

ECE 445
SENIOR DESIGN LABORATORY
PROJECT PROPOSAL

Any-Surface Computer Stylus

Team #86

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Abstract

This project proposes the development of a stylus that can be used improve the quality and accessibility of digital drawing on desktop systems. Conventional computer mice are difficult to use as a drawing tool while alternatives like drawing pads are bulky, expensive, and often overkill for simple sketching tasks. The proposed device aims to combine the convenience of a computer mouse, including the ability to work on most surfaces, with the ergonomics of a pen. The implementation will involve fitting sensors into a ergonomic pen shape and creating a control module to read and convert sensor inputs as well as house any power converters. The expectation for success will be a reliable, cost-effective, and ergonomic tool that makes drawing on the computer easy for all.

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1 Introduction

1.1 Problem

The ability to draw quickly and reliably on a digital document used to be a luxury but is becoming more and more of a requirement. Physical paper becomes harder to find in offices and academia. Yet, the need for hand-drawings is still present. Tasks like signing and modifying documents, note taking, sketching ideas, and even some interviews require the ability to draw on a screen. The old fashion way was to print the original document, make the drawings with a pen, and then scan the document to send back to the computer. Now, touch-screen tablets have taken over academia, but they are large and very expensive tools that are an unnecessary luxury that many cannot afford. Artists solved this problem with the drawing tablet, a touch sensitive surface and an attached stylus. But these are still bulky, expensive, often require special software, and have a learning curve. There is yet to be a solution that is readily available that improves on the ergonomics of drawing with the convenience of a computer mouse.

1.2 Solution

Our product tackles these problems by offering a light-weight, ergonomic stylus that can be used to write on any surface. We want our stylus to instantly connect to a computer and operate with the sensitivity of a regular computer mouse. We're going to use an optical sensor to keep track of movement and a pressure or force sensor on the tip of the stylus so that it writes like a regular writing utensil. We will add an auxiliary button on the side for right click and a scroll wheel so that the pen has full control over the computer when in hand.

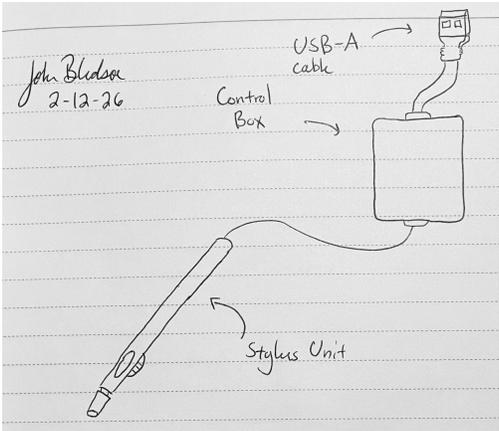


Figure 1: Visual Aid

1.3 High-Level Requirements

To deem our problem solved and our solution successful, we necessitate our product to be able to accomplish the following:

1. Writing speed test: We want our pen to be low latency enough to write as fast as a traditional pen and paper. We will quantify this by saying we want our stylus writing time for a given text to not increase by more than 25% of the time it would take with pen and paper.
2. Optical sensor range: In order for our stylus to work like a regular pen, we need the cursor to move along with the stylus when you pick it up to maintain spacial continuity with the page. We would like the sensor to have enough range to track the paper when the stylus tip is lifted at least 0.5 inches while keeping the optimal (non jittery) movement when close to the page.
3. Ergonomics and easy of use: We want our product to be easy to use and maneuver like a traditional pen or pencil. To accomplish this we are going to keep the stylus part of our product under 30 grams. This should allow for the expected ease of movement needed in a writing utensil.

2 Design

At a high level, the proposed solution is to use the existing software interaction of a standard computer mouse while changing the hardware and housing to have the functionality of a stylus. The stylus is meant to be pen-shaped and lightweight so it will contain only the necessary sensors. This is represented by the first block of the block diagram shown in Fig. 2. To handle the power and processing for the pen is a separated control unit, represented by block two.

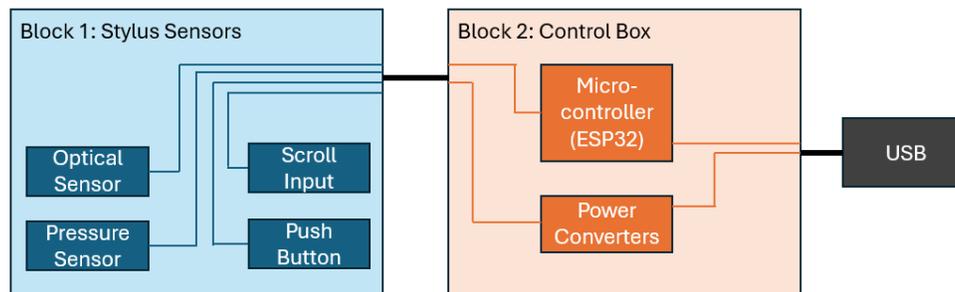


Figure 2: Block Diagram

2.1 Block 1 - Stylus Sensors

In order to keep the physical size of the stylus to a minimum, the stylus will hold only the necessary sensors. The sensors include an optical sensor, a pressure sensor, a push button, and a scroll input.

The optical sensor is responsible for tracking two dimensional movements and will also be the most difficult to implement given the variable height of the stylus off the surface and the need for precision. Traditional optical sensors used in mice are too rigid and will not work at any significant height off the table. Instead, an optical flow sensor could work.

The pressure sensor will detect contact with the surface. This information will be sent to the microcontroller which will have a threshold to output a left click and hold. The best option for pressure sensor are a pressure-dependent resistor which changes resistance with applied force. The other option is a mechanical conversion using a spring-loaded switch for the tip and hall effect sensor to convert it to an electrical signal.

The current design will also include two buttons for additional functionality. One simple push-button will serve as a right click and a scroll wheel for moving the page.

2.2 Block 2 - Control Box

All the sensor information will be sent to the control box where a microcontroller will process the incoming information and convert it to the appropriate mouse signals and send them back to the computer. For this job, an ESP32 will work. It has plenty of inputs for our analog signals, can operate an optical sensor, and has enough processing capability to handle all the sensor information at the same time.

Power will be supplied via USB at 5VDC. For any sensors or pins that may require a different voltage a DC-DC converter will also be needed. A regulator or buck converter can be used depending on power needs.

2.3 Design Considerations

The proposed design is a wired system. The stylus will be connected to the control box through a long flexible wire. This is for many reasons, but most important is keeping the stylus small. Removing the wire would require adding a battery, power converters, and wireless broadcasting system to the stylus. While technically possible, procuring small and sometimes custom made parts would be challenging and packing the pen with these parts and a separate custom mini PCB would take away from the light weight and ease of use of the product. Another concern we had was a potential delay in communication of the pen with the control box that could cause a small delay in physical movement to cursor movement which we think would have a major negative impact on the using experience.

2.3.1 Tolerance Analysis

Tracking the X and Y movement of the stylus is the most difficult task. The plan at this stage is to use an optical flow sensor. These sensors are typically used on drones to track their position above the ground and should work at a variety of distances above the surface. This should eliminate the need for an external pad, so long as the sensor can detect a change in the surface under it.

We figure that we need the stylus to be able to focus up to 0.5 inches away from the surface. We are looking into getting a sensor for that range or we might have to combine a sensor with a lens to modulate the range. This would require some mathematical calculation, but we can't do that calculation until we figure out the sensor we are going to use and how we are going to mount it in the stylus.

Personal preference, such as device sensitivity, can be controlled through the computer by changing mouse settings rather than add unnecessary inputs to the stylus system.

3 Ethics and Impact

3.1 Ethics

Any engineering project is required to comply to the IEEE code of ethics [1]. While the impacts and risks associated with creating or using our stylus are few, decisions should still be made with regard to human safety, privacy, and capability. The three most important IEEE codes we'll have in mind while creating and using our product are Sec I, codes 1, 2, and 5.

3.2 Safety

Besides taking our own safety into account when putting together the project, one concern that we have is the optical sensor used for tracking movement. The sensor is a laser that shoots a focused beam of light that could potentially cause harm if shined into someone's eye. Our sensor will probably be similar to that of a computer mouse but it could be more dangerous because our laser will need to be focused further from the point of emission to so that the stylus can track at a distance. We want to make a point to say that our stylus should be used responsibly and not shined up at anyone's eye.

While there is low risk at the low voltage required for this project, any power conversion should meet certain efficiency and thermal requirements. This ensures the device is not draining batteries if connected to a laptop and not heating up so much as to cause burns or start fires.

Privacy is another important factor when it comes to electronic devices. One advantage of choosing a wired vs a wireless design is having a secure communication channel so no information can be read from the mouse by any third party actors.

3.3 Impact

The impact of our project in societal and economic contexts will be pretty minuscule. While we hope our product could make people's lives more convenient, it's not something that's going to change society in any major way. We intend to be able to create our project very cheaply so that theoretically it would be affordable to people, but it's not exactly something that's going to change the economy in any way. Environmentally, our product also isn't going to be making that much of an impact. We will try to design the project to be as light weight as possible when it comes to resources but even if our product was commercialized, it wouldn't have that much influence on the environment.

References

- [1] IEEE. "IEEE Code of Ethics," Accessed: Feb. 10, 2026. [Online]. Available: <https://www.ieee.org/about/corporate/governance/p7-8>.