Electromagnetic Position Control of a Novel Optical Diagnostic Device

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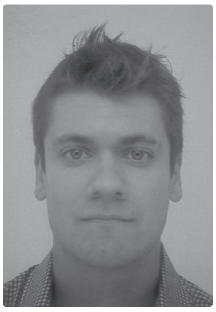
The automatic position control of diagnostic devices allows physicians and healthcare professionals to focus on providing excellent care for their patients by minimising challenges posed by the requirements of exact device placement and keeping the device on target throughout the examination.



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Introduction

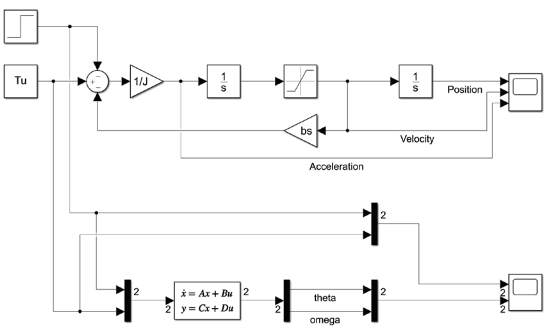
The device to be controlled is a diagnostic aid used in eye care. It consists of precision instruments mounted upon an axis, which is controlled by the user to be positioned as desired.

The system has fixed limits that define the possible range of motion, but the user can also specify a position at which the system should come to a stop. Any position within the fixed range is valid. The position control system tracks the position of the device using sensors and engages the positioning system at the optimal time to compensate the estimated torque present in the system.

There are two main challenges in this project:
- the driving force of the system, the user input, is unknown and can only be estimated,
- the positioning system is capable of deceleration, but not acceleration.

Objectives

While the preliminary study dealt with the system identification, system modelling and the choice of a control approach, the present work deals with data acquisition, determination of system parameters and the application of Model Predictive Control to the problem at hand.



The system modelled as dynamic system (above) and state space model (below).

The objectives are to:
- adequately simulate the system in Simulink using numerical methods,
- adequately simulate the system in Simulink using a state-space approach,
- collect data on a prototype to complete the model by identifying parameters,
- implement the designed controller to target the desired position.

Methods

The system was modelled as a dual-input, dual-output system, seen in the state space model below. The inputs are the torque applied by the user during normal device operation and the feedback torque generated by the system to achieve control; the outputs are the resulting position and velocity of the system. Using a data-driven approach, measurements are made which allow the definition of system parameters such as the friction coefficient and the feedback torque.

Finally, a cost function is defined to approximate the optimal position control solution using a least squares approach.

Results & Outlook

Results are pending at the time of writing, however, system parameters have been identified and the system model has been successfully validated.

Next steps include the completion of the predictive model and implementation of the controller.