On-Road Object Detection using Computer Vision Techniques for Advanced Driver Assistance Systems (ADAS)

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Today’s Discussion

- Objective of the Project
- Overview
- Current Market Scenario
- Sensor’s used
- Previously Developed Algorithm
- Problems Addressed by the New Algorithm
- KITTI Dataset
- Why Python?
- Level Wise Description and Output of the Algorithm
- Performance Evaluation
- Future Scope

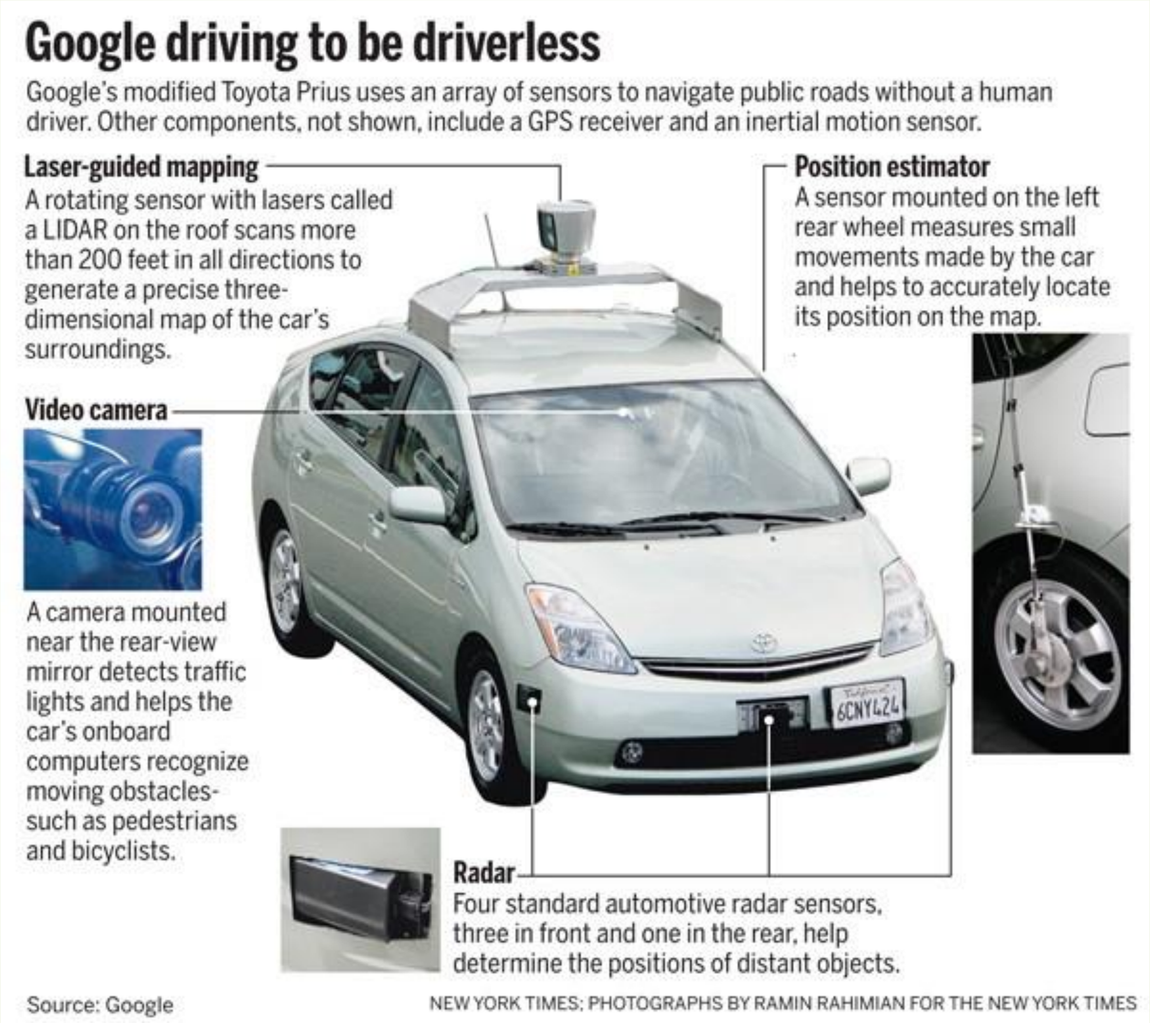
Objective of the project

- Understanding the various computer vision techniques currently being used for on road object detection.
- Developing the initial design of the algorithm in MATLAB, and later implementation using Python with a major focus on improving the processing rate.

Overview of the project

What is ADAS?

Self driving vehicle?



Can a human driver be substituted?

What is the feasibility of this technology?

Current Market Scenario

Self-driving car hits public roads

The latest prototype of Google's self driving car is set to hit public roads in the US. The car wears a hat to hide its sensors and can drive, brake and recognise road hazards without human intervention.

- Video cameras, radar sensors and laser range finders are used to "see"
- The car is electric and can travel 80 miles before recharge
- Max speed: 25 mph, due to a lack of air bags and other federally required safety features
- Google will initially build 25 cars to test in Mountain View, Calif.

The prototype was assembled in Detroit by Roush Industries.

How the car's computer understands the world

- Other vehicle
- Pedestrian
- Cyclist
- Objects that warrant caution
- A crosswalk, indicating the car needs to stop
- A traffic signal, warning of upcoming railroad tracks
- Path of Google's car

Source: Google, AP
Graphic: Tribune News Service

AUTOMOTIVE

Uber's "Self-Driving" Test Cars to Be Overseen by Driver and Engineer

The multimillion-dollar Pittsburgh pilot program will be open to passengers, and comes complete with a special driver and engineer in each vehicle

World's first self-driving taxis debut in Singapore

By ANNABELLE LIANG and DEE-ANN DURBIN Aug. 25, 2016 2:38 PM EDT

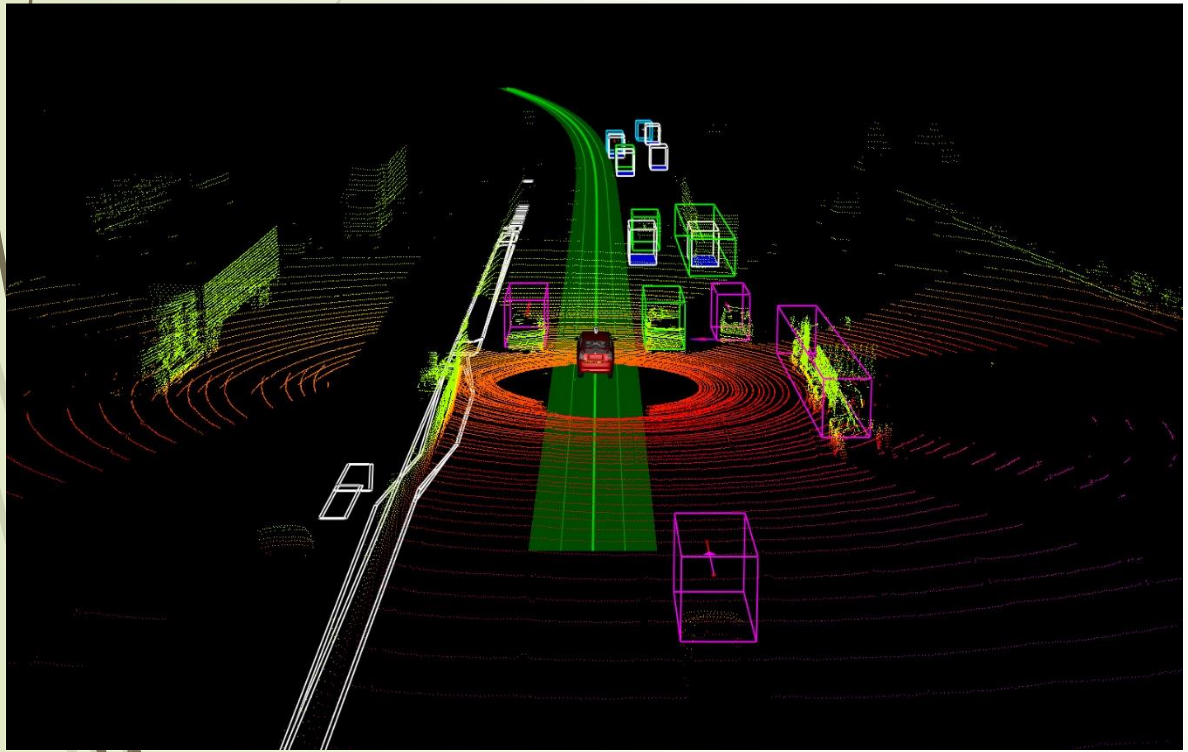
Current Market Scenario

Tesla, Inc.

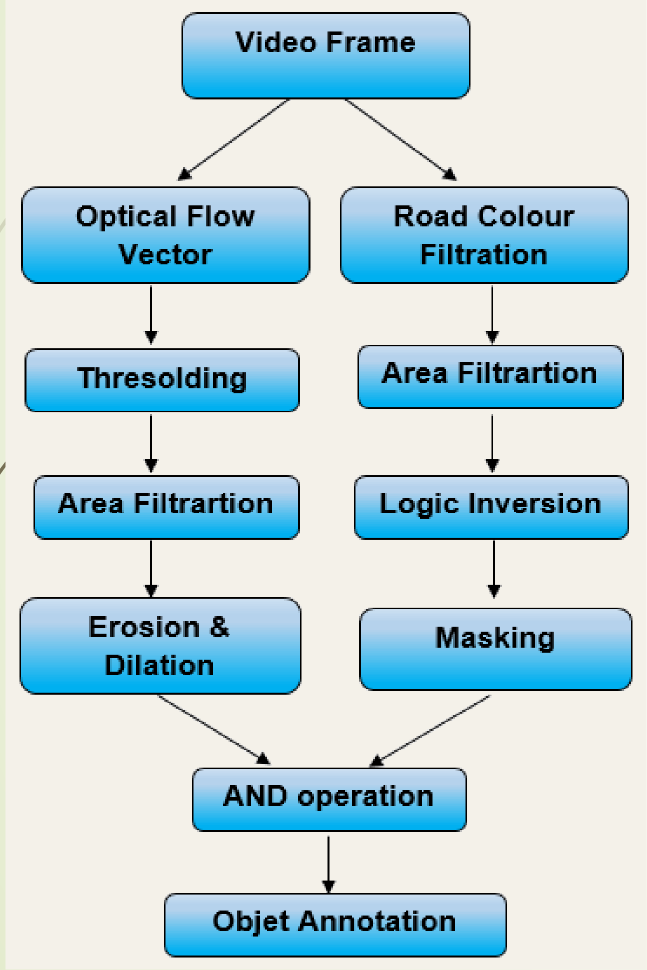
Automaker company

From $70,000

Which sensor is better,
Camera or LIDAR (Light Detection and Ranging) ?



Previously developed algorithm

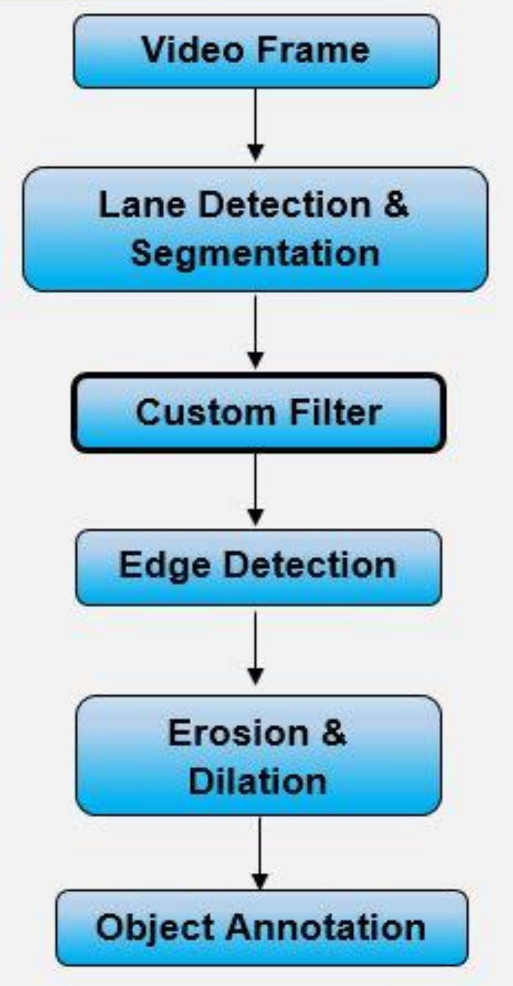


- The proposed system is implemented on windows workstation, powered by Intel i5 - 3.2 GHz with 8GB RAM
- Achieved frame rate is : 4 frames per second, without using system Graphic Processing Unit (GPU)

Drawbacks:

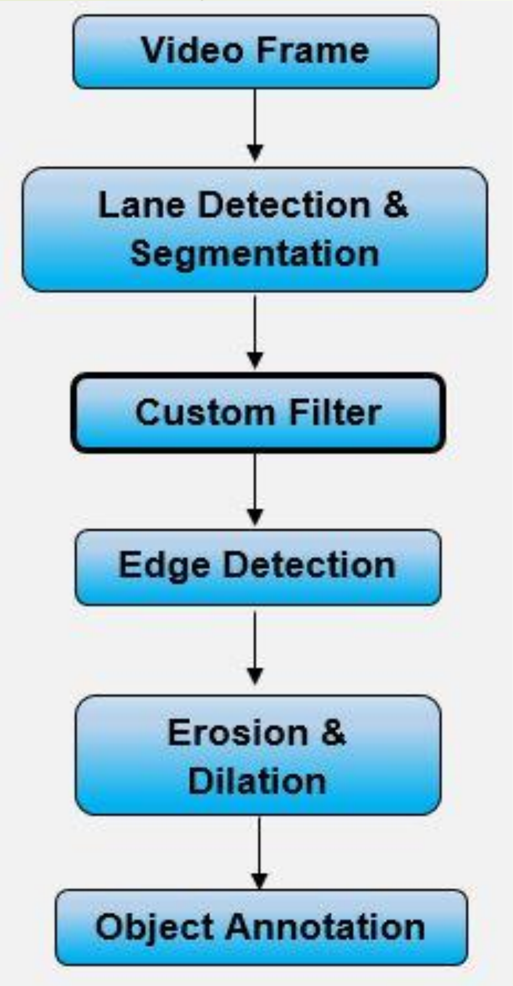
- Several false detections that can slow down the operation of convolutional neural networks(CNN) in next phase
- Discontinuity in detection

Problems addressed by the new algorithm:



- Reduction in the number of filters, thereby increasing the overall computation speed
- Reduction in the number of false detections, that were mainly caused due to signboards and other bright objects in image frames
- Discontinuity in object detections due to variations in surrounding brightness
- Failing to detect objects that have zero relative velocity(moving with the same speed and in the direction similar to the vehicle on which the camera is mounted)

KITTI Dataset



Common features observed in this dataset [5]:

- Most of the roads are one way
- Roads have proper solid white lane line markings
- Roads have proper broken white lane line markings
- A four road junction appears for not more than 8 frames
- Only 50% of the image frame depicts the road(due to the mounting position of the camera)

Why Python?

- It’s an Open Source software
- High processing speed
- Effective usage of hardware
- Is portable between Linux and Windows
- Supports Graphic Processing Unit (GPU) based execution
- Supports implementation on single board computation platforms such as Raspberry Pi

Level wise description and output of the Algorithm:

- Input image frame to the algorithm

- The truncated form of above figure

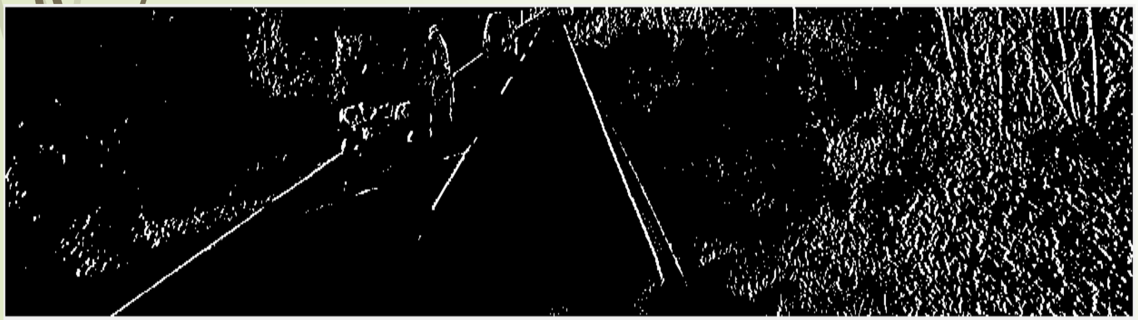
- Grayscale output

Level wise description and output of the Algorithm:

- Output from edge detection filter

- Solid white lane line detection output(Hough Transform)

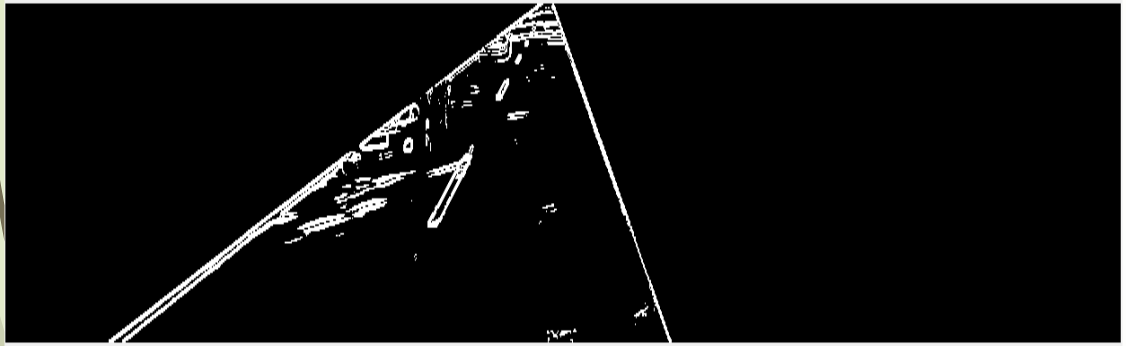
- Output from threshold operation



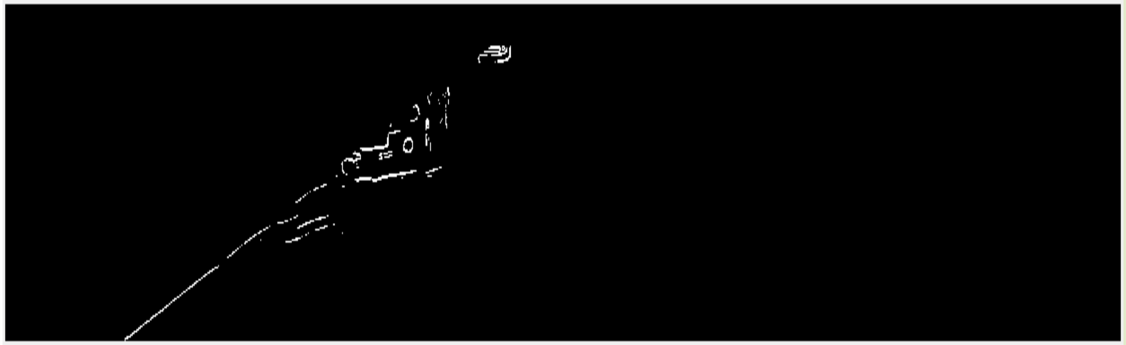
- Road separation from surrounding area

Level wise description and output of the Algorithm:

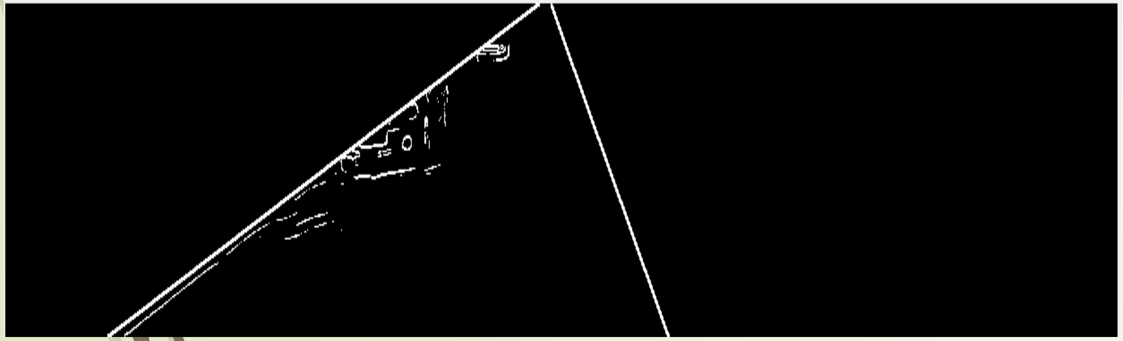
- output from edge detection operation



- output after removing the lane edges



- output from the custom designed filter



- output from area filtration and erosion operations

Level wise description and output of the Algorithm:

- Final output from the algorithm

Performance Evaluation

- The proposed system is implemented on windows workstation powered by Intel i5 with 8GB RAM, 3.2 GHz clock frequency

	FPS(frames per second)	Image Size
MATLAB	7~8	[375,1242]
Python	17~19	[375,1242]

	FPS(frames per second)	Image Size
Proposed Algorithm	38~40	[195,640]
[1],2016	24	[300,400]
[2],2016	10~13	LIDAR
[3],2016	36~38	[640,140]
[4],2015	4~6	[397,120]
[5],2016	30~32	[320,615]
[6],2016	5~6	[500,375]

Further Scope

- This project can be further developed in order to integrate with RADAR based detection system, ultrasound based detection system or, GPS based navigation system

- Additional features such as vehicle tracking, collision indication and lane change indication systems can be developed as an extension of this work.

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[6] Huieun Kim, Youngwan Lee, Taekang Woo, and Hakil Kim, "Integration of vehicle and lane detection for forward collision warning system," IEEE 6th International Conference on Consumer Electronics - Berlin (ICCE-Berlin) 2016, Pages: 5 – 8.

[7] Shaoqing Ren, Kaiming He, Ross Girshick, and Jian Sun, "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks," IEEE Transactions on Pattern Analysis and Machine Intelligence 2016, Pages: 1 – 1.

Thank you