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SYSTEM IDENTIFICATION OF THE LARGE-ANGLE MAGNETIC SUSPENSION TEST FIXTURE (LAMSTF)

by

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The Large-Angle Magnetic Suspension Test Fixture (LAMSTF), a laboratory-scale research project to demonstrate the magnetic suspension of objects over wide ranges of attitudes, has been developed. This system represents a scaled model of a planned Large-Gap Magnetic Suspension System (LGMSS). The LAMSTF consists of a small cylindrical permanent magnet suspended element which is levitated above a planar array of five electromagnets mounted in a circular configuration. The cylinder is a rigid body and can be controlled to move in five independent degrees of freedom. Six position variables are sensed indirectly by using infra-red light-emitting diodes and light-receiving phototransistors. The motion of the suspended cylinder is in general nonlinear and hence only the linear, time-invariant perturbed motion about an equilibrium state is considered.

One of the main challenges in this project is the control of the suspended element over a wide range of orientations. An accurate dynamic model plays an essential role in controller design. The analytical model is first derived and open-loop characteristics discussed. The system is shown to be highly unstable and requires feedback control for system identification. Projection filters are first proposed to identify the state space model from closed-loop input/output test data in the *time* domain. This method is then extended to identify linear systems from the *frequency* test data. A canonical transformation matrix is also derived to transform the identified state space model into the physical coordinate.

The LAMSTF system is stablized by using a linear quadratic regulator (LQR) feedback controller for closed-loop identification. The rate information is obtained by calculating the back difference of the sensed position signals. Only the closed-loop random input/output data are recorded. Preliminary results from numerical simulations demonstrate that the identified system model is fairly accurate from either time-domain or frequency-domain data. Experiments will be performed to validate the proposed closed-loop identification algorithms.