Lab 11

Speech and Image Processing

Group assignment up to 3 students per group.

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Question 10 marks

Linear transformations like translation, rotation, scaling etc. can be applied on images by multiplying the image pixels by a 3x3 matrix

For translation of a pixel (x,y) by distance dx,dy pixels. Origin is the top left corner of the image. New coordinates are obtained by multiplying input coordinate vector with transformation matrix

$$\begin{vmatrix} x' \\ y' \\ 1 \end{vmatrix} = \begin{vmatrix} 1 & 0 & dx \\ 0 & 1 & dy \\ 0 & 0 & 1 \end{vmatrix} \begin{vmatrix} x \\ y \\ 1 \end{vmatrix}$$

For rotation by angle θ

$$\begin{vmatrix} x' \\ y' \\ 1 \end{vmatrix} = \begin{vmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{vmatrix} \begin{vmatrix} x \\ y \\ 1 \end{vmatrix}$$

For scaling of image by Sx, Sy

$$\begin{vmatrix} x' \\ y' \\ 1 \end{vmatrix} = \begin{vmatrix} Sx & 0 & 0 \\ 0 & Sy & 0 \\ 0 & 0 & 1 \end{vmatrix} \begin{vmatrix} x \\ y \\ 1 \end{vmatrix}$$

Write a MATLAB/Octave *.m file script that calculates a transformed image B, given a transformation matrix and an input image A

```
# Start of MATLAB/Octave code below

A=imread('cars.jpg');
A=double(A)/255;

# transformation matrix is T
theta=0.5
T=[cos(theta) -sin(theta) 0; sin(theta) cos(theta) 0; 0 0 1]

figure;
imshow(A,[]);

[...rest of the code to calculate the transformed image B...]
```

Hint: In this problem, given the (x',y') coordinates in the "transformed" image, we need to calculate the "original" coordinates (x,y)

For calculating the colour values at non-integer pixel coordinates, use round() function

Deliverables:

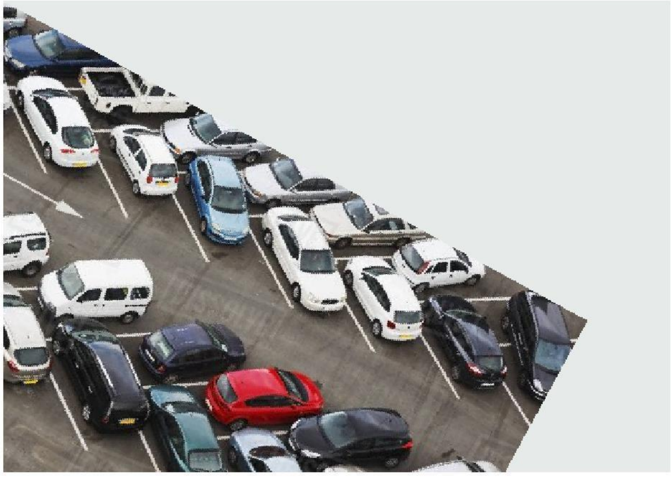
MATLAB/Octave code file ***transform1.m***

Original image e.g. ***cars.jpg***. The image should be different for each group.

Translated image ***translated.jpg*** by some offset dx,dy pixels
Rotated image ***rotated.jpg*** by some angle theta
Scaled image ***scaled.jpg*** by some factors Sx,Sy

<u>Example</u>
Input image cars.jpg

Rotated image rotated.jpg by angle 0.5 radians



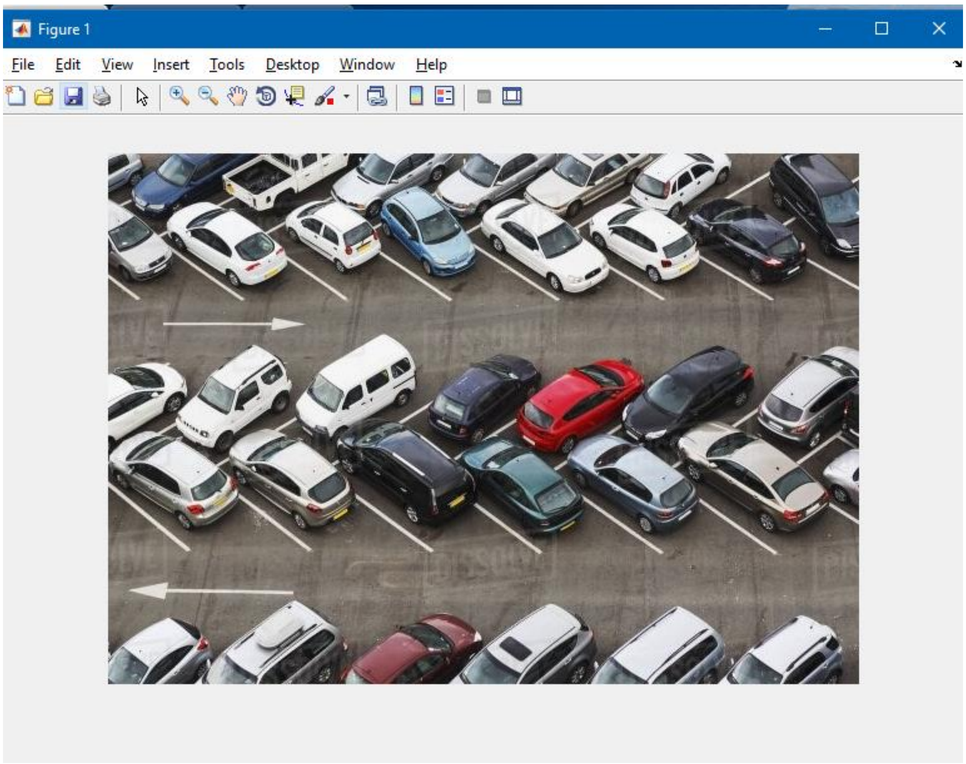
Solution:

```
close all;
imageCars=imread('cars.jpg');
%double image values
imageCars=double(imageCars)/255;

% here transMatrix is transformation matrix
val_theta=0.5;
transMatrix=[cos(val_theta) -sin(val_theta) 0; sin(val_theta)
cos(val_theta) 0; 0 0 1];

figure;
imshow(imageCars,[]);
%B=zeros(tempi(1,1),tempi(1,2),3);
tempi = size(imageCars);
B = zeros(tempi (1,1),tempi (1,2),3);
for i = 1:tempi(1,1)
  for j =1:tempi(1,2)
    B(i,j,:)=[i;j;1];
  end
end

C=zeros(tempi(1,1),tempi(1,2),3);
for i=1:tempi(1,1)
  for j=1:tempi(1,2)
    C(i,j,:)=transMatrix*permute(B(i,j,:),[3,2,1]);
  end
end
C=round(C);

output=zeros(tempi);

tempi2 = size(C);
for i=1:tempi2(1,1)
  for j=1:tempi2(1,2)
    if C(i,j,1:2)>0 && C(i,j,1)<=tempi(1,1) && C(i,j,2)<=tempi(1,2)
      output(C(i,j,1),C(i,j,2),:)=imageCars(i,j,:);
    end
  end
end
figure;
imshow(output,[]);

% transformation matrix is transMatrix
dx=40; dy=20;
transMatrix=[1 0 dx; 0 1 dy; 0 0 1];

C=zeros(tempi(1,1),tempi(1,2),3);
for i=1:tempi(1,1)
  for j=1:tempi(1,2)
    C(i,j,:)=transMatrix*B(i,j,:)';
  end
end
```

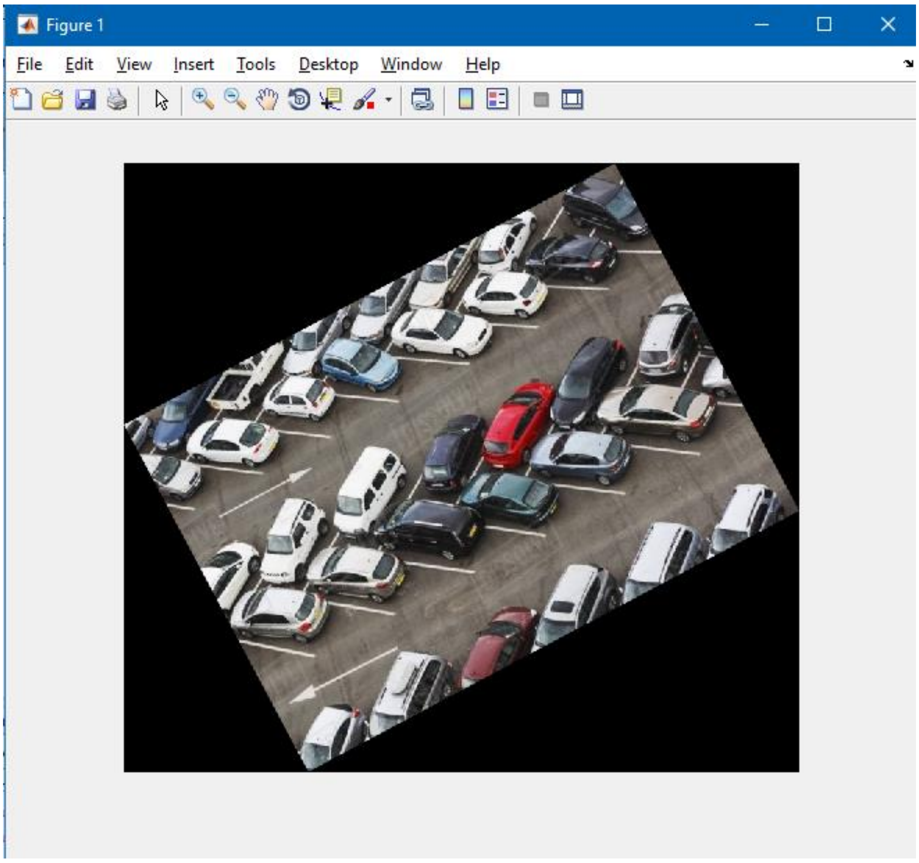
```
C=round(C);
output=zeros(tempi);
tempi2 = size(C);
for i=1:tempi2(1,1)
  for j=1:tempi2(1,2)
    if C(i,j,1:2)>0 && C(i,j,1)<=tempi(1,1) && C(i,j,2)<=tempi(1,2)
      output(C(i,j,1),C(i,j,2),:)=imageCars(i,j,:);
    end
  end
end
figure;
imshow(output,[]);

% transformation matrix is transMatrix
Sx=0.5; Sy=0.5;
transMatrix=[Sx 0 0; 0 Sy 0; 0 0 1];

C=zeros(tempi(1,1),tempi(1,2),3);
for i=1:tempi(1,1)
  for j=1:tempi(1,2)
    C(i,j,:)=transMatrix*B(i,j,:)';
  end
end
C=round(C);
output=zeros(tempi);
tempi2 = size(C);
for i=1:tempi2(1,1)
  for j=1:tempi2(1,2)
    if C(i,j,1:2)>0 && C(i,j,1)<=tempi(1,1) && C(i,j,2)<=tempi(1,2)
      output(C(i,j,1),C(i,j,2),:)=imageCars(i,j,:);
    end
   end
end
figure;
imshow(output,[]);
```

OUTPUT

1. **Original**



2. Rotated



3. Translated

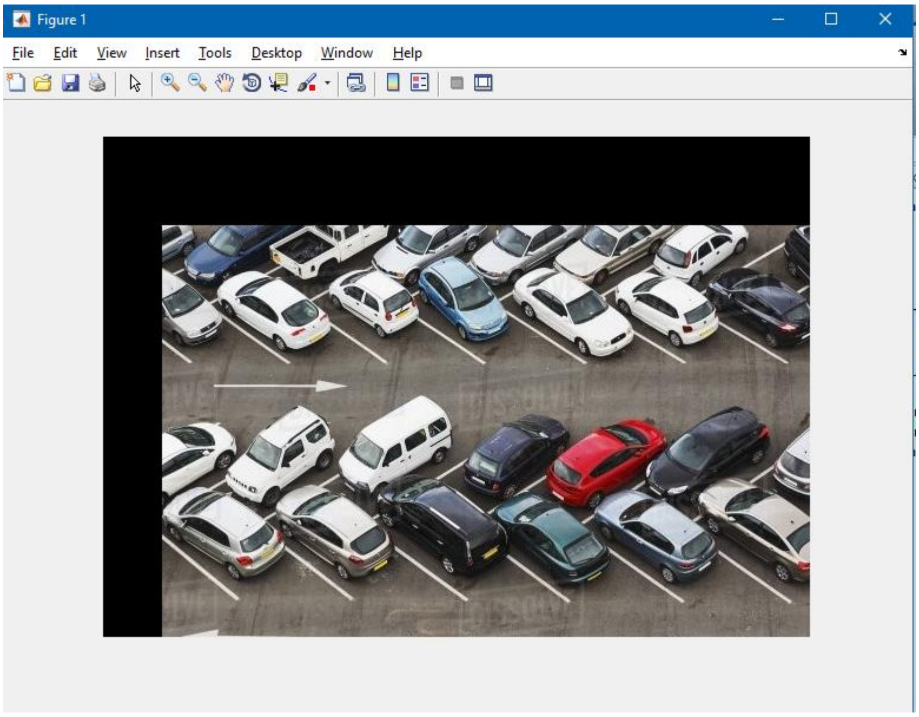


Figure 1
File Edit View Insert Tools Desktop Window Help

4. Scaled

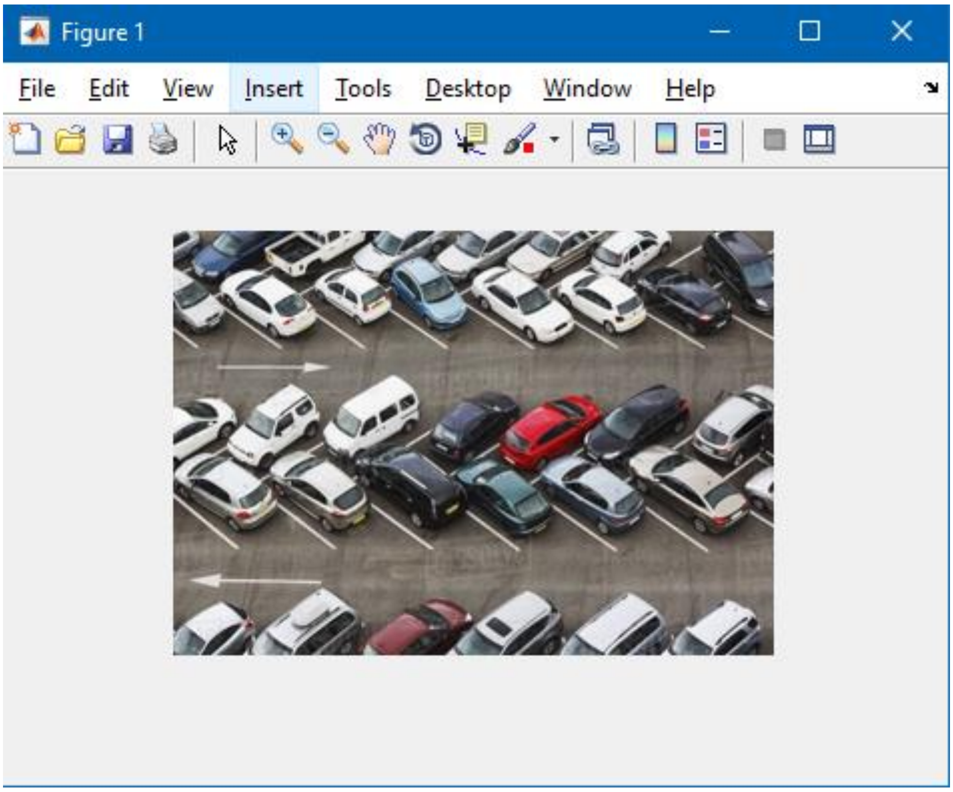


Figure 1
File Edit View Insert Tools Desktop Window Help