Project 2: Final Design Specifications

Principles of Design of BME Instrumentation

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ABSTRACT

The underlying objective of this project is to develop an interface that enables an individual who has undergone a bilateral, below-elbow amputation to intuitively and rapidly control complex computer commands via a multiple-degree-of-freedom biosensor interface.

For the purposes of this project, the efficacy of the interface is examined by testing its performance in controlling a character within a Minecraft-created environment.

The biosignals obtained from the user are received by three accelerometer/magnetometer sensors.

INTRODUCTION

Each of the three sensors is contained in a small integrated circuit chip that is capable of measuring acceleration in the X-, Y- and Z- axes; one is additionally capable of measuring variations in the magnetic field vector to determine changes in direction. This enables us to associate various actions within Minecraft to intuitive and simple motions of the user's body. For example, the action of rotating the head will rotate the camera view of the Minecraft character. Further details regarding these associations are listed below.

As the user moves their body parts in particular ways, the accelerometers will send their output signals to an Arduino which will in turn pass the information to a computer. The computer subsequently utilizes a Python script to convert various movements from the user into keystrokes and mouse movements that will actually control the Minecraft character.

DESIGN DIAGRAMS

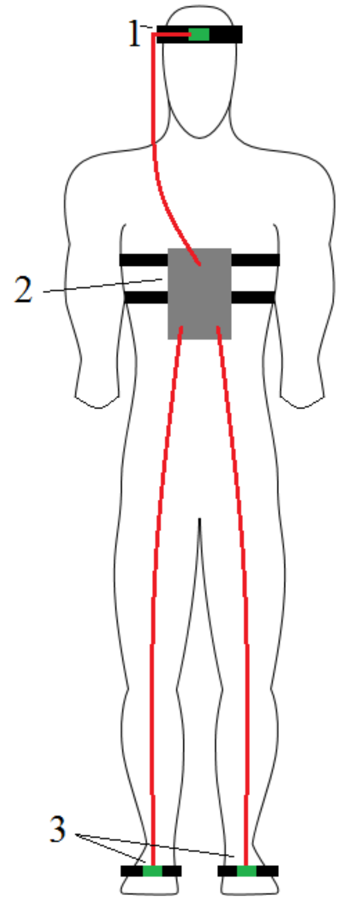

Figure 1: Diagram of bilateral amputee wearing biogaming system
(1) Directional sensor (2) Arduino (3) Control sensors

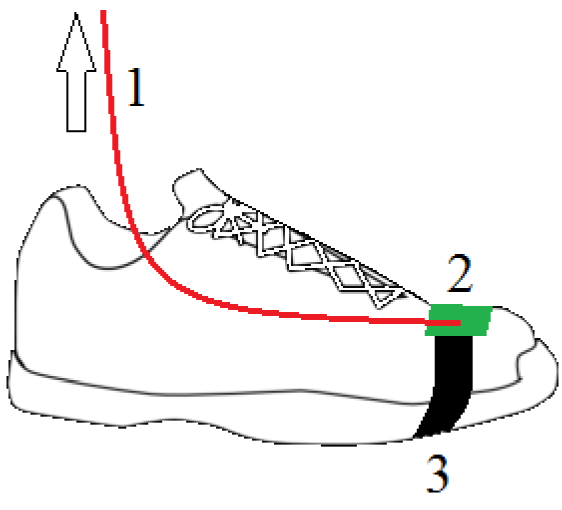

Figure 2: Diagram of control sensor on right foot
(1) Wire to Arduino (2) Accelerometer (3) Velcro strap

DESIGN DESCRIPTION

The biogaming system is composed of three main components as seen in Fig. 1 above.

The dual-function accelerometer/magnetometer is mounted on the head (1) and is referred to as the **directional sensor**. The mounting consists of a pair of safety glasses with the sensor adhered to the bridge. The tilting and rotation of the user's head will control the direction the Minecraft characters moves in and the direction it faces as follows:

Head motion	Character action
Tilt left	Strafe left
Tilt right	Strafe right
Rotate left	Turn view left
Rotate right	Turn view right
Tilt up	Turn view up
Tilt down	Turn view down

Table 1: Motions of the user's head and corresponding actions of the character

Two additional accelerometers are mounted with Velcro straps to each of the user's feet (3) and are referred to collectively as the **control sensors**. The motions of the user's feet will control different actions performed by the Minecraft character as follows:

	Tilt down	Level	Tilt up
Right foot motion	Walk backward	Neutral (stand still)	Walk forward
Left foot motion	Jump	Neutral (no action)	Attack/Use item

Table 2: Motions of the user's feet and corresponding actions of the Minecraft character (within the cells)

As can be seen in Table 2, the right foot control sensor serves as a combined "gas pedal" and "brake pedal" for the character. The left foot control sensor manages various actions such as jumping or attacking.

An **Arduino** placed within in an enclosure (2) is secured about the torso with the use of Velcro straps. The Arduino is wired to the sensors of (1) and (3) to receive the user's biosignals. It will then pass the input on to the computer for processing before being passed on to Minecraft.

CALIBRATION

Prior to operation there is an initial calibration phase that will adjust the sensitivity of the system. This is meant to ensure that the device will work comfortably and effectively for users of different heights working with a variety of computer displays.

The software is programmed to provide a prompt instructing the user to move through various ranges of motion. The median value of this range is then set as the neutral state. Both an upper and lower threshold is determined from the range and this is used to activate the two active states.

For instance, a user will be asked to rotate their head left to right in a range that is comfortable for them. The median value of this range is the neutral state which corresponds to the Minecraft character looking directly forward. As the user turns their head past the upper threshold, this will correspond to the active state of the character turning right. Likewise as the user turns their head past the lower threshold, this will correspond to the active state of the character turning left.

FURTHER DEVELOPMENT

At present the device is designed to be connected to a computer via USB cable. Although this has the benefit of a stable connection between the sensing elements and the computer, we believe that there would be some benefit in adding Bluetooth functionality to the device.

Making the system wireless would grant the user greater freedom of movement during use. However we would have to conduct tests to see if there is any drop in responsiveness that would affect the system’s performance.

SUPPLEMENTARY NOTES

Hansin conceptualized the overall physical design for the system and compiled research regarding the means of interfacing the Minecraft program to the Arduino output.

Can assembled the Arduino and associated electronics by soldering the components together. In addition, she assisted in constructing the various elements to make the system wearable.

Azwad was the principal programmer who composed the Python script that processes the input signals and passes the commands on to the Minecraft program itself.

The entire team collaborated to develop the sensor mappings that associate particular actions with their matching controls.