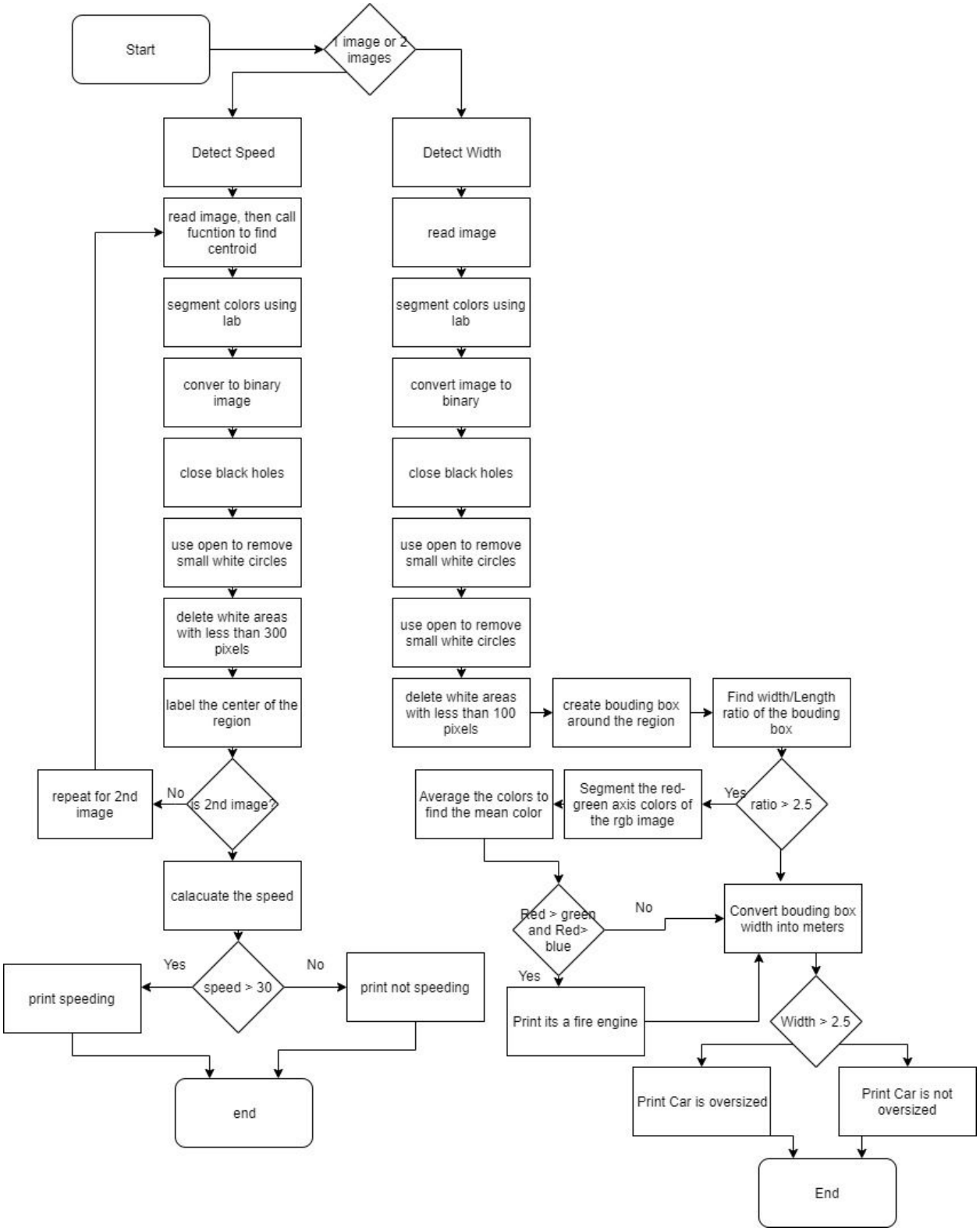
Conditions and assumptions

- The road surface will not be a different color to how it appears in the image shown
- Only a single car will be on the road surface i.e no other objects such as rubbish or debris on the road
- The colors of the car will be easily distinguishable from the road surface
- Only fire engines will be the only vehicles that are 1:3 in length and red
- The width of the vehicle will only need to be assessed when it is directly below the camera
- The size of the vehicle will only need to be tested from the first frame of the image

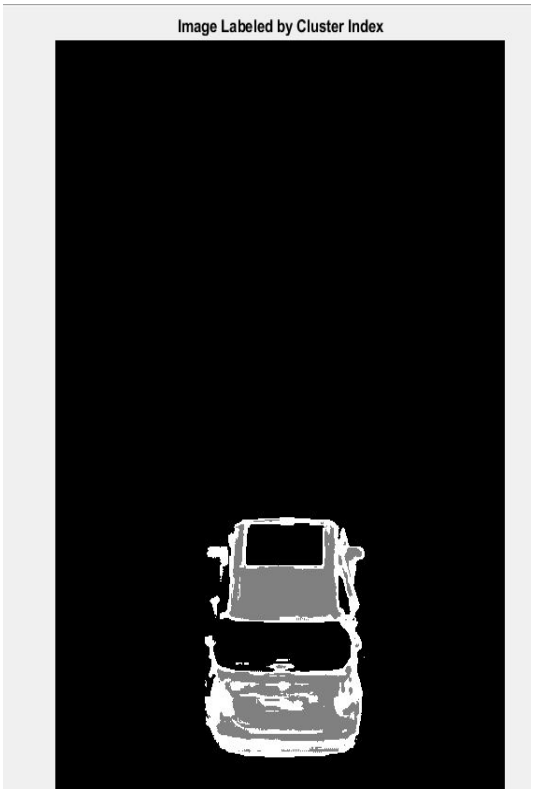
Processing Flowchart



Explanation of stages

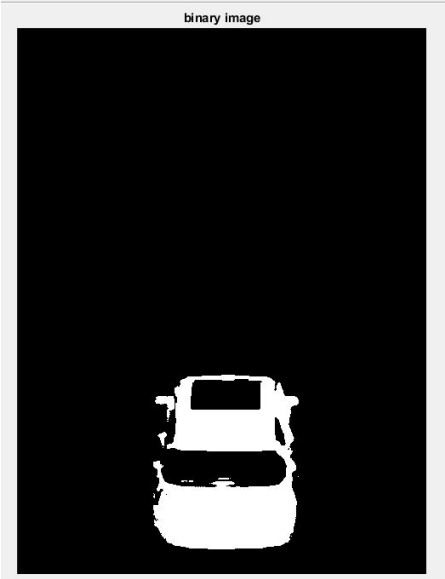
Segment colors using LAB and k means clustering.

```
%segment by colors  L*a*b (luminosity layer 'L*', chromaticity-layer 'a*' ,chromaticity-layer 'b*'
lab_he = rgb2lab(inputImg);
ab = lab_he(:,:,2:3);
ab = im2single(ab);
nColors = 3;
% repeat the clustering 3 times to avoid local minima
pixel_labels = imsegkmeans(ab,nColors,'NumAttempts',3);
figure,imshow(pixel_labels,[]),title('Image Labeled by Cluster Index');
```

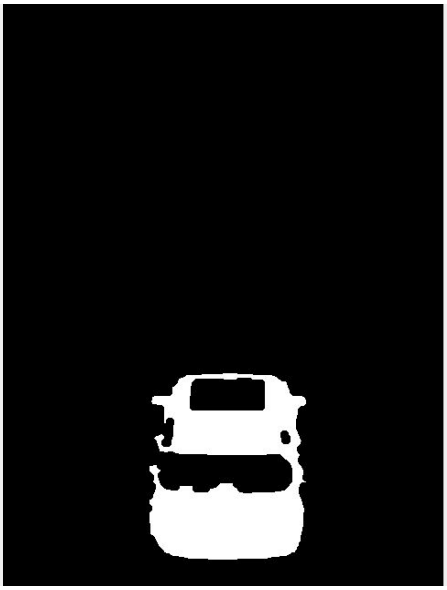


This removes the shadow from the image and shows the foreground as a grayscale image

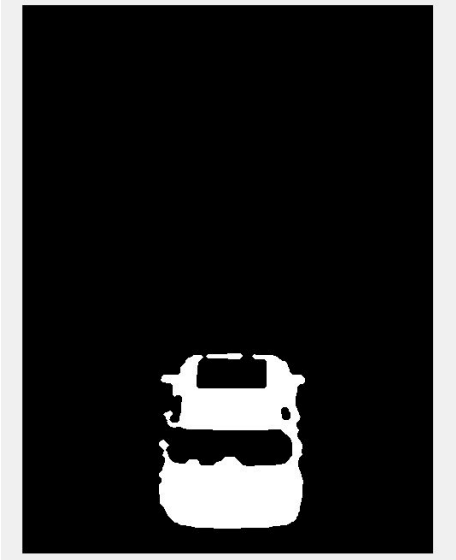
Convert to binary



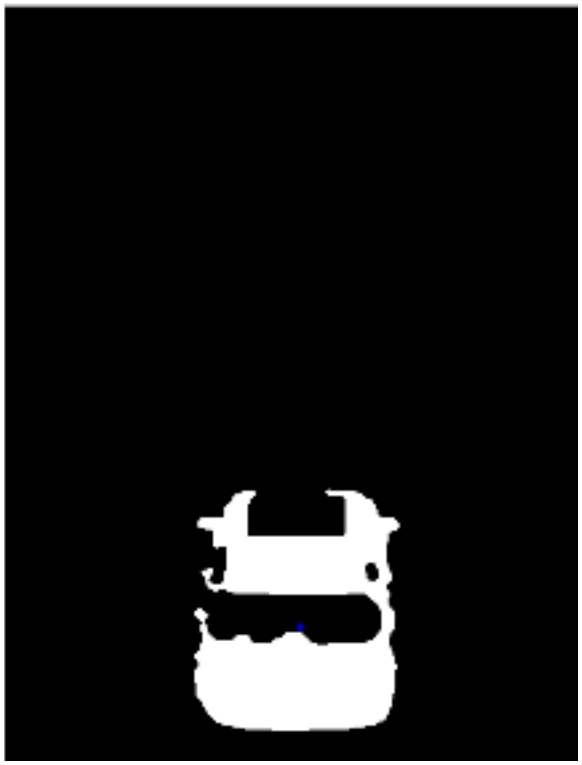
Convert to binary so that morphological operations can be performed



Perform closing so that some of the smaller black gaps are removed, closing value is 5 so that not too many details are lost.

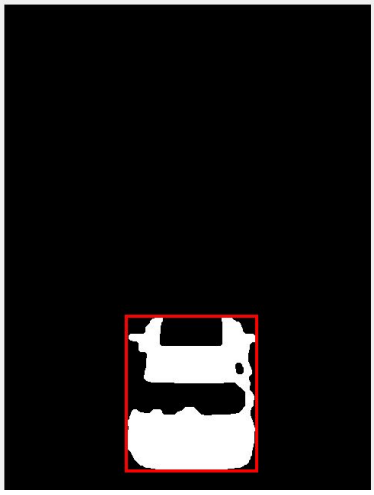


Use open to remove small white spots.

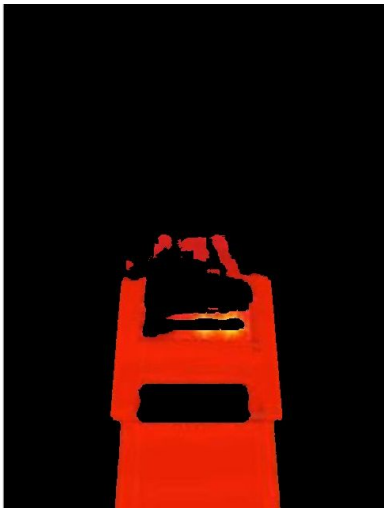


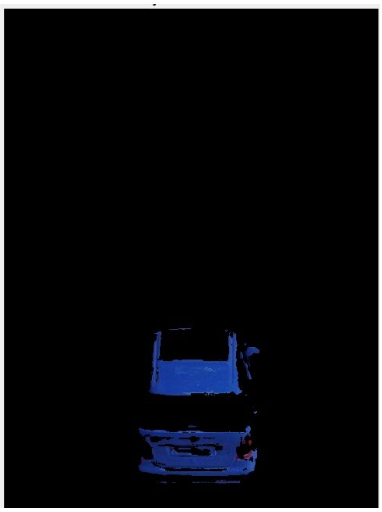
Use bwareaopen to remove larger white areas that have less than 300 pixels and label center of the region with a blue +.

The size detection works the same way as the speed detection except at the end a bounding box is created



If the ratio between length and width is greater than 3.5 and the color is red its is believed to be a fire engine.





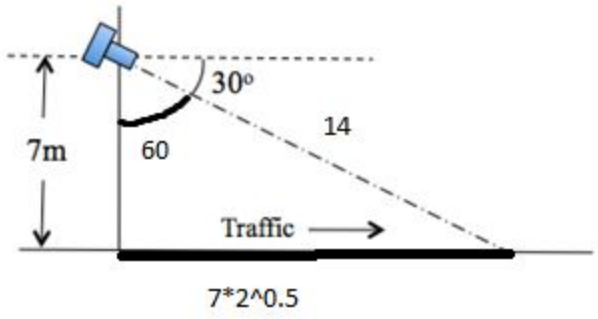
```
%segment the red-green axis colors of the rgb img
mask = pixel_labels==2;
cluster2 = rgb  .* uint8(mask);
figure,imshow(cluster2),title('Objects in Cluster 2');


colVal = 'unknown';
%average color and compare the channels
```

The RGB image has the red-green axis segmented and then the average color is found.The value of the average printed and returned when the script completes

Calculating the speed

Appendix 1 Camera system configuration



Using fov formula **α = 2arctan(d/2f)**

For x :

640* 0.042 = 2arctan(480/2f)
fx = 480/2tan(640*0.042)

For y:
480* 0.042 = 2arctan(640/2f)
fy = 640/2tan(480*0.042)

Using lens equation

Real height / real distance = image height / focal length

Wx = 480/fx * 14sin(30) (sin(30) to offset the camera tilt to be horizontal)
Therefore one pixel in the x direction = 12.291/480 = ~0.0256 M

Wy = 640/fy * 14scos(30) (cos(30) to offset the camera tilt to be vertical)
Therefore one pixel in the y direction = 10.27/640 = ~0.016 M

The pixels in meters for y is multiplied by the difference between the two centroids, to find the difference in meters. This is then divided by the time between the images (0.1s), in order to find the velocity.

The width of the bounding box is multiplied by the pixels in meters x in order to see the width of the car in meters.

Testing Results

Scenario 1: image 001 v image 002

```
Input the secnario you would like to test1
carOne position:525.0588
carTwo position:458.3917
meter per seconds:5.3334
distance travelled :0.53334
Miles/h :11.9304
Car is not speeding
    "car box:160.5"    "car box:408.5"    "car box:171"    "car box:204"

This is blue
meanRGB:  red:1.0964 green:2.1786 blue:5.4216
car size:2.1888
Car is not overSized
Speeding:false Oversized:false Color:blue
```

Scenario 2: image 001 v image 003

```
Input the secnario you would like to test2
carOne position:525.0588
carTwo position:387.298
meter per seconds:11.0209
distance travelled :1.1021
Miles/h :24.653
Car is not speeding
    "car box:160.5"    "car box:408.5"    "car box:171"    "car box:204"

This is blue
meanRGB:  red:1.0964 green:2.1786 blue:5.4216
car size:2.1888
Car is not overSized
Speeding:false Oversized:false Color:blue
>>
```

Scenario 3: image 001 vs image 004

```
Input the secnario you would like to test3
carOne position:525.0588
carTwo position:336.5889
meter per seconds:15.0776
distance travelled :1.5078
Miles/h :33.7277
Car is Speeding
    "car box:160.5"    "car box:408.5"    "car box:171"    "car box:204"

This is blue
meanRGB:  red:1.0964 green:2.1786 blue:5.4216
car size:2.1888
Car is not overSized
Speeding:true Oversized:false Color:blue
```

Scenario 4: fire01 vs fire02

```
Input the secnario you would like to testfire
carOne position:474.1345
carTwo position:246.6421
meter per seconds:18.1994
distance travelled :1.8199
Miles/h :40.7109
Car is Speeding
    "car box:134.5"    "car box:283.5"    "car box:220"    "car box:358"

This is red
meanRGB:  red:35.626 green:5.9083 blue:1.3022
This is a fire engine
car size:2.816
Car is Oversized
this is a fire engine does not need to follow rules
```

Scenario 5 : oversized

```
>> test
Input the secnario you would like to testoversized
    "car box:100.5"    "car box:150.5"    "car box:272"    "car box:298"

This is blue
meanRGB:  red:3.1343 green:5.837 blue:13.8664
car size:3.4816
Car is Oversized
Speeding:false Oversized:true Color:blue
```

Evaluation

Quite a lot of details are lost using in the closing part of the program, for this program it is somewhat acceptable. However some vehicles could have long thin parts sticking out of it causing it to be oversized, these rods could end up being removed by the closing method causing it to be read as not being oversized.

There could be some issues with detection if the car being detected is black, this would mean that the black car would be treated as background meaning that it would not be detected correctly.

The current method of using LAB color segmentation to separate the foreground and background was chosen as the shadows in the image ended up being detected as edges of the car. If enough smoothing and a correct threshold to convert to binary were chosen the car would be drawn without the shadow. However, this meant that a significant amount of detail was lost and the car's width was incorrect and therefore color segmentation was used.

During the calculation of the speed of the car and large amount of rounding is done. This was done to make the program easier to read but this could mean that the outputs of the program would be slightly off.This could be an issue for cars which are on the boundary of speeding or being oversized.

This system also assumes that vehicles that are 1:3 in length and are red are fire engines however there could be other red vehicles that are 1:3 in length and this system would report them as fire engines. The color system needs improvement as at the moment it can only determine if the car is red, green or blue.