Problem 5

(a) As there are 1053 grass images and 250 cheetah images, a reasonable estimate of the prior probabilities would be -

$$P(\text{cheetah}) = \frac{250}{250+1053} = 0.1909$$
$$P(\text{grass}) = \frac{1053}{250+1053} = 0.8081$$

(b) Feature selected for the given task is the index of the second largest co-efficient by magnitude. Given training data is processed to extract the given index. This is plotted on a histogram with a bin count of 64 and bin size of 1 to obtain the following class conditional probability distribution-

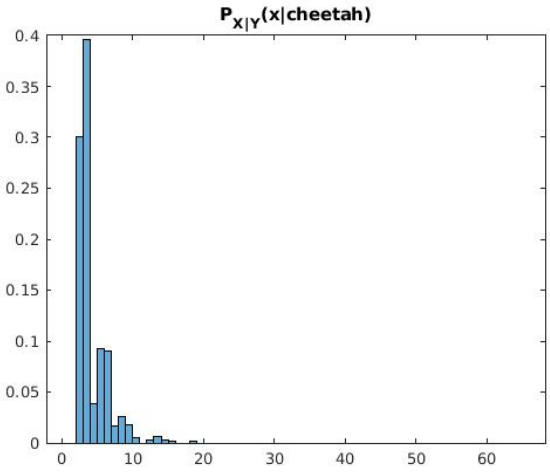


Figure 1: Cheetah

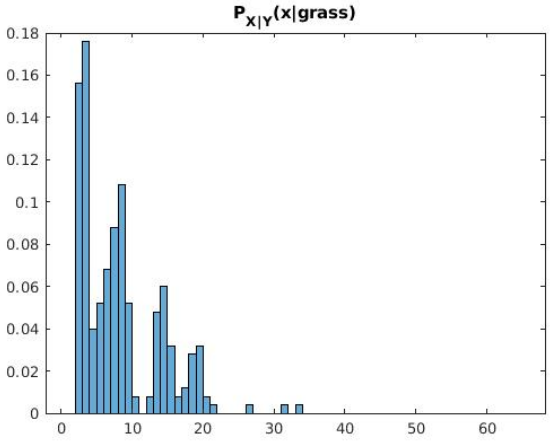


Figure 2: Grass

(c) To segment the image into cheetah or grass, following steps are performed -

(a) A sliding window of size 8X8 and stride 1 is used over the image.

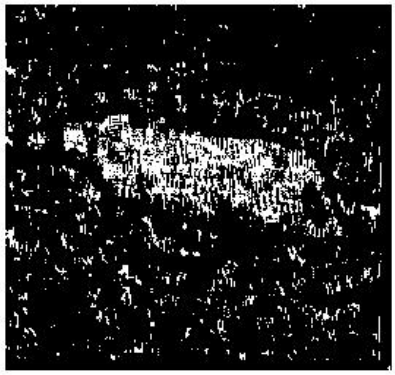
(b) For each window, the DCT is calculated.

(c) This in turn is used to get the feature used i.e. index of second largest co-efficient.

(d) This feature is used to calculate the class conditional probability which is used to get the posterior probability of the 2 classes.

(e) Based on the higher probability value, the pixel is classified as cheetah or grass

(f) A padding of 7X7 is used to get the same resolution of the output mask.



(d) The probability of error by the following formula -

$$P(\text{error}) = \frac{\text{No. of mislabeled cheetah}}{\text{No. of cheetah in GT}} \times P(\text{cheetah}) + \frac{\text{No. of mislabeled grass}}{\text{No. of grass in GT}} \times P(grass)$$

$$P(\text{error}) = \frac{2593}{13209} \times 0.1909 + \frac{8929}{55641} \times 0.8081$$

$$P(\text{error}) = 0.1726$$

MATLAB Code

```
clc;
clear all;

% Load training data
load('TrainingSamplesDCT_8.mat');

%%  5a)
% Calculate a-priori probability
pF = size(TrainsampleDCT_FG,1)/(size(TrainsampleDCT_BG,1) ...
    + size(TrainsampleDCT_FG,1));
pB = 1 - pF;

% Print the a-priori probabilities
disp("Prior probability of cheetah is ")
disp(pF)
disp("Prior probability of grass is ")
disp(pB)

%% 5b)
% Extract index of second largest element
[~,trainBG] = sort(abs(TrainsampleDCT_BG),2,'descend');
trainBG = trainBG(:,2);
[~,trainFG] = sort(abs(TrainsampleDCT_FG),2,'descend');
trainFG = trainFG(:,2);

% Calculate class conditional probability distribution for feature
figure();
hBG = histogram(trainBG, 64, 'BinEdges', (1:65), ...
    Normalization = 'probability');
hBG.Parent.Title.String = 'P_X_|_Y(x|cheetah)';
figure();
hFG = histogram(trainFG, 64, 'BinEdges', (1:65), ...
    Normalization = 'probability');
hFG.Parent.Title.String = 'P_X_|_Y(x|grass)';

%% 5c)
% Predict mask for test image
img = imread('cheetah.bmp');
mask = zeros(size(img));
error = zeros(size(img));
img = im2double(img);
img = padarray(img,[7,7],0,'post');

% Slide a 8X8 window over the image, calculate its DCT
   coeffecients. Select
% the index of 2nd largest value as the feature to calculate
```

```
    posterior
% probabilities.
zigZagIdx = readmatrix('Zig-Zag Pattern.txt');
for i = 1 : 255
    for j = 1 : 270
        block = img(i:i+7, j:j+7);
        dctF = abs(dct2(block));
        fIdx(zigZagIdx(:)+1) = dctF(:);
        [~,idx] = sort(fIdx, 2, 'descend');
        f = idx(2);

        % Make decision based on posteriror probability
        error(i,j) = hFG.Values(f);
        if(hBG.Values(f)*pB < hFG.Values(f)*pF)
            mask(i,j) = 1;
            error(i,j) = hBG.Values(f);
        end
    end
end
figure();
imshow(mask);

%% 5d)
% Probability of error
gTruth = im2double(imread('cheetah_mask.bmp'));
nCheetah = nnz(gTruth);
nGrass = nnz(1 - gTruth);
nMislabeledCheetah = nnz((mask-gTruth)>0);
nMislabeledGrass = nnz((mask-gTruth)<0);
pError = nMislabeledGrass/nGrass*pB + nMislabeledCheetah/nCheetah*
    pF;
disp('Probability of error')
disp(pError)
```