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Novel Locomotion of iMobot, an Intelligent Reconfigurable Mobile Robot

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***Abstract*—The novel features and locomotion of a reconfigurable modular robot called iMobot are presented in the accompanying video. iMobot is designed for search and rescue operations as well as other applications such as research and teaching. It has versatile locomotion, including a unique feature of driving as though with wheels and lifting itself into a camera platform. Future work is envisioned for using these modules in clusters to achieve advanced mobility. The accompanying video demonstrates the various locomotion of iMobot.**

I. Operating Modes

An intelligent reconfigurable mobile robot called iMobot is capable of novel locomotion. Some of its operating modes are presented in this section.

A. Crawling

The most basic motion for a modular robot is crawling. In Figure 1a, the robot is resting on the floor. To crawl forward, it rotates the front section downward to drag itself forward in Figure 1b, and then the back section rotates downward in Figure 1c. Now that the back is planted, it can rotate the front section back up until parallel with the ground, sliding forward in Figure 1d. The rear section then straightens out to push the module forward in Figure 1e. This method of crawling along the ground can be slow, but extremely effective in difficult terrain. What separates this module from others is that if the robot needed to turn from its current trajectory, it can rotate the front or rear faceplate. Figure 2a through 2c shows the module rotating one faceplate to turn counterclockwise.

B. Driving

The next operating mode is driving by continuously rotating the faceplates of the modular robot. The faceplates rotate forward at equal speed shown in Figure 3. If the modular robot needed to turn, it can rotate the faceplates individually, as shown in Figure 2. It can be seen in Figure 3 that, because of the rounded edges of the faceplates, the modular robot does not violently rise up and slap down as would be the case if they were square. Also, the part of the body which makes up the outer sections, keeps the module from spinning in the air when the faceplates rotate.

If the module requires more clearance while driving in rough terrain, it can arch its center, as shown in Figure 4. This motion also brings the faceplates at a more aggressive angle of engagement with the ground.

Another method of driving is rotating the front section 90 degrees and the back section -90 degrees and rotating the faceplates, shown in Figure 5a through 5c. This reduces the overall footprint of the modular robot, allowing it to maneuver in narrower areas. With the faceplates rotating at equal speeds the module can turn by articulating its body.

C. Camera Platform

One of the more unique operating modes is where the module lifts itself into a camera platform. This is unique to this modular robot design and is made possible by rotating faceplate. The modular robot is flat on a table in Figure 6a when it rotates its rear section down until the faceplate is flat on the table in Figure 6b. The front section rotates down in Figure 6c and the faceplate of the rear section rotates 45 degrees to provide a wider platform. The rear section then rotates up to lift the module into the position shown in Figure 6d. Once in this position the module can tilt using the joint of the front section and pan using the faceplate of the rear section, rotating the module in Figure 6e. Future designs will have a camera inside the hollow faceplate, allowing the operator to view the environment from a slightly taller perspective than the crawling robot.

II. Conclusion

This design blends the maneuverability of more complicated modules while keeping a compact shape which lends itself to assembly in clusters, shown in Figures 7 and 8. The developed modular robot and its cluster have many potential applications including teaching of robotics and related technologies, and search and rescue operations. More information about our work can be found in [1-3].

References

[1] Graham G. Ryland and Harry H. Cheng, "Design of iMobot, an Intelligent Reconfigurable Mobile Robot with Novel Locomotion," *Proc of the 2010 IEEE International Conference on Robotics and Automation*, Anchorage, Alaska, May 3 - 8, 2010.

[2] iMobot --- an Intelligent Reconfigurable Mobile Robot, http://iel.ucdavis.edu/projects/imobot

[3] Graham G. Ryland and Harry H. Cheng, "Modular Robot Design Utilizing Rotating Faceplates and Dynamic Motion Control by Robot Pose Manipulation," UC Case No. UC09-598-1, US Patent (pending).

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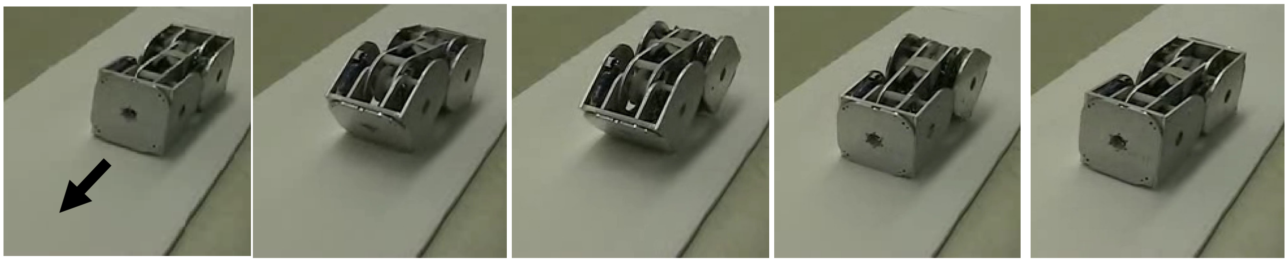
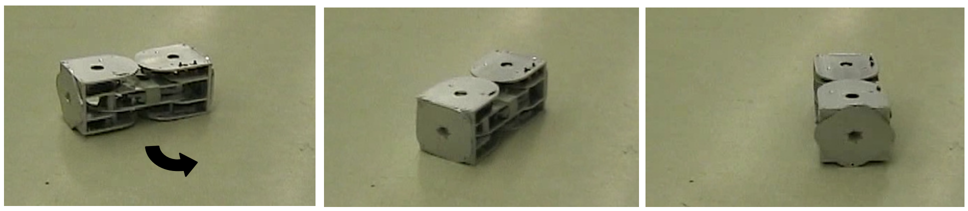


1a. 1b. 1c. 1d. 1c.

Fig. 1. Crawling like an inchworm by rotating front and back sections.



2a. 2b. 2c.

Fig. 2. Turning by rotating faceplates independently.

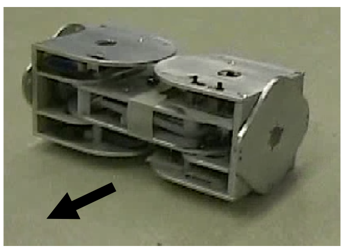


Fig. 3. By rotating both faceplates the robot can drive forward.

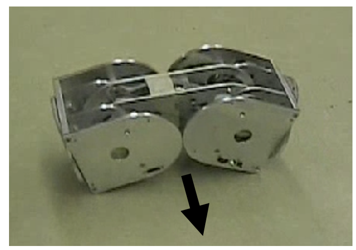
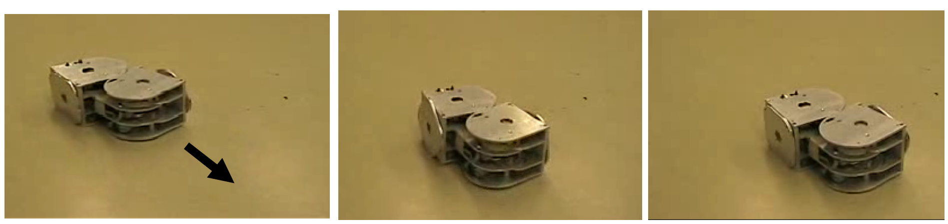
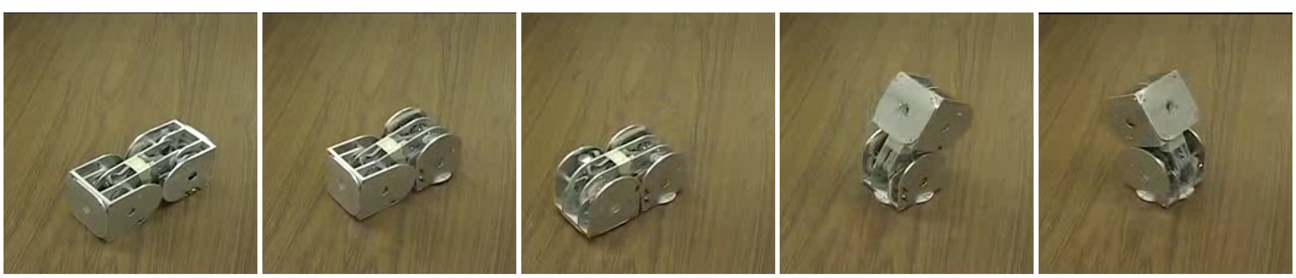


Fig. 4. The robot can gain clearance by arching its back.



5a. 5b. 5c

Fig. 5. Reducing footprint by rotating end sections and driving forward.



6a. 6b. 6c. 6d. 6e.

Fig. 6. Lifting into a camera platform.

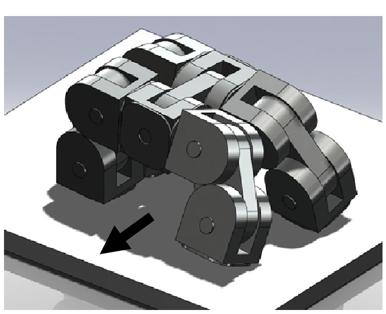


Fig. 7. A conceptual model of a dog-like modular robot cluster.

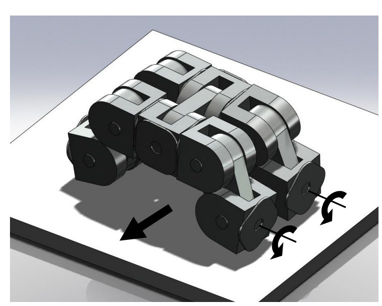


Fig. 8. The modular robot cluster using four wheel drive.