**Safety Visualization in Cooperative Operation with Workers and Construction Vehicle using Temporal LiDAR Data**

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***ABSTRACT***

In Japan, the declining birthrate and aging population have led to a severe labor shortage. Therefore, the construction industry is trying to improve efficiency using autonomous and ICT construction vehicles with construction information modeling and management. Although an unmanned operation is an ideal scenario, construction works in urban areas have technical issues in poor GNSS environments due to multipath problems, in managing autonomous and ICT construction vehicles. Moreover, construction areas are too small and narrow for autonomous construction vehicles in urban areas. Thus, cooperative operation with workers and ICT-assisted construction vehicles is required for construction works in urban areas. Therefore, it is necessary to improve the efficiency and safety of cooperative work between construction vehicles and workers. In our previous research. we focused on laser scanning from a construction vehicle to monitor the safety of construction fields. Although we integrated horizontal LiDAR and vertical LiDAR to recognize workers, the vertical field of view was insufficient to recognize workers. In this study, we integrated horizontal LiDAR, vertical LiDAR, and oblique LiDAR to keep the wider field of view from a construction vehicle. First, three types of LiDARs are integrated to obtain composite LiDAR point clouds. Next, the bucket of the construction vehicle and workers are detected from LiDAR point clouds. Then, worker tracking was applied with range image processing and SLAM processing. Estimated bucket and worker tracking data were used for a safety assessment in the construction field. Through our experiments, we confirmed that our methodology can recognize objects such as a bucket and workers. Moreover, our methodology can visualize safe and dangerous situations using temporal composite LiDAR point clouds. However, technical issues remained such as several types of failures in worker recognition processing. Additionally, in safety visualization, technical issues in real-time processing remained such as sudden stop estimation.

**Keywords:** Point clouds, Laser scanning, Object recognition, Object tracking, Construction vehicle