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Fully Automatic and Real-Time Microrobot Detection and Tracking based on Ultrasound Imaging using Deep Learning

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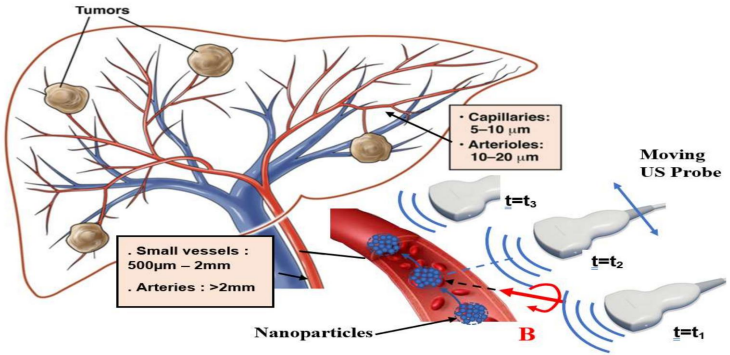
I. Introduction: Problem & Objective

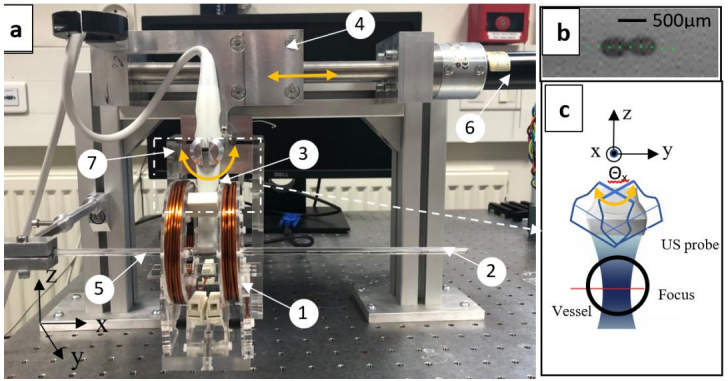
Problems:

- Cancer tumor removal surgeries are often very difficult to perform and can cause permanent damage to some organs.

Solution:

- The micro/nanorobots are promising robots that can accomplish many tasks : Targeted delivery, localized diagnostics, and biosensing.





Objective:

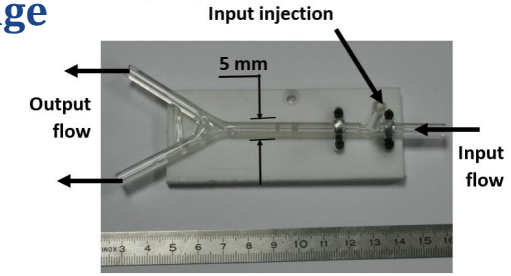
- Real time detection and tracking microrobot using ultrasound imaging.

Dataset

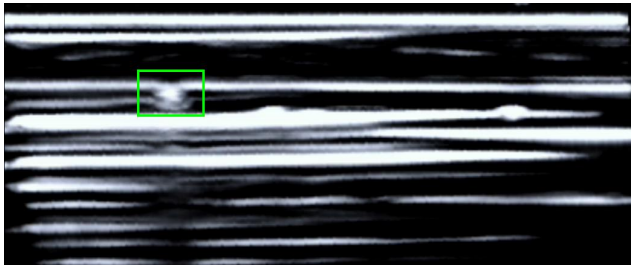
1. Dataset
2. Detection
3. Tracking
4. Experiment Results
5. Conclusion & future work

US image

Microscope image



500 micron each



Detection

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Template Matching:

Robot template	Robot ID	Detection Accuracy
	1 sphere robot	0.8986
	2 sphere robot	0.9130
	3 sphere robot	0.9550

TABLE II: Detection accuracy % comparison between one-, two- and three-sphere robots.

Detection:

- **We used multiple templates for each robot.**

Tracking

1. Dataset
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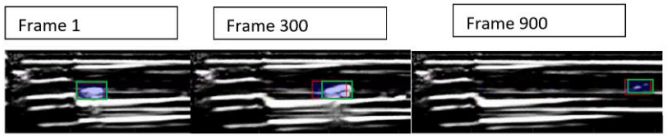
Echo tracker based on VGGnet:

TABLE III: Tracking accuracy % comparison between the tracking technique against classical tracking techniques.

	ECO	Particle filter	Mean-shift	KLT
Three spheres	0.93	0.70	0.58	0.44
Two spheres	0.90	0.69	0.51	0.40
One spheres	0.86	0.50	0.40	-



Tracking:

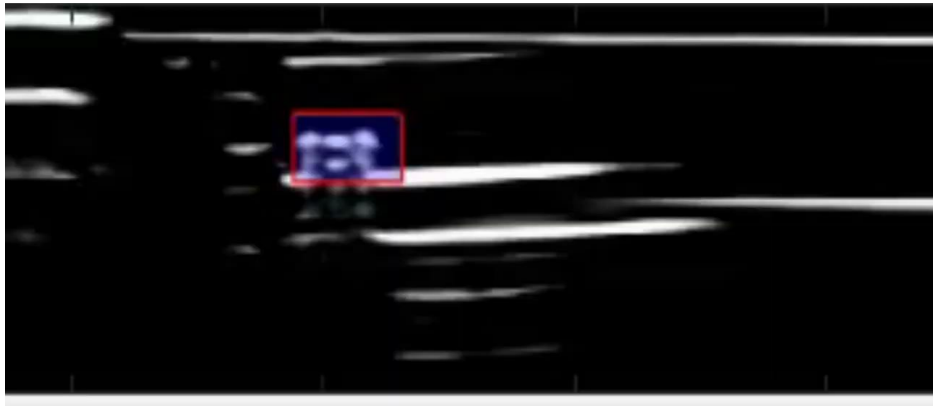
- We have manually labelled and verified the dataset.

Experiment Results

1. Dataset
2. Detection
3. Tracking
4. **Experiment Results**
5. Conclusion & future work

Overall Results:

- We used classic correlation for robot detection AKA template matching.
- Real-time detection of the one-sphere, two-sphere and three-sphere microrobots.
- Track and retrack microRobots at very high speed 8mm/s.



Conclusion and Future work

1. Dataset
2. Detection
3. Tracking
4. Experiment Results
5. Conclusion & future work

Conclusion:

- We were able to detect and track microrobots in real-time
- We were able to retrack the robot after disappearance and as well at high speed 8mm/s.

Future work

- Augment the dataset with more images and different robots.
- Use deep-learning for detection.
- Increase the robustness in B-mode against the low quality US image, low signal-to-noise ratio, and poor echogenicity.

Thank you