ERIF 2008 Final Report
Prof. Matthew Spenko
Agile Mobile Robotics in Challenging Environments.

Objectives

The objective of this research was to investigate the relationship between mobility and agility, the ability to quickly change directions while maintaining speed, in mobile robots operating in challenging terrain. Specifically, we wanted to design and build an experimental prototype omnidirectional unmanned ground vehicle (UGV) that demonstrates a significant improvement in agility over current vehicle designs. The omnidirectional capabilities of the vehicle allow it to instantaneously move in any direction without losing speed. We additionally wanted to develop control and planning algorithms to take advantage of this new class of robots.

Results

This work was done in collaboration with the Robotic Mobility Group at MIT. At the end of the funding period, we successfully built two experimental prototype vehicles. One currently resides at MIT and the other at IIT (see Figure 1). The two vehicles have different suspension designs, but share common control software and electronics. This was done to investigate and evaluate the mechanical designs on rough terrain. IIT's design has lower sprung-mass, which is beneficial for dynamic response on rough terrain, but is more complex than MIT's design.

Figure 1: The IIT prototype vehicle design (left) compared to the MIT design (right)

A detailed photograph of IIT's design is shown alongside a CAD rendering of that part in Figure 2. Future work involves the following tasks:

- Development of version II of the control circuitry for the Active Split Offset Castor modules.
- Investigation of the dynamic equations of motion of the Ultra High Mobility Unmanned Ground Vehicles (UHM-UGVs).
- Experimental characterization of IIT's design as it pertains to mobility and practical characteristics (i.e. durability, energy consumption).

- Development of methods for omnidirectional control of UHM-UGVs on uneven terrain.
- Continued development of a prototype UHM-UGV that will achieve extremely high mobility and agility in very challenging environments.
- Characterization and development of a path tracking control algorithm that incorporates vehicle dynamics.
- Evaluation of the performance of the IIT prototype on a variety of terrain types and comparison of that performance to predictions and MIT's prototype.
- Integration of computation and sensing to improve path tracking and development of semi-autonomous behaviors.
- Investigation of coordinated control of mobile manipulators on an omnidirectional base.

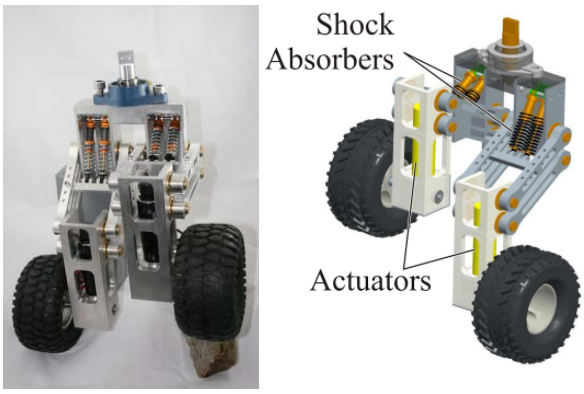

Figure 2: The IIT prototype ASOC design (left) and a CAD rendering of the design (right)

Papers, Presentation, and Funding

A paper was submitted and presented at the 2008 Army Science Conference by the PI. As a result of the work presented at the conference and a subsequent meeting with the US Army TARDEC, external funding of $133,000 has been orally committed for one year. Talks of funding for following years are in discussion. The PI would like to acknowledge that this funding would not have been possible without the initial funding by ERIF.

Iagnemma, K., Udengaard, M., Ishigami, G., **Spenko, M., Oncu, S., Khan, I.**, Overholt, J., and Hudas, G., "Design and Development of an Agile, Man Portable Unmanned Ground Vehicle," 26th Army Science Conference (2008).