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SECOND PRIZE

Paul Lee
University of Strathclyde

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Trustworthy Autonomous Collision Avoidance Decision-Making System for Maritime Autonomous Surface Ships

The recent maritime industry is paving the way towards the "Shipping 4.0" era and autonomous ships, also known as Maritime Autonomous Surface Ships (MASS), these are envisioned to be the key enabling technologies for the fully autonomous maritime ecosystem. However, a new emerging challenge that arises with the advancement of autonomous technologies is their trustworthiness, especially of those that execute mission-critical operations. The aim of this research is to develop a trustworthy Autonomous Collision Avoidance Decision-Making System (ACA-DMS) for MASS. A reference system layout of the expected autonomous collision avoidance system was developed, and a methodology that combines the following methods was employed: i) a digital twin of the system was developed to provide critical external risk metrics; ii) Fault Tree Analysis was conducted to acquire critical internal risk metrics; iii) a deep deterministic policy gradient algorithm was used to make collision avoidance decisions based on both external and internal risk metrics. A cargo ship was employed as a case study, and collision scenarios were developed to investigate the feasibility of the developed system. The derived simulation results verified that after training, the system was able to perform collision avoidance in trained and prior unknown collision scenarios. In addition, it was verified that the consideration of both external and internal risk metrics led to the increase of the system trustworthiness, both qualitatively and quantitatively. This project is expected to have a great impact on the future maritime industry by providing a way forward towards safer, resilient, and more dependable trustworthy autonomous systems.