Magnetic Mobile Microrobotic Control Software Interface

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Abstract

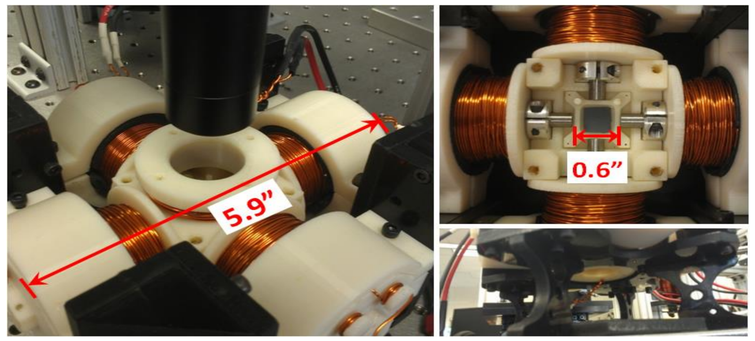
- **Research Goals**
  - Investigate the use and evaluate performance of magnetic mobile microrobots (magnetically controlled submilliliter sized robots)
  - Implement efficient tracking and motion control along with a user-friendly GUI
- **Previous Study**
  - Magnetic microrobots have significantly better power and control capabilities when compared to thermal and electrostatic based microrobots
  - Medical & biological applications:
    - non-invasive surgeries
    - tissue/cell manipulation, characterization

Introduction

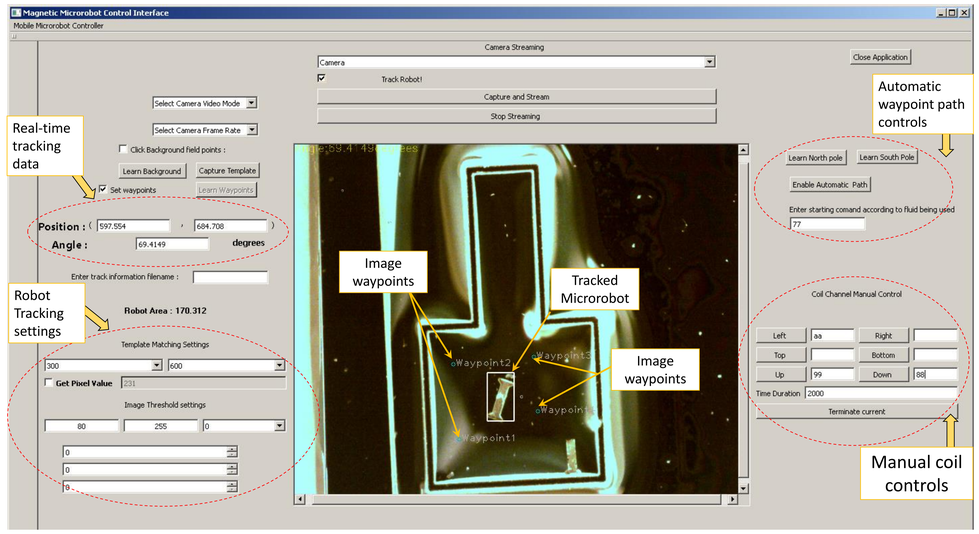
- **Motion Control Interface**
  - Develop efficient user interface for manual and automatic tracking and motion control
  - Entails image processing and hardware interfacing with magnetic coil control system
- **Features and specifications**
  - Created in C++ using OpenCV platform and Qt GUI package
  - Video frame processing provides real-time data of microrobot position and orientation
  - Manual commands and automatic image-based robotic controls
  - Serial Port communication with microcontroller for coil system control

Methodology

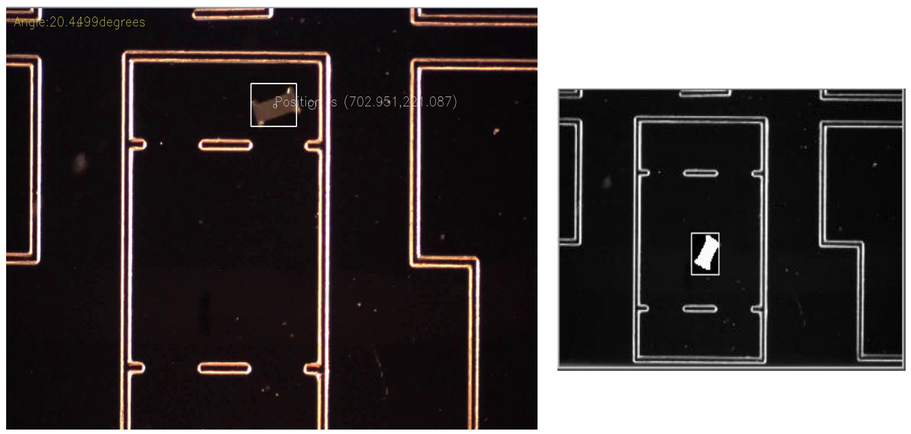
- **Object Detection and Tracking**
  - Tested and analyzed different algorithms
    - Template matching (color, shape, feature & histogram based)
    - Background Subtraction
    - Optical Flow Analysis
  - Most accurate, robust and time efficient combination of algorithms chosen for image processing
- **Hardware Interfacing**
  - Interfacing with microcontroller using USB to UART bridge bus connection
  - Serial port communication to send byte command to each coil



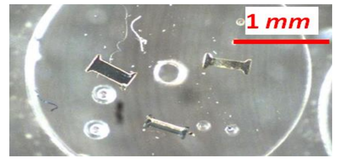
6-coil channel testbed (with solenoids and Helmholtz coil pair), for robotic control



User Interface showing manual (data in text boxes) and automatic control (waypoints in image) of robot



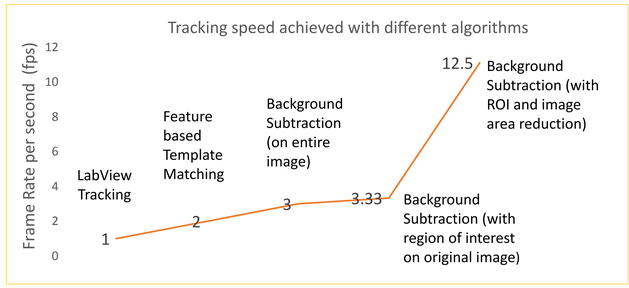
Object detection and tracking using Background Subtraction and Image thresholding



Magnetic Mobile Microrobots

Conclusion

- **Robotic Control through Image processing**
  - Developing a robust real-time tracking algorithm entails constant experimentation and modifications
  - Background subtraction coupled with image thresholding offers an efficient algorithm for image tracking
  - Image downsizing and reduced pixel area through region of interest specification can speed up the processing rate significantly



- **Microcontroller Hardware Interfacing**
  - Microcontroller based coil control control provides organized control of magnetic field produced through the coils
  - Continuous serial port communication commands for automatic motion control requires dynamic adaptability to surrounding testbed conditions
- **Future Work**
  - Develop interface for tracking and controlling Tumbling Microrobots

References

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