

ECE4007 Project Summary

Project Title	Augmented Communication Device	
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Semester	2009 Spring	Intermediate or Final
Project Abstract (250-300 words)	<p>Currently, most computer input devices like keyboards and mice require the user to be able to use their hands. The Augmented Communication Device is a small, lightweight, inexpensive, human interface device. It will enable persons with spinal cord injuries or other impairments that cause limited hand movement to control a computer cursor with head movements, and facial gestures. It will be designed to look similar in form to a Bluetooth headset for cell phones. An on-board microcontroller will use data obtained from an Inertial Momentum Unit (IMU) and an Optical Flow Sensor (OFS) to determine the appropriate movement of the cursor. Software will be written and implemented on the microcontroller to acquire and process IMU and OFS data. The IMU will track nodding and rotating of the head to guide the cursor. The OFS will be placed slightly below the temple, in line with the eyes and used to recognize eyebrow raises as left clicks, and wincing, i.e. closing eyes quickly and tightly, as right clicks. The software used for the OFS will be adapted from an open-source device, called the Wouse. The final product will be a prototype device that will cost \$170 to develop, whose capabilities will be demonstrated by playing a simple computer game.</p>	

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List codes and standards that significantly affect your project. Briefly describe how they influenced your design.	<p>The Augmented Communication Device will make use of the following standards for general electrical safety:</p> <ul style="list-style-type: none"> • OSHA 1910.335(a)(1)(iv): Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed energized parts • OSHA 1910.335(a)(1)(v): Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion • With the ground wire disconnected, the chassis leakage is limited to 100 uA and the patient lead leakage must not exceed 50 uA <p>The group decided to design a non-conductive casing for the device in order to meet these OSHA standards.</p> <p>The Augmented Communication Device will make use of the following standards for intra and inter device communication:</p> <ul style="list-style-type: none"> • USB HID (Human Interface Device) Class interface for mouse communication • Inter-Integrated Circuit (I2C) protocol between the Inertial Momentum Unit and the ARM microprocessor • Serial Peripheral Interface (SPI) protocol between the optical flow sensor and the ARM microprocessor and between the ARM processor and the USB controller <p>The following programming languages will be used for data processing and communication:</p> <ul style="list-style-type: none"> • C for all microcontroller operations, for instance obtaining data from the sensors, processing IMU data, communicating the cursor movements to the host computer • Python to interface with the Wouse library to process the data received from the microcontroller • USB protocol was chosen for the interface between the device and the computer due to its widely available documentation, ease of use and conventionality. All current computers come with USB ports.
List at least two significant realistic design constraints that applied to your project. Briefly describe how they affected your design.	<ul style="list-style-type: none"> • Cost: Limited budget of \$170 to design a prototype of the system. • Time: There is a temporal constraint on the setup time. The Wouse system uses a support vector machine algorithm, which requires training data to develop a model to classify different facial gestures. The training time might be as long as 10-15 minutes and must be collected on a per user basis.

<p>Briefly explain two significant trade-offs considered in your design, including options considered and the solution chosen.</p>	<ul style="list-style-type: none"> • Processing: The Augmented Communication Device would need to have a small response time for a seamless experience for the user. The response time is based on the processing of the Optical Flow Sensor data, mapping of the accelerometer data to cursor movements and the speed of communication between the device and the computer. We are proposing to do all processing on the microcontroller on the device. If this increases the lag beyond the proposed 300ms, we will consider the alternative of moving the processing from the microcontroller to the computer. • Wired vs Wireless: There was also a decision for the team to focus on a wired USB interface instead of transmitting a wireless signal. This allows for simplification of the system since USB would be able to provide onboard power. Consequently, the team does not need to focus on power management.
<p>Briefly describe the computing aspects of your projects, specifically identifying hardware-software tradeoffs, interfaces, and/or interactions.</p> <p><i>Complete if applicable; required if team includes CmpE majors.</i></p>	<ul style="list-style-type: none"> • Inputs <ul style="list-style-type: none"> ○ Head movement data using the IMU ○ Facial gestures like wincing and eyebrow raises using the OFS • Outputs <ul style="list-style-type: none"> ○ Cursor commands identical or identifiable by a Linux OS <p>An Arduino microcontroller will obtain data from both the IMU and an OFS using serial communication. It will then process the data to recognize head movement and facial gestures and send the computer a signal using the USB HID protocol to resemble a mouse. In case that the Arduino microcontroller is the bottleneck in the processing stage, the data will be loaded onto the user's host device and processed by custom software. The software created for the device will then send signals to move the cursor to the operating system.</p> <p>The program will largely use C with the Arduino libraries for interfacing, but USB HID software will be needed as well.</p>

ECE4007: International Program

(Only groups with one or more International Program participants need to complete this page)

Project Title	
Global Issues (Less than one page)	(10 point font, single spaced)