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Port Management using Smart Microwave Radar Sensor

Farok Abdalla
Electronics and Communication Engineering Department, College of Engineering and Technology, Arab Academy for Science, Technology, and Maritime Transport, (AASTMT)
E-mail: Farouk Abdalla salem 11@yahoo.com

M. S. Zaghloul
Electronics and Communication Engineering Department, College of Engineering and Technology, Arab Academy for Science, Technology, and Maritime Transport, (AASTMT)
E-mail: dr_mszaghloul@yahoo.com

Mohamed M. M. Omar
Electronics and Communication Engineering Department, College of Engineering and Technology, Arab Academy for Science, Technology, and Maritime Transport, (AASTMT)
E-mail: Mohammad_yosef@hotmail.com

Abdalla A. Oshah
Electronics and Communication Engineering Department ,College of Engineering and Technology, Arab Academy for Science, Technology, and Maritime Transport, (AASTMT)
E-mail: abdallaabdalmajudoshah86@gmail.com

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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 σ in m^2. These hoping frequencies are used to give the maximum Radar Cross Section for different regular target shapes (cone, cylinder, plate). Since the target Cross Section is a function of wavelength λ we try to achieve the optimum performance of different target in the port and waiting area, port radar and traffic control (VTS). Future maritime transportation research needs to include focus on: (i) maritime shippers, (ii) maritime transport chains, (iii) maritime transportation as a service, (iv) the quality of maritime transportation, and (v) maritime theoretical proposition research

Key words: Radar, sensor, spread spectrum technique, port management

Introduction

Port management is the management of ports. According to a syllabus at the United Nations University: Large ports need to deal with a number of disparate activities: the movement of ships, containers, and other cargo, the loading and unloading of ships and containers, customs activities. 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

Corresponding Author: Abdalla Oshah, Electronics and Communication Engineering Department ,College of Engineering and Technology, Arab Academy for Science, Technology, and Maritime Transport, (AASTMT) E-mail: abdallaabdalmajudoshah86@gmail.com

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 (Hasheminia and Jiang, 2017).

The different types of ports and Harbors can be divided as Home port, Fuelling 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.

Organizing ports by radar , In this study the radar is used as a sensor that senses the ship and identify it size and different dimensions so we can fit the available location with the calculated size adding to that we use the available data about the loading type (EL-Khamy, and Salem,1995; Salem and EL-Khamy,1995) .

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 (Salem and EL-Khamy,1995; Headrick, 1990). 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 that especially influence in the radar cross section of the type of shape of 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 (Sevgi *et al.,* 2001; Hovanessian, 1984).

Analysis RCS for Regular Objects

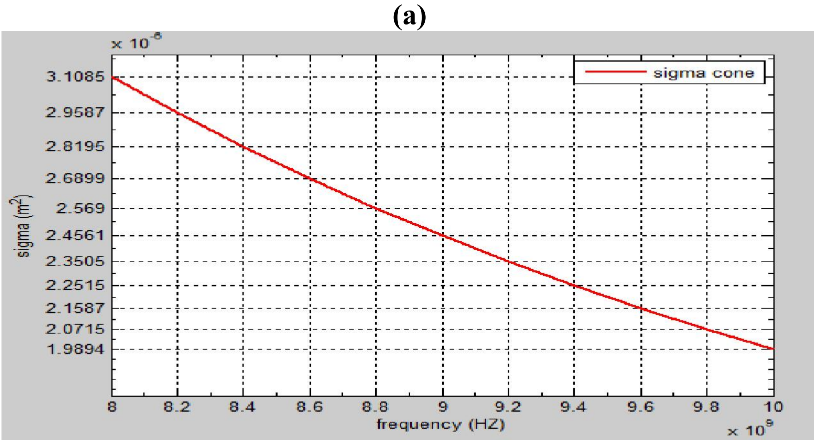
The Table 1 and computer programming are used to evaluate the RSC of regular shape bodies' σ m^2 eg. (cone , cylinder, plate ,…) at different hopped operating frequencies (8 , 8.2 , 8.4, …..10) GHz, to achieve the optimum performance of the port management and waiting areas.

Table 1: Target Cross Section of Regular as a Function of Wavelength λ (Hovanessian, 1984.

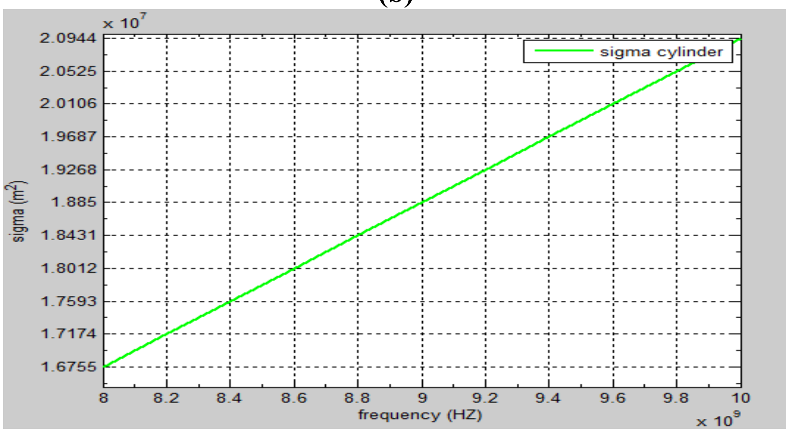
Object	Aspect	Radar cross Section	symbols
Sphere	Any	πr^2	a = radius
Parabolic	Axial	πr^2	A = apex radius of Curvature
cone	Axial	$\frac{\lambda^2}{16\pi}\tan^4\theta$	θ = cone half angle
Circular plate	Angle θ To normal	$\pi a^2\cos^2\theta J_1^2\left(\frac{4\pi a}{\lambda}\sin\theta\right)$	A = radius 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

The following Figures Represent RCS of cone, cylinder and plate, respectively .Figure 1(a) represents the RCS of cone shape. Figure 1 (b) represents the RCS of cylinder shape .Figure 1(c) represents the RCS of plate shape. Figure 2 represents all the RCS of cone, cylinder, and plate shapes.

(a)



(b)



(c)

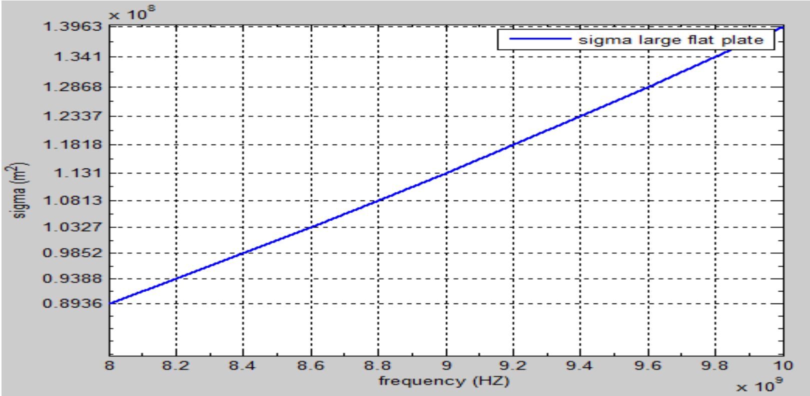


Fig. 1: (a, b, c) Represent RCS of cone, cylinder and plate, respectively.

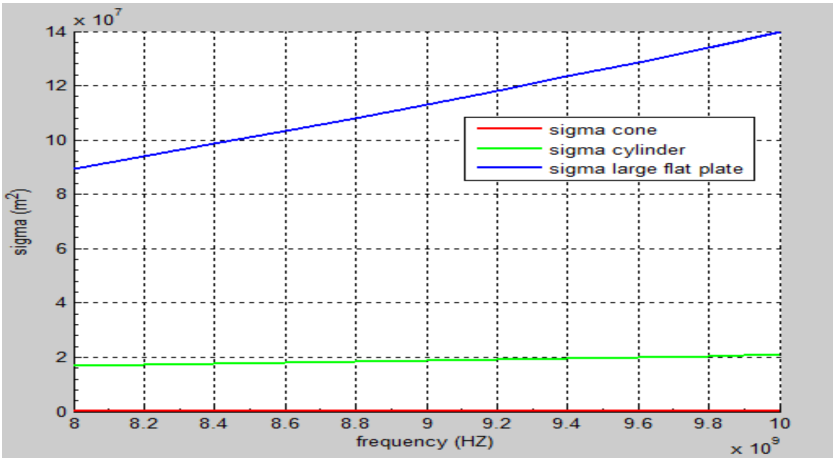


Fig. 2: Represents the RCS of all the three shapes.

Typical Values of RCS for Ships

Theory and practice, helping researchers develop their research skills, business intelligence, team spirit and communicative flair. 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.

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 Abdalla, (1996)

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

Where
M is the total random variation from 0 to 2 π of the relative phases Φ_{ik} between the major contributors σ_i related to each of the *n* geometric segments.

Most statistics in the public domain refer to official customs data (Adland *et al.,* 2017). Most ports are built close to coastlines, where waters are shallower and tend to suffer from deposit sedimentation processes, which reduce depths in operational (Casaca and Casaca, 2017).

Table 2: Typical values for ships (Williams/Cramp/Curts, 1978).

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

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 harper. 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.

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Appendix A

The program for calculating the radar cross section (RCS)

```
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)
```