Shape Memory Alloy Actuated Hand Held Stabilization Device

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EXECUTIVE SUMMARY

Essential Tremor is a prevalent movement disorder worldwide, commonly seen in the elderly. It can have significant consequences on a person's life, making simple, every day tasks very difficult. In some cases, tremor can prevent a person from continuing with a career that requires fine motor skills, or cause a person to lose so much control that they are no longer self sufficient. While many methods exist to counteract the problems caused by hand tremor, currently there is no absolute cure and treatments are primarily symptomatic. Pharmaceutical methods are commonly used, and in extreme cases surgical methods, but these can have health-related side effects and are not permanent solutions. Other solutions include assistive devices which isolate, constrain, or cancel the user's movement. However, isolation devices are too expensive and are not practical for everyday use, and constraining methods can cause the user discomfort and pain. The method of cancellation is currently found only in expensive medical devices used for surgery, but if made less expensive and bulky, may prove to be a feasible method for any person with tremor to improve their quality of life.

The goal of this project is to design and build a handheld device that will actively cancel the motion of tremor by using SMA actuation. This device can be a tool for everyday tasks like eating or applying makeup, or for tasks requiring fine motor skills such as surgery or soldering. Through meetings with project sponsors, experiments, and calculations, a list of customer requirements and corresponding engineering specifications for this new stabilization device were compiled. A few of the most important requirements given by the customer are that the device be simple, easily serviceable, sealed from the inside and outside and use an SMA antagonistic design. For the user it is most important that the device is small, can noticeably cancel motion in a two dimensional x-y plane, and that it is easy to attach and detach a utensil in the device. Most of the engineering specifications were defined by the sponsors based on their previous research, though some were obtained by calculations, experiments, and independent research.

Many methods of concept generation, such as brainstorming, concept trees and information sources were used to create a broad list of ideas and concepts that could be used to solve the design problem. A process of down-selection was performed on these concepts, involving feasibility checks, calculations, and selection matrices to determine which design would best meet the project requirements. Through these processes a rubber foam grip for utensil attachment was chosen. For the movement mechanism, analysis was done on three top designs, and the alpha design was chosen as a combination of the pivot and the two sliding bars designs.

A prototype was fabricated and used to validate the designs. The exterior is made of polycarbonate, with delrin plastic moving parts, and is filled with water for SMA cooling. Two rubber o-rings are used to seal the device. The SMA wires are in plane with the slots, and move the mechanism in a 'right angle pull' configuration. After the device was manufactured, it was validated against the initial customer requirements. The important requirements of frequency, displacement, serviceability, SMA antagonistic, ease of utensil attachment and detachment and water sealed were met. Potential improvements to the device include a new attachment of the SMA wires to the slotted bars and a separate pack for the battery and control circuit board. Using the initial prototype, these and other improvements can be made to the device, eventually resulting in a finished product that will sense and cancel hand tremor motions.