



FORCE LIMITING AUTO GRASP (FLAG) – ENHANCING FUNCTION OF ELECTRIC TERMINAL DEVICES

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INTRODUCTION

A high pinch force electric terminal device (TD) may reach pinch forces of 20-25 lb (88-110 N) in an instant, potentially crushing a fragile object.

New myoelectric TD wearers typically do not have well-developed proportional control. They must be cautious to control their grip force, especially using their TD around children. The goal of this project was to develop a simple, easily enabled force limit feature so the wearer of a high-force myoelectric hand can easily limit their pinch force whenever desired.

Specific Criteria:

- The wearer must be able to turn the feature on/off at will, and control pinch force predictably and easily.
- When enabled, the limited pinch force must safely handle a light plastic cup, an eggshell, or a child's hand, and also allow incrementally increasing the force to reach a desired level of grip force.
- Auto-grasp is also desired, i.e., automatic response to electrode slip or loss of contact with skin.

METHOD

The FLAG feature was designed to be integrated into electric hands and hook-type TDs, manufactured by Motion Control. A small, efficient force sensor is utilized to determine the lightest possible pinch force, after the FLAG feature is enabled, and controls are integrated into the on-board microprocessor, with new control software & firmware, and a 'beeper', for audible feedback.

The wearer enables FLAG by a simple "hold-open" command, for 3 sec.- a 'beep' confirms success. The next grip by the TD is limited to ~2 lb. Each additional 'pulse' of the input signal increases the force ~2 lb. To disable the feature, the wearer repeats the 'hold-open' sequence, confirmed by a double 'beep'.

A randomly selected subset (n=6) of those currently utilizing the feature volunteered to respond to a short questionnaire, usually by phone. All subjects are adults, wearers of myoelectric TDs, all with unilateral UE limb loss, either transradial, or transhumeral. Two subjects were novice wearers of a myoelectric TD, one of whom also used single channel control.

Subjects have used the FLAG feature one month at least, and length of prior experience varies from one month to over 11 years.

RESULTS

FLAG SURVEY OF WEARERS (n= 6)

| SUBSET OF QUESTIONNAIRE QUESTIONS | | Yes | No |
|-----------------------------------|-------------------------------------|-----|----|
| 1 | FLAG increases the tasks performed | 5 | 1 |
| 2 | FLAG provides an additional benefit | 5 | 1 |
| 3 | FLAG is easy to turn ON and OFF | 6 | 0 |
| 4 | FLAG 'Beep' is easy to hear | 6 | 0 |

Figure 1- The six subjects questioned so far felt their number of tasks have increased, adding benefit to their prosthesis. The interviews reveal that the more experienced wearer needs the FLAG feature less than new wearers, whose control of pinch force is less secure.

| TASKS PERFORMED w/ FLAG: | | Used | Not Used |
|--------------------------|---|------|----------|
| 1 | Holding Plastic Cups & Water Bottles | 6 | 0 |
| 2 | Handling/Playing With Children | 6 | 0 |
| 3 | Holding Foods, e.g., cone, Fresh Fruit, Toast | 5 | 1 |
| 4 | hobby and work activities | 6 | 0 |

Figure 2- From the interviews, some tasks are common to nearly all users. The everyday handling of disposable cups and drink bottles, fresh fruit, ice cream cones, are accomplished more easily with FLAG, and playing with children is safer.

DISCUSSION

Clearly, the FLAG users generally found the feature beneficial, and cited increased utilization of their prosthesis because of it. Due to limited space, the tables do not cite the length of usage, but the most experienced wearers all wished they had the feature *while learning* to master proportional myoelectric control. Even so, all but one of the six surveyed felt the feature added to the tasks they could perform with their prosthesis, and also provided new benefits. No User Interface (U.I.) is required for FLAG as yet, but it is planned for future implementation, to allow adjustment to the wearer's preferences.

CONCLUSION

The new FLAG feature makes a positive contribution to wearers of electric TDs, and has been shown to be easy to learn and to enable/disable at will in daily use.

CLINICAL APPLICATIONS

Safety and security of using a high pinch force electric terminal device are enhanced by utilizing the FLAG feature. New wearers are especially aided, while

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developing their control skills, since FLAG helps avoid
damaging fragile objects, or alarming children.

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