別紙４－１（課程博士（英文））

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Abstract (Doctor)

Title of Thesis	3D Mapping by Multi-Sensor Fusion for Construction Cranes

Approx. 800 words

The creation of a 3D map holds significant importance for autonomous systems navigating in unknown environments. The application of 3D mapping spans various fields, including autonomous driving, service robotics, agriculture, augmented reality, and construction. The need for efficient 3D mapping methods is growing with the proliferation of robots and autonomous systems.

Despite extensive research on 3D mapping, particularly for ground vehicles and drones, limited attention has been given to 3D mapping for construction cranes. Current 3D mapping methods encounter limitations when applied to constructing a map for cranes, primarily due to the unique challenges and complexities associated with crane mapping. There is a strong need for innovative approaches specifically tailored for mapping in crane scenarios. This thesis proposes three novel methods for mapping for a construction crane using multi-sensor fusion.

First, we propose a complementary filter and crane structure-based real-time sensor pose estimation and 3D mapping method for construction cranes with an arbitrary motion of the sensor system (2D lidar and IMU) attached to the crane boom. A heavy lidar with a slowly rotating base is needed to make a large-scale map both vertically and horizontally for cranes. In the proposed method, we introduce a complementary filter with moving average filtering for lidar pose estimation, which is more robust to severe vibration than Kalman filter-based methods. As there are only a small amount of overlaps between 2D lidar scans, we propose a map correction method based on pose graph optimization with planar environmental constraints. We evaluate the proposed method in a simulation and a real environment and compare it with one of the state-of-the-art methods. The evaluation results reveal that the proposed method can accurately estimate the sensor poses, thereby generating a high-quality, large-scale 3D point cloud map.

Second, we introduce a method for neural network-based real-time pose estimation using an IMU (inertial measurement unit) and its application in large-scale 3D mapping using a slowly rotating 2-D LiDAR. In this method, a neural network consisting of a convolutional neural network (CNN) and long short-term memory (LSTM) is employed to estimate the change in pose. Firstly,