Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

TIANXIANG LU

BEng (Donghua University, 2016)

“Autonomous Navigation for a Two-Wheeled Unmanned Ground Vehicle”

Department of Mechanical Engineering

Friday, August 21, 2020
1:00 P.M.
Remote Defence

Supervisory Committee:
Dr. Yang Shi, Department of Mechanical Engineering, University of Victoria (Supervisor)
Dr. Daniela Constantinescu, Department of Mechanical Engineering, UVic (Member)

External Examiner:
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Dr. Leslie Saxon, Department of Linguistics, UVic

Dr. Stephen Evans, Acting Dean, Faculty of Graduate Studies
Abstract

Unmanned ground vehicles (UGVs) have been widely used in many areas such as agriculture, mining, construction and military applications. This results from the fact that UGVs can not only be easily built and controlled, but also be featured with high mobility and handling hazardous situations in complex environments. Among the competences of UGVs, autonomous navigation is one of the most challenging problems. This is because that the success in achieving autonomous navigation depends on four factors: Perception, localization, cognition, and proper motion controller.

In this thesis, we introduce the realization of autonomous navigation for a two-wheeled differential ground robot under the robot operating system (ROS) environment from both the simulation and experimental perspectives. In Chapter 2, the simulation work is discussed. Firstly, the robot model is described in the unified robot description format (URDF)-based form and the working environment for the robot is simulated. Then we use the gmapping package which is one of the packages integrating simultaneous localization and mapping (SLAM) algorithm to build the map of the working environment. In addition, ROS packages including tf, move base, amcl, etc., are used to realize the autonomous navigation. Finally, simulation results show the feasibility and effectiveness of the autonomous navigation system for the two-wheeled UGV with the ability to avoid collisions with obstacles.

In Chapter 3, we introduce the experimental studies of implementing autonomous navigation for a two-wheeled UGV. The necessary hardware peripherals on the UGV to achieve autonomous navigation are given. The process of implementation in the experiment is similar to that in simulation, however, calibration of several devices is necessary to adapt the scenario in a practical environment. Additionally, a proportional-integral-derivative (PID) controller for the robot base is used to handle the external noise during the experiment. The experimental results demonstrate the success in the implementation of autonomous navigation for the UGV in practice.