Abstract

Shape memory alloys comprise a unique type of material which is able to undergo a thermally driven, solid-solid phase change, characterized macroscopically by large recoverable strains, while supporting significant load. This process can be harnessed to do useful work as an actuator and indeed, shape memory alloys possess one of the greatest actuation work densities of all active materials. It is because of this that researchers and engineers are interested in using these alloys to create powerful lightweight actuators for several aerospace applications. In current aircraft designs, hydraulic systems represent a large proportion of the total aircraft mass. This thesis documents research done to study and optimize the design and performance of inductively heated two-way shape memory alloy torque tubes intended to provide a lightweight method of actuating aircraft control surfaces. The system electro-thermomechanical response under variable loading is modeled and implemented in Python. The Design of Experiments methodology is utilized to identify important design parameters. Finally, the structural and control design space is explored using particle swarm optimization to achieve optimum control response using a conventional controller design. Experimental measurements are taken to validate the simulated response.