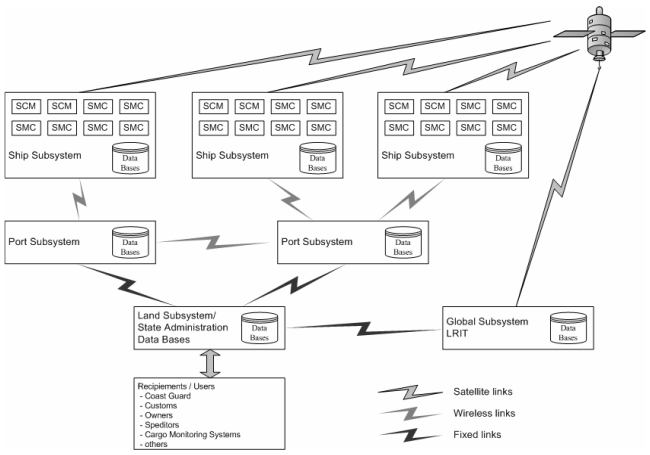

Fig. 1. The concept of the Container Monitoring System
Rys. 1. Koncepcja systemu monitorowania kontenerów

3. The Smart Container Module

The Smart Container Module (SCM) is one of the most important components of the monitoring system, because determining possible threats inside the container can help to localise and neutralise them before they can be dangerous for people, ships and/or ports. The module should be composed of a measurement unit with different sensors and a radio unit, both controlled by the smart processor and operating algorithm. Software for the processor should also be designed, for example in the Software Defined Radio technology (SDR) [2]. The flexibility of the module will enable monitoring and measurements of certain parameters of the container inside. For this purpose the module should be equipped with different sensors inside of the container box [1], depending on a character of the freight, for example: temperature, pressure, humidity, movement (to identify the states of opening/closing of container, movements in the box), possible presence of gases or radiation, etc. It is also important to localise a suspicious containers and every module should be also equipped with a built-in satellite navigation receiver (GPS/Glonass/ GALILEO). The basic information (the travel documents) of the cargo, its content, loading point, destination and additional data should be stored in the module memory and every time it is needed, should be sent to port/ship security service via wireless radio access link. To assure possibly the most efficient data transmission over the radio channels from the module to the port/ship radio base stations, connected to the security data base, the following technical parameters of the radio unit should be designed: frequency band, modulation method, information code system, access scheme, radio network protocols and radio link power budget parameters. It is obvious that the module should have a very small electric power consumption to assure failure-free work of module for a long period of time. Also, very important is the compact construction, which means dimensions of the module as small as possible. Furthermore, the module should be protected from environmental factors impact (for example water-proof, etc.) and should be temper proof with automatic alarm transmission possibilities. To increase possibility of the implementation of the container monitoring system in the future, it is crucial that the container module should be inexpensive. It forces the low costs of the serial production with the preservation of all functional parameters at possibly high level. As we can see, the design of the smart container module will be a complex task. On a Figure 2, a simple diagram of the smart container module is depicted.

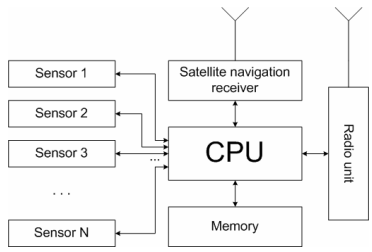

Fig. 2. The smart container module diagram
Rys. 2. Schemat funkcjonalny inteligentnego modułu kontenerowego

4. Main designing challenges

Before implementation of the Container Monitoring System in Polish Harbours of Gdynia and Gdansk, it is needed to specify the propagation factors in the different ports areas. It can be easily done by an analysis of the electromagnetic field measurement results. The estimated propagation models in these areas will be very helpful in designing of the efficient radio infrastructure for the monitoring system. Another significant issue is design of the smart container module prototype with an open architecture, so that its functionality could be easily enhanced in the future without necessity of major modifications of the module hardware. The module prototype will be tested in the real environment and the CMS design will be verified. Finally, it is of a vital importance to built a wireless network onboard on the ship, resistant to the strong interferences and compatible with the other ship's systems, protocols and interfaces used for communication of the ship data base with local, homeland or global security data bases.

5. Conclusion

The results of this project will be used for implementation of the real-time Container Monitoring System in Polish harbours of Gdynia and Gdansk. We hope that it will be original contribution to the improvement of maritime security. The telecommunication infrastructure for these harbours will be designed, built and tested for certain chosen threats scenarios.

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