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## Integrated stereo vision and GNSS approach for sea-state monitoring on a moving vessel

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Monitoring sea state is essential for navigation safety, vessel operability, and offshore/coastal engineering, as it supports the estimation of key parameters such as sea-surface geometry and significant wave height. Traditionally, sea-state information is obtained from in situ instruments (e.g., wave buoys and ship motion sensors) and remote observations (e.g., radar-based systems and satellite products). While these approaches are mature, they may be limited by spatial/temporal coverage, deployment, and maintenance constraints. In contrast to well-established fixed-station solutions, shipborne observations are emerging, coping with non-stationary viewing geometry and vessel dynamics. This motivates system integration, such as stereophotogrammetry with Global Navigation Satellite System (GNSS) observations to provide an alternative route to measure wave metrics from the reconstructed sea surface geometry. The present work describes a shipborne sensing system built around a time-disciplined camera and GNSS synchronization to enable stereo-vision processing and subsequent generation of a 3D point cloud of the sea surface. The whole project approach is technically challenging in realistic marine conditions (e.g., changing illumination, specular reflections, low texture, and intermittent occlusions). The acquisition chain utilizes a GNSS Pulse-Per-Second (PPS) signal to trigger two industrial RGB cameras synchronized via hardware, with deterministic triggering and logging managed by a Raspberry Pi 4. PPS-based triggering provides stable frame time-stamping, enabling coherent fusion with and motion (ship attitude and trajectory) information provided by GNSS. Ongoing tests focus on end-to-end robustness (timing stability, synchronization, and motion sensitivity) and on comparison against independent references when available (e.g., onboard motion sensors and nearby in situ records). The proposed configuration provides a useful instrument for sea-state monitoring, in a scalable and low-cost method.