The Mousegrip

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Abstract
Computer games, often played with others, are a compelling pastime for many. However, they have been criticized for their mouse and keyboard or gamepad interactions, as they support a sedentary lifestyle. In contrast, a "hand exerciser" handgrip device can help strengthen hand and forearm muscles extensively through a simple spring mechanism. Our system "mousegrip" is an exertion interface to control computer applications while simultaneously exercising hand and arm muscles based on a handgrip device. We present a casual game of pong for two distributed players who control the game with a mousegrip each, demonstrating a low-cost approach to "exertion interactions over a distance". By showing how easy it can be to include exertion in interactions with computers, we hope to encourage other researchers and designers to consider exertion activity in their designs in order to support a healthy lifestyle.

Keywords
Exertion, physical, exergaming, ubiquitous, sports, videogames, mobile, low-cost, physical effort, obesity

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces.

Introduction

Obesity is a growing problem, mainly due to the lack of activity in our sedentary lifestyles, in particular children show an alarming rate of increasing overweight issues [13-15]. Approaches to combat this problem include following dedicated exercise programs to increase the energy expenditure and address an energy intake imbalance [15]. However, not everyone enjoys sports or has the time to engage in dedicated sports games. On the other hand, incorporating moderate physical activity on a regular basis can contribute to a healthier existence and work against the pitfalls of a sedentary lifestyle [9]. Computer games, in particular, are often criticized for facilitating a "couch potato" experience. Button presses on mouse and keyboard, or gamepads and joysticks do not afford much muscle movement or energy expenditure. In contrast, a "hand exerciser" handgrip is a small device that can help strengthen a user's grip and improve the hand's motor skills and increase circulation. It can be used in high repetitions for endurance training, and rock climbers use it to strengthen their finger, hand and forearm muscles. It has also been suggested as a stress management tool. Users hold the handgrip device in their hand and try to make a fist, pressing against a built-in spring mechanism. The more force is applied, the more the spring is squeezed together and the stronger the arm muscles have to work. Some studies that advocate the benefits of using handgrips suggest that handgrip exercises can help lower blood pressure [8]. Others suspect a correlation between handgrip strength and a person's overall strength [6] and some suggest usage by musicians. However, exercising with a handgrip is a very repetitive and mundane activity. It usually does not offer any quantifiable feedback and the force exhibited is usually not used further, resulting in a non-meaningful activity for the user.

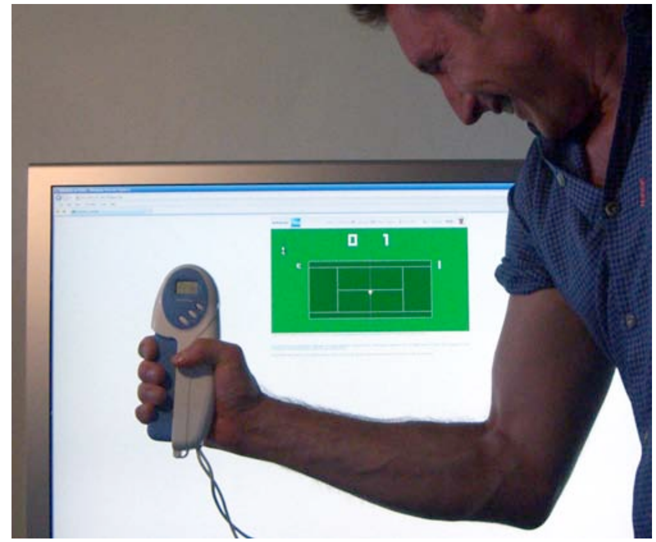

Figure 1. Player playing Pong using the mousegrip.

Related work

An example of electronically measuring arm strength is *Telephonic Arm Wrestling* [16]; there are now several instances installed in museums that include a videoconference to arm-wrestle another visitor over a distance [3]. *Push'N'Pull* [12] is a networked exercise machine which measures how much you pull or push an isometric bar. The applied force is read by sensors and transmitted to a computer in order to support cooperative gameplay between participants. *Virtual Tug-of-War* [4] measures the force applied to a rope in order to allow two distributed teams to compete in a tug-of-war competition. These setups require a dedicated device that is designed for stationary use, require considerable physical space and involve a significant financial investment.

The *Step User Interface* project [10] uses a commercial “Dance Dance Revolution” floor mat to sense a user’s foot movements to control a computer application. It supports tasks that people already perform, but makes them physically more demanding, and hence aims to encourage more physical activity during a working day at a desk. However, the *Step User Interface* requires the users to get up and clear floor space in order to setup the mat. The authors suspected that some users might feel embarrassed if they jump around in an office environment, the *Step User Interface* is therefore probably not very suitable for discreet use.

Commercial developers have created dedicated hardware devices for conventional game consoles that try to address the issue of low energy expenditure by requiring players to exhibit exertion as an alternative to conventional input mechanisms. Exercise bicycles control a virtual car’s speed in racing games [2], and sensors attached to a player’s hands direct the punch in a boxing game [1]. Vision-based systems such as the EyeToy [7] track the player’s hand movements to control martial arts games. However, with most of these solutions, the player has to buy special games that are designed to support the hardware. Solutions with camera support only work in well-lit rooms and do not provide any force-feedback. The Nintendo Wii [17] uses accelerometers and infrared sensors in their input device to measure the player’s hand and arm movements to control a virtual character on the screen. Unfortunately, the device does not support any strong force feedback besides vibration. These alternative input devices are often limited to specific game genres, require a dedicated setup, constitute a substantial financial investment, and are not very mobile.

Mousegrip

We have augmented a handgrip device with computer input technology to allow health conscious users to exercise their hand and forearm muscles while being engaged in a computer interaction. The pressing action exhibited on the handgrip controls a virtual representation on the screen. Our current implementation emulates a standard mouse, and is therefore suitable for a wide range of applications. Furthermore, it is platform independent. The stronger the force the user applies to the handgrip device, the further the mouse cursor travels. Figure 1 shows a user with our prototype controlling a Pong game]. Instead of moving the mouse, the user presses the handgrip together to move the paddle up, and releases to move the paddle down. The pressing action required demands a physical effort and can exhaust the user very quickly, therefore the device satisfies the requirements for an “Exertion Interface” [11]. The system makes the interaction deliberately physically demanding and exhausting, unlike the interaction with a traditional mouse. We call our prototype *mousegrip* due to its synergy of a handgrip device and a computer mouse.

Issues

Due to the nature of a handgrip device, a *mousegrip* can only support mouse movements along one axis. The system therefore lends itself to applications that use only one axis, such as Pong. Other devices have similar restrictions, for example the original iPod also only allows movement along one axis, yet still offers a variety of games. These games could also be controlled with the single-axis control of the *mousegrip*. In order to control the mouse pointer in the horizontal and vertical axis, one could use two mousegrips, one for each hand. However, the devices need to accommodate the strength discrepancy between hands; the non-dominant hand is usually 10% less strong [6]. Furthermore, the choice of game can probably influence the success of the *mousegrip* experience; however, because the system works with standard mouse drivers, a user can experiment with any game or application available to test for suitability.

Benefits

Engaging in physical activity can have many health benefits. Using physical exertion to control mouse movements can not only contribute to general fitness and address weight issues, it also has the potential to help avoiding repetitive strain injuries. By emulating a standard mouse interaction, users have the choice of using a conventional mouse or the *mousegrip*, respectively two *mousegrips*. Users can play games or perform work tasks with our device(s). This work contributes to the concept of combining exercise and computer interaction.

We are aware that performing handgrip exercises are probably not contributing to dramatic weight loss or turn a game player into a professional athlete. However, research suggests that non-exercise activity thermogenesis, which is the energy expenditure of all physical activities other than volitional sporting-like exercise, can play an important role in fat control and energy balance [9]. It should also be noted that the characteristics of the actions afforded by the *mousegrip* lend themselves to short, casual games, instead of long dedicated gaming sessions. The system is surprisingly exhausting especially for beginners, and we believe that combining a handgrip with a casual game experience has the potential to make the exercise more fun, contributing positively to a user's health.

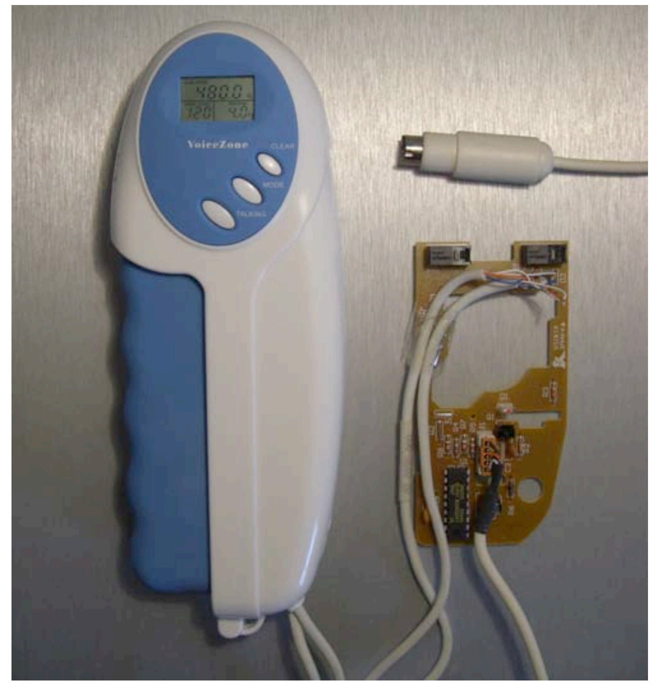

Figure 2. The mousegrip components.

Implementation

The *mousegrip* prototype was built mainly out of two components: a commercially available handgrip and the parts of a used mechanical computer mouse (Figure 2). We augmented the handgrip with the electronics of the mouse so that the pressing action of the handgrip is measured by the infrared receivers of the mouse hardware. The detected light impulses are analyzed with the microcontroller of the mouse, and transmitted as commands via the original cable and connector. Due to the fact that these are original mouse commands, no special driver is required, and the mouse cursor reacts natively to the instructions of the *mousegrip*. However, applications can also utilize the specific characteristics (i.e. spring behavior) of the *mousegrip*.

Advantages

The main advantages of our *mousegrip* are its size and cost: the handgrip fits comfortably in the palm of a hand and takes up little more space than a traditional mouse on a desk. Although the current version is wired, replacing the assembled electronics with components from a wireless mouse could turn the handgrip into an un-tethered version, allowing for more mobile use. One could also envision incorporating the mousegrip with applications running on a mobile phone, creating a truly portable *Exertion Interface* system. Furthermore, the *mousegrip* is small so it can be used while sitting at a desk in an office, supporting a discreet, casual workout. Due to its size, the *mousegrip* is easily available for ad hoc usage (in contrast to an exercise machine in a gym), and this therefore increases the chances of participating in an exertion activity. We also believe people will be less likely to skip recommended typing breaks in office environments when offered a fun opportunity such as controlling a game with the *mousegrip*. The original handgrip we modified costs less than $US 10. We built the interface to the computer out of an old mouse, hence the total cost for the current prototype was approximately $US 15.

Exertion Interactions over a Distance

Due to the exertion the *mousegrip* affords, we believe our prototype could be advantageous in supporting social interactions between geographically distant participants, as suggested by Mueller et al. [11]. In this work, the authors showed that an *Exertion Interface* could be superior in facilitating social interactions between geographically distant users when compared with a mouse-keyboard interaction. The *mousegrip* with its exertion characteristics has potential to support this claim. We have therefore connected two *mousegrips* to two computers and networked them to allow for an *Exertion Interaction over a Distance*. The two players can interact with one another over an audioconference. Although we are aware that this game is only compelling for a short while, we demonstrate with this approach that supporting social connectedness through an exertion activity is achievable with little effort and very low cost, enabling a wide audience to experience a physically effortful game interaction with geographically distant partners.

Opportunities

One way to extend the concept to full-body movements could be to develop a game that utilizes vision detection as input such as offered by the EyeToy [7] and pair it with the *mousegrip*. Players controlling a knight on the screen could use their arm movements to direct the sword, and the grip intensity determines how hard they hit their opponent, and how much force they can withstand when their opponent tries to slash the sword out of their hand. In athletic games, the force applied to the handgrip could determine the strength imposed on a pole in pole vault or the firmness with which a player holds a tennis racket. In an accelerometer-based environment such as the Wii [17], the sensor could track a golfer's swing, while the handgrip determines how steady the player holds the club.

Conclusion

We have presented the *mousegrip*, a low cost input device for computer applications that affords exertion of the hand and forearm muscles. The *mousegrip* can be used discreetly and in an ad hoc fashion due to its small size. It supports simultaneous participation in exercising and playing games, aiming to make the exercise appear less mundane and more fun. The system has the potential to make the computer experience beneficial for general health and fitness. We believe the exertion affordances have the potential to support social interactions between distributed participants while promoting physical activity. The *mousegrip* can provide a valuable addition to traditional input devices due to its health benefits, but also as inspiration for future systems. By demonstrating how easy and cheap it can be to include exertion in interactive systems, we hope to encourage other researchers and designers to consider exertion activity in their designs in order to support a healthy lifestyle.

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