First Scientific Conference

For Marine Science Technology

16 - 17 / 12 / 2019 Sabratha - Libya

The Smart Port Using Microwave Communication Sensor

Abdallah Oshah

Abdallah.oshah6886@gmail.com

Abstract

The purpose of this paper is to review and analyze maritime transportation academic research. This paper uses a smart microwave sensor (radar sensor) operating on hopping frequencies (8, 8.2, 8.4 up to 10) GHz with 0.2 GHz increment for evaluating the target Radar Cross Section (RCS). These hoping frequencies are used to give the maximum Radar Cross Section for different regular target shapes (cone, cylinder, plate). Due to target the radar Cross Section is a function of wavelength . We try to achieve the optimum performance of different target in the port and waiting area. To implement this work, we used different radar cross section for regular shapes, cone, cylinder and plate as example, for each shapes we apply the equation of RCS at different frequency. Then we get and plot the RCS as function of frequency . Moreover we compare the output (o/p) RCS for different shapes. The used program to draw the RCS was MAT LAB.

Key words: Radar, sensor, spread spectrum technique, port management, MAT LAB.

1.1 Introduction

Smart ports are the only ports that will survive, “Smart means: no waste of space, time, money and natural resources. These [factors] correspond to the current challenges of ports: spatial constraints, pressure on productivity, fiscal limitations and the need to be green. Technology and innovations can help, but being smart is also a mind-set. A smart port policy, for example, could be to maximize local value, rather than maximizing cargo flows. Adding to those human resources, anchorages, channels, lighters, tugs, berths, and warehouse. Moreover other storage spaces have to be allocated and released. The efficient management of a port involved between the agents providing and using these resources, and providing management information.

Today's harbor is increasingly involved in management of port operations beyond the technical and statutory role of technology. Ports have to move with times in response to global shifts in maritime trade if they are required to remain competitive. We empirically test the relationship between the delay of containerships and the scheduled operations in a terminal, based on a dataset containing information on 352 containership arrivals during a 9-month period at seven terminals of three North American ports. We find that a vessel is less likely to be delayed when there are more operations scheduled shortly (up to 3 days) after the vessel's berthing window in the terminal. Moreover, we also find that the more containers a vessel needs to unload in the terminal, the less likely that it would be delayed. Both findings support the hypothesis that liners strategically balance the trade-off between delay cost and schedule recovery cost [1]

1.2 Different Types of Ports and Harbors

These can be divided as home port, fueling station, inland harbor, inland port ,landing, out port, port of entry, trust port, dry port, anchorage, wharf, natural gas terminals, oil terminals, coal terminals, container terminals, free port and naval base.

1.3 Organizing Ports by Radar

In case of organizing ports by radar, the radar is a sensor that senses the ship and identify it whether it was a ship load or a trawler or even warship and based on that are locating paving ship. Sensors and electronic warfare, showing how emerging radio frequency and electro-optics technologies are able to offer improved situational awareness, but may also defeat apparently reliable weapons. Wide area surveillance depends on the ability to position sensors at high enough altitudes to see around the curvature of the earth's surface. Conventional microwave radar surveillance schemes employ airplane or satellite platforms to achieve the required altitude.

HF radar systems exploit refractive and directive properties of HF waves to illuminate targets beyond the earth's horizon. Sky wave HF radars use the ionosphere as a mirror to view distant targets. Surface wave HF radars exploit the direction of waves over the conducting ocean surface to illuminate targets beyond the horizon [2,3]. A high frequency (HF) radar conjuration consisting of a sky wave transmit path and a surface wave receive path is presented and analyzed. The transmit signal consists of radiation from a ground-based station that is reacted from the ionosphere to illuminate targets beyond the earth's horizon. If these targets are surface vessels located within a few hundred kilometers of a shoreline, then it is feasible to place an HF receiving array on the shore to detect the scattered surface wave signal from these surface targets. The region of ocean observable by the surface wave receiver is generally two orders of magnitude smaller in area than the ocean illuminated by the sky wave transmitter. Thus it is necessary for the sky wave radar transmit beam to be steered in the direction of the surface wave coverage region for long periods of time, which connects with the requirement for the sky wave radar to scan over its coverage region. The use of multiple-input multiple-output (MIMO) transmit waveform schemes will allow arbitrary transmit beams to be formed on receive, which will mitigate this connect. So we should take advantage of the places in the harbor and the optimal use of the port.

2 Practical work.

Maritime transportation proposition theoretical research may be particularly useful in undertaking research in maritime transportation areas for which data are unavailable, insufficient, difficult to obtain, or of poor quality. The effect of different factors in vessel construction regarding the amount of electromagnetic energy returning to a radar source was studied. These factors are such as the handling of shapes, use of different materials, and vessel size. The methodology in the research was a series of tests designed to validate the results given by the POFACETS, CADRCS software. [3, 4] The 3D models of ships made in the COTECMAR shipyard are used. Riverine support light Patrol boat (PAF-L) and Riverine support heavy Patrol boat (PAF-P), where modifications to the hull are made to vary the angle of incidence of the radar rays and simulation with different types of materials to observe the behavior of the RCS. Results of this research were that they could see that using POFACETS software as a tool to predict radar cross section is suitable for the scope of the objectives of this research. However, it should be noted that large global computational tools are available, which are used in the shipbuilding industry that allow more accurately predicting RCS in warships, considering factors like reflection of radar waves in the sea, conditions of the sea state, and more features such as ability to detect "hot spots" and ray tracing to identify parts of the structure that generate them . Most computational tools for predicting RCS use prediction methods associated with physical optics because it is a high-frequency approximation that provides the best results, it does not consume excessive computational resources, and simulation time is relatively short compared to other methods like moments and the finite difference, which are used in software presented. Nonetheless, the big disadvantage that leads to using other methods different other than physical optics to predict RCS, is that this method only works for high frequencies of detection. Variables were identified type of shape of that especially influence in the radar cross section of the the superstructure and the hull, the type of material used in the construction of the vessel and its likely displacement, which in the experiments performed revealed that the type of material used has the most influence on the RCS followed by the handling of shapes, and displacement. In particular, evidence of the importance of using composite materials with lining in the manufacture of the superstructure of a vessel, such as fiberglass with polyethylene, because they absorb great amount of radar energy in comparison to other materials as the sole use of fiberglass and steel, have high resistance, light weight, and support drastic climate variations ideal for everyday naval operations.

The result of this research focused on using the knowledge acquired during its development in future designs of surface platforms with low radar cross section, which can be done by applying RCS reduction techniques, focusing on the use radar absorbing materials (RAM) in those parts of the ship that require such and the proper handling of shapes in designing the hull and superstructure, which allows significant reductions in the amount of energy reflected to enemy radars [5, 6].

3 Methodology

This Section describes the system methodology for calculate RSC using frequency hopping . The system is summarized in Figure 1, where each block represents stage in the system.

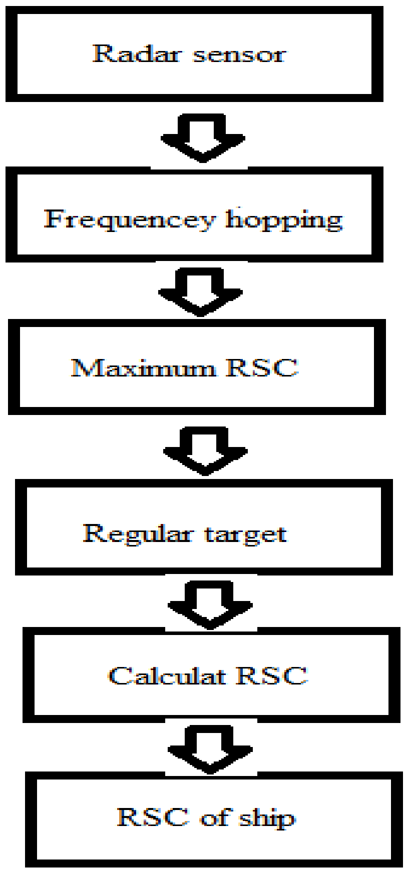


Figure 1. System block diagrams

4 Theory and Calculation.

The Table 1 and computer programming are used to evaluate the RSC of regular shape bodies' σ m^2 eg. (cone , cylinder, plate ,…) at different hopped operating frequencies (8 , 8.2 , 8.4, …..10) GHz, to achieve the optimum performance of the port management and waiting areas.

Table1. Target Cross Section of Regular as a Function of Wavelength λ [6].

Object	Aspect	Radar cross Section	Symbols
Sphere	Any	πr^2	a = radius
Parabolic	Axial	πr^2	A = apex radius of Curvature
Cone	Axial	$\frac{\lambda^2}{16\pi}\tan^4\theta$	θ = cone half angle
Circular plate	Angle θ To normal	$\pi a^2 \cos^2\theta {j_1}^2 (\frac{4\pi a}{\lambda}\sin\theta)$	A = radius of plate
Cylinder	Normal to axis Of symmetry Off normal to Axis of Symmetry	$\frac{2\pi a L^2}{\lambda}$ $\frac{a\lambda}{2\pi\theta^2}$	A = radius L = length θ= off normal angle To axis of symmetry (θ small But not zero)
Large flat plate	Normal	$\frac{4\pi A^2}{\lambda^2}$	A = plate area
Triangular Corner reflector	Axis of	$\frac{4\pi a^4}{3\lambda^2}$	A = edge length

4.1 Typical Values of RCS for Ships

RCS of ship depends on overall size and Gross/displacement tonnage of ship. Typical values for ships are known and described below Table 2. The program of calculating RCS of the regular shape vessel using MATLAB is shown in appendix A

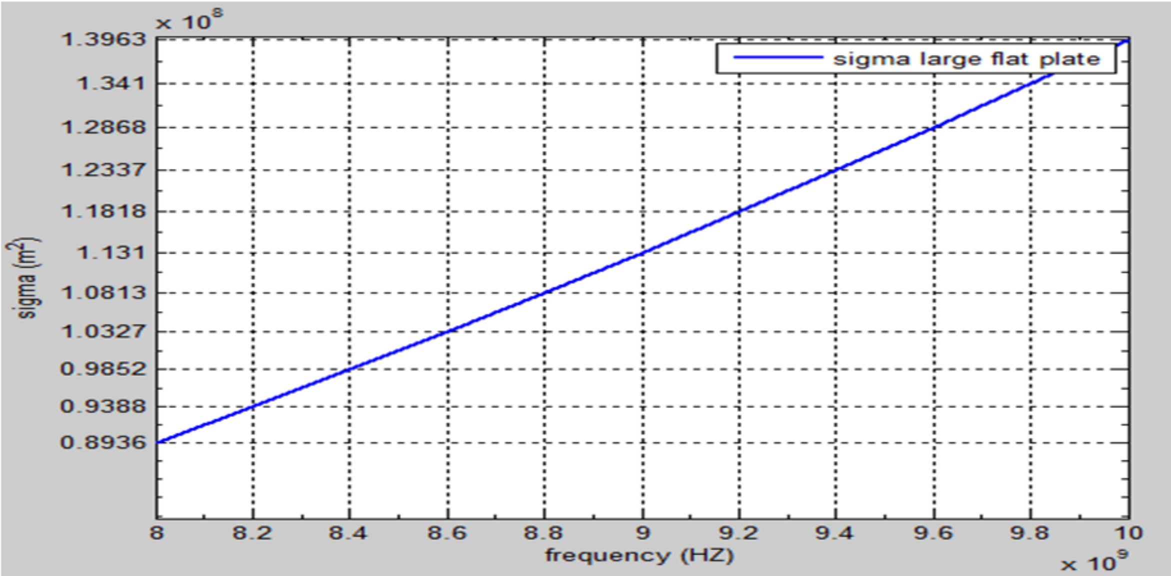
Table 2. Typical values for ships [7]

Ship RCS Table
(Source: Williams/Cramp/Curts, "Experimental Study of the Radar Cross Section of Maritime Targets", Electronic Circuits and Systems, Volume 2, No 4, July 1978)

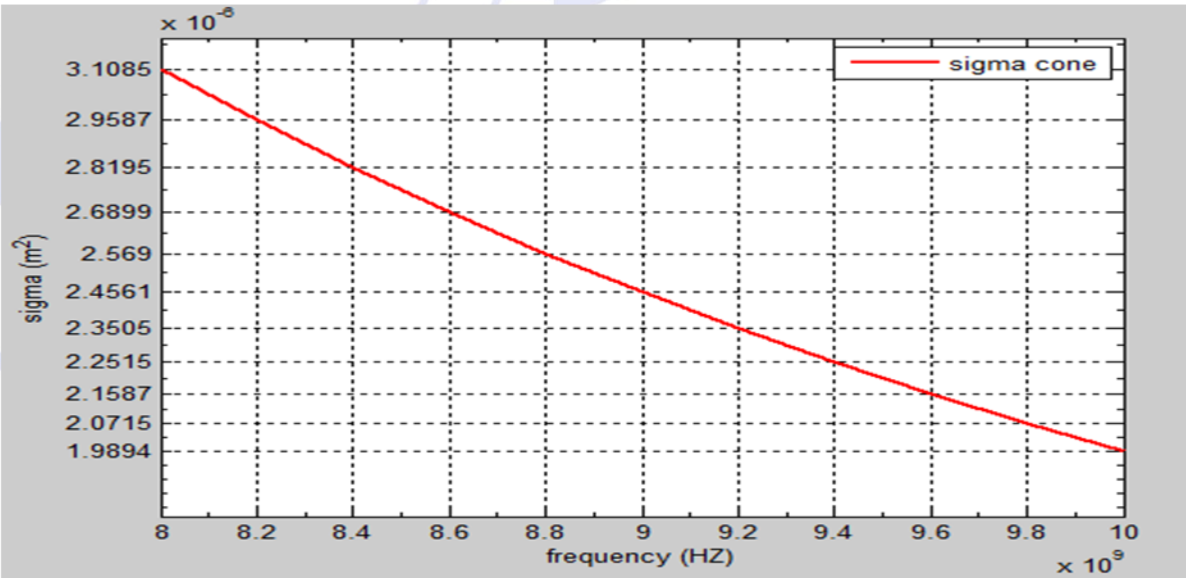
Target Ship			Median radar cross section of target vessel, m^2								
Type	Overall length (m)	Cross tonnage	10	100	1,000	10,000	100,000	1,000,000	10,000,000	approx. min. RCS	approx. max. RCS
Inshore fishing	9	5								3	10
Small coaster	40-46	200-250								20	800
Coaster	55	500								40	2,000
Coaster	55	500								300	4,000
Coaster	57	500								1,000	16,000
Large coaster	67	836-1,000								1,000	5,000
Collier	73	1,570								300	2,000
Warship (frigate)	103	2000*								5,000	100,000
Cargo liner	114	5,000								10,000	16,000
Cargo liner	137	8,000								4,000	16,000
Bulk carrier	167	8,200								400	10,000
Cargo	153	9,400								1,600	12,500
Cargo	166	10,430								400	16,000
Bulk carrier	198	15,000-20,000								1,000	32,000
Ore carrier	206	25,400								2,000	25,000
Container carrier	212	26436**								10,000	80,000
Medium tanker	213-229	30,000-35,000								5,000	80,000
Medium tanker	251	44,700								16,000	1,600,000

5 Results and Discussion

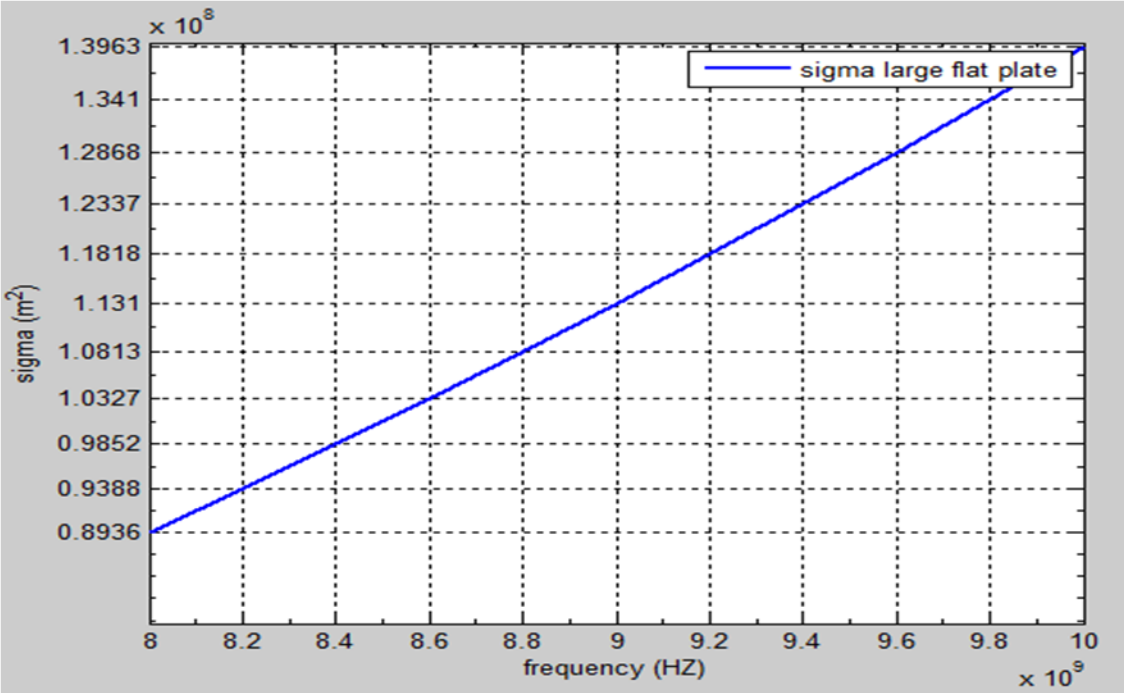
The methodology in Section 3 indicates that The RCS of real ships can be evaluated as integration of regular shapes targets according to table 1



(a)



(b)



(c)

Figure 1 (a, b, c) Represent RCS of cone, cylinder and plate respectively

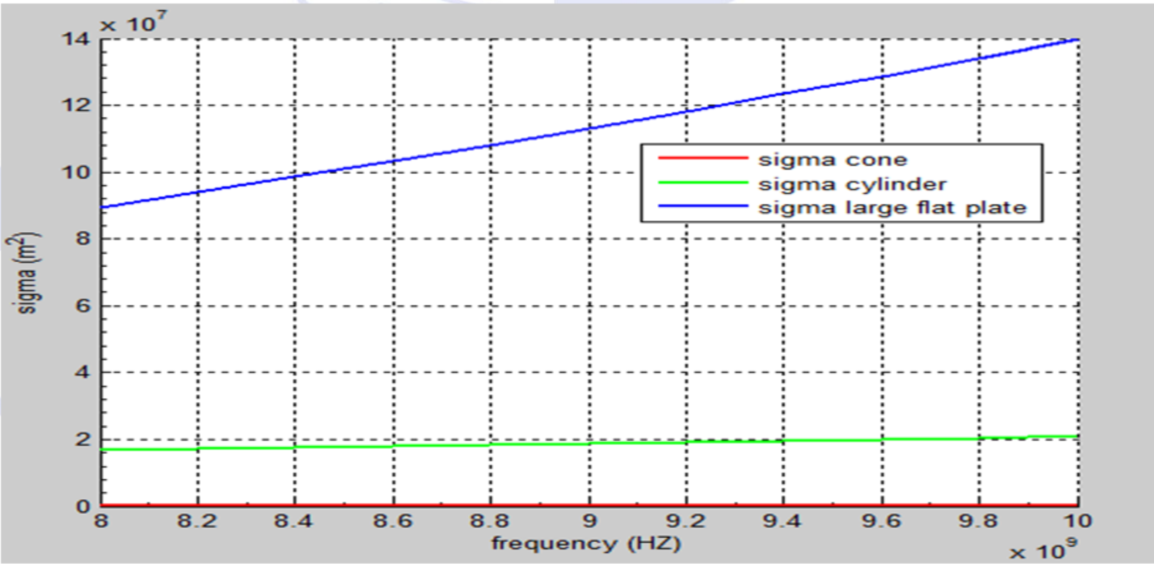


Figure 2 represent the three shapes

The following Figures Represent RCS of cone, cylinder and plate .Figure 1 represent the RCS of cone shape . Figure 1 b represent the RCS of cylinder shape .Figure 1 c represent the RCS of plate shape . Figure 2 represent combination the RCS of cone ,cylinder, and plate shape .

The RCS of real ships can be evaluated as integration of regular shapes targets according to table 1 Furthermore for complex shape body each resultant is assumed to be reflected from the center of gravity (CG) of each geometric segment at particular aspect of interest and average cross section of the complex body for any angle Ψ of radiation incidence by [8].

$$\sqrt{\sigma_{av_y}} = \left| \sum_{i=0}^{n} \sum_{K=1}^{M} \frac{\sqrt{\sigma_i} exp.j\left[\Phi_{ik} \pm \frac{(d_{i-1} \cos\psi_y)2\pi}{\lambda}\right]}{M} \right|$$

Where

M is the total random variation from 0 to 2 π of the relative phases φd between the .major contributors σi related to each of the n geometric segments

Most statistics in the public domain refer to official customs data [9]. Most ports are built close to coast lines, where waters are shallower and tend to suffer from deposit sedimentation processes, which reduce depths in operational [10].

6 Conclusion

Most global trade statistics in the public domain refer to official customs data .Ports are the economic drivers of a country's economy and ships are the principal mode of delivery. As countries develop and their economies grow, reliance on ships and ports also grows. This paper study analysis of the RSC of the regular shape bodies (cone , cylinder , plate ,) , of different hopped operating frequencies (8 , 8.2 , 8.4 , ……10) GHz , to achieve the optimum performance of the port management in using waiting area , and traffic control VTS by identifying the targets and its speed for achieving the optimum solution of the available spaces in the harbor On our study for ship and port management we were able to gain key knowledge and specific expertise in ship, port and transport operations, maritime law, marine finance and general management. Ports are drivers of regional and of countries' economic development.

7 Reference

[1] Hamed Hasheminia & Changmin Jiang, Strategic trade-off between vessel delay and schedule recovery: an empirical analysis of container liner shipping Pages 1-16 Published online: 04 Apr 2017

[2] S.E .EL Khamy, F.A. Salem, "Approach to Radar Target Identification Incorporating Frequency Hopping Spectrum Technique "|, 6th International. Conference on signal processing application and technology ICSPAT, Boston, U.S.A October 1995.

[3] F.A. Salem, S.E.EL Khamy," Three-Dimensional Object Identification by a single radar sensor using Matched frequency Hopping and Angle Diversity (MFH/AD) Techniques 6th International conference on signal processing Application and Techniques 6th Int. conference on Signal processing Application and Technology ICSPAT , Boston , U.S.A. October 1995.

[4] Headrick, J. M. (1990). HF over the-horizon radar. In M. I. Skolnik, (Ed.), Radar Handbook.

[5] Sevgi, L., Ponsford, A. M., Chan, H. C. (2001). An integrated maritime surveillance system based on high-frequency surface-wave radars, part 1: theoretical background and numerical simulations. IEEE Antennas and Propagation Magazine,

[6] Hovanessian, S, A. Radar system Design and Analysis, Artech House, 1984.

[7] Williams/Cramp/Curts, 'Experimental Study of the Radar Cross Section of Maritime Targets', Electronic Circuits and Systems, Volume 2, No 4, July 1978

[8] PhD " the application of spread spectrum techniques for improving Rader target identification in intelligent systems" Germany, September 1996.

[9] Roar Adland, Haiying Jia & Siri P. Strandenes , Journal of Maritime Policy & Management, Are AIS-based trade volume estimates reliable? The case of crude oil exports, Pages 1-9 Published online: 28 Mar 2017

[10] Ana Cristina Paixão Casaca & Manuel Casaca, Journal of Maritime Policy & Management , The flagship journal of international shipping and port research, the impact of muddy bottoms in ports, Pages 1-19 | published online: 03 Apr 2017

7 Appendix A

The program for calculating the radar cross section

```
Enter max value of the sigma  = 100
small coaster (overall length = 40-46 m , cross tonnage = 500)
coaster (overall length = 55 m , cross tonnage = 500)
Enter max value of the sigma  = 10000
coaster (overall length = 57 m , cross tonnage = 5)
warship (overall length = 103 m , cross tonnage = 2000)
cargo liner (overall length = 114 m , cross tonnage = 5000)
cargo liner (overall length = 137 m , cross tonnage = 8000)
warship (overall length = 167 m , cross tonnage = 8200)
warship (overall length = 153 m , cross tonnage = 2000)
warship (overall length = 166 m , cross tonnage = 2000)
ore carrier (overall length = 206 m , cross tonnage = 2000)
medium tanker (overall length = 213-229 m , cross tonnage = 30000-3
Enter max value of the sigma  = 1000000
medium tanker (overall length = 251 m , cross tonnage = 44700)
```