



Physical Intelligence
Department



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Review concerning the dissertation entitled

"Distributed manipulation by controlling force fields through arrays of actuators"

Submitted by Mr. Jirí Zemánek

For the degree of Ph.D. from
Czech Technical University in Prague Faculty of Electrical Engineering Department
of Control Engineering

Due to recent advances in micro- and nanoscale science and technology and increasing demand for new micro/nanoscale materials, devices, and systems for applications in manufacturing, information technology, and biotechnology, creating mobile microrobots that could handle and manipulate microscale entities has become a critical issue. Jiri's thesis research lies within this framework of microscale high precision robotic manipulation systems. He proposed distributed micromanipulation methods by controlling electrical and magnetic force fields through arrays of actuators.

The challenge addressed by Jiri's work is to control of distributed manipulation through physical fields created by arrays of actuators. His thesis addresses manipulation of objects using non-uniform electric (dielectrophoresis) and magnetic (magnetophoresis) fields. He derived mathematical models suitable for incorporation into a feedback control loop for both cases. He observed that the models in the two cases exhibit a similar structure, which encourages the development of a unified approach to control. As the novelty and strength of his proposed arrays of actuators and control methods, parallel manipulation (the simultaneous and independent manipulation of several objects) is possible.

In addition to the developed models and analysis, he experimentally demonstrated his proposed dielectrophoresis- and magnetophoresis-based parallel manipulation and control methods. In dielectrophoresis case, he had both fabrication- and algorithm-based contributions. In magnetophoresis case, he developed an array of iron-core coils to demonstrate centralized and distributed manipulation control methods. His thesis is well written and has many algorithmic and experimental design and control contributions to the microrobotics field. Balance of detailed modeling/theory and experimental work makes the thesis stronger.

In conclusion, Jiri's research work is novel, rigorous and properly conducted. The scientific contributions are clear, going from the original concepts to experimental demonstrations. All experiments are very carefully designed, conducted, and analyzed. His dissertation exhibits an original research work with high quality results and open perspectives for his research community. Many papers in high-impact journals and conferences are the proof of the significance and originality of his research work.

In summary, the author of the thesis proved to have an ability to perform research and to achieve scientific results. I do recommend the thesis for presentation with the aim of receiving a Ph.D. degree.

Stuttgart, July 29, 2018.

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Prof. Metin Sitti