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Revealing the Secret of ICE RADAR model FICE-100

Abstract

Typically, ship's navigation radar tries to filter out sea clutter and produce clearer picture for the purpose of tracking moving targets. Its main purpose on board has been to operate as a collision avoidance device, so far. Different from traditional radars, the X-band navigation radar can be used for other applications such as analyzing wave height and direction or building an image that describes the ice surrounding the vessel. The radar has the ability to detect ridges and large floating obstacles.

From the navigational point of view, global climate change is offering new route for international transportation with a trend of receding ice around the North Pole. Ice detection with the X band radar would be helpful for the mariner since finding old trails in the ice will make it easier to move forward.

In this paper, technology used in the ice radar and user techniques are described. The good example is that by adding a second radar processing unit, two different radar images from the same antenna at the same time can be shown and that will make it easier to recognize situation surroundings at a glance. One image is a collision avoidance image on the main radar screen, and the other is an ice radar image on a second screen for easier navigation in icy waters.

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FURUNO Technology to Make It Possible

1) Make Full Use of Data from Our Antenna

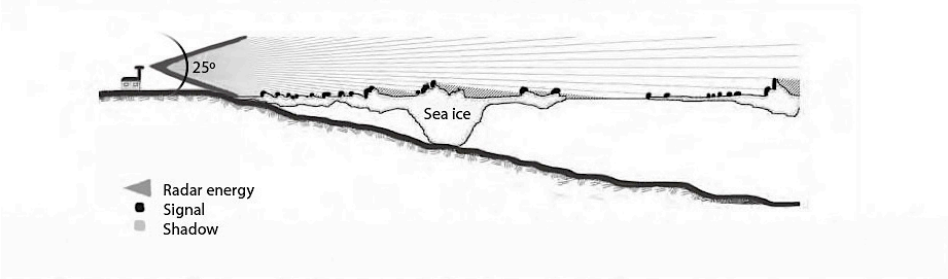
In Ice Radars like the FICE-100, we are interested in the faint signals for building an usable image of the surrounding ice. We make full use of data acquired by our sensitive radar. It is based on the normal FURUNO ARPA radar, and captures a copy of the raw radar signal from the ARPA processor.

2) Stability of the Radar Image and Combining Radar Revolutions

A single radar scan may be too noisy to show all the details in ice. One way to reduce noise from the image is to acquire the data by combining the measured data from many revolutions of the antenna. To improve the picture clarity, it is very important to actually know exactly where the data comes from. If the positions of the images are not accurate, it ends up smoothing the image instead of cleaning it up. Finding the exact position of the data requires exact information of the ships movements and the radars rotation. Our algorithms will take care of finding the exact position.

3) Ridge Detection System: Growler Hidden in Ice Rubble

The height of the ridges can be measured by observing the lack of radar signals behind the ridge.



Schematic illustration of landfast ice and the surface illumination by the radar. Black dots show surfaces from which backscatter could be expected and cross-hatched areas indicate shadow zones from which no signal would be received.

In M/V Oulu Luotsi, Finland.

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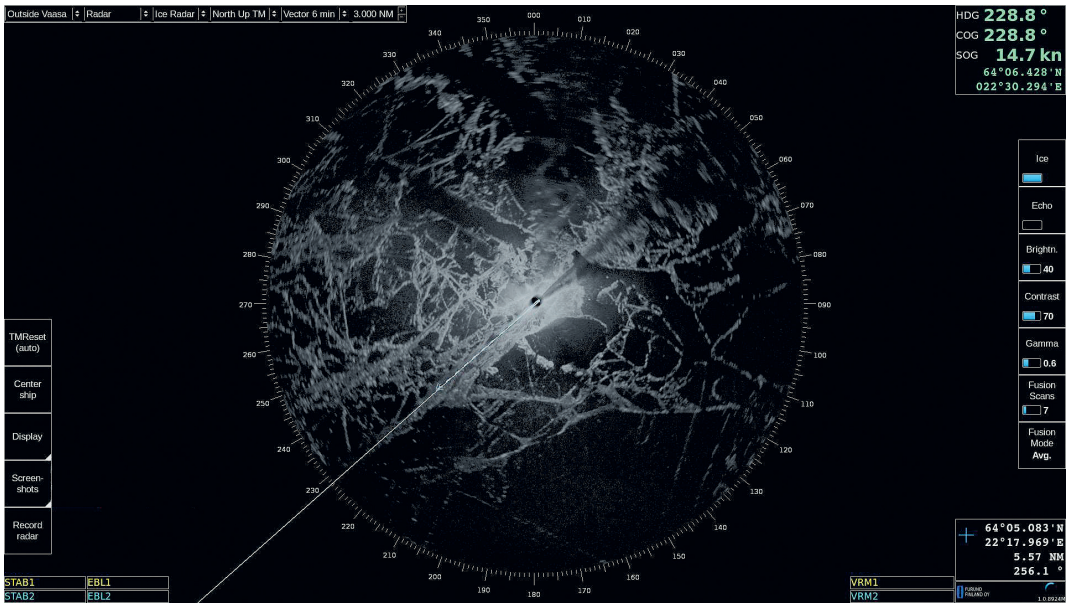
4) Adjustable Screen Filters: to Find Cracks in Ice and Floating



The Ice Radar graphical user interface (GUI) is based on a single screen.

We are particular about how the screen is clear to see. Processor has been programmed to show the sharpest image at most of its capability. A radar antenna will build an image to the radar screen on one rotation. On the other hand, ice radar uses more than two images to detect detailed ice structure surrounding the vessel.

M/V Oulu Luotsi

By adjusting ice filter parameter, you can manage the behavior of the ice filter.

1. Ice – toggle ice echoes on/off
2. Echo – toggle navigational radar echoes on/off
3. 3D – toggle 3D display of ice echoes on/off
4. Adjust gain of the ice echoes
5. Adjust treshold of the ice echoes – increasing treshold will filter out smaller
echoes on screen
6. Adjust number of scans – how many overlapping radar scans are used for the ice echoes
7. Adjust sharpening of the ice echoes – a larger value will use more contrast on the ice echoes that may improve visibility of small structures

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User Tips by FURUNO Engineer

Radar Settings for Detecting Ice

Growler Hidden in Ice Rubble

For finding small details in the ice structure, it is beneficial to use a short pulse with a high repetition rate. For practical navigation in ice conditions a range settings of close to 3 nautical miles or 4 nautical miles is good. At these ranges, there is enough time to react to findings and still expect to see details in the ice structure. Shorter ranges may provide better images. As the vessel may move at around 12 knots while breaking ice sailing, 3 nautical miles takes only 15 minutes. Making decisions about where to sail also requires some time to think. 15 minutes is adequate for avoiding ridges or avoiding areas with high ice pressure.

One of the main risks is an ice breaking that vessel tries to avoid is getting stuck in thick ice. There may also be a big difference in the speed and needed power if vessel has to break her own trail compared to sailing along a trail made by someone else. Ice radar helps to find the old trails, which eventually saves significant amounts of fuel.

Sailing at night, in the icy water

Iceberg and Growlers in the Open Sea

References:

Canadian Coast Guard: Navigation in Ice Covered Waters
http://www.ccg-gcc.gc.ca/Icebreaking/Ice-Navigation-Canadian-Waters/Navigation-in-ice-covered-waters
A. Mahoney et al. / Cold Regions Science and Technology 47 (2007) 233-255

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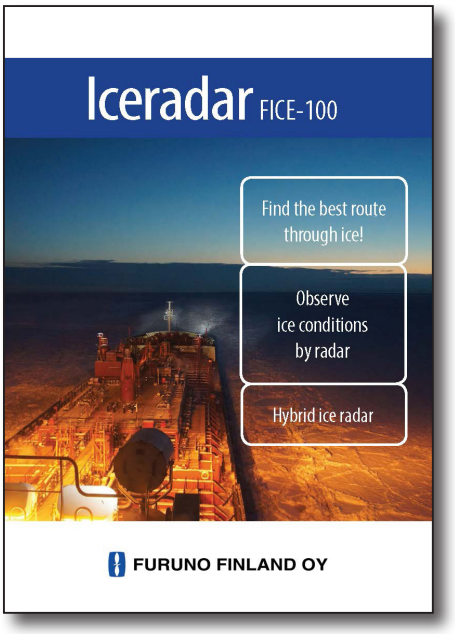
FURUNO ICE RADAR

model FICE-100 Overview

Ice radar displays the ice conditions

The FICE-100 removes the image noise making the fine structures of the ice more visible. Hybrid ice radar captures the raw radar signal from the ARPA processor.

The result is a stable image that includes the fine details found in the radar echoes.



Increase safety

-Visualizes ice structures
-Discovers the optimum route to go through ice
-Shows the track in bad visibility
-Usable ice detection up to 3NM
-Ice radar stabilizes the ice picture compared to the navigation radar using advanced algorithms

Use less power

By using ice radar vessels can find the old rifts, clean ice and channels made by icebreakers and other vessels. Finding and using these, the vessel consumes much less power and saves fuel and time!

FICE-100 is an alternative to an Infrared camera

Infrared cameras are challenging to maintain in icy conditions. Ice radar is a supplementary system for navigation radar to observe ice conditions using the same outdoor equipment.

If you would like to know more about the Iceradar capabilities please contact to Furuno Finland Oy (www.furuno.fi).

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Specifications

General

Ice radar processor with display output DVI or VGA

- Processor power supply
  115/230 VAC, 50/60 Hz (jumper)
- Trackball control unit
- High Resolution high bandwidth digitizer 14 bit, 60 MHz sample rate
- Digitizer power supply 115/230 VAC, 50/60 Hz
- Products have been tested according to IEC60945(2002)

Input Signals

Radar signals FAR-2xx7 or FAR-3000 X-band

- radar video and trigger
- azimuth and heading line signals

Heading, position and speed

Standard

1. FURUNO EC-3000 Iceradar processor
2. Signal cable 5m for FAR-2xx7
3. FURUNO RCU-030 with 2 m cable
4. ScanStreamer DNP2012001 with 2.5 m power cable and 5 m LAN cable
5. Standard spare parts and installation materials

Option

1. Iceradar display with DVI cable (Specify display type when ordering)
2. Optional 10 and 30 m signal cable for FAR-2xx7
3. Optional 15,30,40, and 50 m signal cable for FAR-3000

Interconnection Diagram