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Using Image Processing to Enhance Vehicle Safety

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Motivation

- Automobile safety is an ever present concern in the design of cars
- Many safety mechanisms could be better deployed if the number and location of the people in the car was known
- Unnecessary mess could be prevented by disabling unused safety features
- Sensors in each seat can be cumbersome, expensive, and difficult with vehicle maintenance

Project

- Develop a real time video processing system
- Detect the number of people in the car
- Find the location of those people
- Accomplish this in Matlab's Simulink Toolbox

Background – Image Processing

- Image Processing
  - "The field of digital image processing refers to processing digital images by means of a digital computer."
- Image Morphology
  - The manipulation of images to extract shapes

Gonzalez & Woods, "Digital Image Processing, Third Edition" Saddle River, NJ, 2008

Background – Image Morphology

- Structuring Elements
  - "Small sets or sub-images used to probe an image under study for properties of interest"
  - Basically, you "slide" the block through all of the pixel rows in the image and look for matches. If matches are found, you follow different rules depending on the morphological operation being preformed.
- Thresholding
  - For image morphology to work, you need only two intensity levels. Basically, each pixel either needs to be a one or a zero. In order to do this, thresholding is used. If something is above or below a certain number, make it a 1 else make it a 0.
  - In image processing, a 1 represents white, while a 0 represents black.

Solution
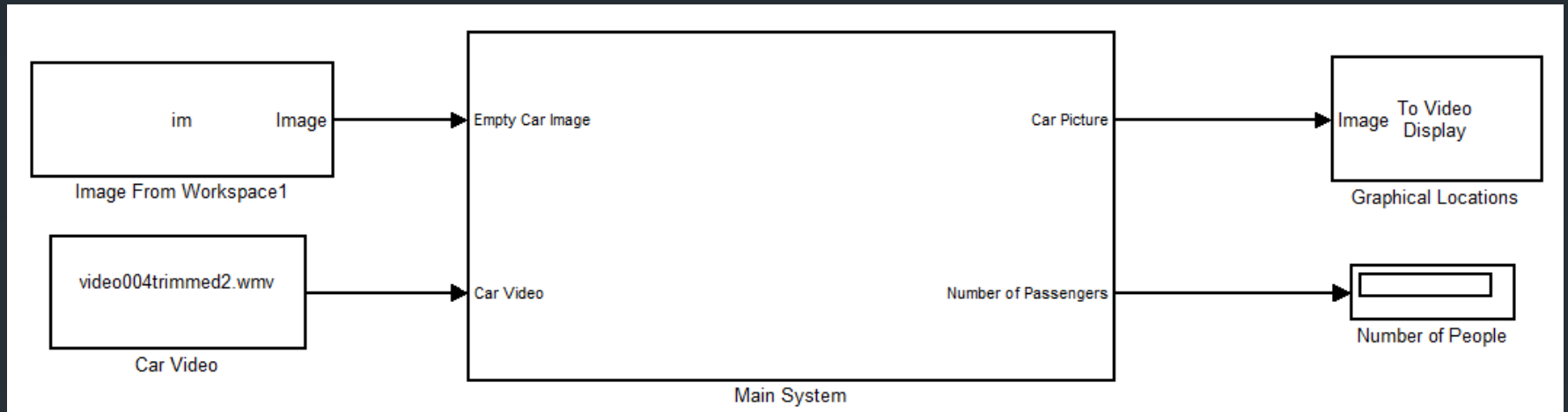
Block Diagram of Our System

Solution

Remove Background
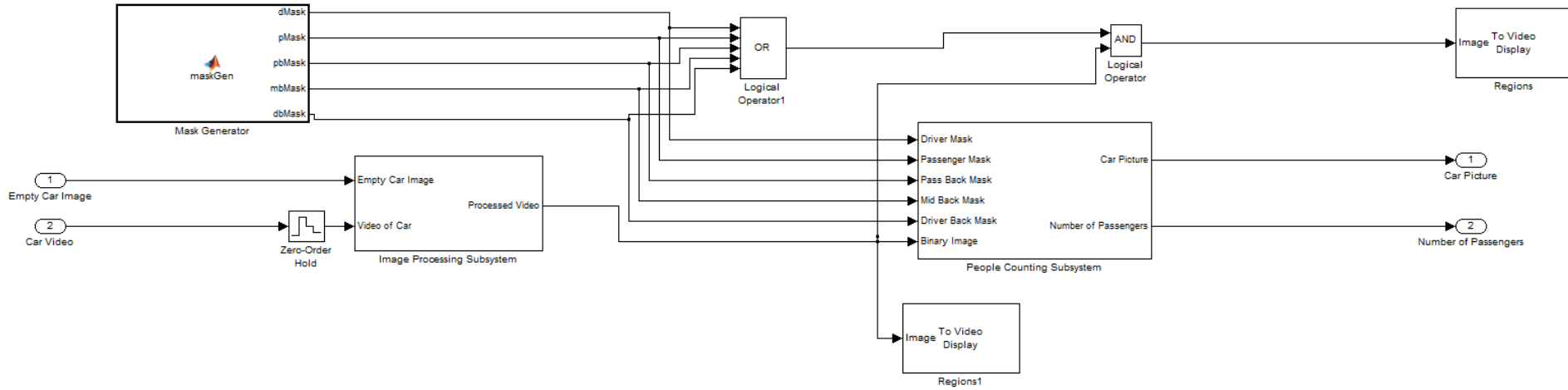
Threshold to create binary image

Erosion

Closing

Apply Seat Mask and Analyze

Solution

Main System Block Break-Down
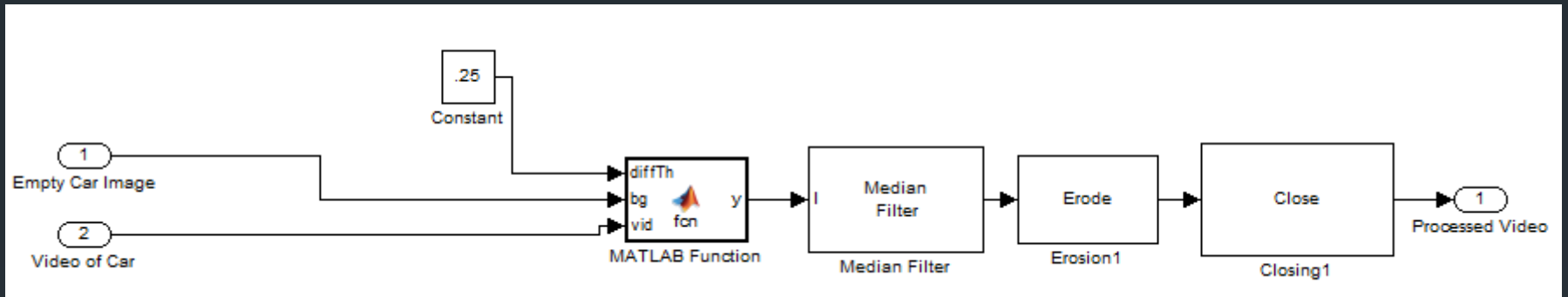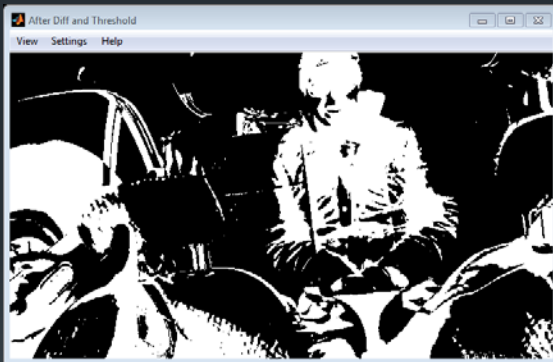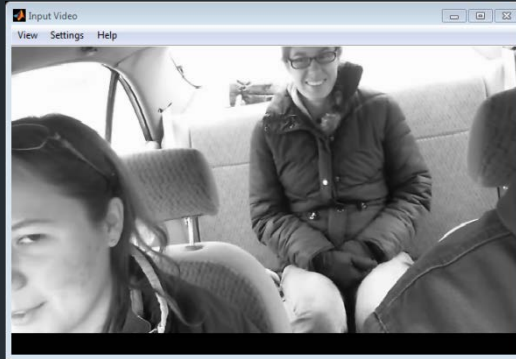
Image Morphology Subsystem

Image Processing Subsystem Block

Background Removal and Thresholding

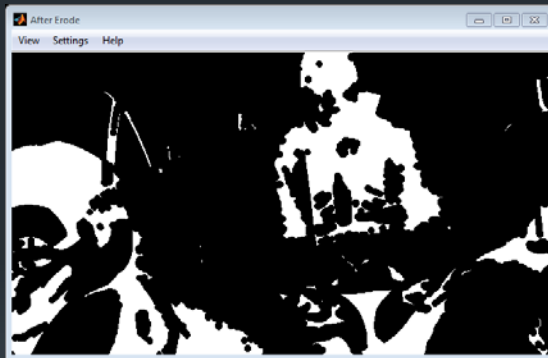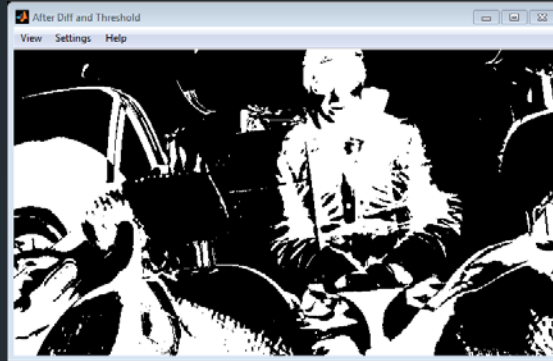

Before

After

- Matlab function block
  - Accepts background, video, and a threshold constant
  - The function checks to see if the video image falls within the range of the background image.
    - If: (background pixel – threshold) <= live pixel <= (background pixel + threshold), then it is considered part of the background, and is given a 0 (black) value.
    - If it's farther away than that, it is given a 1 (white) value.
  - This should give rise to a 2 intensity level image, with big blobs of things that are people.
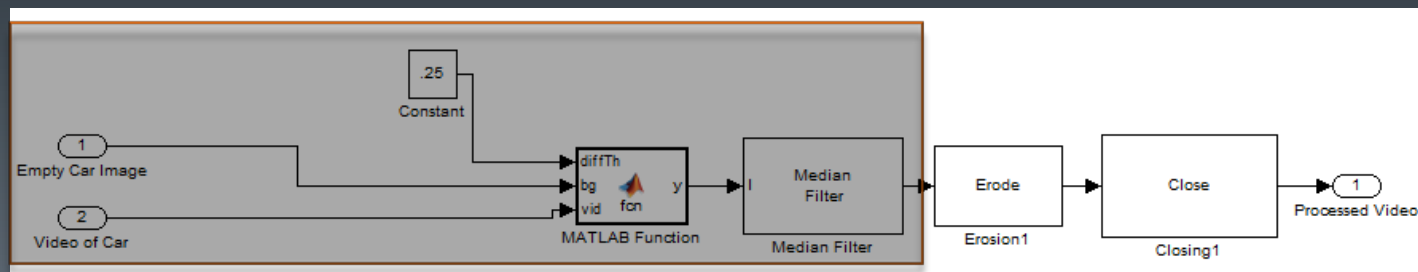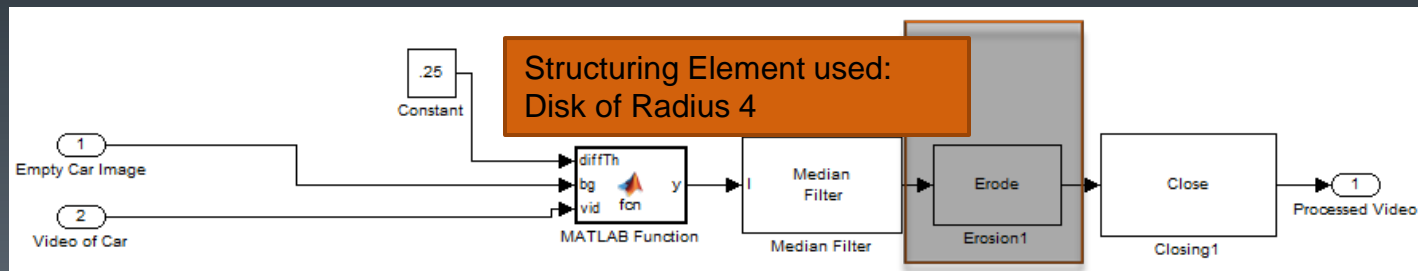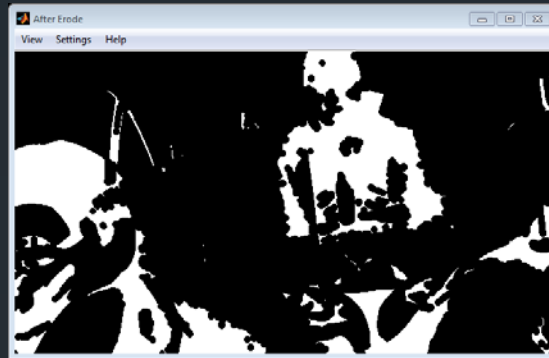
Erosion

Before

After

- Slides a structuring element through the image looking for matches. If it finds one, it turns the center pixel of the block white in the actual image, else it makes it dark.
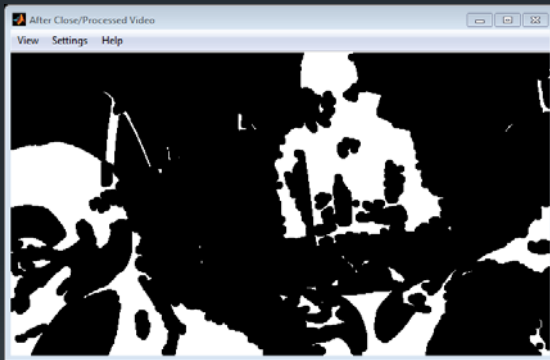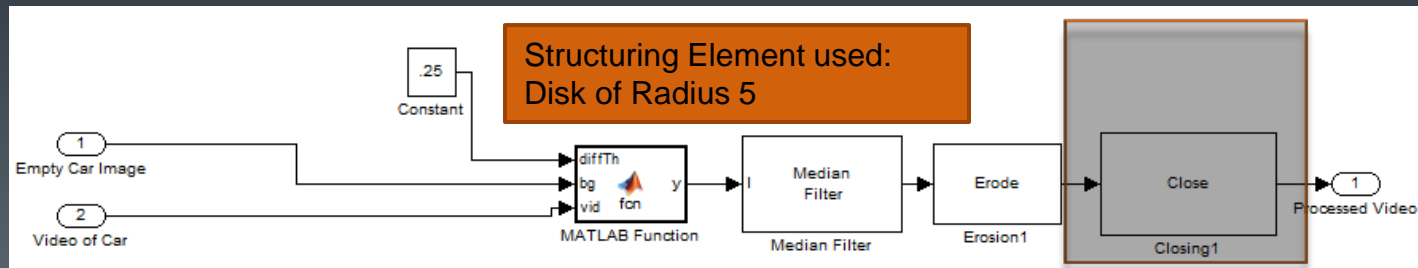

Structuring Element used:
Disk of Radius 4

Closing

Before

After

- Dilation followed by Erosion
  - Dilation is the opposite of erosion

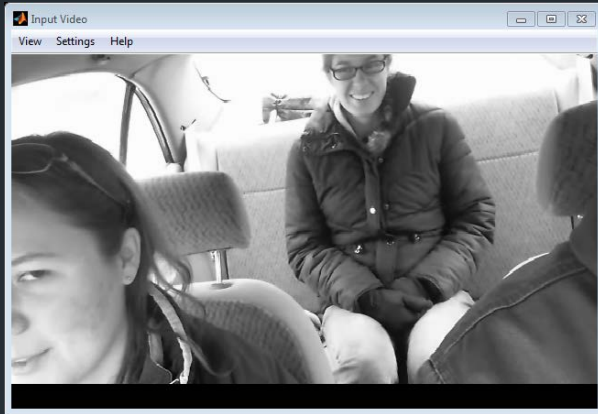Structuring Element used: Disk of Radius 5
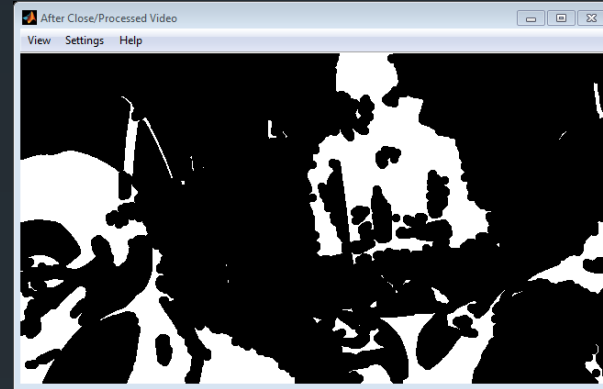
Seat Masks & Decision Making

- Ands the image with "Seat masks"
- Leaves only one "seats" light pixels
- Sums all of the pixels in the image
- Thresholds: If it's over a certain amount, there's a person, else there isn't.
- Displays the information both pictorially and with a numerical value.
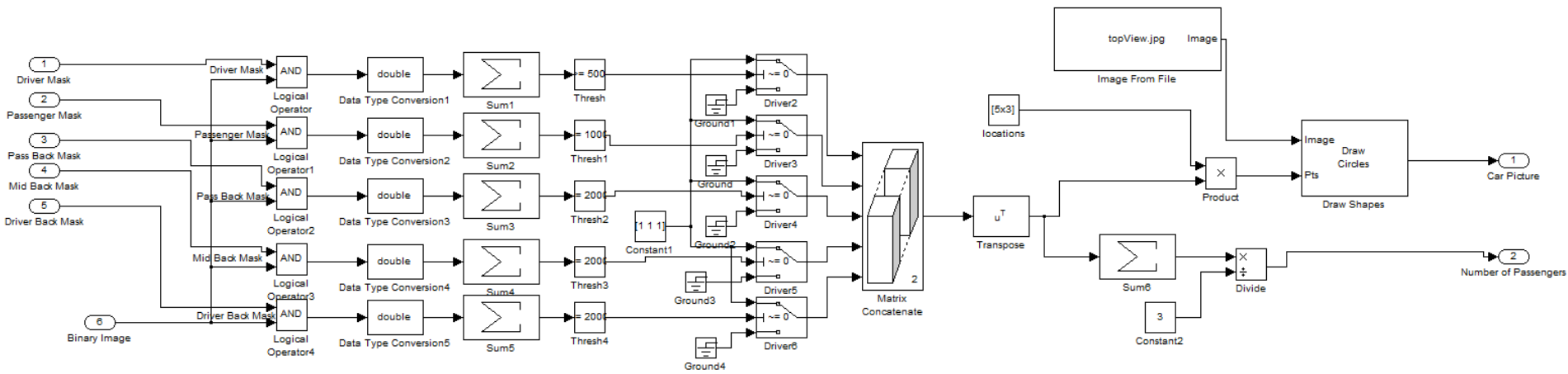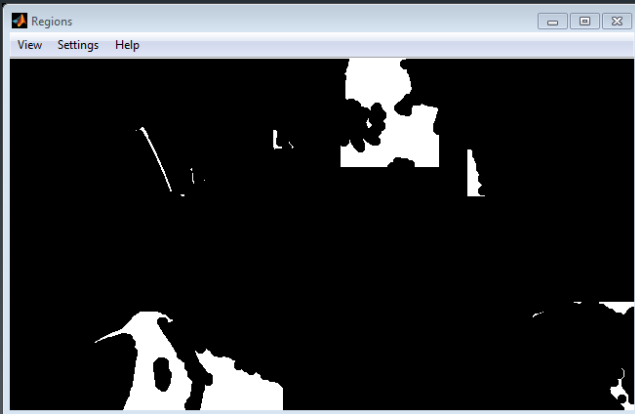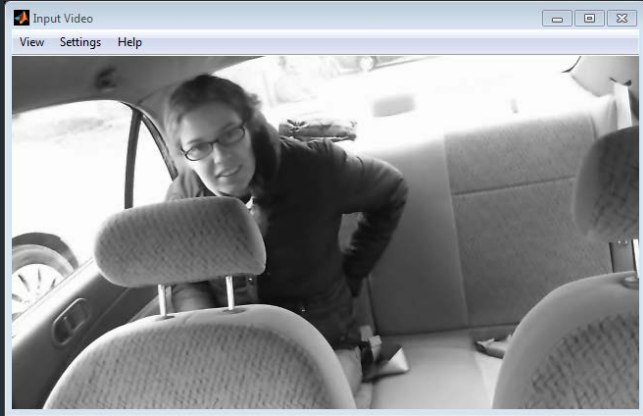
Results
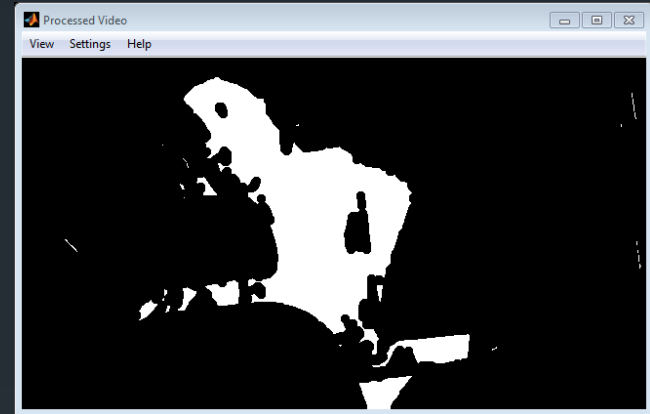

Original

After Image Morphology

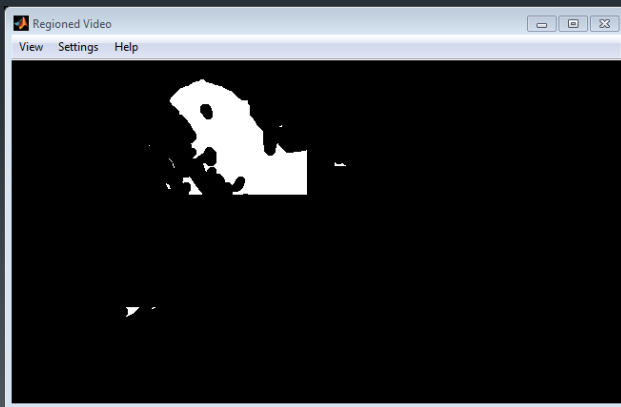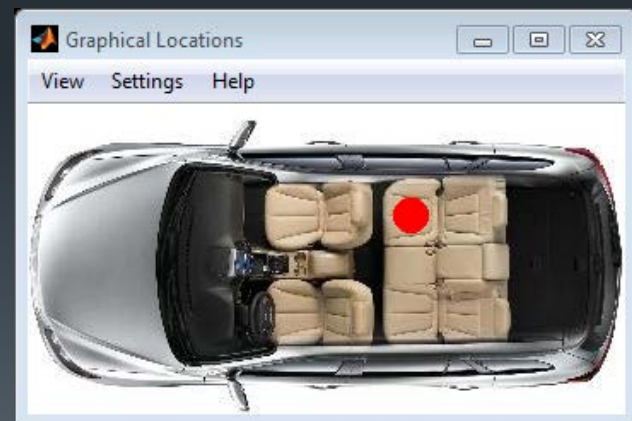After Mask

Output Display

Results

Original

After Image Morphology

After Mask

Output Display

Conclusions

- The system worked as expected as it detected the location of people in cars.
- Problems and Limitations:
  - Sometimes it mistakes "larger" people in the front of the car as people in the back of the car.
  - It has only been tested on one car in one type of lighting.
- Future research:
  - Test on the same car with footage under different lighting.
  - Test on multiple types of cars
  - Add more than one camera, and fuse them to eliminate errors.
  - Using integral to get background image