The Roadrunner: A 2-D Powered Rimless Wheel Robot for Energy-efficient and Rough Terrain Locomotion

Scott Miller*, Ezra Ameperosa*, Kyle Seay*, Rico Jovanni Ulep*, Pranav Bhounsule
Department of Mechanical Engineering, University of Texas at San Antonio, Texas, USA
Scott.Angus.Miller@gmail.com, Ezra.Ameperosa@gmail.com, jsairborn@gmail.com,
RicoJU@yahoo.com Pranav.Bhounsule@utsa.edu
* equal contribution

1. Motivation

Our prime motivation is to develop energy-efficient rough terrain legged robots. In the past, we have developed energy-efficient legged robots leading to a 40 mile endurance walking record [1]. However, in that work the robot walked at a single speed and only on level terrain. In this paper, we provide design details and future plans on developing an energy-efficient, rough-terrain legged robot, capable of walking and running.

2. Robot design details

Our robot, called the Roadrunner, is based on the passive rimless wheel studied by Coleman et al [2]. Fig. 1 shows a 3D rendering of the robot. The Roadrunner robot consists of two rimless wheel subassemblies, (see Fig. 2 for one of the wheel), connected to each other through a shaft. The shaft is connected to a 22.2 V brushless DC motor through a timing belt and is shown in Fig. 3. The motor is powered by two 3S Lithium Polymer batteries connected in series and is controlled by an Arduino Mega 2560 micro-controller, all of which are housed inside the box shown in the Fig. 3. A gamepad controller can be used to actively control the speed of the robot through radio frequency communications with a range exceeding 100 feet.

The legs have an axial spring to provide compliance and there are point feet. Our design allows replacement of the springs and feet (material and shape), if so desired. The robot is 3D printed which allows it to be light weight. The rest of the assembly including the flange and axle is made of aluminum**.**

3. Future plans

Our short term goals are; (i) experimental tuning of the leg stiffness for energy-efficient motion, and (ii) experimental tuning of motor speed to enable walking, running on level ground and on uneven terrain.

Our long terms goals are; (i) developing a hi-fidelity and experimentally verified model of the rimless wheel robot, (ii) development of model-based control strategies for energy-efficient locomotion on rough terrain, and (iii) experimental verification of the control strategies on the robot.

References

[1] Bhounsule, P. A., Cortell, J., Grewal, A., Hendriksen, B., Karssen, J. D., Paul, C., & Ruina, A. (2014). Low-bandwidth reflex-based control for lower power walking: 65 km on a single battery charge. The International Journal of Robotics Research, 33(10), 1305-1321.

[2] Coleman, Michael J., Anindya Chatterjee, and Andy Ruina. "Motions of a rimless spoked wheel: a simple three-dimensional system with impacts." Dynamics and stability of systems 12.3 (1997): 139-159.

Fig. 1 - A 3D Rendering of the Roadrunner Robot

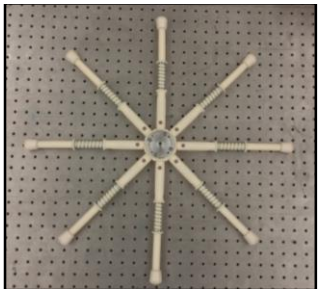

Fig. 2 - Rimless Wheel Subassembly

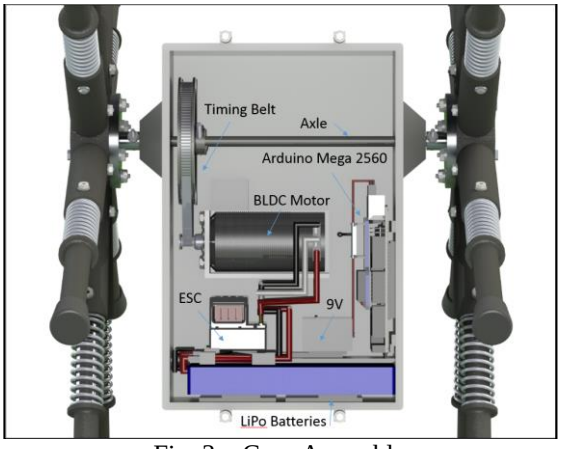

Fig. 3 – Case Assembly