Full Ahead with FURUNO
Digital Transformation

FURUNO

More details on
www.furuno.com

Achieve safer and more efficient autonomous ship operation with Furuno's innovative electronics

Towards the Digital Transformation of the Shipping Industry

Over the last few years, the shipping industry has seen a rapid increase in the use of cutting edge digital technology to visualize operational status, on-board and off-board navigation, and engine systems.

Based on the most recent advancements in marine electronics and communications technologies, Furuno is developing new technological innovations to achieve safer and more efficient autonomous ship operations.

To see the unseen, and beyond

"Seeing the unseen" is one of Furuno's business themes, which we achieve through the following two systems.

- A "Recognition Support" system, which makes use of marine electronic equipment and unique sensor technology to provide a better understanding of the surrounding situation.
- A "Decision Support" system that analyzes collected data and helps the operator avoid dangerous objects based on enhanced situational awareness.

The future of the shipping industry as we envision it

Objective: Zero Maritime Accidents

ENVISION

Autonomous Vessel

Analysis and Judgement

Condition Detection

Situational Awareness

Recognition Support

Decision Support

Ship Operational Support

Designing the unmanned ship of tomorrow

With the collaboration of companies from various sectors, this MEGURI 2040 program, supported by the Nippon Foundation, is committed to developing the world's first unmanned vessel by 2025.

As a member of this consortium, Furuno is contributing to the trials and build-up of related technolgies technologies for autonomous navigation by leveraging the technical expertise we have accumulated through the development of marine Radar and wireless communication.
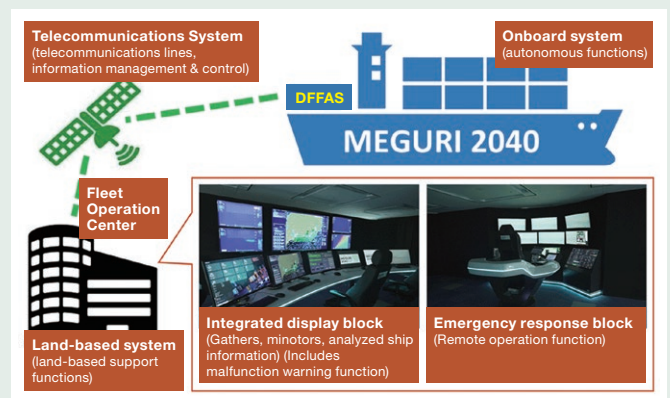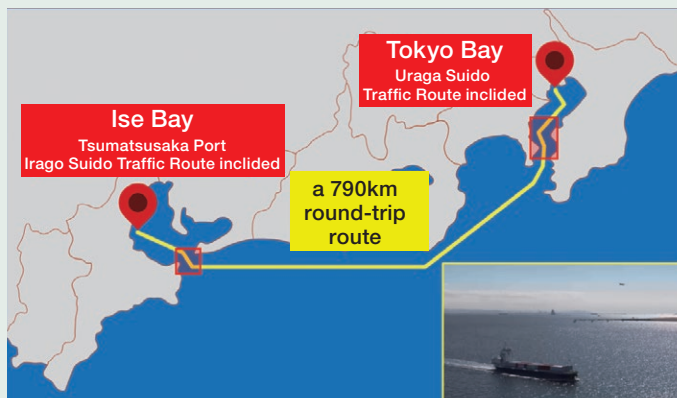
Furuno is one of the five consortia chosen for this program.

無人運航船 プロジェクト
MEGURI 2040
日本財団 THE NIPPON FOUNDATION

"Creating the Future of Fully Autonomous Ships - A Grand Design by a Group of Experts" project (Japan Marine Science Inc. and 21 other companies)

The DFFAS (Designing the Future of Full Autonomous Ship) Consortium[1] conducted a demonstration test of full autonomous navigation between Tokyo Bay and Ise Bay (about 790 km round trip) from February 26 to March 1. During this trial, a voyage including offshore navigation, bay navigation, coastal navigation, and berthing manoeuvres (between Tokyo Port and Tsumatsusaka Port) was successfully completed by an autonomous navigation system using a container ship "SUZAKU". This container ship was equipped with an autonomous navigation system, telecommunication systems, and anomaly prediction functions with the help of a fleet operation Control Center which could operate the ship by satellite and land signals.

Tokyo Bay
Uraga Suido Traffic Route inclied

Ise Bay
Tsumatsusaka Port
Irago Suido Traffic Route inclied

a 790km round-trip route

Telecommunications System
(telecommunications lines, information management & control)

Onboard system
(autonomous functions)

DFFAS

MEGURI 2040

Fleet Operation Center

Land-based system
(land-based support functions)

Integrated display block
(Gathers, minotors, analyzed ship information) (Includes malfunction warning function)

Emergency response block
(Remote operation function)

*1 The DFFAS Consortium is led by Japan Marine Science Inc., and includes Bemac Corporation, Eizo Corporation, Furuno Electric Co., Ltd., Honda Heavy Industries Co., Ltd., Ikous Corporation, Japan Hamworthy, Co. Ltd., Japan Marine United Corporation, Japan Radio Co., Ltd., Kinkai Yusen Kaisha Ltd., Mitsubishi Research Institute, Inc., Mitsui Sumitomo Insurance Company, Ltd., Miura Co., Ltd., MTI Ltd., Nabtesco Corporation, Nihon Shipyard Co., Ltd., Nippon Yusen Kabushiki Kaisha, NTT Communications Corporation, NTT Corporation, NTT Docomo, Inc., NX Shipping Co., Ltd., Pluszero Co., Ltd., Sanwa Dock Co., Ltd., Sky Perfect JSAT Corporation, Sunflame Corp., Suzuyo Marine Co., Ltd., Tokio Marine & Nichido Fire Insurance Co., Ltd., Tokyo Keiki Inc., Weathernews Inc., and YDK Technologies Co., Ltd.

Furuno led the technical development group for the autonomous navigation system and technical development group for the emergency response system that contributed to the success of this demonstration test.

North-up display   Bow

Port Radar   Bow Radar

Stern Radar   Starboard Radar

A screenshot of Millimeter Wave Radar (combined 4 radar display images)

▶ Autonomous Navigation System

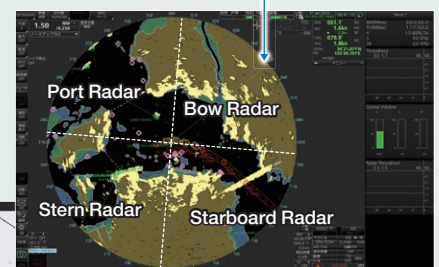(APExS: Action Planning and Execution System for full autonomous)

We led the team that developed the autonomous navigation system (APExS: Action Planning and Execution System) that performs the voyages (from one port to another) as planned while preventing collisions based on information obtained from onboard sensors. We are also responsible for the development of the Action Planning Unit (APU) that plays a central role in APExS. The APU integrates target information obtained from the Millimeter Wave Radar (newly developed for the demonstration tests), X/S Band Radar, AIS, and Camera Image Recognition System (manufactured by ORCA AI) to understand the ship's surrounding conditions. In addition, it includes functions to calculate the necessary maneuver plan for collision avoidance in cooperation with the collision avoidance planning system (manufactured by Japan Marine Science Co., Ltd.) and to send control commands to the autopilot, DPS, and speed pilot to control the next movement of the ship.

APU screen shot
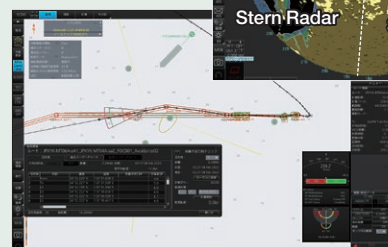
▶ Remote Emergency Response System

Constituting the Fleet Operation Center (FOC), REPS ensures the safety of the vessel by providing remote support and control from shore when the autonomous navigation system deems it necessary.
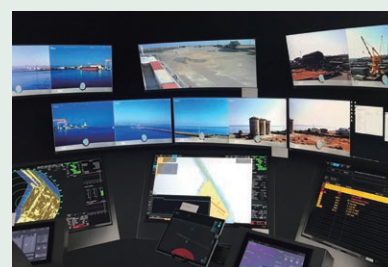

Remote Emergency Response System

無人運航船プロジェクト
MEGURI 2040 | THE FOUN
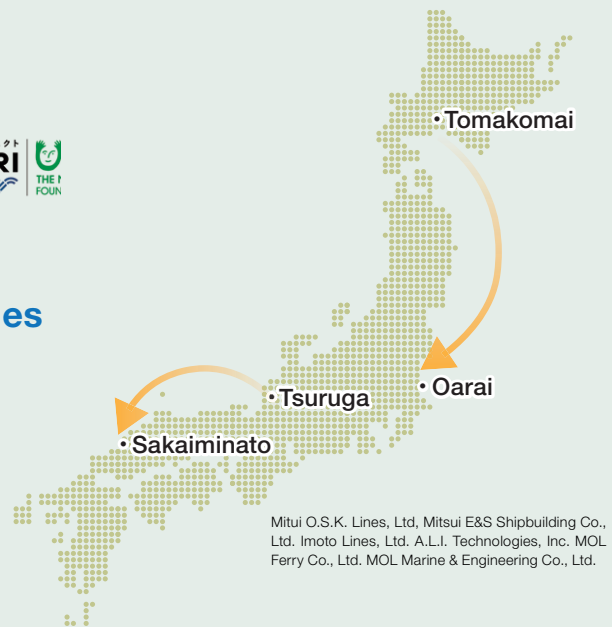
Demonstration of unmanned technology on Japanese container ships and car ferries
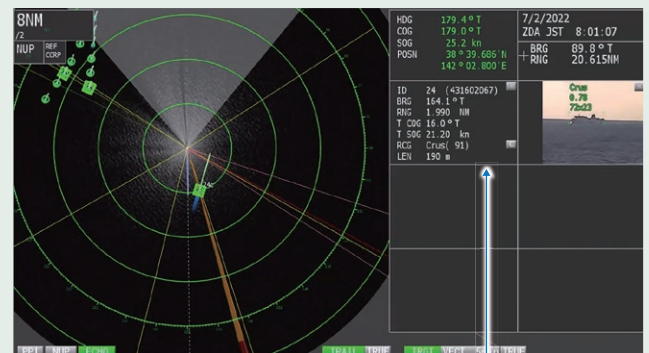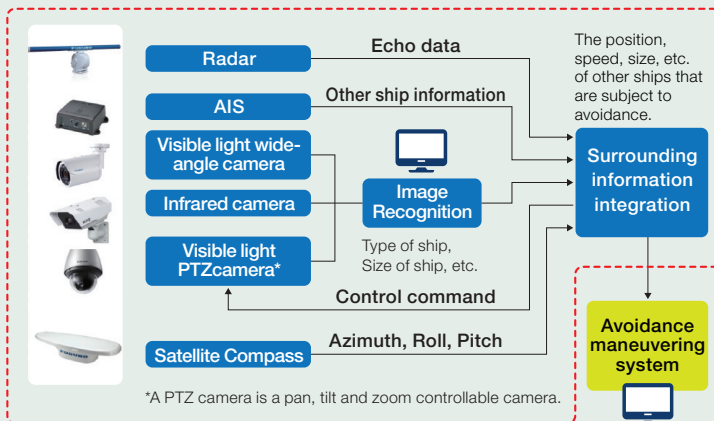### (Mitsui O.S.K. Lines, Ltd. and 7 other companies)

This unmanned operation experiment was conducted on the commercial route of "Sunflower Shiretoko" (a large car ferry) in February 2022. The ship navigated about 750 km from the port of Tomakomai in Hokkaido to the port of Oarai in Ibaraki Prefecture for 18 hours, day and night.

•Tomakomai
•Tsuruga
•Oarai
•Sakaiminato

Mitui O.S.K. Lines, Ltd, Mitsui E&S Shipbuilding Co., Ltd. Imoto Lines, Ltd. A.L.I. Technologies, Inc. MOL Ferry Co., Ltd. MOL Marine & Engineering Co., Ltd.

Furuno currently oversees the development of an automatic situational awareness system for the "Awareness" portion, which means that the navigators' constant watch is no longer necessary during the voyage. We are also working on the development of a Berthing Aid System that calculates the relative distance between the quay and the hull.

▶ Automatic situational awareness system

The automatic situational awareness system measures and displays positions, speed, vessel types and obstacle positions by integrating information from Radar, AIS and camera images information to the autonomous vessel operation control system to establish a safe route plan when there are other vessels or obstacles on the defined route.
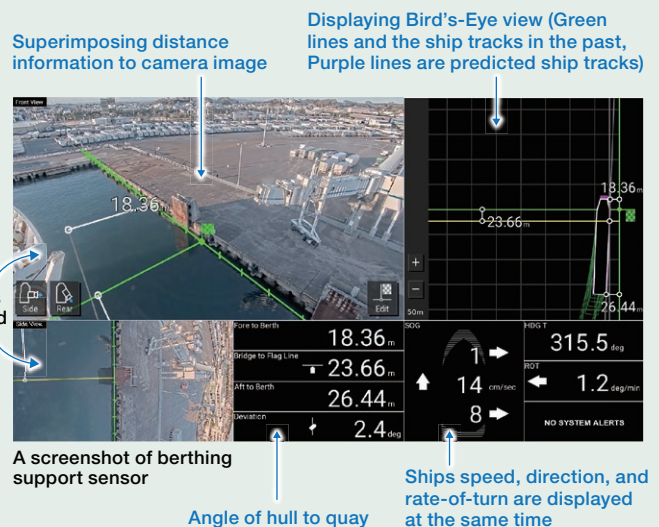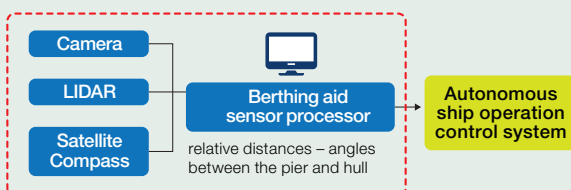
◯ : Radar supplemental target
△ : AIS receiving target
☐ : Camera image recognition target

Radar — Echo data
AIS — Other ship information
Visible light wide-angle camera
Infrared camera — Image Recognition
Visible light PTZcamera*
Type of ship, Size of ship, etc.
Satellite Compass — Azimuth, Roll, Pitch
Control command

The position, speed, size, etc. of other ships that are subject to avoidance.

Surrounding information integration

Avoidance maneuvering system

*A PTZ camera is a pan, tilt and zoom controllable camera.

A screenshot of the Automatic situational awareness system

Vessel type recognition result Crus represents a passenger ship

▶ The Berthing Aid System

The Berthing Aid System calculates and visually displays accurate relative distances and angles between the quay and the hull based on LiDAR/camera/Satellite Compass information providing the necessary information to the vessel's autonomous control system during automated berthing.

Camera
LIDAR
Satellite Compass
Berthing aid sensor processor
relative distances – angles between the pier and hull
Autonomous ship operation control system

Superimposing distance information to camera image

Displaying Bird's-Eye view (Green lines and the ship tracks in the past, Purple lines are predicted ship tracks)

Camera images can be switched
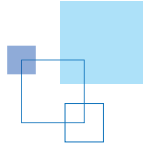
A screenshot of berthing support sensor

Angle of hull to quay

Ships speed, direction, and rate-of-turn are displayed at the same time
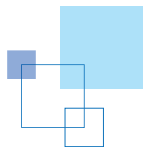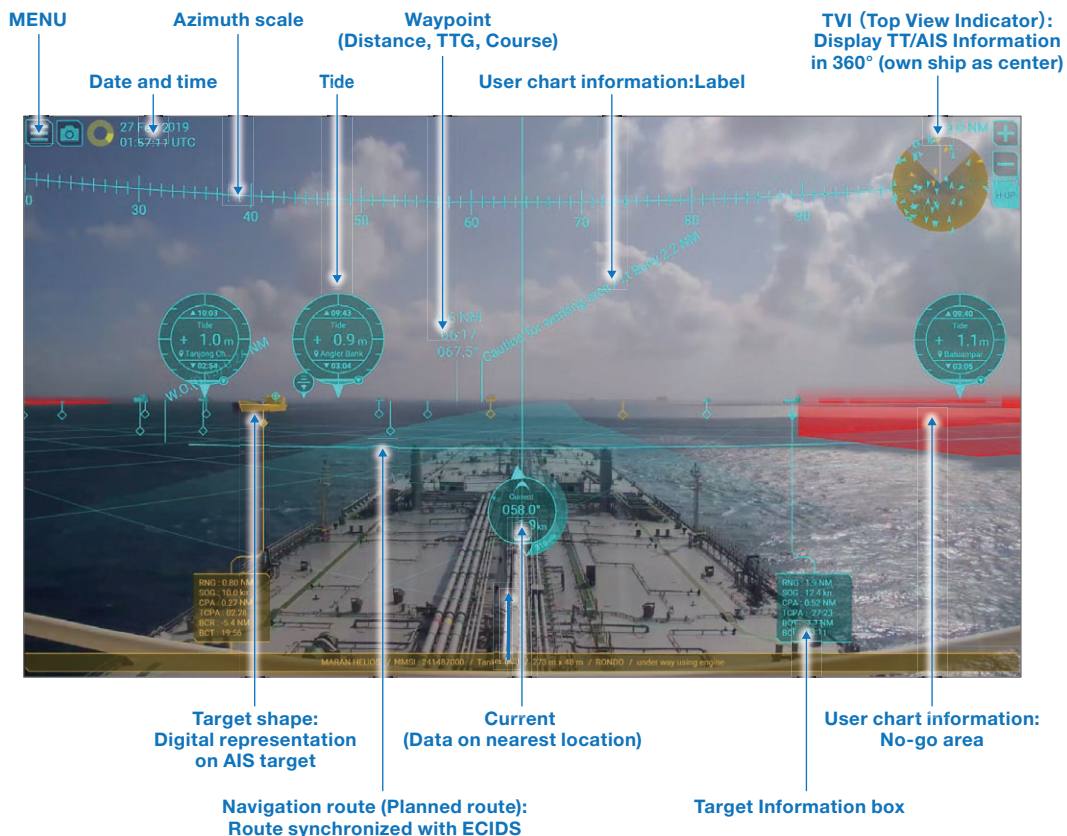
Introducing products/technologies

**Furuno is developing new products and technologies
to the future of unmanned ship navigation.**

AR Navigation System

The AR Navigation System is a navigation and maneuvering support system for ships that takes full advantage of Augmented Reality technology. The system uses AR technology to superimpose navigational information on images captured by a camera mounted in front of the vessel. Even in adverse weather conditions or at night when it is difficult to see, the display shows the ship's route and information on other vessels, making navigation much more peaceful, safe, and comfortable.

ENVISION

MENU

Date and time

Azimuth scale

Tide

Waypoint
(Distance, TTG, Course)

User chart information:Label

TVI（Top View Indicator）:
Display TT/AIS Information
in 360° (own ship as center)

Target shape:
Digital representation
on AIS target

Navigation route (Planned route):
Route synchronized with ECIDS

Current
(Data on nearest location)

Target Information box

User chart information:
No-go area

Camera Image Recognition System

Using Artificial Intelligence technology, we are developing onboard cameras capable of identifying ship types, navigation buoys, and other objects. The camera will not only be used to identify objects but will also be combined with the Radar and AIS technologies already on board to achieve unprecedented object detection reliability, thus contributing to greater safety at sea without the need for human presence.
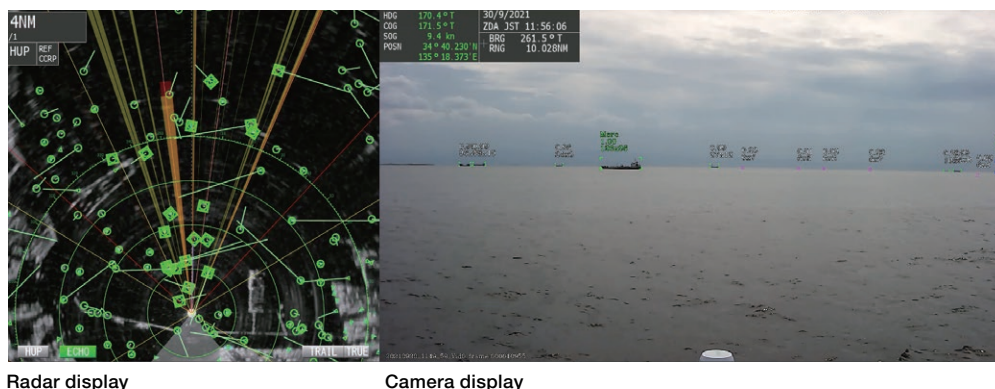

Radar display

Camera display
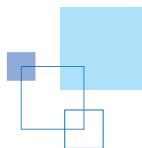
Millimeter Wave Radar

A clear picture of the surroundings is crucial in achieving autonomous navigation. Millimeter Wave Radar uses higher frequencies than conventional navigation Radar, detecting smaller objects at close ranges and other vessels in congested waters with greater accuracy. Combined with a wide variety of sensors such as Radar, visible light cameras, and infrared cameras, the Millimeter Wave Radar provides a stable overview of the situation around the vessel, regardless of weather or light conditions.
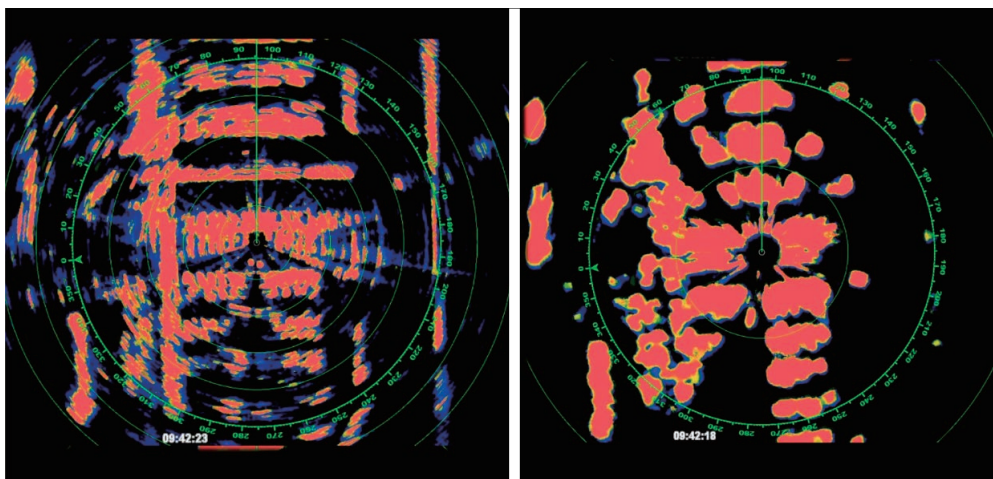
Millimeter Wave Radar   **X-band Radar**
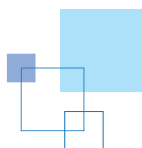
3D Bird View System

The 3D Bird View System is a unique mode using virtual technology that provides the user with an overhead bird/third person view of their own vessel in 3D for maximum situational awareness around the vessel and safe navigation. This view mode overlays essential information such as chart information, Radar data, AIS, and risk of collision areas. The height, angle, and zoom levels can be freely adjusted, allowing the user to check from all directions instantaneously to have full situational awareness in every direction at all times. It is a perfect support tool for safe route planning and collision avoidance, particularly in busy areas where dozens of vessels enter and leave ports at the same time.
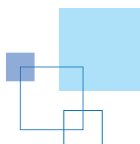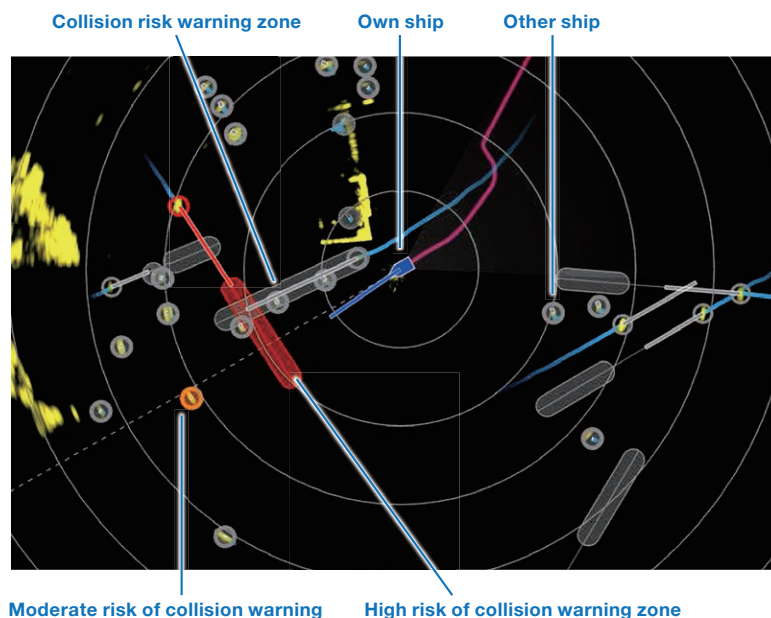

Target information   **High risk of collision warning zone**

Route   **Own ship**   **Other ship**   **Buoy**

Risk Visualizer™

In extremely busy waters (such as ports entrances and exits), all vessels must make a continuous effort to watch out for other vessels in the vicinity in order to avoid a collision. Furuno's Risk Visualizer is an innovative technology that significantly reduces the risk of collision by alerting the user to potential collision areas with colored indications. This technology is based on an advanced algorithm that has studied and analyzed numerous data samples from real maneuvers and navigation data, provided by operators and navigators to obtain highly reliable predictions.
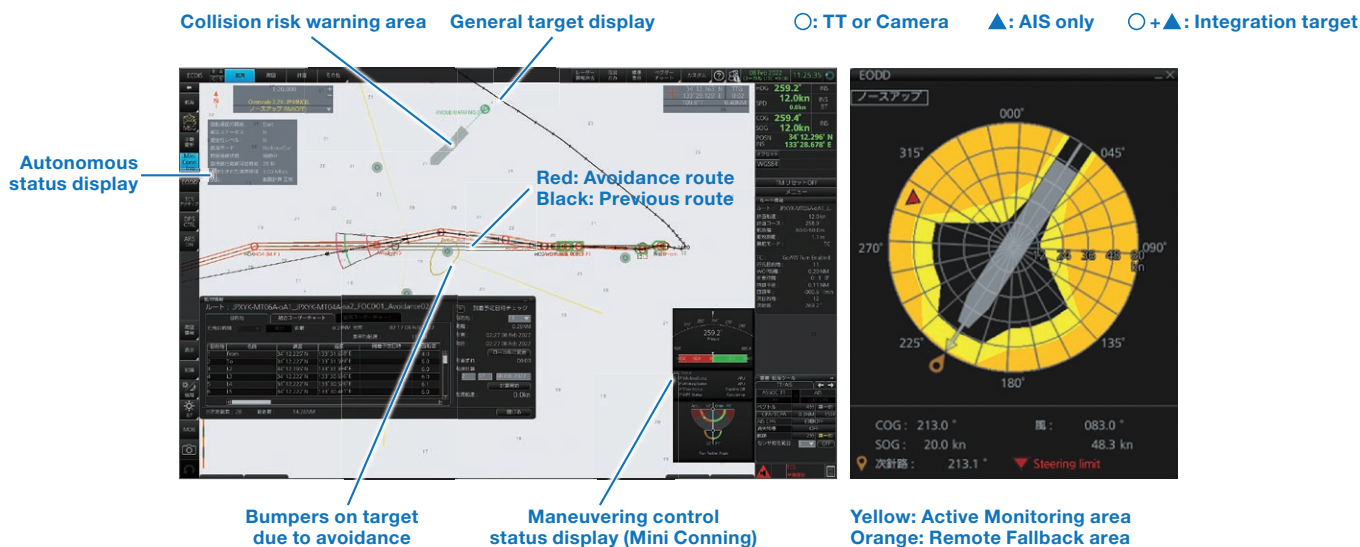
RISK VISUALIZER

Collision risk warning zone   Own ship   Other ship

Moderate risk of collision warning   High risk of collision warning zone

Action Planning Unit

The Action Planning Unit is a central element of the automatic navigation system in development to realize fully autonomous ships: the APExS-auto (Action Planning and Execution System for full autonomy) concept*. This unit integrates data from a multitude of different sensors to collect information accurately and identify objects around the vessel, detecting any potential risk of collision. Based on the information obtained, the Action Planning Unit calculates the best route and readjusts the course to take to avoid a collision. The route to be avoided is then automatically integrated into the current route plan, and the ship is redirected to follow the safest route via the DTC (Drive Train Controller: a group of functions that control the rudder, engines, thrusters, etc.). Thanks to its comprehensive integration capability, the Action Planning Unit paves the way for fully autonomous navigation.

*A framework to realize fully autonomous ships proposed by NYK, MTI and Nippon Kaiji Kagaku, which has received basic certification (AiP) from the Nippon Kaiji Kyokai and Bureau Veritas. The system will achieve autonomous navigation through AI that will take over navigation-related tasks, such as information gathering, analysis, planning, and approval, which are currently performed by humans.

Collision risk warning area   General target display   ◯: TT or Camera   ▲: AIS only   ◯+▲: Integration target

Autonomous status display

Red: Avoidance route
Black: Previous route

Bumpers on target due to avoidance   Maneuvering control status display (Mini Conning)

Yellow: Active Monitoring area
Orange: Remote Fallback area

* Please refer to "MEGURI2040"Fully autonomous ship framework section.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

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