Wearable Computing
First Semester Report
Fall Semester 2010

by
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ECE401

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ABSTRACT

With the growing fascination in mobile/portable devices comes the question, what is the easiest way to access information throughout the day? Clearly, having to pull out a laptop, tablet or cell phone every time you need access to information can be frustrating. What if there was a device that could be worn everyday that put this information at your fingertips without having to dig into your bag or pockets? Our wearable computer allows users to interact with their system via simple hand gestures and view data in an easy to use graphical user interface that can be displayed virtually anywhere.

We have taken current color tracking techniques used in the Touchless software development kit (SDK) and spun it so hand gestures can be recognized by using only a webcam. The webcam is worn on an apparatus that hangs from the user’s neck that also harnesses a pico-projector. The webcam takes in gestures which manipulate the graphical user interface that is projected onto nearby surfaces by the pico-projector. This system will allow users to easily access information using nothing but their hands. Not only is this a new and exciting way of using computers, but the hand gestures used to control the system are simple, which enables this computing system to be used by almost anyone.

Human-computer interaction (HCI) is a heavily researched area in today’s technology driven world. Most people experience HCI using a mouse and keyboard as input devices. We wanted a more natural way to interact with the computer that also allows instant access to information. We are developing a real-time system that is always on and available to collect data at any moment but also is accessible “on-the-fly”. Our aim is to make our machine usable and receptive to the user’s needs in a timely manner. We do this by developing algorithms to detect hand gestures that map to controlling the graphical user interface (GUI) in an expected manner. This allows the user to access this information without the need to turn on a laptop or reach in their pocket to view their computer device. In the future we will be tethering multiple health sensors to our system that will provide a user and their physician or other family members access to up-to-the-minute health statistics. We will also be looking at shrinking our apparatus as well as moving from a laptop to a smaller portable device for our processing engine.
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Chapter I – INTRODUCTION

Modern society has quickly embraced the world of technology, and has openly accepted for the integration of computers in our everyday tasks. According to the International Telecommunication Union, close to 30% of the 2010 world population connects to the internet on a regular basis\(^1\). With the ever increasing popularity of the internet, and the use of computers in our daily lives, developers are creating useful and manageable technology that is easily accessible whenever and wherever it is needed.

As senior Electrical and Computer Engineering majors at Colorado State University, we have taken on the task of developing a computing system that will effectively integrate a computer with the user’s daily life. With a successful project, we will have created a wearable computing system that anyone and everyone can easily carry with them every day that includes a sensor network to monitor and report various information about the user.

Our wearable computing system is being developed with the incorporation of a display and controls that can easily be seen and used without requiring a laptop or other cumbersome device. By wirelessly connecting a smartphone with a webcam and a pocket projector, we are creating a device that will be non-intrusive and non-restrictive. The projector will project a graphical user interface in front of the user, and the webcam will take in video of the user’s surroundings. With the webcam, the user will have the ability to control the system by using simple hand gestures. This wearable interface will allow the user to manage the different functions of the system and wirelessly communicate with the smartphone device that will never need to leave the user’s pocket. Our prototype can take many forms: a pendant worn around the neck, a clip on device that can be attached at numerous locations or even a single-strap backpack with the hardware embedded in the strap.

A key attribute of the developed system will be the incorporation of various health monitoring sensors. These devices may include a heart rate monitor, pulse oximeter, skin thermometer, accelerometer and/or gyroscope. The inclusion of these devices will allow the user to monitor their personal health in real-time, and will have the ability to send alert notifications and health information to healthcare professionals.

Ideally, the wearable system will be used in a way that will allow the user to keep track of their health and easily call for emergency help if needed. A heart rate monitor and pulse oximeter will be able to monitor pulse and cardiac functions, a skin thermometer will check the user’s body temperature. An accelerometer or gyroscope will be used to observe the user’s movements, and will use a “free-fall detection” protocol to identify if the user collapses or falls down. Emergency assistance can be immediately alerted based on the sensor data collected.
Within this report, we will describe in detail all of the different processes and procedures we have been working on in our effort to develop a working and effective prototype of our wearable computing design. In Chapter II, we discuss similar various projects that are being developed concurrently with our wearable system. Today’s recent and most innovative interactive computing systems include features that are comparable to our design. Similar devices that incorporate a gesture-aware interface include cutting edge video gaming systems like the Wii, Xbox, and PlayStation. The SixthSense gestural interface project from the MIT media lab has many elements we were looking for in our prototype and has had a major influence on the development of our project.

Using the related work of other interactive computer designs as reference for our project design, we describe in Chapter III the technical features that we have integrated into our project. Within this section we will describe our creation of an easy to use graphical user interface (GUI), our software coding process and details, and our physical project design specifications.

While developing our wearable computing system and its features, there were some technical problems encountered. Chapter IV specifies the technical issues that we have encountered in the design process of our prototype. Some concerns we have include inefficient video quality, unreliable color identification and tracking, inaccessible webcam features and programmatic difficulties with the pico-projector.

The problems that we have encountered in the development of our project have not deterred us from the exciting direction our design is headed. Chapter V explains the decisions and approaches we have taken to arrive at our project’s current state. The strenuous trial and error process led us to the realization that a great deal of work would be needed to complete this exciting design project. After much research & work, we came up with a plausible and marketable product, and are very excited to see the end result.

After making a decision as to what we wanted to create for our project, we set goals for the development of our design. Chapter VI discusses these goals and plans that will hopefully be set in motion over the coming spring semester. Our primary task is to effectively incorporate medical sensors into our prototype’s list of functions. In addition to working on the sensors, we also will be attempting to downscale our system to make it more portable. The gestural interface design currently uses a laptop as a computing engine, but ideally should run off a smartphone or tablet PC. After we have a working and compact design, we would like to investigate different power consumption algorithms so that we can decrease our power usage and increase our battery life.

Once we have created a working and efficient product, we will move on to the business side of the project. The marketing demographics for our design project are described in Chapter VII. One working design will be marketed to the general health services community so they can get constant real-time health information. The second target market that we would want to
pursue would include the elderly population. Senior citizens would be able to use our product to
decrease the number of trips to the doctor, and more importantly, have the ability to notify
emergency personnel if needed.

Every engineering organization has a written “Code of Ethics” that all professional
engineers need to abide by. This code is set in place so that every engineer and client can be
protected from unethical practices such as copyright infringement and the right to confidentiality.
Chapter VIII touches on some ethical concerns that we may encounter with our design, and
discusses the actions that are being taken to prevent any violation of the Engineering Code of
Ethics.
Chapter II – REVIEW OF PREVIOUS WORK

Gesture recognition is prevalent in numerous types of technology today. Currently, all major gaming consoles implement some type of gesture based game play. Microsoft implements their gesture gaming via Kinect, Sony through PlayStation Move and PlayStation Eye and Nintendo with its Wii Remote. Pranav Mistry, a PhD candidate at the MIT media lab created SixthSense, a groundbreaking wearable computer, which was the inspiration for our wearable computing project.

Microsoft’s Kinect is a controller-free gaming experience for the Xbox 360. The Kinect sensor device uses a simple RGB camera along with 3D depth sensors to adapt to the gamer’s environment. It accomplishes this by mapping the environment into a 3D picture and locating the player’s body which can then be used to control games on the console. This popular and fast selling technology shows that people are very interested in getting rid of input devices for their entertainment machines and control the environment with their gestures. The Wii and PlayStation also accomplish similar gesture-based gaming with the use of gesture control devices. The Nintendo Wii uses a wireless controller that has an accelerometer to sense motion. The PlayStation uses a uniquely colored wand that their PlayStation Eye camera tracks to detect motion. The aforementioned gesture-based devices are shown in figures 1, 2 and 3, respectively.

Pranav Mistry’s SixthSense is a wearable gestural interface that lets a user interact with digital information using natural hand gestures. (See figure 4.) We used the SixthSense design when creating our own prototype as it has very similar qualities that we wanted to implement. SixthSense also enables hand gesture recognition using color fiducial tracking and computer-vision techniques. SixthSense incorporates the following applications that demonstrate how well this type of gesture-based system works: a map application that uses natural hand gestures to zoom and pan the images, a drawing application that allows a user to draw anything using their fingers, a camera application that takes pictures if the user presents a “frame” gesture, and the ability to draw symbols in the air using the index finger to accomplish certain tasks.

Mistry’s wearable device incorporates a pendant like design that hangs from the neck. He uses a plastic ruler to support a digital webcam, pico-projector and mirror. He wears four different colored fiducials on the tips of his fingers for his color tracking algorithms. SixthSense has incorporated many design phases including one built in to a hat, another on a helmet and the one we are temporarily using, the around-the-neck pendant. We are designing a similar mechanism to incorporate hand gesture interaction between digital information and the user. However, we will be tethering medical sensors such as a heart-rate monitor, pulse oximeter and accelerometer to collect real-time statistics on the user’s health and make it accessible by a few flicks of their hands.
Figure 1: Microsoft Kinect

Figure 2: PlayStation Move

Figure 3: Wii Remote
NOTE: It can be seen that we borrowed Pranav Mistry’s pendant design while producing a prototype of our project. This design is a temporary installment as we test our software package and will reevaluate our design in the coming semester.
Chapter III – TECHNICAL FEATURES

The first element of our wearable computer involves the interaction layer. We first had to design an easy-to-use graphical user interface. This GUI needed to be easy to read and straightforward in order to manipulate with simple hand gestures, all the while being aesthetically pleasing. We first developed a home screen on paper that is used to select from various applications and has a local clock at the top center of the screen.

Before we implemented our GUI in code, we first had to find a way to implement our hand gesture interaction layer. After numerous hours of research we discovered Touchless SDK. This software development kit provides us with the color tracking algorithms that we desired for our project. This C# solution analyzes each image captured from the webcam’s video feed and searches for the RGB value of each colored marker. It then provides access to current data on each marker that we can use for recognizing gestures. Visual Studio was used as our development environment and our code was done in C#. This kit also has a webcam library that is linked in that enables us to easily capture and manipulate the webcam’s video feed. Touchless SDK was added to our project using the statement:

`using TouchlessLib;`

After researching and testing the Touchless library we began working on our GUI’s main menu panel. Figure 5 shows a screen shot of this main screen. It was then important to map the location of the colored markers onto the main screen so the user knows how their fingers are manipulating the GUI. The user can select applications by moving their fingers left or right from the center of the screen and then pinching their thumb and index finger together to select the desired application. Once the fingers are pinched a routine is called to bring the wanted application’s panel to the front. A current application variable keeps track of the current application layer and is used to determine which user interaction maps to which action in the GUI. An example map application is shown in Figure 6.
Figure 5: GUI Main Menu

Figure 6: Map Application
To update the markers from the video feed we added the following marker event handlers:

```csharp
_touchMgr.Markers[0].OnChange += new EventHandler<MarkerEventArgs>(UpdateMarkerBlue);
_touchMgr.Markers[1].OnChange += new EventHandler<MarkerEventArgs>(UpdateMarkerRed);
```

With these event handlers we can add implementations for hand gesture recognition as well as calling methods related to handling GUI updating. So far we have only employed simple gestures for choosing and starting an application as well as exiting the application to return to the home screen. The pinched method returns true if the user’s fingers are pinched and is deployed as follows:

```csharp
private bool pinched()
{
        return false;

    int blueX = _touchMgr.Markers[0].CurrentData.X;
    int blueY = _touchMgr.Markers[0].CurrentData.Y;
    int redX = _touchMgr.Markers[1].CurrentData.X;
    if ((Math.Abs(redX - blueX) < 10) && (Math.Abs(redY - blueY) < 15))
    {
        return true;
    }
    return false;
}
```

The exit method determines if the user has pinched their fingers in the upper-right corner of the application which signals the software to exit the current application and return to the main menu. The exit method is as follows:

```csharp
private bool exit()
{
    MarkerEventData blueData = _touchMgr.Markers[0].CurrentData;
    MarkerEventData redData = _touchMgr.Markers[1].CurrentData;

    if (!blueData.Present || !redData.Present)
        return false;
    if (pinched())
    {
        if ((redData.X > 290) && (blueData.X > 290) && (redData.Y < 40) && (blueData.Y < 35))
            return true;
    }
    return false;
}
```
Currently we have only implemented two marker fiducials, which limits the number of hand gestures we can put into practice. However, because of the simplicity of handling marker events, it will be unproblematic to add two more markers for the left hand which will enable us to include very detailed gestures to control our system. Also, the next big step for our system is to add medical sensors that collect data and store them in a database which can then be accessed using our gesture interface. Our current design, made up of a webcam, wooden ruler and pico-projector, can be seen in Figure 7. The wooden ruler creates a stable mechanism for harnessing the camera and projector.

Figure 7: Wearable Computing Prototype
Chapter IV – TECHNICAL PROBLEMS

There are a few concerns that we have come across while working on this design that should be noted in this paper. These problems will be addressed in the near future and, once resolved, will make our prototype much more reliable and stable for everyday use. The main problems we are concerned with are capturing video and reducing the noise we get when detecting colors. We also are having difficulties interfacing with the projector and programmatically turning it on/off when desired.

The webcam includes many features and properties that make it ideal for use with a desktop or laptop. However, these automatically set properties come as a burden in the world of color tracking. Because the color tracking algorithms are so sensitive to the RGB value they are looking for, it is essential that this value does not change depending on the environment the user is in. The only way to add a marker to the Touchless SDK, currently, is to take a picture of the fiducials that will be used with the system and then statically adding them at load time of the software package. The C# code for adding a marker is as follows:

```csharp
Bitmap bmp = new Bitmap("fileLocation");
_touchMgr.AddMarker("blue", bmp, new Point(207, 93), 8);
_touchMgr.AddMarker("red", bmp, new Point(220, 148), 10);
```

If the camera is setup to automatically change brightness, contrast, zoom and other properties, the fiducials that the webcam detects constantly differ from the original color marker bitmap. However, if we can statically set the webcam to settings that help detect our fiducials in any environment, we will have a much more stable prototype. The settings of the camera can be set by opening up the camera’s dialog box with this line of code:

```csharp
_touchMgr.CurrentCamera.ShowPropertiesDialog(this.Handle);
```

The problem here is that a user must have a mouse and/or a keyboard to change the values in the properties dialog box. If the camera ever loses power the settings are automatically reset to their defaults and we lose the state that we want our camera to be in. Once we figure out a way to access the COM interface of the Logitech webcam we are using, we will be able to programmatically send commands to set the state of the device as we see fit.

A similar problem exists with the projector and being able to access its features programmatically. We do not want the projector to always be on, which means that we will have to programmatically turn the projector on if a certain event has happened. We are currently looking into turning the projector on using a hand gesture or possibly adding a small button to our system that will immediately turn on the projector and the user will be able to access everything they need.
Chapter V – DESIGN DECISIONS AND ALTERNATIVE APPROACHES

Several approaches and decisions were considered during the creation process of our design. We knew that we wanted to create a wearable computing system that would be non-intrusive, easy to use and would help the user in their everyday life. Using the SixthSense project from MIT as a guide, we envisioned a device that would be worn on the body and controlled by identifying the user’s hand gestures. What we still needed to figure out was how our finished product would be used and who would be included in our target market?

Our first idea was to integrate embedded systems into a piece of clothing to be worn by a handicapped individual that specifically uses a wheelchair. With this purpose, the system would have the ability to help the handicapped individual with everyday activities that are more difficult while in a wheelchair. The idea behind this design was to give easy access and control to the handicapped individual’s home as well as commonly visited locations. This design direction proved to be too primitive and short-sighted for our senior design project.

After deliberating about another use and focus for our project, we decided to orient our system towards the student market. We wanted to be able to help a student stay organized and function within an educational setting. We had planned on including features that would benefit a student while in class and also within a social environment. While in class our device would be able to record lectures with video and sound, and also possibly give the student the ability to take digital notes on the actual video feed. Another feature we had thought of was a facial recognition algorithm that would recognize the people in the user’s social network and be able to store details about “friends” in a database including pictures, names, and other miscellaneous data. Other aspects that we had planned to include were a daily log of music heard filtered by the location and time of when it was heard, and to incorporate a GPS and activity log which would allow the user to track the different activities that they had participated in over the course of the day. The last feature we wanted for our device was the ability to store and display electronic copies of the user’s many textbooks. The student “life organizer” quickly proved to be a reach for us based on our very limited budget and small amount of time to accomplish our goals.

Meeting once again to discuss the direction of our project, we finally came up with a reasonable yet challenging direction for our design. The ability to monitor one’s health in real time along with an emergency contacting system, our new project’s path was exciting and full of possibilities. We decided that we wanted to orient our project towards people who may need medical assistance and constant health monitoring. In addition to keeping track of different health attributes, our wearable prototype will include a few other functions including a map, a drawing application and other useful applications.
Chapter VI – CONCLUSION AND FUTURE WORK

VI.1 Conclusion

This semester has let us produce a wearable gestural interface that is used to control a computing system. This includes the hardware and software shell that makes it possible to interact with a system void of a computer mouse and keyboard via hand gestures, a webcam and a projector. The projector displays the easy-to-use graphical interface developed in-house which in turn is navigated using simple video processing techniques through the camera. This hardware package is currently harnessed in a wearable pendant that is worn around the neck and connects to a full-size laptop.

VI.2 Future Work

As we move forward with our project we have four main goals we would like to focus on: sensors, scale, power consumption, and performance. Our current prototype is the interface for which our desired final project will run, but the necessary hardware and style need to be modified to bring our prototype to a meaningful and useful design with added functionality and marketability to a broad user group.

Our first step will be to include medical sensors to collect data from the user. Sensors that fall into this category are heart rate monitors and pulse oximeters. These will be our main focus so that we can collect relevant data on a user’s current health status. We have selected a heart rate monitor that also has the capability to take a two contact EKG for additional information. We also plan to explore what other types of health data we can collect with small and non-obtrusive sensors to expand the collectible data.

Other types of sensors we are investigating include accelerometers and other sensors that do not directly relate to medical sensing but that can add to the data collected and expand the functionality of the device. We are currently looking at a three axis accelerometer that will allow us to track the movement and activity of the user. This will also add the possibility of incorporating fall detection to our system and send an emergency alert if necessary.

In connection with the work on incorporating sensors will we be examining the best collection methods for the sensor data, the best ways to prioritize and display data to the user and how we can compile the data and find correlations that will be important for the user or a medical professional. We will need to explore specific use cases for the device and determine what data will be relevant for each case. Based on some of the previous work that has been done in the area of medical sensing, some of the target groups are the elderly population and pre and post operative patients. After looking at the data in the aforementioned work, we will look into expanding to other segments of the population.
The size of our device will significantly impact the possible applications and the ability to classify it as a wearable computer. The display and control are in a wearable and compact form but our current processing is performed with a full size laptop. Our goal is to reduce our computing platform to either a tablet PC or smartphone which will include more portability and a less obtrusive device. However, we have to take into account processing power when downsizing our system, so that our real-time video processing and sensor data collection are not affected in a negative manner. When researchi

Monitoring possible power consumption will be a necessary component in future decision making. To keep the device as a small wearable computer we need to avoid the need for a large additional power supply. Since this device will be worn daily for constant monitoring we need a battery that can last a full day on one charge. Some of our power consumption control will be from the peripherals and processing platform we select. A significant percentage of power consumption will come from constant video processing of our gestural interface, so more efficient algorithms might have to be engineered. We will also be researching the possibility of putting portions of our design in sleep mode for optimal periods of time to save power. One example of a power saving technique will be having a control to turn off the pico-projector when the user is not currently interacting with the controls or viewing information from the system.

Finally, we will also continue to improve the functionality of the computer interface itself. This means that we will make our graphical user interface respond to simple and intuitive hand gestures as well as making the graphical user interface as simple to navigate and read as possible.
Chapter VII – PRODUCT MARKETING

As we approach finding all possible users and use cases of our device in the coming semester, we will better be able to determine out target demographics for marketing our product. In the device’s current state, the product could be marketed to a computer user who wants quick and unobtrusive access to their computing device, i.e. laptop or smartphone. The final prototype, with the incorporated health sensors and completed user interface, would be ideal for users’ who want instant access to health information without the need of physically pulling out a computer.

Two potential demographics we are currently exploring for our health-monitoring device are the elderly population and pre/post operative patients. For pre and post op patients our marketing would be aimed at the medical professionals who would need to collect this data. In most cases the device would be used for long term use by the patient for sensor data collection. Hospitals could also be a target market to use our device for short-term patient monitoring. We believe that this device will aid medical personnel in tracking the recovery process of post-operation patients outside of the hospital.

For elderly users the device could be marketed both through health care professionals and directly to the elderly population. For medical professionals, there would be the opportunity for regular, ongoing preventative care and monitoring with fewer offices visits, and detailed, current data of their patients’ status. The users themselves could be marketed to directly or through a recommendation from a health care professional or from Medicare. Healthcare professionals could recommend the device for the user to be better aware of their health status between medical office visits. Marketing to the elderly population would focus on the idea of adding independence and immediate, vital medical information. The device could decrease the need for constant monitoring by a live in nurse and could give the user updates on their health status. Our possible target demographics and marketing schemes may evolve as we explore other uses for the device.
Chapter VIII – ETHICS

The engineering code of ethics is something that should be followed and practiced, especially when designing a new product. The two possible ethical situations we want to avoid with the design of our wearable computing system is the potential use of someone else’s idea, and the transmission of end user confidential information (ie: medical data).

One ethical situation we may encounter as noted in the American Society of Mechanical Engineers’ (ASME) Code of Ethics is that “Engineers shall respect the proprietary information and intellectual property rights of others, including charitable organizations and professional societies in the engineering field.” Since our project is similar to other designs that have already been created, we may encounter ethical issues regarding these similarities. The way that we will attempt to avoid this issue is by incorporating a health monitoring sensor network to our gesture-controlled interface. The health monitoring orientation of our design is the major aspect of our project that sets us apart from all other similar developments. In addition, we will give credit in writing to designs that have inspired our project.

Along with possible copyright infringement, the second ethics violation that we will need to recognize is our current inability to securely transmit confidential health information. Many organizations including The National Society of Professional Engineers (NSPE) mention in their Code of Ethics that “Engineers shall not disclose, without consent, confidential information concerning the business affairs or technical processes of any present or former client or employer, or public body on which they serve.” A premise for our project is the ability to transmit a person’s health information wirelessly to a doctor or other health service as needed. The ethical issue with this is the idea that a person’s confidential health information will be broadcasted over a wireless network which is accessible to a wide variety of users. We will need to address this issue more when we begin working on our wireless sharing of information, but for now we are investigating ways of creating a more secure network. This will include research into secure hash algorithms and other cryptography techniques.
REFERENCES


BIBLIOGRAPHY


APPENDIX A – GLOSSARY

Accelerometer
An electronic device that measures proper acceleration, or the acceleration experienced relative to freefall.

C#
A general purpose object-oriented programming language made by Microsoft. C# is part of the .NET framework and has syntax very similar to Java.

COM Interface
The component object model is a binary interface that enables inter-process communication and dynamic creation in a wide range of programming languages.

Event Handler
Methods implemented in source code that handles actions that is initiated outside the scope of the program.

Fiducial
An object, usually colored, that is used in video processing to be tracked in a live video feed. Colored fiducials can be tracked and then handled in code to represent hand gestures.

Gesture Recognition
A programmatic solution that uses mathematical algorithms to analyze the movements of the face or hand and determine which gesture is being presented to the system.

Graphical User Interface (GUI)
A user interface implemented in software that allows a user to interact with the program in an intuitive manner.

Heart Rate Monitor
An electronic personal monitoring device that allows a person to measure their heart rate in real time.

Human-Computer Interaction
The study of interaction between people and computers. This is commonly accomplished using a mouse and keyboard as input devices.

Pulse Oximeter
An electronic medical device that indirectly measures the oxygen saturation of a person’s blood.
**Real-Time System (RTC)**
The practice of making software reactive to strict time restraints and incorporate appropriate response mechanisms.

**RGB**
An additive color model comprised of red, blue and green color values.

**Software Development Kit (SDK)**
A set of development tools that aids in the creation of applications in a software package.

**SixthSense**
A wearable gestural interface designed by Pranav Mistry at the MIT Media Lab.

**Touchless SDK**
A webcam multi-touch object tracking software development kit.

**Visual Studio**
An integrated development environment (IDE) from Microsoft that is used to develop console and graphical user interface applications.

**Wearable Computer**
Computers that are worn on the body of the user that can be used in behavioral modeling, health monitoring systems and reality augmenters.
### APPENDIX B – BUDGET

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APPENDIX C – IEEE GRANT PROPOSAL

Application for IEEE Mini-Grant for Student Application Papers Applying Industry Standards

1) DATE OF APPLICATION: October 15, 2010

2) Project Title: Wearable Computing

3) Student(s) Name(s) and contact Information, including email and postal address:
   Celia Rose Pietsch    email: celiarpietsch@gmail.com  p:
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   Ethyn Feldman    email: ethyn_f@yahoo.com  p:
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   Fort Collins, CO 80526

4) Name of Student Project Leader: Nick Brantley

5) Name of Faculty Advisor/Mentor and contact Information. Must include email and postal mailing address:
   Sudeep Pasricha    email: sudeep@colostate.edu  p:
   1373 Campus Delivery
   Electrical and Computer Engineering
   Colorado State University
   Fort Collins, CO 80523-1373

6) Institution: Colorado State University

7) Program/Course: Embedded Systems and Senior Design
Wearable Computing

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The goal of our project is to create a computer that anyone and everyone can bring with them on an everyday basis and incorporate sensors to monitor and report health status. The plan for the final product is to have a display and controls that can easily be seen and used without requiring a laptop or cumbersome device and wirelessly connect our unit to transmit the data. The controls will be through simple hand gestures and possibly voice commands communicating wirelessly with a smart phone to increase our possible computing power. Our prototype can take many forms: a pendant worn around the neck, a clip on device that can be attached at numerous locations or a single-strap backpack with the hardware embedded in the strap.

The project will start off by offering solutions to the many needs people have throughout the day. This will include taking pictures, facial recognition, friend database, music recognition, etc. We are starting off by making a straightforward graphical user interface that will be controlled through simple hand gestures to power these applications. We intend to simplify everyday tasks by allowing a user to have constant access to their computing needs without having to take out a laptop or mobile device. We are also researching power-friendly means to allow the computing system to acknowledge when a user needs the system without user activation.

We will then attempt to interface our wearable computer with medical sensors to acquire important data throughout the day. These sensors may include a heart rate monitor, pulse oximeter, skin thermometer, accelerometer and/or gyroscope. The inclusion of these devices will allow the user to monitor their current personal health while having the ability to send alert notifications to healthcare professionals.

We will begin our project by using our prototype with a laptop but will eventually move to a mobile device that a user can keep in their pocket. Our prototype will communicate with the mobile device by a wireless connection: 802.11, ZigBee or Bluetooth. As we explore incorporating sensors with our prototype we will examine additional IEEE standards for accelerometers/gyroscopes, pulse oximeters and wearable heart rate monitors.

**Budget:** Our proposed prototype will include a web camera and projector to give us control of the device and have an unobtrusive display. Our current budget has allowed us to obtain said projector and webcam. As we expand the functionality of the unit to different sensors and tasks, our budget needs will expand. Some of the expenses we will incur include Smartphones ($200 - $300 each), accelerometers ($50), heart rate monitors ($50), and pulse oximeters ($50-$100). This grant will be critical to help us realize our project’s potential.

**Technical Standards**

- IEEE 802.11 a/b/g/n
- IEEE 802.15 ZigBee, Bluetooth
- IEEE USB 2.0/3.0
- IEEE standards for accelerometers/gyroscopes like 1554-2005
- IEEE P11073-10404 for pulse oximeters
- IEEE P1107310406 for heart rate monitors
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Touchless SDK
We would like to thank the developers of the open-source Touchless SDK. This software development kit gave us the mechanism to perform color tracking and let us quickly dive into handing gesture recognition for our computer interface. Without this SDK we would have had to develop our own color tracking algorithms which would have set us back significantly.

IEEE
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