

Title: Airbrush: The Digital Finger Painting Experience

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Problem statement: In this project, we will build a virtual canvas where anyone can draw using a colored marker on hand. A virtual canvas with a white background will be created with the option to select colors and clear the canvas. We will use the camera to capture a live video stream, and then use the movement of our hand as a colored marker to draw on a virtual canvas. When we move the marker onto the predefined colors, the stroke color of the marker will be changed. If we put the marker on the "Clear All" option, the canvas will be cleared. Each frame on the stream will be converted into HSV color space and a mask will be generated. We will use morphological operations to preprocess the mask for detecting the marker correctly. The movement of the marker will be detected with a contour and the center point of the contour will be used to draw/put color on the canvas.

Related work: Object detection and movement tracking in videos is a very common problem that has been studied for a long time which has applications in different fields including surveillance systems, robotics, etc.. Li et. al. [1] proposed a statistical model in HSV space, a multi-criteria decision, a speedup morphological filter, and a connected components labeling algorithm to accurately segment objects in a video under varying lighting and shadows. Summerah [2] presents a strategy to automate the process of recognizing and tracking objects using color and motion in real-time using HSV color space values and OpenCV, resulting in an accuracy of 90% in tracking objects. Ray et. al. [3] proposed a novel approach to an automated visual surveillance system that efficiently detects and tracks moving objects in a video by compensating for pseudo-motion in the background, modeling the background, detecting moving objects through differences, refining object regions, attributing objects, and tracking them with a Kalman filter. Sangale et. al. [4] uses mean shift and particle filters for real-time object detection and tracking in video sequences while Hedayatullah et. al. [5] tracks objects by combining the object's color (using HSV components) and texture features (using Local Binary Pattern). Kang et. al. [6] also uses HSV color space with ROI random sampling and similarity comparison to detect object motion for robot grasping. In this project, we will use object movement tracking using HSV color space and different morphological operations to track the movement of a marker on a variable background and use the path coordinates to draw on a virtual canvas.

Proposed work: Here is a more detailed step by step description of our proposed task:

- **Environment:** We will need Python, OpenCV, and Numpy. These libraries will help us capture the live stream from the camera, convert the frames into the HSV color space, and perform various image processing operations to accomplish our goal.
- **Create a virtual canvas:** Using OpenCV, we will create a white background as the virtual canvas. The size of the canvas will be based on the captured video stream.
- **Live stream and HSV color space:** We will use OpenCV's VideoCapture class to start the camera feed and capture the live stream. We will convert each frame from the camera stream into the HSV color space. The HSV color space is more suitable for color-based image processing tasks, as it separates the hue, saturation, and value components of the image. This will help us remove noise, detect the marker movement easily.
- **Generate a mask:** We will use some predefined HSV values to generate a mask. The mask will be used to detect the color of the marker. We will apply morphological operations, including dilation and erosion, to the mask to remove noise and improve the accuracy of the marker detection. This step will also help to remove small and unwanted regions from the mask.
- **Detecting the marker movement and drawing:** We will find the contour of the marker in each frame to detect the movement of the marker. We will find the contours of the regions in the mask that correspond to the marker, and use the center point of the contour to draw on the virtual canvas.
- **Change color and clear the canvas:** An option to clear the canvas and change color by detecting the marker placement over the "Clear All" and/or predefined color options. We can do this by checking the position of the marker and if it's over the "Clear All" option, we can set the virtual canvas to a white background or check if it is over any predefined color and change the stroke color accordingly.
- **Repeat the steps:** You will repeat these steps continuously to draw on the virtual canvas in real-time as the marker moves. You will also need to check for the termination of the camera feed and handle it properly.

This is a more in-depth explanation of the steps involved in building a virtual canvas using a colored marker.

References:

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