INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	Hema Gurung
Roll Number	:	10610313
Programme of Study	:	Ph.D.

Thesis Title: Self-sensing Shape Memory alloy wire alloy wire actuator using Kalman filters

Name of Thesis Supervisor(s)	:	Dr.Atanu Banerjee
Thesis Submitted to the Department/ Center	:	Mechanical Engineering
Date of completion of Thesis Viva-Voce Exam	:	08/11/2017
Key words for description of Thesis Work	:	Self Sensing, SMA, Kalman Filters

---

SHORT ABSTRACT

Shape Memory Alloy wire actuators are very popular for offering large actuation force as well as displacement among other smart materials. The response of a SMA wire actuator is non-linear and hysteretic. In literature, sophisticated feedback controllers are being proposed to tame the behaviour of SMA actuators. Thus feedback sensors, measuring the response of the system being actuated by SMA wires, become essential part of the system. To get rid of the external sensors, the fact that the electrical resistance of a SMA wire varies during actuation, has been harnessed as a measured of the system output. This implies the use of SMA wire as a self-sensing actuator. In literature, this has been implemented mainly, by developing empirical relations, from the series of experimental data obtained for a given system, relating the change in electrical resistance of the SMA wire and the system response. Though, these approaches yield reasonably good response; however, are limited to a specific system and under specific loading. Moreover, no methods are proposed to obviate the noise that are available in the measured resistance data, particularly at low voltage level. For soft system, where hysteresis is significant, obtaining a unique relation is questionable. As a solution, in this thesis, different Kalman filters, as estimators are developed for SMA actuated linear and nonlinear systems. For a given time varying voltage signal, the stress and temperature of the SMA wire actuator are estimated using a dynamic model of the SMA actuated system and measured electrical resistance of the SMA wire. An Extended Kalman filter model of the system is developed and implemented in a real-time hardware, and is found to produce qualitative estimation of the system response. The Unscented Kalman filter is also explored to improve the estimation accuracy. Finally, a modified version of the Extended Kalman filter is proposed by augmenting some of the uncertain parameters of the model as state variable. This approach is found to estimate the system response with appreciable accuracy. In fine, the EKF model has also been implemented in a low cost hardware, Arduino Uno, to demonstrate the applicability of the developed approach, in practice, using the less resourceful hardware.