A Mouse with Realtime Adaptive Mickey Ratio Adjustment by Grasping Force

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ABSTRACT

In remote pointing devices, there is relationship between the motion of operation terminal and that of the pointer. In usual, the gain of this relationship is not adaptive in operation even though it is adjustable before the operation. But this gain adjustment is a quite difficult function. According to Fitts' law, pointing tasks is easier when the target is larger and the distance is shorter. Large gain means the short distance and small target, small gain means, as opposite to above, long distance and large target. This paper proposes a realtime adaptive gain adjustment for an answer of this dilemma. This adjustment function is recommended to be controlled by operator's grasping force of operation terminal to avoid increase of complexity of operation. For an example, a computer mouse with realtime adaptive Mickey ratio adjuster is considered.

KEYWORDS: mouse, Mickey ratio, grasping force, Fitts' law

INTRODUCTION

There are many kinds of remote pointing devices, for example, industrial robot manipulators, cranes, surgery manipulators, and so on. Computer cursor on the screen is also a kind of remote pointing devices. On the other hand, there are many types of operation terminals, for example, keyboards, joystick switches, levers and so on. Computer mouse is also a type of operation terminal.

Fitts' law gives time T that takes an operator for a pointing task on a target of size S at distance of D [1]. It is:

$$T = a + b\log_2(D/S + 1) \qquad (1)$$

where "a" and "b" are experimentally determined constants.

Necessary time is thought to be related to difficulty of the task. Easier task needs less time. According to Fitts' law, pointing tasks is easier when the target is larger and the distance is shorter.

Mickey ratio ("MR" in following part) is the gain between mouse motion and cursor motion. Larger MR gives faster cursor speed. It offers as same effect as smaller target at shorter distance. Smaller MR causes equivalent effect with larger target at longer distance. Constant gain is not effective to decrease D/S of the equation (1) even if it is adjustable before tasks are started. As long as MR is not realtime adaptive adjusted, it is impossible to optimize the pointing task by setting MR.

EFFECT OF REALTIME ADAPTIVE GAIN

The most important point of this idea is that during each task, **parameters D and S are not simultaneously effective**, although they present as D/S in equation (1). D is effective when the cursor moves toward the target (in following part, "approaching phase"), and S is effective after the cursor arrives near around the target (in following part, "positioning phase").

If during each task the gain were adjusted larger in approaching phase and smaller in positioning phase, the easiness of the task would increase. This is realtime adaptive gain adjustment.

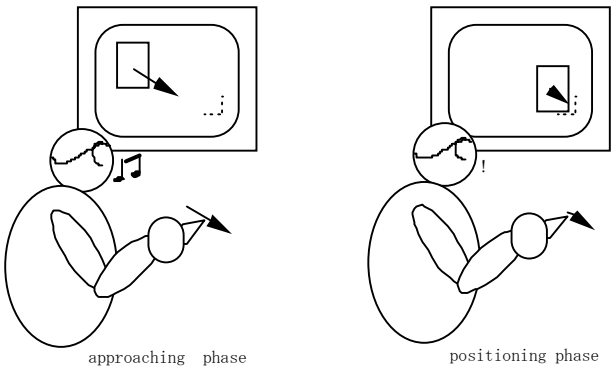

Figure 1: Two phases in a dragging task

EFFECT OF USING GRASPING FORCE

To adjust MR, new switches or other new gears shouldn't be supplemented, because they increase the complexity of operation system. That has the opposite

effect to the purpose of "increase easiness of the task". The realtime adaptive gain adjustment should be automatically controlled.

Some studies are known for icon selecting tasks. Effect of tactile feedback is analyzed by Akamatsu et al. [2]. Study of Worden et al. shows that sticky icons are effective, especially for older adult people [3]. Dennerlein et al. [4] describe advantage of force feedback in some targeting tasks.

Worden et al. explain that “sticky icons” are icons which have automatic MR reduction when the cursor is on the target icons. Decreasing MR locally on the icons, effective size of the target becomes larger, which makes it easier to stop the cursor on the target icon [3]. Sticky icons can be physically actualized by force feedback in case of computer mouse [2].

Generally, the target exists only in the user’s idea or is created instantly during the pointing task. The target cannot be distinguished by the computer before the user finishes each pointing task. Information of pointer position is no useful to MR adjustment. Approaching to positioning phase translation is quite a psychological process of the user, some physical or physiological parameter may be influenced. It is only user’s operation itself that is available for realtime adaptive MR adjustment. The information for distinguish these two phases must be detected from the user’s physiological or physical behavior. This paper proposes that grasping force is available.

Napier’s study indicates that grasping style is adaptive, and it depends not only on the grasped object but also on the purpose of grasping [5]. Although Napier didn’t mention to grasping force, it is expected to be an important parameter.

In precision tasks, more stiffness and robustness of hand position are necessary than those in rough tasks. For this purpose, it is natural that muscles of arm and hand are more tensioned to keep enough stiffness and robustness of hand position.

To apply this to pointing tasks, in positioning phase, task requires more precision operation than in approaching phase. It means that muscles are expected more tensioned in positioning phase than in approaching phase. The mouse is expected to be grasped more firmly in positioning phase than in approaching phase [6].

MR adjustment system of the proposed mouse detects this grasping force. It sets MR lower when the mouse is grasped more firmly than pre-set threshold. Thus, the proposed mouse is expected to support more natural and more comfortable usability than current type of mouse.

EXPERIMENTAL PROTOTYPE

Figure 2 shows the block diagram of proposed mouse. The grasping force detector and the MR adjuster (shown in thick line and gothic letters) are added to current type mouse.

Because the proposed mouse can contain cursor speed adjustment function in its body without any extra equipment or software, users can receive the advantage mentioned above only by replacing mouse.

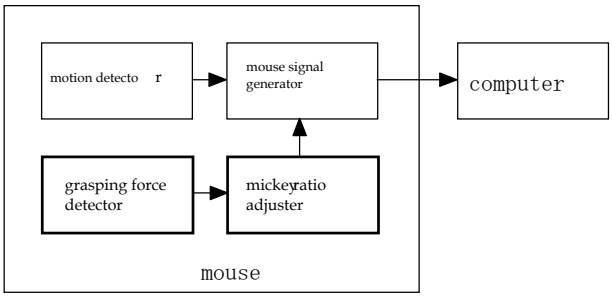

Figure 2: Block diagram of cursor signal in proposed mouse

CONCLUSION

A mouse with realtime adaptive MR adjustment is proposed. Remote pointing tasks are separated in approaching and positioning phases. Realtime adaptive MR adjustment increases both of these two phases easiness.

In general pointing tasks, these two phases cannot be known before the task is started. Detecting of grasping force has a possibility to provide natural usability to realtime adaptive gain adjustment for grasping type operation terminal.

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