

MAGNETIC MANIPULATOR (MAGMAN): DESIGN AND IMPLEMENTATION IN MATLAB

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The prototype of a novel experimental platform for education and research on distributed manipulation by shaping physical force fields through arrays of sources will be presented. Description of both the hardware realization and (an example of) the control system implementation in Matlab/Simulink will be given. Some experimental results will be shown.

The platform uses an array of coils to create and shape the magnetic field. One or several iron balls are placed into the field on a flat horizontal surface and they roll in response to the field. Positions of the balls are sensed in real time and these measurements can be used for closing the feedback loop commanding the current flowing through the coils. The controller can bring the objects to desired locations as well as steer them along predefined trajectories.

Design of the platform is modular and allows for simple reconfiguring and expanding. Each module consists of four coils, driving and measuring electronics, a processor and connectors. Modules are interconnected by an RS-485 bus and commanded from PC. It is possible to control both the polarity and the magnitude of the current flowing through each coil. Position of the ball is measured using a resistive touch foil. Alternatively/additionally it can be obtained using image processing, which is a bit slower but allows for tracking of several balls.

The mathematical model of the platform was built by experimental system identification while Matlab was used to gather the measured data and find the parameters of model that fit the measurements. Based on the model, a controller was designed. The controller keeps the popular cascade structure with the innermost loop responsible for achieving the forces requested by the higher-level control loops. Numerical optimization problem had to be solved in real time to find suitable setting of currents. Finally, a convenience of the use of iPad as a graphical user interface was demonstrated.

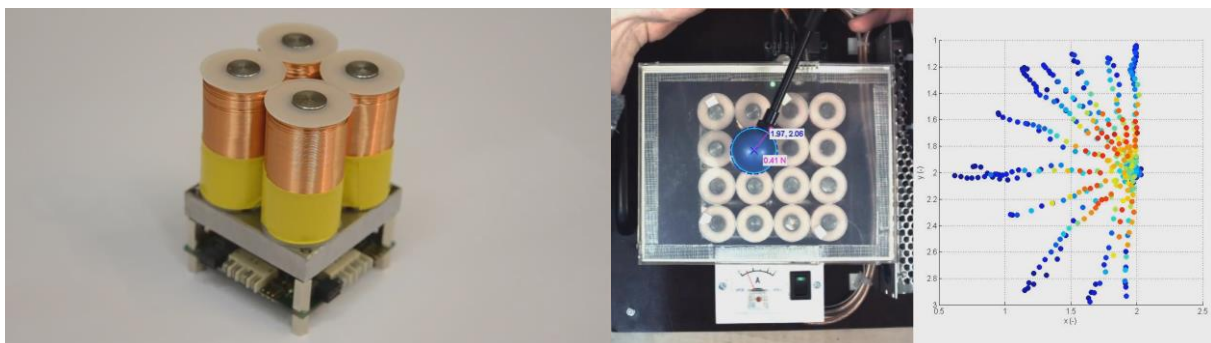


Fig.1: One module of the platform and measuring of data for experimental identification.

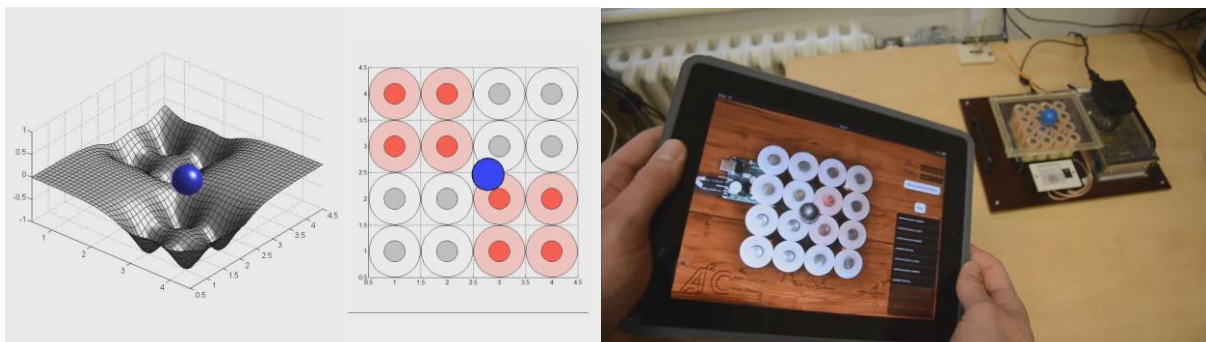


Fig.2: Mathematical model of the platform and experiments with the platform and iPad GUI.