MAS2011 Introduction to Visual Media Programming 2022-02 Midterm Exam

Subjects: Rigid motion; Rotation & Translation; Kinematics; python programming

(1) A and B are 2x2 matrices given as:

$$A = \begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix} \quad B = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$$

Calculate the following two matrix multiplications:

(1.1) C = A B

(1.2) D = B A

(2) You are given a 2D point P = (2, 0). What is the coordinate vector Q if you apply rotation by 30 degrees? Compute it by using the equation: Q = R(θ=30) P

(3) Describe a python function to make the set of vertices of a regular N-gon by sampling N points around the circle of unit radius.

```
def makeRegularNgon(N):
    vertices = []
    # provide your code here
    return vertices   # vertices is a numpy array of shape (N, 2)
```

(4) Describe a python function to obtain a list of every pixel coordinate connecting two end points (x0, y0) and (x1, y1):

```
def getLineCoordinates(x0, y0, x1, y1):
    coordinates = []
    # your code here
    return coordinates
```

Here, the variable **coordinates** is a numpy array of shape (N, 2) where N is the number of points. This process is called 'rasterization'.

(5) Following is a part of the main() function to draw a star shape in the canvas image:

V = makeRegularNgon(5)

drawStar(canvas, V)

Describe the python function **drawStar()** to draw a star shape using vertices of a regular pentagon. You may assume that **drawLine(canvas, p, q)** has already been defined, where p & q are two end points of the line segment connecting p and q.

*You are given vertices of a rectangle defined by: P = np.array([[0,0], [6, 0], [6, 2], [0, 2]]). Use this for the problems from (6) to (10).

(6) What is the 3x3 matrix for rotation of 60 degrees?

(7) Compute the 3x3 matrix H that (1) rotate P by 45 degrees and (2) translate by (3, 1). Sketch the result of this transformation; it doesn't have to be 100% exact but should be good enough.

(8) Now (1) translate P by (3,1) and (2) rotate by 30 degrees. What is the transformation matrix H? Provide a sketch of the result of this transformation.

(9) Provide a python code to draw a windmill of 4 wings, rotating 5 degrees per frames.

(10) Provide a python code to animate a clock. Because we have only one rectangle, the two needles indicating hour and minute have the same length. Use red color for minute-needle and green color for hour-needle. The animation must be such that when the minute-needle rotates 360 degrees, the hour-needle rotates 15 degrees. The clock starts from 12 o'clock. Describe the **main()** function only.