# Hand Held Force Magnifier for Microsurgery

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**Introduction**: Microsurgery is an important subset of surgery in fields such as ophthalmology and vascular surgery. One major challenge in such delicate procedures is the lack of sense of touch for the surgeon. To improve the surgeon's perception of tissue properties such as stiffness and viscosity at the tip of the surgical tool, we have been developing a novel surgical device, the Hand Held Force Magnifier (HHFM). The HHFM measures tissue forces at the tip of the tool and magnifies the forces delivered to the user's hand. The clinical applications of the HHFM include, but are not limited to, the repair of tiny blood vessels that are too delicate to be felt by the surgeon's hand, and ophthalmological procedures on the cornea or lens.

**Materials and Methods**: The HHFM uses a sensor to measure the force between the tip of the tool and its handle, which is held by the user's fingers. The measurement is amplified and fed back to an actuator. The actuator produces a proportionally greater force between the handle and a brace that is attached to the user's hand, in the same direction as the measured tool tip force. The HHFM therefore provides the user with an enhanced perception of the force between the tip of the tool and the target. A series of psychophysical experiments have been conducted to validate the effectiveness of the HHFM, for which an experimental platform was built. The objective of the study is to investigate whether the HHFM affords better control for users asked to hold small target forces, simulating real life scenarios that surgeons often encounter during microsurgical procedures. In this experiment, subjects are asked to contact a flat target using the HHFM with the magnification on or off. When the subjects reach the target force, they are instructed to hold that force steadily for a short period of time. Subjects' performances are studied in each experimental condition, at three different force levels. We hypothesize is that subjects will be able to better maintain smaller target forces using the HHFM with the magnification on, as quantified by the mean and standard deviation of the forces applied to the target.

**Results and Discussion**: Although the validation study is still ongoing, preliminary results show that the HHFM can improve isometric low force control. For one particular trial, when the target force was 5 grams (49mN) and the magnification was turned on, the mean force applied by the user was 5.17 grams (51mN) with a standard deviation of 5.26 grams (52mN); without magnification, the mean force applied was 14.13 grams (139mN) with a standard deviation of 13.33 grams (131mN). The obtained results demonstrate that when the magnification was on, the mean force applied was closer to the target force with less variability compared to when the magnification was off.

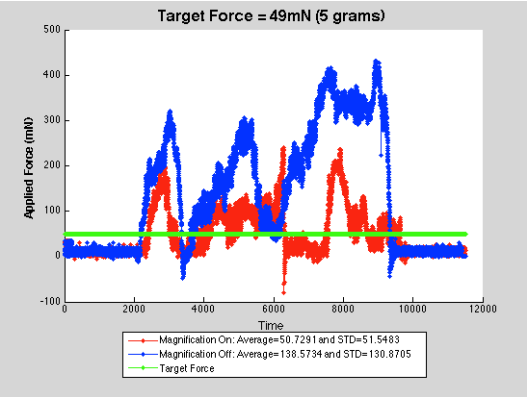


**Figure 1. The blue line represents the force profile when the magnification was off, the red line represents the force profile when the magnification was on, and the green line represents the target force. When the magnification was turned on, the user was able to hold closer to the target force of 5 grams (49mN) with less variability.**

**Conclusions:** The preliminary results demonstrate that the Hand Held Force Magnifier provides better control for the users when they encounter small forces by augmenting their perception of the forces at the tip of the tool. Additional experiments that vary key parameters such as the magnitude of magnification are needed to further validate the previously drawn conclusion and the effectiveness of the HHFM.

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