COLREGs-Compliant Autonomous Collision Avoidance Using
Multi-Objective Optimization with Interval Programming

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High contact density environments are becoming ubiquitous in autonomous marine vehicle (AMV) operations. Safely managing these environments while still accomplishing their mission greatly taxes platforms. A legitimate concern exists that AMV collisions could become more frequent as contact density increases. In situations where AMVs are not necessarily performing a collaborative mission but are instead only using shared physical space such as multiple vehicles running on the same river, a high demand exists for safe and efficient operation to minimize mission track deviations while preserving the safety and integrity of mission platforms. With no existing protocol for collision avoidance of AMVs, much effort to date has focused on individual ad hoc collision avoidance approaches that are self-serving, lack the uniformity of fleet-distributed protocols, and disregard the overall fleet efficiency when scaled to being in a contact-dense environment. This research shows that by applying interval programming and a collision avoidance protocol such as the International REGULATIONS for Prevention of Collisions at Sea (COLREGs) to a fleet of AMVs operating in the same geographic area, the fleet achieves identical mission efficiency concurrent with significant reductions in the number of collisions observed. Within this research, a basic collision avoidance protocol was analyzed against an AMV-COLREGs protocol while parameters key to collision avoidance were studied using regression testing and analysis of both real-world and simulated statistical data. Further, a testing metric was proposed for declaring AMVs as "COLREGs-compliant" for at-sea operations.

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