

THE USING OF RADAR BY SEA-RIVER SHIPS IN INLAND NAVIGATION ON LOWER PART OF Odra RIVER

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Abstract

The sea-river navigation consists on ships manoeuvring on inland waters to ports, which are situated sometimes a few hundredths kilometers inside to land. On polish waters, the sea-river shipping is possible mainly on Odra, Wisła and Warta rivers. Such shipping is much advanced on water areas of Świnoujście, Police and Szczecin ports. The leading of safely navigation requires first of all the high accuracy ship's positioning to avoid the contact with fixed objects and other ships. Therefore, the requirements for position accuracy are much stricter than those in open sea and offshore navigation. The radar is one of the basic devices, which facilitates safe navigation in various conditions-especially in reduced visibility. The basic information for the navigator is presented on the display screen. Presently, the display commonly used on board sea-going ships and other sailing craft is the type „P” display (PPI-Plan Position Indicator). The exploitation restrictions of radar can caused some problems in detection, discrimination and presenting of situation during navigation on inland water areas. There is possibility to shipping of sea-river ships to the ports in lower part of Odra river. The paper presents some problems of using the radar in inland navigation on these area. The results of real research will be showed.

Keywords: *inland transport, sea-river navigation, radar*

1. Introduction

Navigation in inland waters has to meet the same requirements as those for pilot navigation, namely safety and effectiveness. This is due to the relation between the vessel size and restricted water area. Therefore, the requirements for position accuracy are much stricter than those in open sea and offshore navigation. In many cases the sea-river ships move on waterways (natural and artificial) inside of land for hundreds kilometers. The leading of safely navigation requires first of all the high accuracy ship's positioning to avoid the contact with other ships and fixed objects. It can be natural objects (coast, water bottom) and artificial (water port structures-locks, bridges etc.) obstructers. Such kind of shipping is called as pilot's navigation. It necessitate the proper knowledge of navigators and adequate of navigation bridge equipment.

A ship sailing within a given shipping area has to meet the following conditions of safe navigation:

- maintain a safe underkeel clearance,
- keep a wide berth to navigational obstructions,
- avoid a collision with other sailing ships.

Manoeuvring of a vessel in any area always has a certain amount of risk of accident, an undesired event that may result in losses [1]. Such accidents are mainly unintended contact of the

vessel hull with other objects in the area. These are often port or waterway structures that, on the one hand, are designed to facilitate vessel movement in an area, on the other hand in certain conditions they may hamper navigation [3]. This fact is called as navigational accident with results can cause:

- loss of human health or life,
- loss or damage of the cargo and ship environment pollution,
- damage to port building structure,
- waist of salvage operation,
- loss of potential profit due to blocking of the port or this part.

Accept of typical floating inland craft (barges, push units), the sea-river can navigate on inland waters. There are happened different type of craft (cargo, passengers, recreational). In many European countries, the sea-river shipping is important element of transport system. Main feature of such shipping is fact, that ships can sail inside of land and carry of cargo without many times transshipment. This method decreases the risk of damage of cargo and increases the expedition of goods. Apart from, the land roads are unburden, because the cars transport is dynamically progressed all last years. On Polish waters, the sea-river shipping is possible mainly on Odra River (its lower part), lower section of Wisła river, and on Warta river and Bydgoski Canal, which connect the Odra and Wisła Rivers. Much advanced is sea-river shipping on water areas of Świnoujście, Police and Szczecin ports. The tests of initiating of sea-river ships on lower part of Odra river to the south on port of Szczecin (to the German port of Schwedt) was carried out.

Restricted areas are a specific type of navigating areas where many factors, limiting the manoeuvring of a vessel, can reduce the safety level of navigation. The characteristic feature of these areas is that a vessel cannot freely choose the way. In many cases restricted areas are fairways and channels of substantial length; particularly those leading to inland harbors may be far more than a hundred kilometers long, running through natural water reservoirs and rivers. That is why navigation along these waterways differs from offshore waters and port approach channels. Navigating in restricted areas includes the following steps [2]:

- planning a safe manoeuvre,
- determination of vessel's position in a given area with a preset accuracy,
- steering the vessel so that a safe manoeuvre can be performed.

Navigation in restricted areas is also called pilot or pilotage navigation. The gravest effects of failing to maintain the conditions of safe navigation may occur when a ship hits a navigational obstruction [3]. These may be natural or man-made (port or navigational structures). Natural obstructions depend on hydrological processes in a waterway. The human intervention changes these conditions in a variety of ways which aim at facilitating or just enabling navigation. On the other hand, however, even the structures substantially improving sailing conditions in many cases make up obstructions to navigation. These man-made structures comprise surface or submerged structures which together with installations, construction arrangements associated with these structures, technical equipment and other equipment relevant for the function a given structure make up one technical-functional object. From the point of view of limitations of traffic in an area, hydro-technical structures include:

- objects formed due to dredging and silting work, particularly harbour and shipyard water areas, such as outer harbours, basins, sea and inland fairways, approach channels, passing and turning areas,
- channels,
- structures of fixed aids to navigation, water-based beacons, leading marks and navigational lights, dolphins,
- sea locks,
- buildings connected with transport, such as road and rail bridges, submerged tunnels.

This results from the fact that the safety of vessels can only be fully provided in an area of deep water where underkeel clearance will be more than sufficient and large, or rather, sufficiently wide for any kind of manoeuvre.

2. The features of radar in inland shipping

The radar is one of the basic devices which facilitate safe navigation in various conditions-both reduced and good visibility. The radar as a technical device significantly helps conducting a vessel by presenting a proper image of a situation around the vessel. The use of radio waves for detecting objects enables a display of a situation that would be particularly difficult in poor visibility (fog, precipitation, night). In this way the radar facilitates steering a vessel in conditions in which human observation is much hampered, if not impossible [3]. Nevertheless, radar observation also has some limitations resulting from the manner radar operates.

The use of radar for navigation can be said to have two basic goals:

- avoidance of collisions with stationary objects (natural objects such as the shore or bottom, and artificial objects such as port or other structures),
- avoidance of collisions with other ships.

In both cases the operation of the radar can be divided into the following stages:

- detection of an object that results in a graphic presentation on the radar screen,
- object identification on the radar screen by the navigator,
- measurement of the detected and identified object (its position, movement parameters etc.).

The exploitation features of radar to assume of its use are following:

- maximal range,
- minimal distance of detection,
- distance discrimination,
- azimuth discrimination,
- accuracy of range measurement,
- accuracy of azimuth measurement.

These features depend on technical radar's parameters according of construction features of installed radar, and user don't have any effect on choose of type of device. Only one parametr can changed by user in radar-long of range of power transmitted impulse (time of duration). The restrictions in radar working have especjally meaning in restricted water areas like inland waters [5].

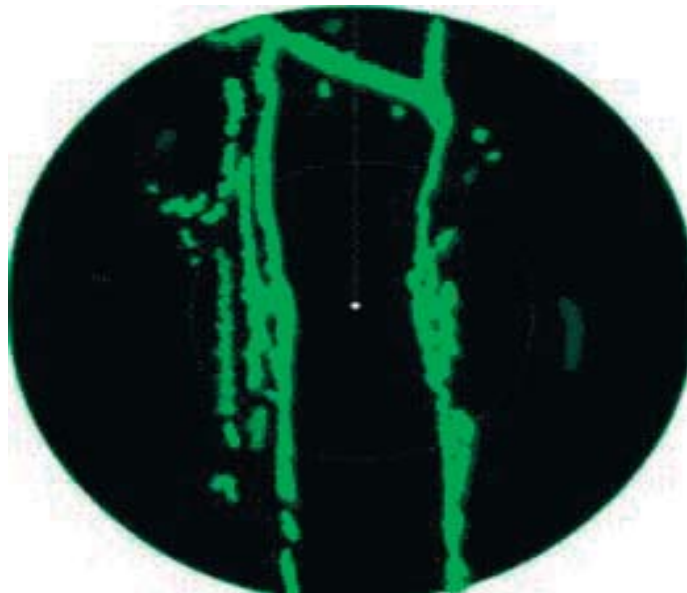


Fig. 1. Radar display-Plan Position Indicator

The basic information for the navigator is presented on the display screen. Presently, the display commonly used on board sea-going ships and other sailing craft is the type „P” display (PPI-Plan Position Indicator). Fig. 1 presents the radar screen with such picture. The display,

showing a radio-located chart which illustrates the area surrounding the vessel, makes it possible to read out the range and direction (heading or bearing). Target echoes are displayed as spots displayed on the radar screen. Due to easy transformation of the polar coordinate system of the display into the Cartesian coordinate system of marine charts plus „bird’s eye view” imaging, the image interpretation is generally simple, except for a few particular situations. In spite of all the advantages of the panoramic display that make its use quite common, it should be noted that there are a number of shortcomings that limit substantially its range of applications. These are situations where navigation takes place in restricted areas, mainly rivers and channels or canals. When the range scale of observation is the same for the entire displayed area around the vessel, it often happens that the useless part of the screen (land beyond the shoreline) makes up 70% or more of the observed screen. Taking into account the width of a restricted area, the screen diameter (width) and the minimum operating range scale, it may turn out that using a radar in such a situation is much more difficult.

The presented above restrictions of radar can caused some problems in detection, discrimination and presenting of situation during navigation on inland water areas. These problems were practically examined on ship in inland navigation on lower part of Odra river.

3. Lower part of Odra River

The aim of examination was lower section of Odra river [4] from port barge on Regalica river (part of Odra river), (739 km) to south direction to western lock in Hohensaaten-Germany (~666,7 km), (Fig. 2). Next during opf shipping to upper part of river, in sequence was passed following objects:

- cłowy bridge (737,3 km),
- pionierów bridge of Szczecin City (737 km),
- bridgehead on Regalica river (736,2 km),
- car-railway bridge in Podjuchy (734,45 km),
- railway bridge in Podjuchy (733,5 km).

Afterwords the ship gone to Klucz- Ustowo Canal up to Westrn Odra to aviod the affecting of current on Odra river (730,5 km). To navigate to upper Western Odra, the following objects were met:

- Autostrada bridge on Western Odra (727,4 km),
- Bridge in Mescherin (717,2 km),
- Bridgehead in Gartz (710,5 km),
- High voltage line (706,9 km).

After passing of high voltage line, the ship change the course to Canal Friedrichsthaler Wasserstraße (707,1 km). The following bjects are observed on canal:

- buoys,
- characterisic orifice of canal,
- bridge on canal,
- western lock in Hohensaaten.

The examination was made on ship ODRA LOYD 9 with especjally pick up of superstructure (Fig.3). Two barges were pushed. The avarege speed of unit was 10 km/h. The ship was equipped in RACAL DECCA River Radar-RR2050MT.

The main parametres of radar:

- transmitter power impulse: 12 kW,
- antenna aperture: 1382 mm,
- cross section width: 1,2°,
- side lobes: 28 dB,
- diameter of indicator: 17',
- ranges: 0.5, 0.8, 1.6, 4, 8, 16, 32 km.

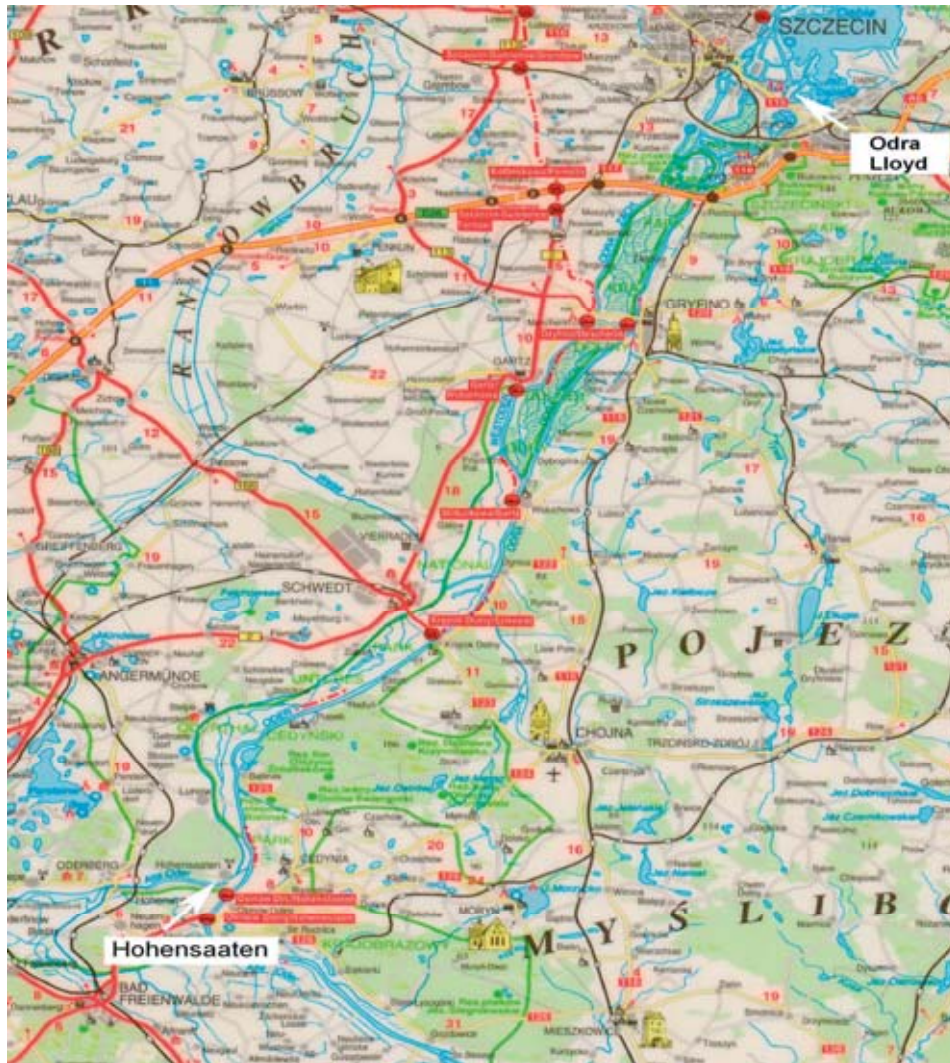


Fig. 2. The lower part of Odra River



Fig. 3. The superstructure of ODRA LOYD 9 ship

The photographs of radar screen and real viewing of characteristic objects were carried out. Additionally, the satellite photographs by Google Map was used to analyse of observed situations Fig. 4-8 present some situations during voyage on lower part of Odra river.

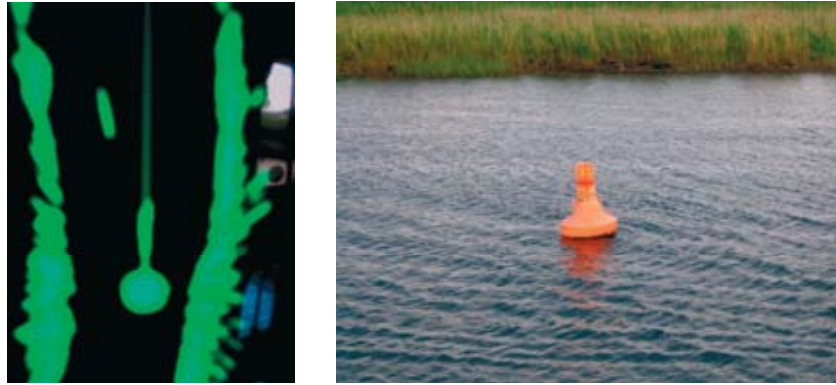


Fig. 4. The buoy of left side of waterway



Fig. 5. Pionierów bridge in Szczecin

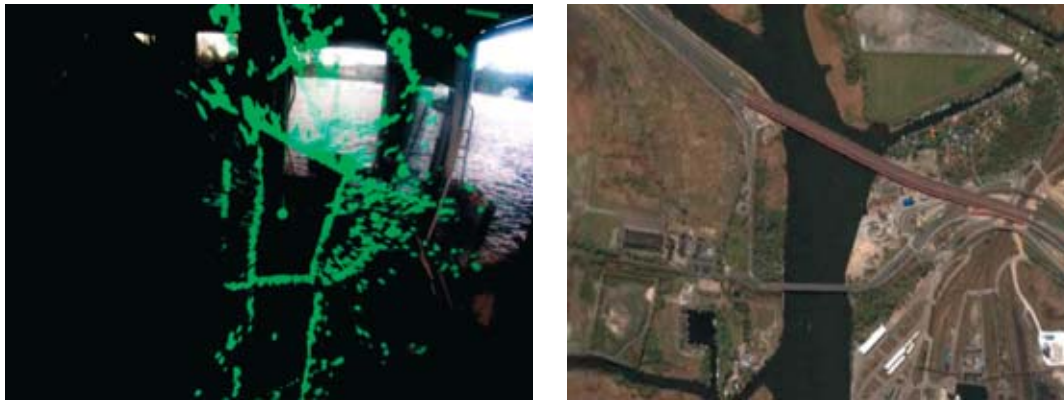


Fig. 6. Approach to Dąbie Lake thru Regalica river

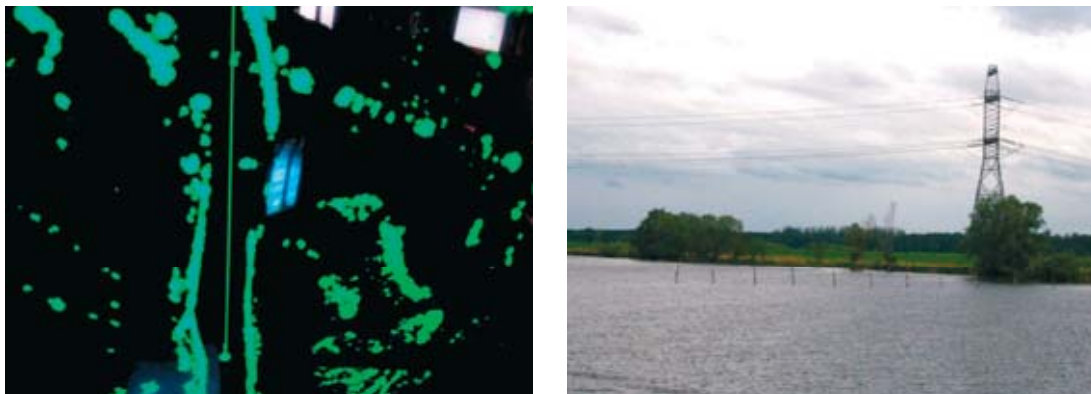


Fig. 7. High voltage line

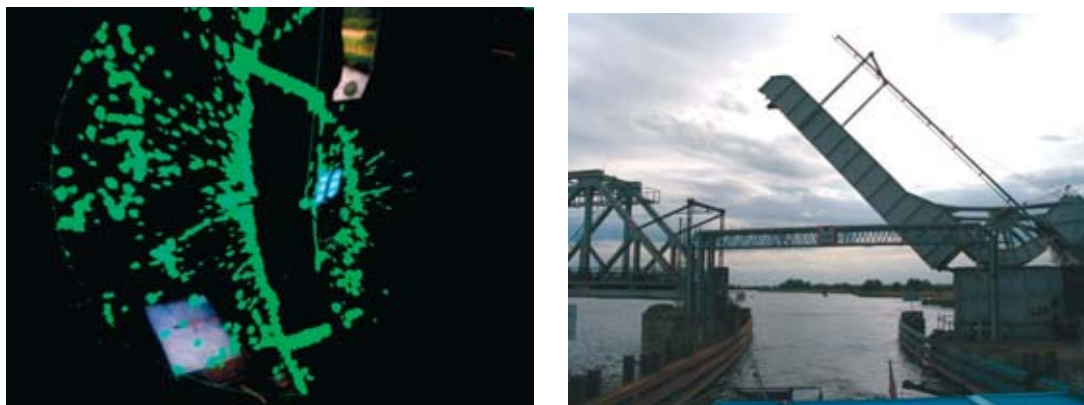


Fig. 8. Railway bridge in Szczecin-Podjuchy

4. Summary

The analysis of carried out test permit to following conclusions:

- the shape of target presented on radar screen is similar to real shape of detected object, when the horizontal angle of cross section width of antenna is less than width of object,
- on small ranges, shape of target depend on lenght of power transmitted impulse and horizontal antenna aperture,
- when target moves to edge of radar screen (the distance increase), then its width changes by enhancing,
- by adjustment of gain, the width of target can be changed,
- the width of target depend on its radar cross section and distance to the ship,
- the identification of object is easier on smaller ranges.

The safety of navigation in restricted waters, particularly inland waterways, depends on the accuracy of determining the position of a vessel manoeuvring within such waters. The radar is one of the devices for position determination. The most common mode of display showing the present situation on the screen is a panoramic display (bird's eye view) similar to that of a navigational chart. The presented above restrictions of radar can caused some problems in detection, discrimination and presenting of situation during navigation on inland water areas. But results of carried out test on using radar to navigate on lover part of Odra rived shoved, that this device is useful. The farther researches will be continued.

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