MOTION PLANNING AND CONTROL OF FOUR-WHEELED MOBILE ROBOT FOR AUTONOMOUS OFF-ROAD NAVIGATION

R. D. Wijesinghe[1], K. S. Samarakoon[1], R. M. T. P. Rajakaruna[1]

[1] Department of Mechatronics, Faculty of Engineering, South Asian Institute of Technology and Medicine (SAITM), Sri Lanka. Email: thilini.r@saitm.edu.lk

ABSTRACT

Autonomous robots with high mobility in unstructured natural environment have significant potential in explorations, military applications and rescue efforts. Navigating in unstructured terrain present many challenges such as wheel slipping and skidding in uneven ground, obstacles in path due to vegetation and other features, slopes, slippery or wet surfaces. In order to achieve autonomous navigation, the robot should be equipped with tools for high level perception to identify traversable spaces against obstructions in the path. In addition, localizing or positioning off-road robots under wheel slips etc has been studied extensively in literature for remote operations.

In this work, we present an autonomous off-road mobile robot design with a four wheeled structure. The mechanical structure of the robot consists of four independently driven actuators supported by a chassis designed to withstand hazardous conditions. Navigation architecture has been implemented using low-cost sensory devices and an off-the-shelf camera for vision-based feature detection. The design also supports a low-cost wireless communication unit used for training purposes as well as for remote operation.

Vehicle design was tested extensively in rough terrain traversing over slopes up to 30^o and a variety of surface textures including light vegetation, with the aid of the remote operation system. Real-time response of the robot was also tested for continued mobility with orientation changes.

The navigation architecture of the robot is based on real-time sensor inputs on orientation, acceleration and obstacles ahead as well as from wheel encoders. Maintaining the computational complexity of the algorithm at a minimum was a priority as the robot motion control is driven by real-time input on the layout of its surrounding and motion feedback system. Key features are identified in the path of the robot, and are used to estimated displacement and orientation of the robot using online feature tracking.

The estimated displacement and orientation of the robot and the feedback from wheel encoders were compared against the kinematic model of the robot to detect instances of ambiguity accounted for non-traversable terrain. The ground contact of each wheel is estimated using a current sensory method. In the event of an obstruction or difficulty in the path, the robot attempt to divert from desired trajectory and attempt to reach the reference path by circumnavigating the difficult terrain.

***Key Words*:** Off-road robot, Feature tracking, Feature detection, Vision-based navigation