

Smart Swimming Pool Surveillance System

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Drowning is a serious public safety hazard in aquatic areas, where quick responses are required to avoid deadly events. This study recommends developing a smart swimming pool surveillance system based on Artificial Intelligence (AI) and real-time monitoring to detect swimmers, recognize their behaviors, and detect drownings. The proposed system integrates camera-based tracking, posture estimation utilizing the MediaPipe framework, and machine learning-based activity detection to facilitate comprehensive surveillance in designated aquatic areas. There are two AI systems used: a scene classifier and a frame-by-frame activity classifier for identifying whether a swimmer is swimming actively, drowning, or inactive. The overhead cameras utilizing pose landmark detection take video frames and extract body key points from them, and put them in a specified bounding box for normalization. Masking by the user restricts the monitoring to the swimming zones, and real-time visual feedback utilizing color-coded real-time bounding boxes (green for swimming and red for drowning) gives instant swimmer status awareness. The system was trained and tested with a custom-created dataset of 90 videos (30 each) and achieved classification accuracies of 80% for swimming and drowning situations, 60% for frames with inactive scenarios, and ultimately an overall accuracy of 83%. Furthermore, the system is able to provide timely mobile alerts for hazardous activities detected, thus greatly minimizing the response time for life-saving interventions. Although using cameras to detect drowning has been explored in different settings, most previous studies concentrated on open water or general anomaly detection. It uses MediaPipe for real-time posture estimation and combines activity-level and scene-level classifiers to improve decision-making. This research contributes to enhancing pool safety by automating the monitoring tasks and helping lifeguards make important decisions. Future work involves improving detection for multiple persons, refining pose estimation to consider occlusions, and incorporating the system into centralized monitoring systems for large-scale adoption.

Keywords: AI, Image processing, MediaPipe, Scene classification, Surveillance system