CMPUT414 Lab Excercise 2

Due date Jan 27, 2019

1 3D Transformations 60%

Write the transformation matrices for:

- The transformation matrix which can transform the set of points $\mathcal{A}$ to $\mathcal{B}$, where $\mathcal{A}$ and $\mathcal{B}$ are as follows:

$$\mathcal{A} = \{(0,0,0),(1,1,1),(2,2,2),(3,3,3)\},$$
$$\mathcal{B} = \{(4,-5,6),(5,-4,7),(6,-3,8),(7,-2,9)\}$$

- The transformation matrix which can transform the set of points $\mathcal{A}$ to $\mathcal{B}$, where $\mathcal{A}$ and $\mathcal{B}$ are as follows:

$$\mathcal{A} = \{(1,1,1),(2,2,2),(3,3,3),(4,4,4)\},$$
$$\mathcal{B} = \{(1,2,3),(2,4,6),(3,6,9),(4,8,12)\}$$

- The transformation matrix which can transform the set of points $\mathcal{A}$ to $\mathcal{B}$, where $\mathcal{A}$ and $\mathcal{B}$ are as follows:

$$\mathcal{A} = \{(5,5,1),(3,1,1),(4,3,1),(2,-1,1)\},$$
$$\mathcal{B} = \{(-1,7,1),(1,3,1),(0,5,1),(2,1,1)\}$$

Tips: You can either draw points manually, or using a geometry software package to find the correlation between points in $\mathcal{A}$ and $\mathcal{B}$ (e.g. Geogebra `http://app.geogebra.org/3d/`).

2 Experiments 30%

The image below consists of a large number of points with color, called "pixels". When we draw all these pixels, we see the image. Now we have a image of a "smile" and the following Matlab code draw all the pixels in 3D space to show the image. Can you modify the program to separately transform the image by the transformation matrices computed captured above?

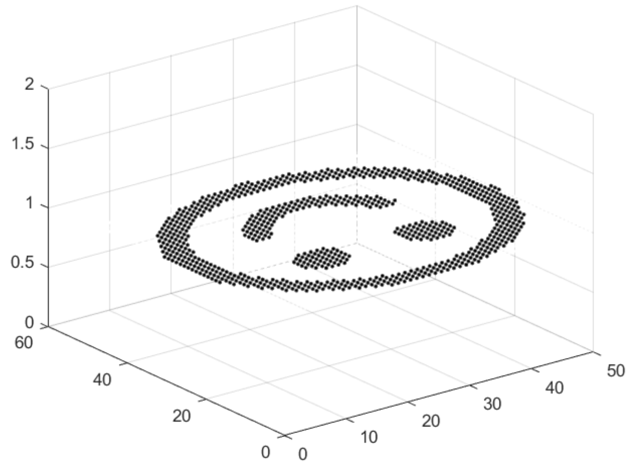
```
clear all
close all
clc


im = double(imread('./smile.png'));

[row_im column_im] = size(im);

figure
set (gcf,'Color',[1 1 1])

for x = 1:column_im
    for y = 1:row_im
        if im(y,x) == 255
            plot3(x,y,1,'w.')
            grid on
        else
            plot3(x,y,1,'k.')
        end
        hold on
        drawnow
    end
end
```

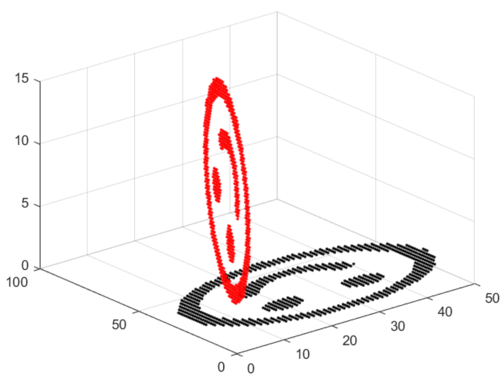


3 Advance 10%

In a real application we can only observe the positions of points before and after the transformation. Therefore, how to capture the transformation matrix based on these positions becomes an interesting problem to solve. This is closely related to the issues of image registration, 3D reconstruction of computer vision. Let us assume that we already have the positions of points before and after transformation, which are denoted as $\mathcal{A}$ and $\mathcal{B}$.

- Could you capture the transformation matrix between the points $\mathcal{A}$ and $\mathcal{B}$(an approximate solution is also fine) ?.
- Actually, $\mathcal{A}$ consists of points of the image "smile" in the previous experiment. Transform the image by the transformation matrix you captured, the visual results should be look like the figure shown below:

$$\mathcal{A} = \left\{ \begin{array}{ccc} (41, & 39, & 1), \\ (46, & 21, & 1), \\ (6, & 11, & 1), \\ (46, & 25, & 1), \\ (32, & 32, & 1), \\ (4, & 36, & 1), \\ (15, & 16, & 1), \\ (28, & 37, & 1), \\ (47, & 31, & 1), \\ (47, & 36, & 1), \\ & \vdots & \end{array} \right\} \mathcal{B} = \left\{ \begin{array}{ccc} (28.6, & 77.8, & 12.2), \\ (20.6, & 64.3, & 11.4), \\ (7.6, & 18.3, & 2.4), \\ (22.6, & 68.3, & 11.8), \\ (23.3, & 62.7, & 9.7), \\ (19.7, & 41.5, & 4.5), \\ (11.9, & 31.4, & 4.7), \\ (25.0, & 64.1, & 9.4), \\ (25.8, & 75.2, & 12.6), \\ (28.3, & 80.2, & 13.1), \\ & \vdots & \end{array} \right\}$$



Tips: You can use any programming language to draw the figure, but I personally encourage you to use Matlab, which should make it easier to draw the figure, transform the points or analyze the pattern.