Memo

Date:    July 31, 2006
To:      Dr. Chen, Computer Science Department Chair
From:    Arm Surwaranaratana
          Marcela Reyna
          Javier Villarreal
Subject: Proposal for student research on eye tracking hardware and software

Purpose
The purpose of our proposal is asking the Department of Computer Science to fund a student research in which we will develop an eye tracking library and drivers.

Summary
This proposal is asking the Department of Computer Science at the University of Texas Pan American to fund our student research on eye-tracking software and hardware and its applications. We will experiment with cameras using two separate placement positions. In our first position, one camera is mounted on the head and records the eye and the other camera points to the user’s view which is then used as a frame of reference. In the second position, only one camera is used which is stationary in front of the monitor pointing towards the user. Our aim is that the user will benefit from our inexpensive software and hardware suite by applying it to a variety of different research topics.

The research currently available on eye-tracking devices and software has focused on learning how people respond to certain web, magazine, and advertisement layouts. An example involving web layouts is discovering whether the user carefully looks at certain sections of a webpage or merely glances over it. Using eye tracking software, researchers have monitored patterns people follow when reading information online. The beginning left side of the webpage is usually carefully read, while the right side of the page is then skipped over. Studies have also shown that smaller fonts tend to keep the user’s attention longer while larger fonts are overlooked.

Since computer vision solutions are typically expensive, we would like to create a software and hardware suite which is affordable for the general public. We want to provide smaller research groups an inexpensive solution. As part of this suite, we want to develop a learning algorithm and extensive tools in order to provide even more complexity and flexibility to our solution. These tools include a library, input drivers, and utilities which will make use of the library and “gaze” analysis software.

We have Dr. Tsai, a Computer Science professor at the University of Texas Pan American, as a contact whose expertise is computer vision. With his help, and the assistance of other students we would like to begin our research August 24, 2006 and continue until the end of the spring 2007 semester.
**Introduction**
At the University of Texas Pan American students are encouraged to participate in undergraduate research. Unfortunately, most students are unaware that funds are available. There are two reasons for our research; the first is to develop an affordable eye tracking solution for input and research aid. The second is to encourage others to propose their own ideas.

Eye tracking research and development has taken place in the field of Human Computer Interaction (HCI). But many of the current solutions involve large ‘bulky’ head mounts that are intrusive and uncomfortable. The current solutions are expensive and price changes depending on equipment used and complexity of the software. Development is lacking for every day use of eye tracking as primary input. Our goal is to improve current eye tracking algorithms for both head mounted cameras and stationary camera solutions. Our final development will be an open source set of user input drivers and software to utilize eye tracking technology.

As mentioned previously, there has already been research in this field, but there are no practical input solutions. There have been several algorithms available for eye-tracking that we may freely build on. Our status throughout the year will be documented on our website which is open for anyone to view or use our work.

**Proposed Procedure**
The following tasks will be done: first we will work with camera placement then develop an algorithm to measure a user’s point of gaze and finally create an eye tracking library along with helper applications and prediction algorithms.

1. Design camera placement for data acquisition
2. Develop technique to measure the user’s point of gaze
3. Combine development to create unified eye tracking library
4. Utilize eye tracking library to create input drivers
5. Create prediction algorithms
6. Create helper applications

**Task 1: Design camera placement for data acquisition**
The aim for the research will require us to use both the head mounted and stationary camera placements which will allow us to gain maximum data results. We want to have a single stationary eye tracking camera as our end product, but since head mounted cameras yield simple data sets, we will be using that placement to develop the preliminary eye tracking techniques. After working with camera placement, we will also include infrared lighting to illuminate the eyes allowing us to easily identify it.

**Task 2: Develop technique to measure the user’s point of gaze**
There already exists a technique to extract the location of the pupil which is called the Starburst algorithm and is implemented in many applications; however, the algorithm can be inaccurate when the pupil is not completely in view. We intend to build on the algorithm and/or derive our own algorithm to do pupil center estimation and correct the
problems the Starburst algorithm has so that there will be accurate results even if the user 
blinks or blocks the pupil in any way. Infrared reflectors will help in measuring the user’s 
point of gaze and will be discretely worn by the user.

Task 3: Combine all development to create unified eye tracking library

Many applications are developed from eye tracking technology. To make programming 
more efficient for application programmers, we will create a unified eye tracking library 
which will provide an eye tracking hardware abstraction layer. Such a library would 
allow independent development of eye tracking technology and applications.

Task 4: Utilize eye tracking library to create input drivers

Utilizing the eye tracking library, we will create input device drivers to simulate the use 
of a mouse. We will also conduct research on creating new input methods with eye 
tracking concepts.

Task 5: Create prediction algorithms

Our research is not restricted to development of an input device to replace a mouse or 
keyboard; we would also develop prediction algorithms to aid the user in everyday 
computer interaction. Such prediction algorithms will aid the end user by having 
automatic scrolling, automatic menu pop ups, predicting if the user wants to switch to the 
background window, and more human-computer interaction which we will research 
further on once we reach this task.

Task 6: Create applications

For the eye tracking technology to be useful, it would need a set of applied software. A 
gaze analysis application would be developed to allow the study of user interfaces in the 
field of psychology, communication, and other departments at the University of Texas 
Pan American. Additional applications include an eye driven window manager and eye 
gesture based user interactions.

Schedule

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start Date</th>
<th>Finish Date</th>
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<tbody>
<tr>
<td>Design camera placement for data acquisition</td>
<td>1 Sept. 06</td>
<td>22 Sept. 06</td>
</tr>
<tr>
<td>Develop technique to measure the user’s point of gaze</td>
<td>25 Sept. 06</td>
<td>1 Nov. 06</td>
</tr>
<tr>
<td>Combine all development to create unified eye tracking library</td>
<td>2 Nov. 06</td>
<td>2 Dec. 06</td>
</tr>
<tr>
<td>Utilize eye tracking library to create input drivers</td>
<td>Dec 3. 06</td>
<td>7 Jan. 07</td>
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<tr>
<td>Create prediction algorithms</td>
<td>8 Jan. 07</td>
<td>8. Feb 07</td>
</tr>
<tr>
<td>Create applications</td>
<td>9 Feb. 07</td>
<td>9 Apr. 07</td>
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Qualifications and Experience
Our group members each possess a wide range of different skills which when combined makes us effective and corporative together.

Arm Suwaranaratan is the project leader and has a strong interest in HCI (human computer interaction). Arm brings a robust background in HCI research and image processing to the project. He previously has developed hardware drivers for the Winbond W83627THF sensor board for the Windows XP operating system and a kernel patch for ARP spoofing vulnerability for Linux kernel with proof of concept. His extensive programming experience will help drive software development.

Marcela Reyna is a lab consultant with the University of Texas Pan American where she has gained experience in working with groups and helping others. As a result, Marcela knows how to keep everyone focused and promote productivity. She is a hard worker who will put in the extra effort when learning new concepts. Her expertise in mathematics will be invaluable to the algorithm development of the project.

Javier Villarreal is currently employed with Smartcom Inc as Computer Technical Support. Javier understands how to communicate well with people because of his skill in dealing with customers. Javier has experience with UI design and development that will be useful in creating a friendly and intuitive interface for the software solution. His analytical nature and attention to detail will also help maintain and prevent errors during the lifetime of the project.

Budget
The budget for our research is shown below. The following equipment is not available from other departments and we will be modifying them.

<table>
<thead>
<tr>
<th>Number of Items</th>
<th>Item</th>
<th>Amount</th>
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<tbody>
<tr>
<td>6</td>
<td>Fire-I firewire monochrome cameras 640x480 at 30 fps</td>
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Total Cost: $2650