**Introduction**

The problem being solved In this assignment is to identify the position of the car plate , crop out the part of the car plate , and extracts and show the characters on the car plate on small segments . My team have attempted multiple approach on this problem . The first approach was based on our intuition that a car plate is a rectangle plane with 4 edges and the edges meets at the corners . So we tried to crop the car plate by finding the car plate using Hough Transform and Corner algorithms but we realized that a vehicle can have more lines that are stronger than the edges on the car plate for example , the lines on the grill on the front of the cars and the outlines of the car. Our second attempt was to generalised the position of the car by assuming that it is around a certain position and used edge algorithm to detect the car plate . After both attempt , one of our team mate , Yeow Kin Ren figured out the way to extract the car plate , but even with this solution , we realised that a few conditions need to be met so that the car plate can be detected accurately .

Condition:

1. The car plate must be around the centre of the image
2. The image must only have a single car plate , and no other object in the image that have stronger corner than the car plate

**Methodology**

**Diagram

Description automatically generated**

**Pre-processing**

During the pre-processing , the algorithm will generate all the corners , then it will select the 25 strongest corner and remove any outliers in this list of corners . We assume that the car plate is the only object with high frequency of corners in the image . After detecting the corners of the car plate , we crop out the car plate using the minimum x , y and maximum x , y coordinates .

**Image skeletonization**

After cropping out the image we generate the skeleton for the car plate and remove any unwanted branches by pruning the image .

**Example**

**A picture containing diagram

Description automatically generatedA picture containing shape

Description automatically generatedA picture containing text, sign, plate, dishware

Description automatically generated**

Skeleton Pruned

**Splitting Rows**

If the pruned image have width and height ratio that is similar to the width and height ration of a double row car plate , then split the row using image dilation . The idea of dilation is to use a rectangle SE with high width / height ratio so that the characters on the same row can merged together into a single white strip and so the two rows can be separated by a thin black line , then we loop through the row to find the black line and use the black line to crop out the upper and lower row .After splitting , the rows are recombined into a single row .

**![Text

Description automatically generated]()Example**

Shape, rectangle

Description automatically generated

**![Text

Description automatically generated with medium confidence]()**

**Splitting Columns**

In this stage , we have a skeletonize , pruned and binarized car plate that only have a single row of characters . We use dilation with SE with high height / width ratio so that each character will dilate until only a white column left with black lines separating each column . Here each column is a character . By Looping through the column , we can find the boundaries and crop out the character segments .

**Example**

Shape, arrow

Description automatically generated**![Text

Description automatically generated with medium confidence]()**A picture containing text, chain

Description automatically generated

**Detailed Description**

**Pre-processing**

I = rgb2gray(imresize(imread("Plate9.jpg") , [512,512]));

Icrop = imcrop(I , [128 128 256 384]);

corners = detectHarrisFeatures(Icrop);

strongestCorner = corners.selectStrongest(25);

TF = rmoutliers(strongestCorner.Location,'median');

X = min(TF(:,1));

Y = min(TF(:,2));

h = max(TF(:,2)) - Y ;

w = max(TF(:,1)) - X ;

new= imcrop(Icrop , [X-10 Y-5 w+20 h+10]);

figure,imshow(new);title("Extracted Plate");

The first step is to resize the image into a standard size , then extract the grey scaled image using rgb2gray . The second step is to crop out the center part of the image because we assume that the car plate is around the center . The third step is use Harris detection algorithm to extract the 25 strongest corner and use rmoutliers to remove corners that are not around the car plate . we used median to remove the outlier because we want the area where the corners appeared the most . The fourth step is to use these corners to find the minimum x ,y , the width of the plate and the height of the plate , then we use imcrop again to extract the car plate with those values .

**Image skeletonization**

Iafter = imcomplement(imbinarize(uint8(new)));

skel = bwmorph(imcomplement(Iafter),'skel',Inf);

figure,imshow(skel);title("Skeleton");

prunned = bwmorph(skel , "spur" , 3);

figure,imshow(prunned);title("Prunned");

The first step is to processed the image using imbinarize so that the image pixels are only 1 and 0 which makes it easier to process later on . The second step is to skeletonize it so we can have the character with one pixel thick only . We also prunned the image so that unwanted branches from skeletonization are removed by using

bwmorph(skel , "spur" , 3).

**Splitting Rows**

% If got two rows then split it in half and join it back with the first row

[w h] =size(prunned);

d = h-w ;

if d <= 25

[character\_head, character\_width] = getLump(prunned, 1);

Image = [] ;

for i = 1:length(character\_head)

[k w] = size(prunned);

X = 0;

Y = character\_head(i);

h = character\_width(i);

im = imcrop(prunned , [X Y w h]);

im = imresize(im, [500 1200]);

Image = [Image {im}];

%subplot(1,length(character\_head) ,i ), imshow(mat2gray(im));

end

a = montage(Image , 'Size', [1 2]);

a = a.CData;

a = imbinarize(a);

prunned = bwmorph(a, 'thicken');

end

The first step of splitting the row is to check the difference between the height and the width , if the difference is less or equal to 25 , the number 25 is an arbitrary number set to fit the data set . If the detected car plate is indeed two rows , then use the getLump function to get the separate rows , then use montage to recombine those rows .

**Splitting column**

[character\_head,character\_width] = getLump(prunned , 0);

for i = 1:length(character\_head)

[h z] = size(prunned);

X = character\_head(i);

Y = 0;

w = character\_width(i);

im = imcrop(prunned , [X-2 Y w+2 h]);

im = imresize(im, [1200 500]);

subplot(1,length(character\_head) ,i ), imshow(mat2gray(im));

end

Use getLump again to dilate the car plate with SE and extract the separate character on the car plate . The rest of the function will loop through each character and print it out in separate subplots .

**getLump(image , dir)**

image is a binarize , skeletonized and prunned image

dir is the direction you want to dilate , if you want to dilate it to get row , then dir = 1

if you want to dilate to get column , then dir = 0

Basically it will dilate the image with the pre-set SE for each dir , then depending if it is row or column , it will loop through the dilated image to find the boundaries , if a boundary is found it will store it in the character\_head and character\_width and returned it.