A Robotic Platform for Evaluating Autonomous Construction Methods

Walker Gosrich, Maira Saboia, Vivek Thangavelu, and Nils Napp. Contact: walkergo@buffalo.edu

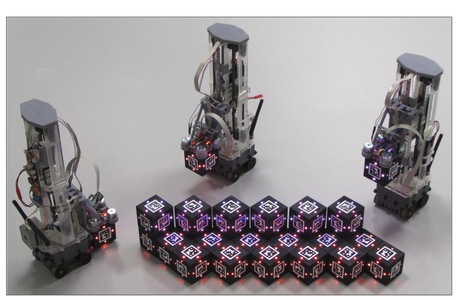
University at Buffalo
The State University of New York

Motivation

Autonomous construction systems are in need of a versatile, self-contained robotic agent that can operate over uneven terrain.

Autonomous construction on uneven terrain has important applications in environments dangerous or unpleasant for humans, such as disaster areas or extraterrestrial sites. These environments are rarely prepared, flat surfaces. To navigate and construct on this irregular, unknown terrain, robots must be flexible and robust. They must be able to move from point to point without falling or losing position accuracy on a variety of surfaces, and they must be able to pick up and place a variety of rigid and amorphous objects, even with the position and sensor error that comes from an unknown environment. We present a robot platform capable of these tasks.

TERMES collective construction system from Harvard SSR.



BeBot-based collective construction system from Allwright et al.

Design Objectives

1. Reliable movement over variety of uneven terrain
2. Accurate position feedback
3. High stability
4. Able to pick up and place variety of objects
5. Tolerant of some positioning error
6. Capable of on-board perception, planning, and control
7. Long operational duration
8. Inexpensive, off-the-shelf components

Design

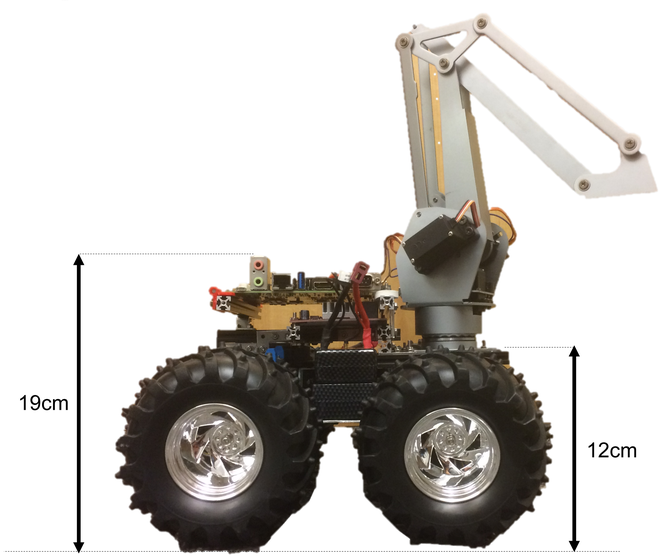
Version 1.0

Features:
- 5cm chassis clearance
- Differential drivetrain
- Low stiffness suspension
- All-terrain wheels
- Motors with high accuracy encoders
- uArm robotic arm
- Simple single-actuator gripper
- Microprocessor: Jetson TK1
- Dual LiPo batteries
- All commercially available parts

Drawbacks:
- Unstable on inclines
- Poor grasping performance
- Diminished arm reach
- Internal electronics difficult to access

Version 2.0

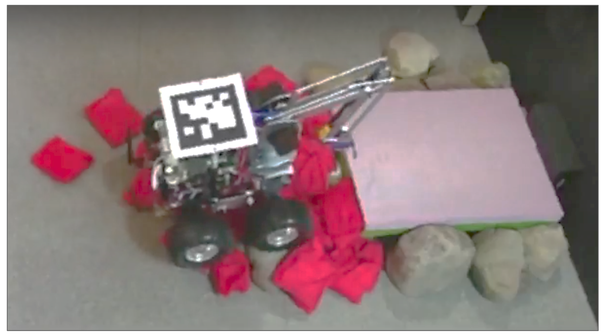
Improvements:
- Electronics and uArm lowered by 3cm to increase stability
- Batteries press fit for stability and easy interchangeability
- Open-source, fully 3D printed gripper with better performance
- Microprocessor hinges for easy electronics access



Applications

The versatility of this platform makes it fit for a broad range of applications. Due to it's self-contained nature, the platform could very easily be used for collaborative construction, in either a distributively or centrally controlled system.

Presently, it has been outfitted for use in a single-robot construction system using external vision to build an access ramp of filled bags (below image)



Future Development

Future iterations of this platform will incorporate a more modular design: each component will be easily removable and replaceable, with universal connectors. This will increase the versatility of the robot, allow it to automatically remove and charge batteries, and permit its use in work on self-assembly and self-healing.

References

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