THE 6TH CIGR INTERNATIONAL CONFERENCE 2024

ICC JEJU, KOREA

PROGRAM BOOK

CIGR 2024

DIGITAL AGRICULTURE

MAY 19-23

Day 3, May 22 (Wed.) | Scientific Program

S7-12 Technical Section 7: Information Technology

10:15 - 11:45 Halla B (3F)

Chair(s): CHAN-SEOK RYU (Gyeongsang National University)

S7-12-01 10:15 - 10:30

Detection of grapes and cutting point for a grape harvesting robot in smart vineyard by using only depth data

Author: SHOUTA SASAYA (KITAMI INSTITUTE OF TECHNOLOGY)

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YOHEI HOSHINO (Kitami Institute of Technology)
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YUKI FUJII (Kitami Institute of Technology)
TOMOYA SEGAWA (Kitami Institute of Technology)

S7-12-02 10:30 - 10:45

A pneumatic soft gripper with enveloping structure for spherical fruit grasping

Author: QINGYU WANG (Zhejiang University)

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S7-12-03 10:45 - 11:00

VTMF-net: a visual tactile multimodal fusion network for grasping slip detection

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S7-12-04 11:00 - 11:15

Plant trait analysis on reconstructed 3D model using RGB-D sensing techniques

Author: XIANGHUI XIN (Seoul National University)

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DAEYOUNG KIM (Seoul National University)
GHISEOK KIM (Seoul National University)

S7-12-05 11:15 - 11:30

Real-time dense reconstruction of greenhouse crops based on Graph-optimized SLAM algorithm

Author: YU ZHENG (Chonnam national University)

Co-author(s): ÖMER FARUK İNCE (Agricultural Automation Research Center, Chonnam National University)
KYEONG-HWAN LEE (Chonnam national University)

S7-12-06 11:30 - 11:45

Oriental melon pose estimation using weakly supervised region proposal for harvesting robot

Author: SEUNGWOO KANG (Department of Biosystems Machinery Engineering, Chungnam National University)

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Real-Time Dense Reconstruction of Greenhouse Crops Based on Graph-Optimized SLAM Algorithm

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Abstract

Greenhouse agricultural technology, currently on the cusp of a digitization revolution, faces significant challenges due to the complex spatial configurations in modern greenhouses. Our study introduces a real-time 3D reconstruction system for greenhouse crops using Simultaneous Localization and Mapping (SLAM) technology, a significant advancement in agricultural monitoring. Utilizing RGBD cameras, our system captures intricate 3D point cloud frames in real-time. These frames undergo feature extraction for pose estimation, crucial for accurate 3D modeling. The system's efficiency is amplified by retaining only keyframes in memory, forming an optimized pose-graph, thus conservatively utilizing computational resources. The model's architecture incorporates backend loop closure detection, reinforced with marker constraints for enhanced accuracy. This is followed by a global optimization process, ensuring the model's high fidelity. The integration of the optimized pose graph with keyframes results in a detailed 3D point cloud model of the greenhouse environment, offering accuracy in spatial representation.

The coefficient of determination (R^2) of 0.996, the minimum root mean square error (RMSE) of 6.26 millimeters for ground control points, and the RMSE of 2.1 centimeters for the absolute pose error (APE) of camera trajectories demonstrate the reliability and precision of the model's accuracy. In summary, this study introduces a sophisticated and efficient approach for 3D reconstruction of greenhouse crops, significant for advancing high-throughput phenotypic analysis and digital agriculture. This methodology not only enhances spatial understanding of greenhouse environments but also sets a new standard in agricultural technology innovation.

Keywords: SLAM, RGBD, Pose Estimation, Real-time Reconstruction

References:

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Acknowledgments

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Figures:

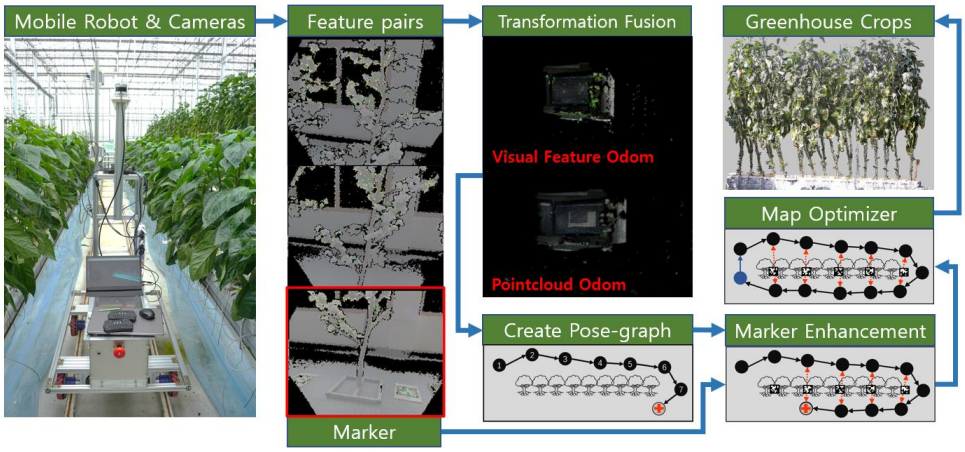

Figure 1: Algorithm Flow Schematic.

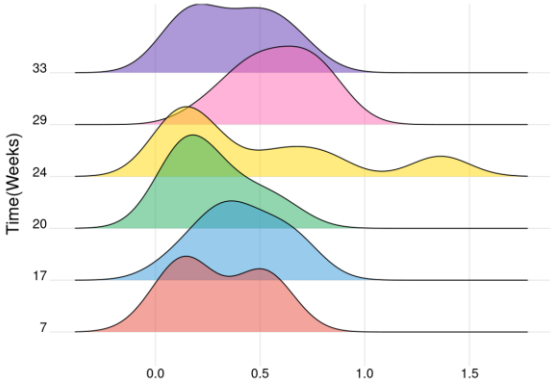

Figure 2: Error density distribution map (KDE).

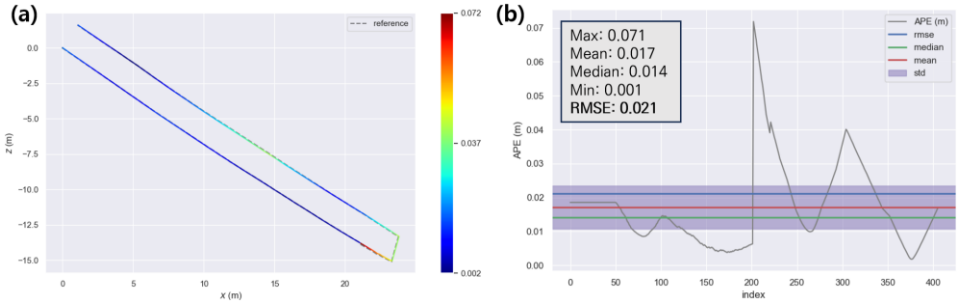

Figure 3: Trajectory accuracy, (a) Trajectory with error mapping, (b) APE error in reconstructed trajectory.