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Construction Quality Management based on Digital Twin using Autonomous Scanning UGV

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Abstract: Recently, construction sites have faced significant challenges due to arbitrary changes and poor communication between general contractors and subcontractors. This study proposes a technological solution by integrating Unmanned Ground Vehicles (UGVs) into the existing workflow of apartment construction. By analyzing current processes, we identified a scenario where UGVs, equipped with LiDAR (Light Detection and Ranging) systems, can generate and provide real-time 3D models of construction sites. These models can be linked with extended reality (XR) technology or office PCs for intuitive comparisons between digital and actual site conditions as a digital twin of the construction site. The study suggests an improved construction process that enhances contractors' understanding and on-site efficiency and enables managers to monitor progress effectively. To address challenging terrain on construction sites, a caterpillar driven UGV was developed, equipped with stereo cameras, a LiDAR sensor for scanning and gathering environmental data, and an embedded PC for data processing. Utilizing SLAM (Simultaneous Localization and Mapping) technology, the UGV autonomously navigates and scans the site at night, minimizing disruptions. Additionally, an embedded system analyzes images from stereo cameras to assess the quality of construction, mapping the findings onto 3D models. This innovation allows site managers to efficiently verify construction quality and identify issues without manual inspections, significantly improving site management efficiency.

Key words: smart construction, construction management, digital twin, UGV auto pilot, SLAM

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