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Integration of Stereo Vision and MOOS-IvP for Enhanced Obstacle Detection and Navigation in Unmanned Surface Vehicles

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Abstract
This paper addresses the development of a stereo vision-based obstacle avoidance system using MOOS-IvP for small and medium-sized Unmanned Surface Vehicles (USVs). Existing methods predominantly rely on optical sensors such as LiDAR and cameras to discern maritime obstacles within the short- to mid-range distances. Nonetheless, conventional cameras encounter challenges in water conditions that curtail their effectiveness in localizing obstacles and planning paths. Furthermore, LiDAR has limitations regarding angular resolution and identifying objectness due to data sparsity. To overcome these limitations, our proposed system leverages a stereo camera equipped with enhanced angular resolution to augment situational awareness. The system employs recursive estimation techniques to ascertain the position and dimensions of proximate obstacles, transmitting this information to the onboard control unit, where MOOS-IvP behaviour-based software produces navigation decisions. Through the real-time fusion of data obtained from the stereo vision system and navigational data, the system is able to achieve Enhance Situational Awareness (ESA) and facilitate well-informed navigation decisions. Developing a state-of-the-art maritime object detection technique, the system adeptly identifies obstacles and swiftly responds via a vision integration protocol. During field tests, our system proves the efficacy of the proposed ESA approach. This paper also presents a comprehensive analysis and discussion of the results derived from deploying the proposed system on the Suraya Surveyor USV platform across numerous scenarios featuring diverse obstacles. The results from these various scenarios demonstrate the system’s accurate obstacle detection capabilities under challenging conditions and highlight its significant potential for safe USV operations. Authors

Author Keywords
Autonomous vehicles; Cameras; Collision avoidance; Feature extraction; Laser radar; MOOS-IvP; Navigation; Object Detection; Obstacle Avoidance; Optical sensors; Situational Awareness; Stereo Vision; Stereo vision; Unmanned Surface Vehicles

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