

The Summer Undergraduate Research Fellowship (SURF) Symposium
7 August 2014
Purdue University, West Lafayette, Indiana, USA

Improved Microrobotic Control through Image processing and Automated Hardware Interfacing

Archit R. Aggarwal, Wuming Jing, and David J. Cappelleri
Department of Mechanical Engineering, Purdue University

ABSTRACT

Untethered submilliliter-sized robots (microrobots) are showing potential use in different industrial, manufacturing and medical applications. A particular type of these microrobots, magnetic robots, have shown improved performance in power and control capabilities compared to the other thermal and electrostatic based robots. However, the magnetic robot designs have not been assessed in a robust manner to understand the degree of control in different environments and their application feasibility. This research project seeks to develop a custom control software interface to provide a holistic tool for researchers to evaluate the microrobotic performance through advance control features. The software deliverable involved two main aspects: 1) Real-time microrobot detection and tracking through image processing, achieved through testing with different combinations of built-in tracking algorithms in OpenCV package, and 2) hardware interfacing with a microcontroller based coil control system through serial port communication for direct control of the magnetic coils. The robotic motion control was studied using error mode correction strategies to provide a robust, accurate and time efficient image stream based robotic controls. The user interface developed conducts change in brightness and rotation invariant tracking with an efficient speed of 12 frames per second and performs real-time calculation of robot's position and orientation. It provides robust automatic control of directing microrobotic motion along the specific path waypoints entered on the images, through recursive serial bus communication. The project showcases the advanced importance and the powerful tool of image processing and microcontroller based communication in conducting the performance analysis of promising microrobotic designs.

KEYWORDS

Microrobotics, Image Processing, Computer Vision, Background Subtraction, Object tracking, Serial port communication, OpenCV C++ API, Software Development

REFERENCES

- Xiaoping, Q., Qiheng, Z., Yimin, O., Jiaguang, M. "A Method for Object Tracking using Shape Matching," *Signal Processing Systems Design and Implementation*, 2006. SIPS '06. IEEE Workshop, pp.372,376, Oct. 2006
- Jing W., PaganoN., Cappelleri D.J. (2013). A novel micro-scale magnetic tumbling robot. *Journal of Micro-Bio Robotics*. Vol., 8(1), pp. 1-12. doi : 10.1007/s12213-012-0053-1.