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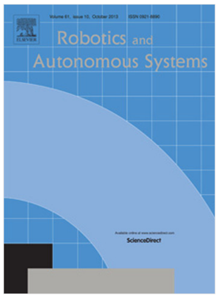

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Simultaneous Surface Scanning and Stability Analysis of Wheeled Mobile Robots using a New Spatial Sensitive Shield Sensor

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Abstract

To achieve a complete sense of a typical mobile robot moving on the rough and unknown surfaces, a new sensitive shield attached to the robotic wheel is developed with the principle of the total resistance of a circuit. Contact point detection using the new sensitive shield empowers the wheeled-robots to scan the surface, to find the spatial stability measure and to control itself in the absence of camera and laser. The resistive circuit, whereby the sensor is developed, includes a conductive wire, a resistive wire, an impulse voltage source and an additional resistor. All these elements are assembled as an exterior sensitive shield attached to the outside of the wheel. The main advantage of the resistive shield is to determine the exact locations of the spatial contact point on the thick wheel only by means of an input data. Using the data detected from the sensitive shield, the control process can produce the accurate rotational velocities of the wheels required for pursuing a desired path. Furthermore, the results of the new sensor enhance the accuracy of the spatial stability measure. The results of this research imply how the accurate contact point detection aided by the new sensor yields a reliable approach for surface scanning and stability measure calculation.

Keywords: field robotics, wheel-surface contact, resistive shield, tactile sensors

1 Introduction

For the field robots to operate effectively, they have to be equipped not only by the robust mechanical structure, but also by the effective sensors to uncover the environment properties. Such real applications involve usually missions on uneven surfaces including obstacles [1, 2], holes, ramps and cliffs. Indeed, finding the surface characteristics and the contact point estimation become essential for these robots to overcome severe conditions [1]. Field robots can be empowered by enhancement in the sensors, mechanical system and control algorithm. Considering the sensor improvement, the field robots are usually equipped with a set of gyroscope, accelerometers and encoders which are sufficient for the locomotion on flat surfaces. Moving on an uncertain and rough surface containing undefined obstacles and undetermined friction condition, this set of sensors cannot detect many parameters of the environment such as exact contact point, obstacles position, stability margins, dynamic terms and friction force of the wheel. The soft terrain's conditions such as soil deformation matter in the real exploring environment can complicate the state estimation even more than rigid rough surfaces [3]. Evaluation of the rover dynamics and kinematics parameters such as sinkage amount of the soil facing soft terrains [4] and exact contact point detection on the rigid rough surfaces imply necessity of the surface sensing. Distance detectors such as laser or ultra-sonic sensors can detect the obstacles located in the robot environment [5-7]. The sensors detecting normal and friction force of the wheel can be used to detect undefined dynamic parameters which cannot be found by the set of accelerometer, gyroscope and encoder [8]. The vision based sensors [9, 10, and 11] or optical detectors [12] as lasers can approximately estimate the surface around the robot. The sensitive bumpers can detect the contact between surface and the body. For the advanced application such as uncertain gripping or uncertain contacts between a part of the robot and the environment, force sensors (FSR) and tactile sensors can