1. **Proposed Project**
    a. **What is the application domain / area you are proposing to work in?**

    The proposed project focuses on the processing of images in the YUV format. Specifically, the project aims to manipulate individual pixels by changing their positions and adjusting their RGB values. Totally, there are 20 different types of image operations, due to team size and time constraints, our group will likely concentrate on implementing a subset of these operations.

    b. **What is the proposed computation problem / algorithm(s) you intend to tackle?**

    The computational problem we intend to tackle involves implementing algorithms for specific image processing techniques on YUV-formatted images. Specifically, we are interested in diving into three main types of image operations:

    i. Edge detection: This operation identifies the edges within an image to highlight areas of rapid intensity change. This is often a crucial preprocessing step for some computer vision tasks. To detect an edge of the image, the intensity of the center pixel (E) in the figure 1 is changed to (-A-B-C-D+8*E-F-G-H-I) by applying the filter on it.

Filter					Original Pixels				
X	X	X	X	X	X	X	X	X	X
X	-1	-1	-1	X	X	A	B	C	X
X	-1	8	-1	X	X	D	E	F	X
X	-1	-1	-1	X	X	G	H	I	X
X	X	X	X	X	X	X	X	X	X

Figure 1: The original pixels and its filter

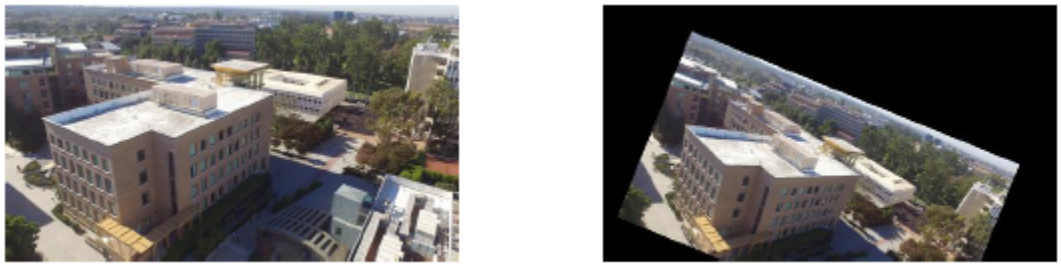
(a) Original Image (b) Edge Image

Figure 2: An image and its edge counterpart

ii. Rotate and Zoom: This operation rotates and zooms the image. It can be essential for image alignment and scale normalization. To correctly rotate and adjust the scale of the images, we should apply the rotation matrix to get the new x and y coordinates. Alpha is the scale factor and CxCy are coordinate of the rotation center.

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta/\alpha & -\sin\theta/\alpha \\ \sin\theta/\alpha & \cos\theta/\alpha \end{bmatrix} \begin{bmatrix} x - C_x \\ y - C_y \end{bmatrix} + \begin{bmatrix} C_x \\ C_y \end{bmatrix}$$

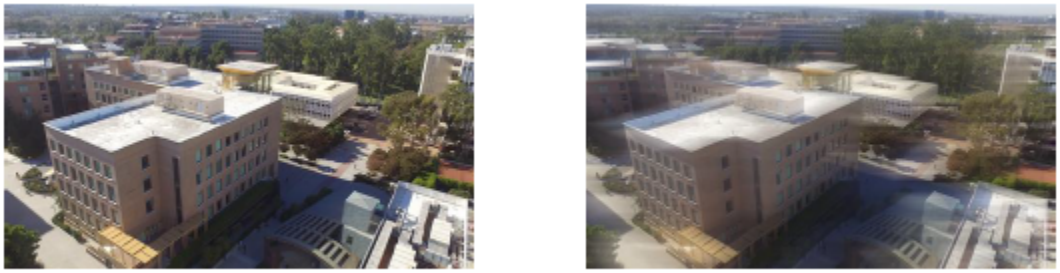
Figure 3: Rotation matrix



(a) Original Image (b) Rotated Image

Figure 4: An image and its rotated and zoomed counterpart

iii. Motion Blur: This simulates the effect of movement on the image, often used for artistic purposes or to mimic real-world capturing conditions where motion occurs. Similarly, the idea is also to take a pixel and combine it with the surrounding pixels by doing some special calculations.



(a) Original image (b) blurred image with motion blur=40

Figure 4: An image and its motion blur counterpart

c. **What is the code base you will be using as a baseline to check for correctness and compare performance against?**

   Our code base will be an unoptimized but correct version of the image processing algorithm we already implemented. This will serve as our ground truth for the correctness. After we complete the fast code implementation of these algorithms, we will verify their correctness by comparing the intensity values at some coordinates to those produced by the baseline implementation.

d. **Describe the size(s) of the dataset(s) you may need, and how you are getting the dataset(s).**

   The dataset we require consists of the dimensions (width and height) of the input YUV images along with the corresponding RGB values for specific coordinates. Typically, the RGB values will range from 0 to 255. We have already written some functions to handle this data.

e. **What architecture do you intend to target?**

   We are going to use the ECE cluster (ece006.ece.local.cmu.edu) for this project.

2. **Work Division**

   Group member: Zijie Huang, Ningyan Zhang, Yueze Cao

   Each member will take care of one case of image filter.

3. **Date/Time of next meeting**

   6:00 PM - 7:00 PM Sept 27

   6:00 PM - 7:00 PM Oct 4

   6:00 PM - 7:00 PM Oct 11