Chapter 5

Conclusions

Through this research we intended to show the inadequacy of the existing phenomenological constitutive models for one-dimensional SMA materials. To this end, we developed a model for an SMA-actuated robotic arm. The model was verified against the experimental data. It was shown that under certain condition discrepancies exists between the behavior of the system and prediction of the model. The SMA constitutive model shortcomings were further investigated using a dead-weight SMA-actuated system. An enhanced phenomenological model was developed to address the needs for a better one-dimensional phenomenological SMA model. According to this model, martensite to austenite phase transformation takes place when the temperature of the SMA element is between the austenite start and the austenite final temperatures. Within this limit, phase transformation takes place whenever the distance between the temperature of the SMA element and the austenite final temperature decreases. Similarly, the austenite to martensite phase transformation takes place

between the martensite start and martensite final temperature. The transformation takes place whenever the temperature in within this limit and the distance of the temperature of the SMA element and the martensite final decreases. It is worth noting that these four transformation temperatures are stress dependent and therefore the effect of stress is considered in the phase transformation.

Some of the issues related to position control of SMA-actuated systems were also studied. For a class of SMA actuators the stress of the SMA element varies as the result of the actuation. Specifically, the control challenge of this class of actuators was studied. Some of the linear and nonlinear control methods were investigated. An observer was also designed to enhance the performance of controllers.

This research can be continued in several directions:

- The experiments with the SMA-actuated dead-weight system can be repeated while the temperature of the SMA wire is measured. This can be done by using non-contact temperature measurements.

- The control algorithms designed for SMA actuators can be experimentally tested.

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