Fujitsu develops high-accuracy fuel efficiency estimates through a ship's operational data

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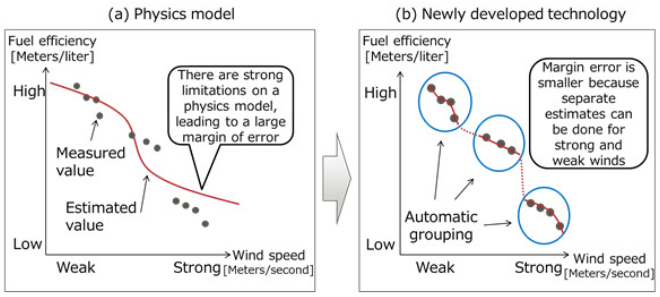

Figure 1: Physics model vs the newly developed technology

Fujitsu Laboratories today announced the development of technology that uses analysis of ship-related big data to estimate fuel efficiency, speed and other performance in actual sea conditions, to a highly accurate margin of error of less than 5%. This newly developed technology puts to work Fujitsu Laboratories' propriety high-dimensional statistical analysis technology to estimate the performance of ships actually at sea.

The technology utilizes a massive volume of measurement data gathered while the ship is underway, including sensor data of meteorological and hydrographic conditions such as wind, waves, and ocean currents, ship engine log data, and data about the speed and position of the ship. By applying the results of this research to Tokyo University of Marine Science and Technology's weather routing simulator for evaluation, Fujitsu Laboratories demonstrated it could improve fuel efficiency by about 5% from previous results, with ships that navigate the shortest shipping routes.

With this technology, it is possible to accurately estimate a ship's performance in actual sea conditions, which previously had a large margin of error, enabling evaluation of ship performance, design feedback, and significant improvements in fuel efficiency when used in ship navigation. This technology uses Fujitsu's AI technology, Human Centric AI Zinrai, and Fujitsu Laboratories will continue to improve its estimation accuracy through further operational trials going forward. The technology will be exhibited at Fujitsu Forum 2016, which will be held May 19th and 20th at the Tokyo International Forum (Chiyoda-ku, Tokyo, Japan).

Background

In the shipping industry, the impact of shipping on the environment and the economics and safety of navigation are huge issues. In 2012, the amount of CO2 emitted by seaborne shipping reached about 900 million tons, roughly 3% of the world's total CO2 emissions. In line with revisions to a convention of the International Maritime Organization (IMO), a dedicated arm of the UN, which went into force in 2013, there are now restrictions on CO2 emissions for newly built ships. There are also cases in the maritime shipping industry where a company's annual cost of fuel exceeds several hundred billion yen, so there is also a need for reductions in fuel costs.

Issues

If maritime operators have an accurate grasp on the effects of meteorological and hydrographic conditions on a ship's fuel performance, they can determine whether it is better, in terms of fuel efficiency, to take the shortest route, or to take a longer route to avoid the wind and waves. However, as existing ship performance estimation technologies rely on experiments with model ships in tanks of water, or on physics model simulations, they could not take into account the complicated

interactions of the wind, waves, and ocean currents with ship conditions. This problem led to large margins of error in predictions.

About the Technology

Now, using Zinrai AI technology on big data from ships, Fujitsu Laboratories has developed high-accuracy technology that estimates ship performance in actual sea conditions, with a margin of error less than 5%. In addition, by collecting and analyzing operational data from ships actually at sea, this technology is being put to use in designing safe and economical ships and in navigating ships at sea. This technology uses Fujitsu Laboratories' propriety high-dimensional statistical analysis technology to analyze and learn from high-dimensional data that incorporates a variety of directly measured data from ships that are underway, including meteorological and hydrographical sensor data of wind, waves, and ocean currents, as well as ship engine log data, ship speed and position data. The technology then estimates the ship performance under meteorological and hydrographical conditions for which there is no actual measurement data. Key features of the technology are as follows:

1. Technology that does analysis using data as is from actual travel

Fujitsu Laboratories' propriety high-dimensional statistical analysis technology allowed measurement data obtained from ships underway to be used as is, for the successful analysis of the influence of a variety of simultaneously integrated factors, such as meteorological and hydrographic conditions. This enables performance estimates that incorporate the complex interaction of conditions, including wind, waves, and ocean currents, based not on synthesized data from experiments in tanks of water, but on data gathered as-is from actual ships at sea.

2. Technology that automatically groups measurement data, and adjusts the degree of machine learning for each group

With physics models, because physical phenomena, such as the strength of the wind, for example, have to be expressed uniformly in a simplified model, it was impossible to raise the level of estimate accuracy (Figure 1a). With this technology, the high-dimensional data, which incorporates a variety of measurement data, is automatically grouped by similar meteorological and hydrographic conditions, and then machine learning and estimation are carried out on each group individually (Figure 1b). Overly prioritizing actual measured data for machine learning can create a problem where the estimation accuracy goes down for conditions which have not been experienced and there is no measurement data. This problem is solved by automatically adjusting the group boundaries so that no group has data that matches measurement data too closely. This enabled a uniform reduction in prediction error.

Results

Carrying out joint research with Tokyo University of Marine Science and Technology, Fujitsu Laboratories applied this technology to measured data held by the university from actual ships at sea, including wind and wave data, and the ship's fuel consumption, and successfully and accurately estimated the ship's speed performance and fuel consumption performance to within a 5% margin of error. By combining this technology with the Tokyo University of Marine Science and Technology's weather routing simulation, they verified that, for a Pacific Ocean shipping route from Tokyo to Los Angeles, by taking an optimal route based on the ship's performance, as determined by this technology, as opposed to the most direct route, fuel consumption could be cut by about 5%, greatly reducing both fuel costs and CO_2 emissions. Feeding back data from voyages by previously developed ships into the ship design process, this technology can enable the design of safe ships with high fuel efficiency. In addition, changes in ship performance before and after maintenance and also before and after applying various fuel-efficient technologies can be quantitatively evaluated.

Future Plans

Fujitsu Laboratories will continue to improve prediction accuracy through joint research with Tokyo University of Marine Science and

Technology. In addition, they will carry out trials with a number of ship types and routes, aiming to offer services through Fujitsu's location information cloud service, FUJITSU Intelligent Society Solution SPATIOWL, in fiscal 2016.

Provided by Fujitsu