Caterpillar Equipped Mobile Robot Working on Rough Terrain based on Dynamic Windows Approach

Tianyuan Guan[1] Chen Tean[1] Kyeong-Hwan Lee[1,2,*]

[1]Department of Rural and Biosystems Engineering, Chonnam National University
[2]Agricultural Robotics and Automation Research Center, Chonnam National University

Introduction

Background

Caterpillar equipped mobile robot have great potential to deal with various kinds of fieldwork even in com-plicate landforms.

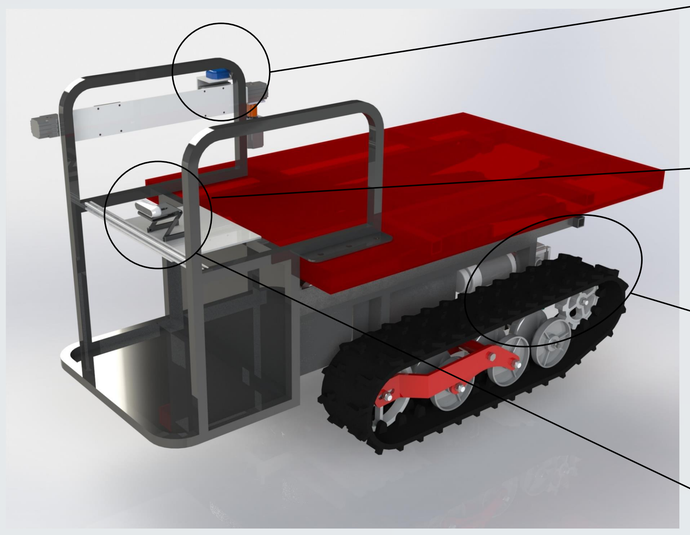
Objective

In our research, we develop a caterpillar type mobile robot system with simplified dynamic window approach for the agriculture application of rough terrain.

<Caterpillar Mobile Robot >

Material and Methods

Caterpillar Mobile Robot

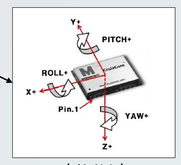


〈Design and 3D modeling of caterpillar mobile robot〉

〈 RTK-GPS 〉

〈 D435 Depth Camera 〉

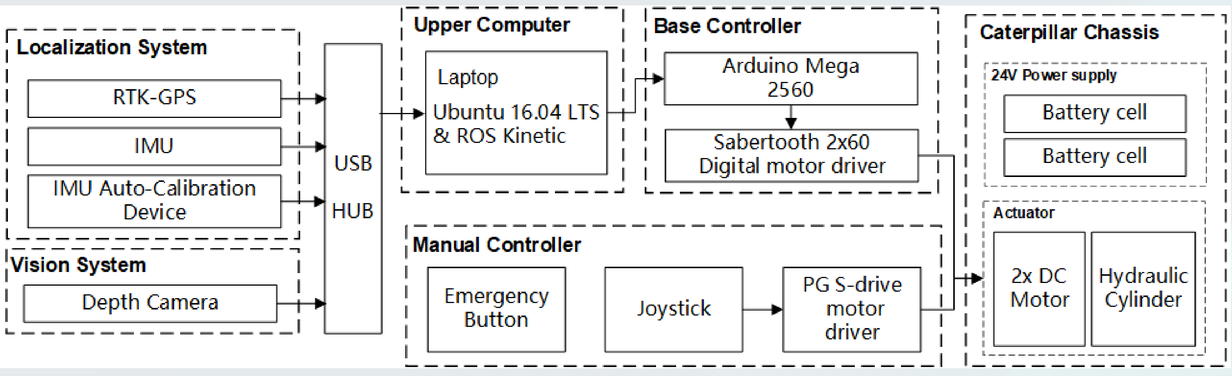
〈 DC Motor Driver 〉



〈 IMU 〉

- **Localization system**: RTK-GPS, IMU, Static heading angle measurement device
- **Controller** : ROS based global planner and local planner

Hardware Diagram of Control System

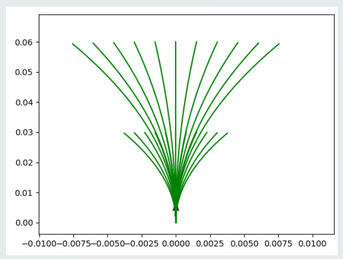


Simplified Dynamic Window Approach

- Velocity Sampling

$$V_m = \{v \in [v_{min}, v_{max}], \omega \in [\omega_{min}, \omega_{max}]\}$$

$$V_d = \left\{ \begin{array}{l} v \in [v_c - \dot{v}_b \Delta t \ , v_c + \dot{v}_a \Delta t] \cap \\ \omega \in [\omega_c - \dot{\omega}_b \Delta t \ , \omega_c + \dot{\omega}_a \Delta t] \end{array} \right\}$$

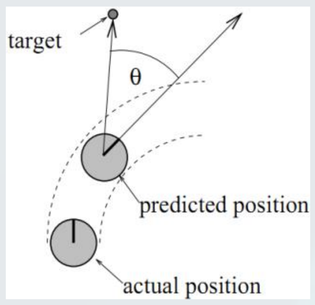


All possible trajectory
in single simulation period

- Velocity Estimating

Robot velocity estimated by

- Heading angle,
- Current speed,
- Distance to goal



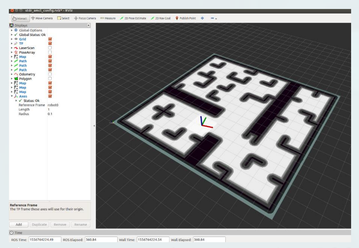
Mobile robot velocity estimating

$$G(v, \omega) = \sigma(\alpha \cdot heading(v, \omega) + \beta \cdot dist(v, \omega) + \gamma \cdot velocity(v, \omega))$$

Results and Discussion

- Navigation simulation was done based on ROS platform.
- The caterpillar mobile robot could travel in a certain environment and the error was less than 5 cm.
- The caterpillar mobile robot can follow various path smoothly even in rough terrain.

〈 Caterpillar mobile robot prototype 〉



〈 Navigation simulation based on ROS 〉

〈 Working on rough terrain 〉

Conclusions

As the results of experiments :

- The mobile robot could cruise certain paths accurately even in rough terrain with less than 5cm error.
- The caterpillar mobile robot could be applicable for outdoor agriculture usage with high accuracy.

References

1. Jung, Seungmin, et al. "Trajectory generation algorithm for smooth movement of a hybrid-type robot Rocker-Pillar." *Journal of Mechanical Science and Technology* 30.11 (2016): 5217-5224.
2. Seder, Marija, and Ivan Petrovic. "Dynamic window based approach to mobile robot motion control in the presence of moving obstacles." *Proceedings 2007 IEEE International Conference on Robotics and Automation*. IEEE, 2007.

Acknowledgements

This work was supported by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, Forestry (IPET) through the Advanced Production Technol ogy Development Program (No. 318904-3) and the Agriculture, Food and Rural Affairs Research Center Support Program (No. 714002-7), funded by the ministry of Agri culture, Food and Rural Affairs.

Sensors and Intelligent Biosystems Lab.
Chonnam National University