EEL 4924 Electrical Engineering Design
(Senior Design)

Preliminary Design Report with Diagram(s)

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Project Title: Ehrgeiz

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**Project Abstract:**

This project aims to design a human interface device (HID) for computers, an innovation of the mouse and keyboard. The design consists of a pair of wireless gloves that can translate hand gestures into input that a computer can understand.

This project encompasses USB Interfacing, writing a driver for an HID compliant device, high resolution analog to digital conversion and sensors, multiple wireless device communication, and writing packets that are HID compliant. Among these five areas, USB interfacing and the concept of HID compliant devices have not been encountered by the member so dynamic research is much required.

The five areas to be discovered within this project are so diverse that the member will definitely be advantageous in job hunting. Although intense research is a must, this project will sell when it succeeds.

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*Figure 1. System Level Design*
Features

The invention, Ehrgeiz, offers the end-user the ability to ease the communication between him and computer graphics designing and 3D modeling. Ehrgeiz allows the user to more intuitively control graphical user interfaces with his two hands.

The main features offered by Ehrgeiz are the following:

- Hand movement/gesture translation using accelerometers and flex resistors
- Wide range of movement for each hand through completely wireless connection between the gloves and the base device
- USB connectivity allows for modernization
- HID compliancy that allows for Plug-and-Play
- Acceptable resolution of hand movement/gesture -> computer screen resolution conversion when gloves are used as a mouse
- Multiple flex resistors allow higher resolution to allow more intuitive hand actions that represent users’ intended action on the computer
The Competition

A very similar device to Ehrgeiz is Oblong’s g-speak platform. Both designs are actually based on the movie Minority Report. The g-speak platform, however, is a spatial operating environment, much like an operating system in itself. Although the g-speak is a more futuristic and high-tech design, it isn’t economical and uses too much resource, and mainly spatial resource. My design aims to be comfortable and economical in a way that it would be possible to have every home possess one.

Figure 2. G-Speak Platform
(http://www.gizmag.com/the-real-life-minority-report-computer-interface/10469/)
Another similar invention was developed by the defense company Raytheon based in Massachusetts. The version was also based on the same movie, Minority Report. In fact, the company hired John Underkoffler, who proposed the similar concept used in the movie, to design the glove. The gloves also work based on image processing through a camera that tracks the gloves. Again, a system that is completely different from my idea of using flex resistors and accelerometers.

Figure 3. Raytheon’s version of Minority Report glove
(http://www.newscientist.com/article/dn7271)
**Technical Objectives:**

Since the project aims to be an HID compliant device, a device that any computer with HID compatibilities can recognize, the final product may be used on any application that uses computers. Moreover, since the concept of the project is hand gesture and hand manipulation, the design is more intuitively useful for computer graphics design applications such as 3D Modeling, Adobe Photoshop and its other products, and even as a disability resource.

Ehrgeiz consists of three devices, the base device and the two gloves for each hand.

**The Base Device**

The base device handles the communication between the gloves and the computer. It uses a microcontroller by Atmel that has a USB class that can handle USB interfacing. It has the USB receptacle or cable that is physically connected to the computer. It has an RF wireless module, preferably an XBEE that receives the signals from both gloves wirelessly. Basically, the base functions as a bridge that converts the serial data that comes from the gloves into HID compliant data that can be understood by a computer.

Components include the following:
- AT90USB1287 – microprocessor runs at operating voltages of 2.7V-5.5V.
- ISO7240 – isolator runs at operating voltages of 3.3V – 5V.
- XBEE – runs at 3.3V-5V
- USB powered – power comes from the USB port of the computer, USB power output is mostly 500mW at 5V

The USB port should be able to power up both the microprocessor and isolator.

![Figure 4. Base Device System Level Design](image)
The Glove Devices

The glove devices handles all hand movement/gesture translations and wirelessly sends each separate data into the base device. The gloves can use most Atmel ATMEGA microprocessor that has at least 6 ADC pins to accommodate the sensors. There will at least be two ~1.5” flex resistors in series in each fingers and a 3-Axis accelerometer for each hand. This accounts to a minimum of 6 ADC pins from each microprocessor per glove. Data will be transmitted wirelessly via RF wireless modules and an XBEE on each glove can accomplish this. Each packet will contain the glove ID and the bytes that represent the gesture. The packets will then be handled by the base device. This minimizes the process time of the glove microprocessors since 6 ADC calls may take a lot of time.

Components include the following

ATMEGAXX – most Atmel microprocessor runs at operating voltage of 2.7V-5.5V.
Accelerometer Board – runs at 2.4V-5.25V
Flex Resistor – runs like a normal potentiometer
XBEE – runs at 3.3V-5V

A battery will be used to power each glove and power consumption is still uncalculated.

Figure 5. Glove Device System Level Design
Explanation of the Concept Selection

**Operating System:** PC operating system

**Windows XP** - I use XP on my computer and am researching how to write XP drivers in case I need to.

**Linux** - Willing to learn how to write drivers for Linux but I prefer XP over this.

**USB Interface:** I have looked up how I can interface USB with AVR and found 3 possible solutions.

- **FT232BM (FTDI)** - Using an FTDI chip, and writing the drivers through the given programming software, I can write a driver that interfaces my application with XP.
  

- **AT90USB** - This is a recent creation by Atmel and it has USB functionalities. I am still looking into this.

- **AT90USBKEY** - A ready made board with an AT90USB microcontroller on board that can already interface with a PC soon as you program the microcontroller with the given example codes.

**Wireless Interface:** IEEE802.15.4 or Bluetooth Protocol

- **2 TX Xbees, 1 RX Xbee** - An Xbee installed on each of the glove and 1 on the base. Depending on how the XBEE receiver can handle flow control and lost message, 2 RX Xbees may be installed on the base.

- **Bluetooth** - In case the Bluetooth protocol is easily acquireable, in terms of hardware and hardware cost, Bluetooth may be implemented.

**Base Microprocessor:** Microcontroller required in interfacing the wireless glove and PC via USB

- **Atmega324P** - I am quite familiar with the use of this microcontroller and it's good that it has 2 UARTs and can run stable on 3-5V. If FT232BM is used as the USB Interface, this will definitely be used as the Base microprocessor.

- **AT90USB1287** - I'm not familiar with this one, but since it's also an Atmel MicroP, it has the same RISC as the Atmega324p. The good thing about this one is that it has USB functionality so it would be rather easy to implement USB Interfacing using this one, but I need to learn it still.
**Glove Microprocessor**: Microprocessor that will do all the Analog-Digital Conversion. One will be used on each glove.

**Atmega324P** - again, since I am already quite familiar with this microP, I will be using this one, and it also has enough ADC ports necessary for converting Analog signals.

**Glove Sensors**: Sensors that will be used to translate hand gestures.

**Flex Resistors** - Resistors that change resistance depending on how much bend it gets. To be equipped on each finger. Required for final implementation.

**Accelerometers** - sensors that measure gravity. Will be equipped on each glove to measure how much the hands are moved. Required for final implementation.

**Touch sensitive buttons** - In case additional inputs are necessary, touch sensitive buttons will be equipped on the gloves since regular buttons may be too bulky.

**Software**: program to test interface onto.

**Windows Desktop** – easiest way to test mouse functionality of gloves

**Notepad** – easiest way to test keyboard functionality of gloves

**Advanced Software**: program to apply interface onto

**Adobe Photoshop** – I’m familiar with the shortcut keys in Photoshop so it would be easy to write a compatible handshaking system between the glove and Photoshop.

**SolidWorks** - I'm familiar with this since we use it in class, the problem with this is it doesn't rely on shortcut keys alot, which will be very useful for my implementation.

**AutoCAD** - I'm not familiar with this but if it uses shortcut keys, then it will be very optimal that I use it to test my implementation.

**Power Source**: Source of power

An external battery will be used to power up each of the microprocessor in the gloves. The USB VCC and GND coming from the PC will be used to power up the base for common Ground.
**Cost Objectives**

<table>
<thead>
<tr>
<th>Product</th>
<th>Amount</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT90USB1287</td>
<td>1</td>
<td>$15.00</td>
</tr>
<tr>
<td>ATMEGAXX</td>
<td>2</td>
<td>$5.00</td>
</tr>
<tr>
<td>XBEE</td>
<td>3</td>
<td>$20.00</td>
</tr>
<tr>
<td>Accelerator Boards</td>
<td>2</td>
<td>$30.00</td>
</tr>
<tr>
<td>Flex Resistor</td>
<td>20</td>
<td>$15.00</td>
</tr>
<tr>
<td>Gloves</td>
<td>1 pair</td>
<td>$10.00</td>
</tr>
<tr>
<td>Isolator/USB Receptacle</td>
<td>1 of each</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

**Total Cost:** $455.00

Table 1. Expected Cost Objectives

Other devices that are similar to Ehrgeiz uses more complex yet non-economical sensory devices such as imaging so they are generally more expensive to implement.

**Division of Labor**

Since Team XD consists of one person, all labor is done by the single member. Here is a summary of the significant events in the design.

- Research on USB Interfacing
- Write AVR side driver for HID
- Interface base board with PC via USB
- A/D testing for gloves
- Build glove board
- Analog to Digital to HID conversion
- Transmit Glove data to PC
Introduction
Project Proposal
Research on USB Interfacing
Write AVR side driver for HID
Interface base board with PC via USB
A/D testing for gloves
Build glove board
Analog to Digital to HID conversion
Transmit Glove data to PC
Demo (team)

Table 2. Gantt Chart showing work schedule
References


[5] AT90USB1287 microprocessor datasheet

[6] XBEE RF Module datasheet

[7] ADXL330 accelerometer datasheet