

Human Robot Interfaces for Mobile Manipulators

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Abstract—The uBot-5 is a highly capable general purpose platform for mobile manipulation research. The uBot-5 stands about 0.5 m tall and features two four degree of freedom arms, a trunk rotation, and a dynamically stable base. This summary describes the uBot-5 and some of its capabilities including pick-and-place and tele-presence tasks. The figures in this summary are of the uBot-4, a prototype of the uBot-5. We propose to demonstrate the uBot-5, featuring a video teleoperator interface.

I. UBOT-5 PLATFORM

The 2005 final report for the NSF/NASA Workshop on Autonomous Mobile Manipulation, signed by 23 prominent robotics researchers, identified mobile manipulation technology as being critical for next generation robotics applications [1]. It also identifies a need for appropriate research platforms for mobile manipulation. The uBot-5 is a small and lightweight dynamically balancing mobile manipulator built to address this need. It was designed to be highly capable, durable, economical, and safe to operate.



Fig. 1. The uBot-4 performing plowing, stacking, pushing, and throwing tasks.

The uBot-5 is dynamically stable, using two wheels in a differential drive configuration for mobility. Dynamically stable robots are well suited to environments designed for humans where both a high center of mass and a small foot print are often required. In the case of the uBot-5, which behaves much like an inverted pendulum, active stabilization becomes easier as the robot (and thus the center of mass) becomes taller. The uBot-5 can also employ whole body postural control afforded by its dynamically stable configuration to generate greater pushing and pulling forces than are possible on an equivalent statically stable platform [2].

The uBot-5 has two four degree of freedom arms and a rotating trunk. Each arm is roughly 0.5 meters in length and the bi-manual workspace contains a significant portion of the ground plane. The arms are strong enough to brace when the platform is destabilized and to do a pushup to return to a vertical posture from the prone position should it fall down. The uBot-5's active stabilization, small size, and relatively

low mass allow it to comply to unplanned “bumps” reducing the probability of damage to itself, nearby people, or the environment.

II. APPLICATIONS

We predict that the vast majority of interesting and useful mobile manipulation applications will require acquiring, transporting, and placing objects—so-called “pick-and-place” tasks. The uBot-5 was designed to address such tasks using a variety of strategies. Figure 1 shows the uBot-4 performing shoveling, stacking, pushing, and throwing tasks.



Fig. 2. A three-question stroke diagnosis through video phone with motor tasks that are demonstrated by the uBot.

When equipped with a flat screen monitor and a web cam (see Figure 2), the uBot-5 can be used for social tele-presence applications. Additionally the tele-operator can use the uBot-5's manipulation capabilities to perform useful work. These capabilities allow a family member or friend to use the uBot-5 to check on or assist an elderly or ill person. Additionally, doctors or EMTs could use such a platform to remotely perform routine or emergency medical checks.

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REFERENCES

- [1] O. Brock and R. Grupen. NSF/NASA Workshop on Autonomous Mobile Manipulation (AMM). <http://www-robotics.cs.umass.edu/amm/results.html>, August 2005.
- [2] Bryan J. Thibodeau, Patrick Deegan, and Roderic Grupen. Static analysis of contact forces with a mobile manipulator. In *Proceedings of the 2006 IEEE International Conference on Robotics and Automation*, Orlando, FL, May 2006.