A Study on An Automatic Navigation System Basing on Radar and AIS Data

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1. Introduction

Safety of navigation is always a matter of great importance. Thence, a deal of efforts has been made to ensure the navigation safety in parallel with satisfying economic demands. The aim of this research is to construct an Automatic Navigation System to reduce the workload of navigator while taking maneuver, together with ensuring the safety and efficiency of navigation, basing on the available supporting equipments such as Radar/ARPA and AIS. The system should be able to solve the following tasks:

- Continuously be on watch to detect any arising risk of collision on the intended route.
- Conduct real-time calculation of the shortest route to be clear from any dangers, together with maintaining in proximity of the planned route.
- Automatically handle the own ship to keep the intended track while keeping on watch for possible risk of collision with coming targets.

2. System Overview

![System Configuration](image)

Fig 1. System Configuration

The system is a computer based program consisting of 3 modules solving the previously mentioned 3 tasks.

A Watch Keeping module continuously receives target movement data through radar and AIS. These data is used to find out any newly approaching targets, deviations in existing target course, speed etc. to decide if the current route of own ship is safe. If it is not the case, it will activate a route generation module. The Route Generating module uses target motion, environmental constraints and Own Ship maneuverability to produce the Minimum Time Route to safely avoid all the dangers. A Tracking Control block handles the ship on the calculated route.

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3. Dynamic Program for Route Generation

Solution to the safe route producing problem is the dynamic programmer. Using this method, a grid system is built in the navigable area between the start point and the end point. A safe route for own ship is the shortest route from start point, via 1 grid point on every lines to reach the destination that does not cause the ship to enter a restricted area, to go out of limiting line or to be in risk of collision with other target ships. In this study, filters are applied for target information to reduce noise effects. Residual errors and Own ship deviations are also taken into account by applying suitable error circles.

![Route Producing Algorithm](image)

Fig 2. Route Producing Algorithm

4. Study case

![Case Study](image)

Fig 3. Case Study

A ship is supposed to follow a planned route. At point A on this route, the system detected the approaching of 2 ships that has risk of collision and the minimum time route for collision avoiding is calculated (route AB). While on route AB, route generator was activated again as other 2 ships were approaching. Then, the route part CD is produced. Note that point D is on the planned route, therefore own ship will not go away from the planned route.