IMAGE PROCESSING SYSTEM FOR LEATHER DEFECT IDENTIFICATION

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ABSTRACT

The defects on a leather surface may be caused by the poor material handling process during the production and manufacturing stages. It is essential to eliminate the natural variations and artificial injuries on the leather surfaces, in order to control the quality of the products and achieve customer satisfaction. To date, the visual inspection of the leather defects is performed manually by human operators. Thus, this study aims to introduce an automatic defect detection technique by employing a deep learning method. Specifically, the proposed method consists of two stages: classification and instance segmentation. The former stage distinguishes whether the piece of the leather sample contains a defective part or not, whereas the latter is to localize the precise defective location. To accomplish the tasks, the dataset is first collected under a proper laboratory environment.

The purpose of this self study is to use the image processing to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image.

INTRODUCTION

Leather defects are imperfections occurring in the grain surface or surface of the hide or skin, which ultimately result in the unsightly appearance and weakness of the resultant leather. Defects that appear in the finished leather are the result of damage to the raw skin, poor storage or improper processing during manufacturing. Dye transfer from leather is the result of insufficient colour fixation. For example, it can be caused by excessively concentrated dyes or insufficient washing after the dyeing stage. If the colour concentration is too high, bronzing can also occur.

In the liming process, excessive contact with fresh air can cause liming stains on the grain side of the leather. Irregular blood stains are caused by lack of drainage of the salt liquor after the preservation of the hides by salting. Colour defects can occur if the applied colouration does not cover uniformly, especially on already damaged areas. Fat marks on leather occurs where leathers have a high fat content, such as sheep leather. Tannin stains are caused by uneven concentration of the tanning agent in the leather production. Basically leather is the skin of animals after it is treated to many processes that refine it and beautify it. Below are some examples, which are typical in practice and make the leather partially unusable and cause higher waste.

Many of the skin damages are not detectable on the rawhide. They only become apparent after the first processing stages in the tannery.

Barbed wire scars and scratches:- Animals can incur a whole range of scars and scratches caused by contact with sharp objects, such as thorns or branches. The number of scars, their length, width and spread across the skin are all factors that determine the extent of the use of such leather.

Pitchfork injuries:- Pitchfork injuries, , are caused by prodding the animals with sharp objects. They are also known as goad marks.

Warts:- Cattle get warts, just like humans. warts deteriorate the skin quality.

Horn scratches and blows:- Injuries from horn occur during bullfight and leave significant scar .

Surgical scar:- Animals can also have surgical scars which are visible on the leather.

Neck wrinkles –

Creases:-They occur in cattle in the neck and abdomen, where the connective fibres are longer.

Insect bites:- Tick bites and stings of other insects appear as small surface damages on the skin.

Image processing which is a low level process reduce noise , does contrast , enhancement , image sharpening .Then image analysis done which is a mid level process . It does Segmentation & Classification . Then there is vision derived which is a high level process . It is making sense of an ensemble of recognized objects .

EFFECTIVE MATLAB APPLICABILITY:-

Color-Based Segmentation Using K-Means Clustering:-

K-means clustering aims to partition data into k clusters in a way that data points in the same cluster are similar and data points in the different clusters are farther apart. Similarity of two points is determined by the distance between them. The similarity measure is at the core of k-means clustering. The k-means clustering algorithm attempts to split a given anonymous data set (a set containing no information as to class identity) into a fixed number

(k) of clusters. The resulting classifier is used to classify (using k = 1) the data and thereby produce an initial randomized set of clusters. The problem is computationally difficult (NP-hard); however, efficient heuristic algorithms converge quickly to a local optimum. K-Means clustering tends to find clusters of comparable spatial extent, while the Gaussian mixture model allows clusters to have different shapes .

PROCEDURE:- First the image is read from graphic file & then RGB is converted into CIE 1976 L*a*b* & then the image is converted into single precision colors .The Clustering thus made are repeated three times to avoid local minima . After it , the K-Means Clustering based image segmentation is done in which image is labelled by Cluster Index and then masking is done for each cluster . L*a*b*provides sufficient precision for most computation task & then scaling the range of array elements & binarizing them to 2-D grey scale image to finally obtain the final image .

CASE 1:- WRINKLES ON LEATHER

PROGRAM

```
A = imread('MM4.jpg');  %Read image from
                         graphic file

imshow(A); pause(20);

lab_A = rgb2lab(A);    %Convert RGB to CIE
                       1976 L*a*b*

ab = lab_A(:,:,2:3);

ab = im2single(ab);     %Convert image to
                         single precision

nColors = 3;            % repeat the
                        clustering 3 times to
                        avoid local minima

pixel_labels =
imsegkmeans(ab,nColors,'NumAttempts',3);
                        %K-means clustering
                        based image
                        Segmentation

imshow(pixel_labels,[]);
pause(20)
title('Image Labeled by Cluster Index');
mask1 = pixel_labels==1;% Gives pattern with
                         specified display
                         name

cluster1 = A .* uint8(mask1);
imshow(cluster1);pause(20);
title('Objects in Cluster 1');

mask2 = pixel_labels==2; % Gives pattern
                          with specified
                          display name

cluster2 = A .* uint8(mask2);
imshow(cluster2);
pause(20);
title('Objects in Cluster 2');
mask3 = pixel_labels==3; % Gives pattern
                          with specified
                          display name

cluster3 = A .* uint8(mask3);
imshow(cluster3);pause(20);
title('Objects in Cluster 3');
L = lab_A(:,:,1);
L_blue = L .* double(mask3); % Provides
                          Sufficient
                          precision for most
                          computation task

L_blue = rescale(L_blue);     % Scale range
                              of array
                              elements
idx_light_blue =
imbinarize(nonzeros(L_blue));% Binarize to
                              2-D gray scale
                              image
blue_idx = find(mask3);
mask_dark_blue = mask3;
mask_dark_blue(blue_idx(idx_light_blue))= 0;
blue_nuclei = A .* uint8(mask_dark_blue);

imshow(blue_nuclei);pause(20);
title('Blue Nuclei')
```

RESULTS:-

<u>(1) **IMAGE SHOWING WRINKLES ON LEATHER** (2) **IMAGE SHOWING PIXEL LABELS ON CLUSTER INDEX** (3&4&5) **IMAGE SHOWING CLUSTER 1 , CLUSTER 2 & CLUSTER 3** (6) **FINAL IMAGE AFTER MASK AND BINARY OPERATION**</u>

MATLAB ENABLING TEXTURE SEGMENTATIN USING GABOR FILTERS:-

Texture segmentation is done to identify regions based on their texture. The goal is to segment the different or irregular pattern from the beckground or required pattern. The segmentation is visually obvious because of the difference in texture between the two. K-means iterative clustering algorithm applied to image texture segmentation:-The K-means algorithm is a robust, unsupervised clustering algorithm applied here to the problem of image texture segmentation. The K-Means algorithm involves two steps. First, K-means is applied. Second, the K-means class assignments are used to estimate parameters required to improve the solution. Gabor filters and co-occurrence probabilities are used as texture features.

PROCEDURE:- First the image is read from graph & then Returns a row vector whose elements are the lengths of the corresponding dimensions of image . Then resizing image & converting RGB image to gray scale . An RGB image is a three dimrensional byte array that explicitly stores a color value for each pixel . RGB images are made up of width , height & three channels of color information . Scanned photographs are commonly stored as RGB images .Then Start image segmentation row wise & columnwise . After it Sample wavelength in increasing powers of two starting from 4/sqrt upto the hypotenuse length of the input image & then Rounding it towards the negative infinity of the value . Then using Gabor filters which Provide gabor magnitude in terms of wavelength & energy . Then choosing sigma wavelength which is matched to gabor filter, extracting each feature . A smoothing term K equal to 3 is introduced whose value determining how much smoothing is applied to the gabor magnitude response . Then creating a mesh plot which is a three dimensional surface having solid edge colors &no face colors & then extracting high level feature from data of concatenate arrays .Then appling element wise opearation to two arrays with implicit expansion enabled and does principle componenet analysis of raw data . By K- Means clustering , partionind n-by-p matrix into K clusters obtaining n-by-1 vector containing cluster indices of each observation .After it piecewise distribution segmentation over copies of arrays is done . After doing K-Means clustering based image segmentation and overlaying label matrix region on 2-d image & obtaining labled image with additional pixel information.

CASE 2- PITCH FORK INJURIES

PROGRAM

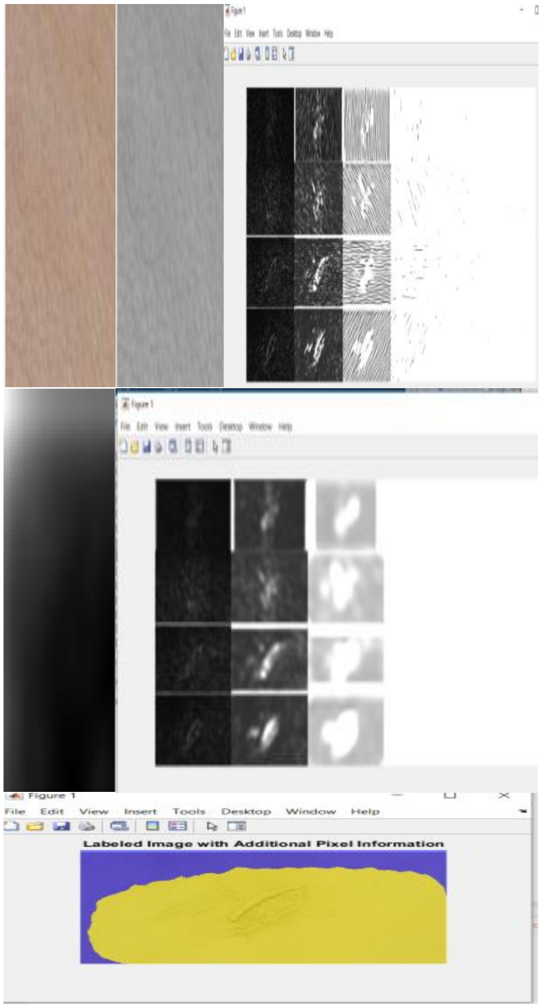
```
A = imread('PF4.png');      % Read image from
                             graphic file
size (A)
A = imresize(A,0.75);    % Returns image that
               is scale times the prior image

A=A(1:100,1:100, 1:3);
Agray = rgb2gray(A);       % Convert RGB image
                   or color map to gray scale
figure(1)
imshow(A);pause(20);
imageSize = size(A);
figure (2)
imshow(Agray);pause(20);
numRows = imageSize(1);        % Read rows of
                         binary table column
numCols = imageSize(2);     % Read columns of
                         binary table column
figure
wavelengthMin = 4/sqrt(2);%Sample wavelength
                              in increasing
                              powers of two
                              starting from
                              4/sqrt(2)
wavelengthMax = hypot(numRows,numCols);
                              % Sample
                              wavelength in
                              increasing
                              powers of two
                              starting from
                              4/sqrt upto
                              hypotenuse
                              length of the
                              input image
n =
floor(log2(wavelengthMax/wavelengthMin));
                        %Round towards the
                         negative infinity
                         of the value
wavelength = 2.^(0:(n-2)) * wavelengthMin;
deltaTheta = 45;
orientation = 0:deltaTheta:(180-deltaTheta);

g = gabor(wavelength,orientation);% Round
                        towards the negative
                        infinity of the
                        value
gabormag = imgaborfilt(Agray,g);  % provides
                        gabor magnitude
                        response of the gray
                        image after gabor
                        filter operated upon
for i = 1:length(g)
sigma = 0.5*g(i).Wavelength;%chosen sigma
                        wavelength is
                        matched to gabor
                        filter,extracting
                        each feature

K = 3;                      % A smoothing
                        term K is
                        introduced. It'S
                        value determining
                        how much smoothing
                        is applied to the
                        gabor magnitude
                        response


gabormag(:,:,i) =
imgaussfilt(gabormag(:,:,i),K*sigma);
end
X = 1:numCols;
Y = 1:numRows;
[X,Y] = meshgrid(X,Y);
                       %Creates a mesh plot
                        which is a three
                        dimensional surface
                        having solid edge
                        colors & no face
                        colors

featureSet = cat(3,gabormag,X);
%Extracting high level

feature from data of

concatenate arrays


featureSet = cat(3,featureSet,Y);
numPoints = numRows*numCols;
X = reshape(featureSet,numRows*numCols,[]);
X = bsxfun(@minus, X, mean(X)); %Apply
                                element-wise
                                operation to
                                two arrays
                                with
                                implicit
                                expansion
                                enabled .
```

```
X = bsxfun(@rdivide,X,std(X));   %Apply
                 element-wise operation
                 to two arrays with implicit
                 expansion enabled.

coeff = pca(X);                  % Does
                        principle component
                        analysis of raw data

feature2DImage =
reshape(X*coeff(:,1),numRows,numCols);
figure (3)
L =imshow(feature2DImage,[]);pause(20);
 kmeans(X,2,'Replicates',5);         %does K
                        means clustering to
                        partition the
                        operation of
                        the n-by-p data
                        matrix X
                        into K clusters ,
                        returning an n-by-1
                        vector(ldx)
                        containing cluster
                        indices of each
                        observation

% L = reshape(L,[numRows numCols]);
figure (4)
%imshow(label2rgb(L));pause(20);   %Show the
                        conversion of the
                        label matrix into
                        RGB image

Aseg1 = zeros(size(A),'like',A);
Aseg2 = zeros(size(A),'like',A);
BW = L == 2;
BW = repmat(BW,[1 1 3]);           %Repeat
                        copies of arrays

Aseg1(BW) = A(BW);                   %Does
                           piecewise
                        distribution
                        segmentation
Aseg2(~BW) = A(~BW);                 %Does
                          piecewise
                        distribution
                        segmentation

figure(5)

imshowpair(Aseg1,Aseg2,'montage');pause(20);
                              %Display
                        multiple image
                        frames as
                        rectangular
                        montages

RGB=imread('PF4.png');
RGB=imresize(RGB,0.5)
imshow(RGB);pause(20);
L = imsegkmeans(RGB,2);pause(20);    %Kmeans
                        clustering based
                             image
```

```
                                        segmentation
B = labeloverlay(RGB,L);                  %Overlay
                                        label matrix
                                        regions on
                                        2-D image

imshow(B);pause(20);
title('Labeled Image')
wavelength = 2.^(0:5) * 3;
orientation = 0:45:135;
g = gabor(wavelength,orientation);
I = rgb2gray(im2single(RGB));        %
                                   Convert RGB image
                                   to gray scale

gabormag = imgaborfilt(I,g);        % gives
                                   gabor magnitude
                                   of the output of
                                   the set of
                                   filters on 2-d
                                   image

montage(gabormag,'Size',[4 6]);pause(20);
for i = 1:length(g)
    sigma = 0.5*g(i).Wavelength;      %
                                   chosen sigma
                                   wavelength is
                                   matched to gabor
                                   filter ,
                                   extracting each
                                   feature

gabormag(:,:,i) =
imgaussfilt(gabormag(:,:,i),3*sigma);
end
montage(gabormag,'Size',[4 6]);pause(20);
                              %Makes image frame as
                               Rectangular montage
                               of the gabor
                               magnitude response

nrows = size(RGB,1);
ncols = size(RGB,2);
[X,Y] = meshgrid(1:ncols,1:nrows);
                              %Creates a mesh plot
                              Which is a three
                              Dimensional surface
                              Having solid edge
                              Colors & no face
                              Colors .

featureSet = cat(3,I,gabormag,X,Y);
                             %Extracting high level
                             Feature from data

L2 =
imsegkmeans(featureSet,2,'NormalizeInput',tr
ue);
C = labeloverlay(RGB,L2);
                             % Overlay label matrix
                             Regions on 2-D image

regions on 2-D

image

imshow(C);pause(5)
```

```
title('Labeled Image with Additional Pixel Information')
```

RESULTS:-



1) IMAGE OF PITCHFORK INJURIES ON LEATHER 2) GREY PICTURE OF THE IMAGE 3) K-MEANS OUTPUT OF THE IMAGE 4) MONTAGE OF GABOR MAGNITUDE 5) MONTAGE OF GABOR MAGNITUDE AFTER DETERMINING SIGMA 6) IMAGE WITH ADDITIONAL PIXEL INFORMATION

RESULT & DISCUSSION:-

In first attempt using the L*a*b* color space & K- means clustering which use Eucledian distance metric to segment colors & converting into clusters obtaining blue object in one of them . After extracting brightness level of pixel then thresholding with global threshold getting dark blue cell nucleias end result . The Wrinkles & Horn scratches on leather which are major defect are clearly identified and marked using this method but for the small defects like Pitch fork injuries ,this method is not found practically generous . For this , using gabor filter followed by K-means clustering & then choosing sigma & determining gabor magnitude & then obtaining additional pixel information after segmentation proved effective . Thus second method is more applicable for fine defects.

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Meher Kumar is born in Uttar Pradesh, India on December 28, 1981. He graduated in Electrical Engineering from Engineering College, D.E.I., Agra, U.P. in 2019 and pursuing M.Tech in Engineering Systems and Managements from Engineering College, D.E.I., Agra, U.P. , India and working in the area of Quality control of Footwear.

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