

HandMade

The final project for @pybae, @MikkelKim, @tsherlock, and @iancai.
Our team name is HandMade!

Our members:

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Pitch

There is a growing market in drawing tools, such as [Paper](#) and [Sketchpad](#). These tools don't seek to replace the power of heavy applications, such as PhotoShop, but instead seek to provide a simple interface to allow users to quickly sketch up their ideas.

There have been several burgeoning ideas in this region as well. [Rocketboard](#), which allows users to draw on a whiteboard to share thoughts in real time, [FlockDraw](#), and much more.

Our app seeks to do the same, but in a unique way.

Rather than relying on mice or touch surfaces for input, our app will take input from the user by a camera. By using real-time hand tracking, we can track the motions of the hand to simulate drawing on a virtual whiteboard.

We can come up with a set of gestures to represent each action:

- An index finger pointed to the camera will represent the drawing state.
- A palm moving will cause the current whiteboard view to move.
- A closing fist represents zooming out
- A opening fist represents zooming in

And these gestures are hypothetical as of the moment, and will likely changed based on user input.

Our end goal is to create a desktop application that relies on the laptop's camera as input and provides a virtual whiteboard that users can write on, zoom in, zoom out, move around, and share (if time permits) to other users.

Objectives

Objective 1: Preprocessing

- Compute background
- Background subtraction
- Convert to YCrCb
- Threshold on each channel
- Morphology (erode and dilate) on each channel
- Merge channels
- Bitwise and operator with original frame
- Threshold final image
- Morphology (erode and dilate) final image
- Gaussian Blur
- Result: A binary image of the hand with most background noise

Objective 2: Detect hand motion

- Contour extraction
- Polygon approximation
- Max inscribed circle and radius
- Find region of interest
- Convex hull
- Convexity defects
- K-curvature
- Min enclosing circle
- Result: Contours, convexity defects, and circles of the hand from Objective 1

Objective 3: Gesture Recognition (TBA)

- Simple heuristics to detect static gesture
- For example:
 - 0-1 fingers detected, then close palm
 - 4-5 fingers detected, then open palm
 - 1 finger detected and no thumb, then pointing
- More research to be done here
- Result: Coordinates of where the gesture is and a flag corresponding to the gesture

Objective 4: OpenGL Whiteboard

- Design a modular system for gesture recognition
- Link up the x, y coordinates to drawing on an OpenGL canvas
- Implement an interface for multiple brushes, colors, and the like
- Result: A GUI showing an OpenGL whiteboard (built on Qt as a backend)

Objective 5: HTML5 Canvas (optional)

- Link up the OpenGL whiteboard in step 4 to HTML5 Canvas
- Make the updating real time
- Optimize the speed
- Launch on a server (most likely heroku)
- Result: Real time mirroring to a server of the image

Schedule

Our implementation will likely be in C++, OpenCV, and OpenGL. Our goal for the final project is to have a working demo of the whiteboard, with the above gestures implemented, and if time permits, present the whiteboard in real time online.

13 Nov:

- Objective 1

20 Nov:

- Objective 2

2 Dec:

- Objective 3
- Objective 4
- Objective 5 (maybe)

Proposal 1

We quickly realized that our initial goals were quite ambitious in terms of the scheduling of the project.

After doing some research into the field, we've come up with the above scheme for accomplishing the goal.

There are three main objectives that we aim to accomplish.

1. Preprocessing
2. Hand detection
3. Gesture recognition

Preprocessing includes the background subtraction, threshold and finding the hand in binary.

Hand detection represents actually finding the hand using a variety of techniques.

Gesture recognition represents associating a sequence of static frames to the gesture.

As for what we've accomplished so far, we did the entirety of the first objective. The current code is pushed up to the github.

The code itself works for a clean background (such as a whiteboard or a solid color wall), and noise detection will be a recurring focus throughout our project.

We mainly described the process in the objective above.

In terms of the code itself, we have a c++ make build with several classes and unit tests. There is definitely more to come in what we can accomplish.

The trello is the best way to see what we've accomplished.

The paper that we've been following closely is "Hand tracking and gesture recognition system for human computer interaction using low cost hardware".