PERFORMANCE EVALUATION ON LOCAL CULTURE-BASED PASSIVE RADAR

By Basuki Rahmat

PERFORMANCE EVALUATION ON LOCAL CULTURE-BASED PASSIVE RADAR REFLECTOR FOR TRADITIONAL FISHING BOATS IN INDONESIA

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SUMMARY

The accident of a fishing vessel hit by a large rmerchant ship has been quite common in Indonesia. It is because the large vessels failed to detect the fishing boats clearly, which was exacerbated by the absence of passive radar reflector on-board. The previous study found that the attempt to introduce passive radar reflector to local fishing communities need to consider the design of the radar reflector inharmonywiththeornamentation found on local fishing boats. Based on the above issue, the passive radar reflector that adopts the ornamentation on local traditional fishing vessels has been designed and tested. The standard octahedral passive radar reflector was covered by casing in the form ofMosque dome made of fiberglass reinforced plastic as an adaptation of local culture. The test showed that there is a slight difference on the performance of passive radar reflector with and without FRP casing.

1. INTRODUCTION

Fishing or being a fisherman is among the most dangerous and riskiest occupations. The International Labor Organization (ILO) estimates that around 24,000 work accidents happen every year in the world fisheries Occupational health and safety on board is also a major problem in capture fisheries in Indonesia. One type of frequently happened accident is a collision between a fishing boat and a much larger steel ship. An example of a case is the collision between a fishing boat with a container ship in the waters of Masalembu, Madura in November 2019, which nearly killed 12 fishermen on the boat [1]

Collisions between traditional fishing boats and large ships happen because the presence of traditional fishing boat is often not detected by the captain of large ships. This applies especially at night or in foggy areas as the captain's view is relatively limited. A non-fulfilled safety requirement by traditional fishing vessels such as the absence of standard lights and navigation equipment is also one of the aspects that increase the risk of a traditional fishing vessel collided with a large ship [2].

In addition to navigation lights, according to FAO and IMO recommendations, navigation equipment that is also required to be installed on fishing vessels is radar reflector. Radar reflector serves to reflect radar waves from large ships, especially on small non-ferrous vessels such as wooden and Fiberglass Reinforced Plastic (FRP) boats, so the position of small vessels equipped with radar reflectors can be detected and identified by large ships.

Currently, most of the small vessels with wood and fiberglass hull and slim design (curved or sloping surface reflectsless), Event hose with masts and engines do not possess enough reflective qualities. This results in insufficient reflective qualities to make it highly visible on radar screens. A Containerships and Tankers requires long downtime and a wide turning radius. Ensure detection and ship recognition distance from overtaking ships under all Weather and sea conditions are very important to avoid disaster.

In the meantime, the introduction of a new technology to the fishing community should pay attention to the fishing community's concern about local culture in order to ensure the fishing community's acceptance of the new technology or new design on fishing boats [3]. By considering the fishing community embrace of new designs and technologies influenced by local culture, the design of the radar reflector to be installed on local fishing boats should give a room for the existing design or ornamentation on local fishing vessels.

A study of social and technical aspects was carried out to ensure that the alternative design of the radar reflector, which is based on ornamentation commonly found on traditional fishing vessels, can be accepted by the fishing community as well as work effectively as a radar reflector. Analysis of the fishing community potential acceptance of radar reflector showed that the fishing community was highly interested in installing a radar reflector on their fishing boats after knowing the function of the radar reflector. However, they were more enthusiastic in using a radar reflector that resembled the ornamental design on local fishing boats than the IMO standard [2].

The conventional radar reflector is made of three planar circles or squares of metal intersecting at right angles, forming eight trihedral lreflector, known as octahedral. An essential design feature of reflector which greatly enhances the reflective amount of signal returned, is the accuracy of right angles formed between the plate. In research that has been carried out in the coastal area of Banyuwangi, this form is less attractive to fishermen. Because they have a culture that is applied to their ships where the ornament is in the form of a mosque dome. Therefore, a modification of the radar reflector design was made where the dome shape is made of fiberglass, while the radar reflector is made in 2 sizes, namely 20 cm x 20 cm x 20 cm and the size is 30 cm x 30 cm x 30 cm. The test is carried out by placing the radar reflector in the dome and thetest is carried out in a controlled room, the test is in an airtightroom called the anechoic chamber. The measurement of theRCS radar reflector is carried out to see the effect of the dome shape and the size of the radar reflector on the performance of the radar reflector.

2. EXPERIMENTAL AND EVALUATION

First stage of the study was designing the prototype of passive radar reflector. As the results of the initial study, the design of the local culture-based passive radar reflector was referred to the forms of ornamentation that exist on traditional fishing boatsfound in local fishing community in Muncar, East Java. The ornamentation that was used as reference based on the form of Mosque doom model which can be found in top of the local fishing boat mast, as seen in Fig.1

The prototype consists of standard octahedral passive radar reflector that is placed in the “catch rain” position and covered by casing in the form of Mosque dome made of Fiberglass Reinforced Plastic.The use of mosque dome is based on ornamentation that is mostly found on the traditional fishing boat in East Java.

Figure 1. The ornamentation of traditional fishing boats

To evaluate the performance of the proposed passive radar reflector, Indoor measurements were carried out in the anechoic chamber at the National Institute of Aeronautics and Space (LAPAN). The anechoic chamber is a simulation of free space and far-field conditions. The equipment used in the measurement of the Radar CrossSectionconsistsof:

1) AnechoicRoomlocatedattheEMCLaboratoryofthe LAPANBRINSatelliteTechnologyCenter.Thefrequency used is adjusted to the frequency between 2-13GHz.
2) VectorNetworkAnalyzertypeVNAAgilentN5221 AE
3) Antenna3-12GHz
4) Radar Reflector
5) Dome

ThemeasurementmethodisasshowninFigure2. [4]

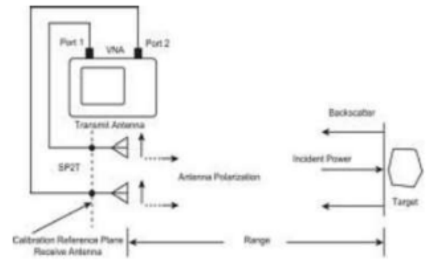
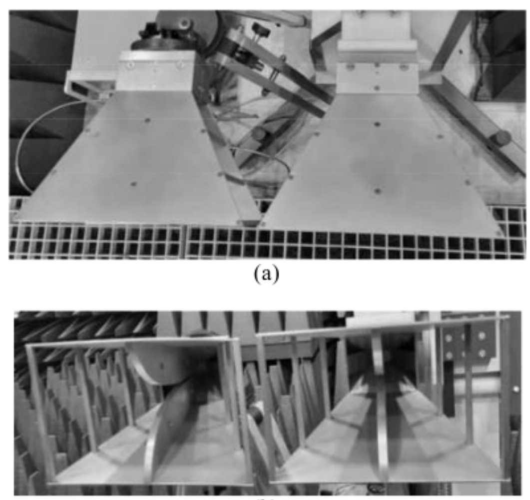


Figure 2. Measurement Setup.

The transmitting antenna (connected to port 1 VNA) and receiving antenna (connected to port 2 VNA) are positioned in the same plane position, as shown in figure 2. The measurement target is a radar reflector mounted on a low reflectance base. The measurements as shown in the figure 2, represent the VNA as radar, where S21 is measured. The coaxial cable output port 1 is connected to the coaxial to rectangular waveguide transition (E plane in the vertical direction). The output of port 2 is connected to the output of the wave receiving antenna. The two antennas are placed as close as possible [5,6,7,8]. Where the distance between the two antennas is determined to be 1.6 cm. Figure 3 shown how to setup the antenna.



(a)

(b)

Figure 3.The Antenna Setup

The distance between the passive radar reflector as the test object and the sending and receiving antennasis adjusted to the settings that already available at the test location, which is 10 meters. The measurement setup in the anechoic chamber looks like Figure 4..

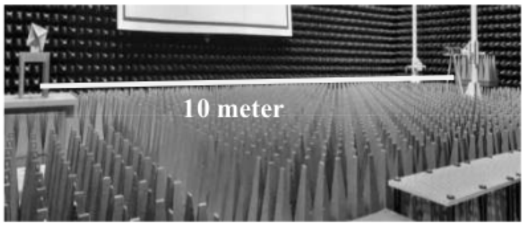


Figure 4. The measurement setup in anechoic chamber

3. RESULT AND DISCUSSION

The measurements were conducted by placing the test object, which is the radar reflector, as far as 10 meters from the transmitting and receiving antennas. The position of the radar reflector is shown on Figure 4. The first measurement was at 0 degrees. Afterward, the test object was shifted 15 degrees. The resolution of the degrees taken was 15 degrees so that at an angle of 90 degrees, 6 measurement data were obtained from the test. The next step was to shift the radar reflector in the opposite direction from the initial position by the same degree which was 15 degrees. As a result, another6measurement data was obtained. The data resulted from this first stage is measurement data with various positions for radar reflector without dome casing. The next step was to give the passive radar reflector a dome casing made of 2 layers (600 gram/m^2) of Fiberglass Reinforcement Plastic. Then the measurement process was carried out in the first stage. The measurements were made in the frequency range of 3 GHz to 12 GHz. The results of the measurement of the radar reflector without DOME with a shift in the value of the positive degree are shown in Figure 5 and 6 below sequentially.

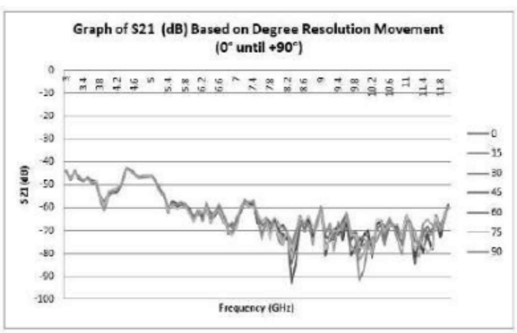


Figure 5.Graph of S21 (dB) Based on Degree Resolution Movement (0^0 – 90^0)

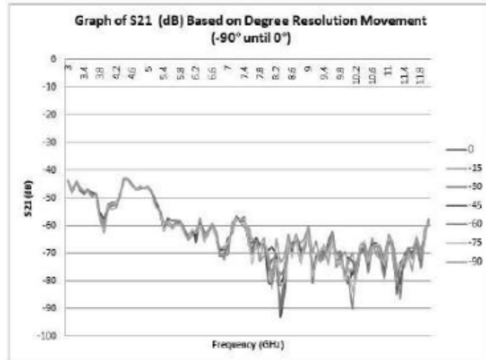


Figure 6 Graph of S21 (dB) Based on Degree Resolution Movement (-90^0 - 0^0)

The cover of this dome-shaped mosque is made of 2 layers of FRP and was planned to be painting based on local design. The choice of the dome shape is inspired bylocal culture or local wisdom of the Banyuwangi. Local people really like the shape of the mosque dome. The dome shape that was used as the casing of the passive radar reflector can be seen in Figure 7.

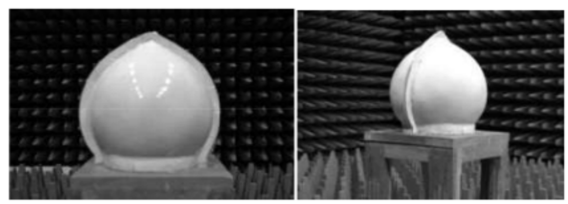


Figure 7 Passive Radar Reflector casing in the form of Dome

The measurement results of the passive radarreflector covered by FRP dome casing with positive and negative degree shift values are shown in Figure 8

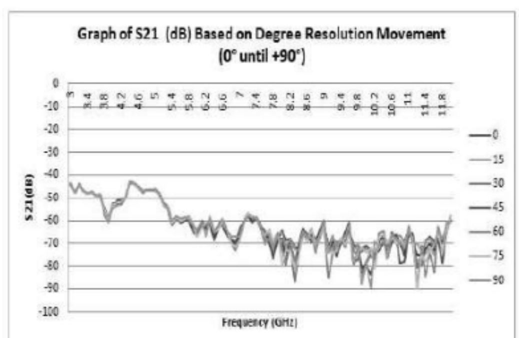


Figure 8. Graph of S21 (dB) Based on Degree Resolution Movement (0^0 – 90^0) with Dome

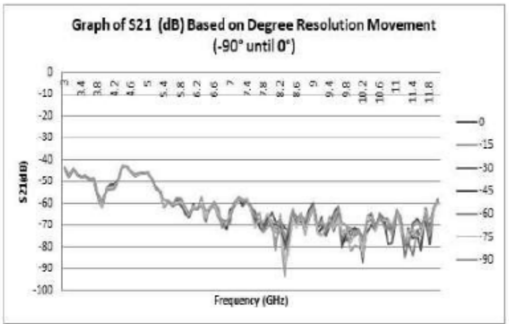


Figure 9. Graph of S21 (dB) Based on Degree Resolution Movement (– 90⁰ - 0⁰) with Dome

In order to identify the effect of FRP casing in the form of mosque dome, data from previous results have been compared. As seen in Figure 10, the measurementsare resulted from 2 conditions: radar reflector without dome casing, and radar reflector using dome casing. The graph shows that there is no significant difference between the presence of DOME and the absence of DOME.

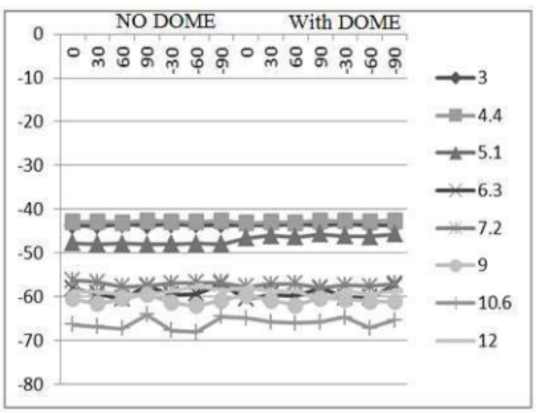


Figure 10. S21(Transmission Coefficient) Result for both passive radar reflector with and without FRP casing

7. CONCLUSIONS

From the graphs of Figures 5 and 6, it appears that in the 3 - 4 GHz frequency range the Radar Reflector performance shows the best value at 3GHz, in the 4-5 GHz frequency range the performance shows the best value at 4.4 GHz frequency. In the 5-6GHz frequency range, the performance shows the best value at 5.1GHz frequency, in the 6-7GHz frequency range the performance shows the best value at 6.3 GHz frequency, in the 7-8GHz frequency range, the performance shows the best value at 7.2 GHz frequency. In the 8-9GHz frequency, the performance shows the best value at a frequency of 9 GHz, in the 9-10 GHz frequency range, the performance shows the best value at a 9 GHz frequency, in the 10-11 GHz frequency range, the performance shows the best value at a frequency of 10.6 GHz. In 11-12GHz frequency, the performance shows the best value at 12 GHz frequency. It means that the degree resolution does not affect significantly to the performance of passive radar reflector when using the position of catch rain. The result of comparison between passive radar reflector with and without FRP casing in the form of mosque doom also shows that there is no significant difference regarding the performance of radar reflector.

8. ACKNOWLEDGEMENTS

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