A Chording Glove for Games: Development of a Wearable Game Device

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Abstract. In this paper, we describe the development of a SKKU glove, a wearable computing device for entertainment and games that can be used in wireless environments. The glove is equipped with chording keyboard mechanism for natural and flexible input and control of games, and a set of accelerator sensors for gathering information from hand gestures. Since the glove can be worn and used only in one hand, it not only provide a natural way to access games, but also helps the gamers with disabilities, particularly those who can use only one hand. The system configuration and the interface for input and control for the glove are presented.

1 Introduction

For years, many research efforts have been made in designing various entertainment technologies enjoyable and natural to users. To make access and play games efficiently, users need a convenient access tools and interfaces to give the users primary role to control the games by themselves. This includes how handy their gaming accessories are to carry, and how suitable their computing devices and interfaces are for navigation and control as well as command input.

Like many other emerging technologies, entertainment technologies are characterized by being different from traditional computing devices in the physical appearance and the contexts in which they are used. This paper proposes a glove-based entertainment device that can provide mobile users with accessibility and usability to various gaming environments. The SKKU gloves equipped with a wireless communication module can be a good interactive device to many computers for games since the hands and fingers are the most natural and dominantly used parts of the body in our daily lives. Many simple gestures of the hands reveal so many different contexts which the users deal with. Using hands, humans can naturally develop unique and effortless strategies for interacting with computer games. In other words, hands do not have to hold and manipulate interfacing game devices, but hands can be the interfacing game devices themselves.

2 Background

Some glove-based input devices, though, have capabilities to make decent control input in addition to their intended functions of gesture recognition and space navigation. Pinch Gloves (Bowman, Wingrave, Campbell, and Ly, 2001; Thomas and Piekarski, 2002) are glove-based input devices designed for use in virtual environments, mainly for 3D navigation, and N-fingers (Lehikoinen, J., Roykkee, 2001) is a finger-based interaction technique for wearable computers also utilizing finger pinching. Pinching is basically the motion of making a contact between the tip of thumb and a fingertip of the same hand. It uses lightweight gloves with conductive cloth on each fingertip that sense when two or more fingers are touching. Pinch gloves were also used in a wearable computer for information presentation with an augmented reality user interface as well as for a text entry mechanism (Rosenberg, 1998).

Most of previous works, however, on glove-based input devices were intended for text input with general computers, not targeted for control devices in entertainment nor game environments. The current works investigate the utilities, functionality, and usability of the chording gloves as a game device.

3. System Configurations

3.1 System Functions

The design of game gloves began with the arrangement of the functions of the gloves as a game controller. The three functions of the glove system were designed based on the modes that are required in most games: positioning for cursor orientation, controlling for making command inputs, and perceiving for multimodal feedback from the game. The functions were purposed to provide human-friendly nature of fun with the users.

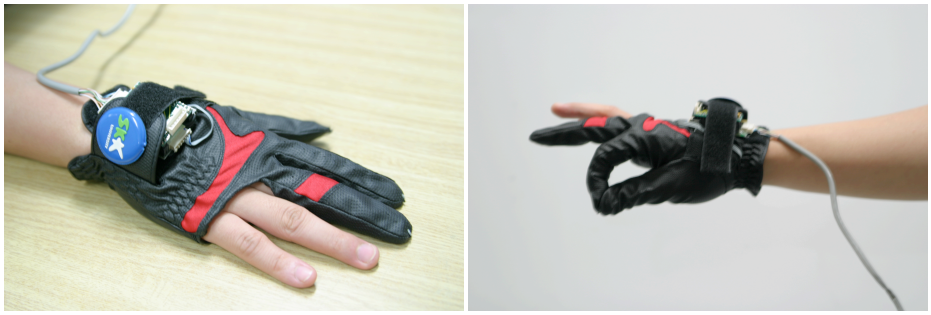

Fig. 1. The chording glove for game with the acceleration sensors to detect hand motions in space. The pinching motions generate commands for game. The thumb acts as a ground to conduct electricity to the 4 keys on the fingertips made of silicon.

Positioning. Two 2-dimensional ADXL202 acceleration sensors were used to detect and calculate the amount of the three dimensional hand motions in space. The glove can make directional motions to control the game cursors in 6 DOF motions (Shown in Fig. 1).

Commanding. All the commands required by games can be made by the key combination of the gloves, which consist of finger contacts between the fingers with silicon inks. The system uses finger tapping to make input for game control. Chording is possible by making simultaneous tapping with multiple fingertips to the thumb. Two keys are placed on the fingertips of the index and middle fingers on the palm side of leather gloves, and on the thumb for the ground. The keys are made of conductible silicon ink applied to the fingertips with the rectangle of 1.5 cm by 1.3 cm. The keys become "pressed" once the voltage through the silicon ink rises above 3.5 V with contact with the thumb (Shown in Fig. 2). The voltage outputs of chord gloves are connected to an embedded controller that translates chord information into its corresponding control. The corresponding finger force to generate 3.5 V is set to 3.50 N to avoid unwanted activations with light contact between the fingertips and the thumb. The glove weighs approximately 28.5 grams.

3.2 System Structure

The 16F874 microprocessor is used for controlling and analyzing the signals from the gloves. The controller also works for functions of converting the signals to control codes and sending them to PC or game stations using a Bluetooth 1.1 (aircode) wireless adapter. The controller works with a 9V battery.

The voltage outputs of chording gloves are sent to an embedded system that translates chord information into its corresponding code, character, or number. The chord glove-based input device can be used in connection with computers or PDAs directly as a portable keyboard/mouse. The controller transmits signals from the gloves to the computing consoles, mobile phones, and other game stations with a Bluetooth module to control them.

4 User Performances

User can control the selected target by rotating the wrist in three dimensions. However, an issue was raised in wrist rotation for control activation: setting threshold for activation with limited rotation ranges without degradation in user performance.

To set the optimal ranges for control threshold, we performed a pilot experiment to measure the success rate of wrist rotation in gaming situations for 5 young subjects with the average age of 23.3 years. In a racing game condition, while wearing the SKKU gloves and maintaining a natural hand position, subjects were asked to rotate the right hand wrist far enough to a given degree at a sound prompt while gaming with the gloves to the right (clockwise) and to the left (counterclockwise) directions. Three different degrees were given to the subjects at 45, 90, and 120 degrees in ran-

dom orders for each direction. A total of 10 trials were measured for each rotation degree. The feedback regarding successful wrist rotation was not given to subjects after each trial at all.

The results showed the best performances in 45 degrees, and the performances drop rapidly as the required rotation degree increases. The wrist rotation for greater than 90 degrees seems not to be desirable since wrist motions with bigger rotating ranges not only lack accuracy but also cause the gaming hand to fatigue easily. Such motions can take the user's fun factor away, which is not desirable for new devices.

5. Conclusion

The glove-based game interface in the form of our SKKU chording glove that was developed in our research for controlling game devices showed promises and problems. The glove has distinct advantages over conventional push-button based onboard game control panels in that the glove can be always carried and worn easily. Users can also access games more naturally with the glove-based game device in any position without being restricted by the conventional wire to the game consoles. It is light, and can be carried easily, and takes less space than any other game control device. Since we always use our fingers and hand in a daily life, to make codes in combination by touching the thumb and other fingers together can be easy to remember and natural to perform. The thumb and finger tapping is natural. One other advantage of the SKKU chording glove is that it can be expanded to a universal game device for anybody who may be limited to use only one hand. It can provide access to games for people with physical disabilities.

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