Smart Steering Robot for Autonomous Vehicle In Reverse Parking

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Why do we need a smart steering system?

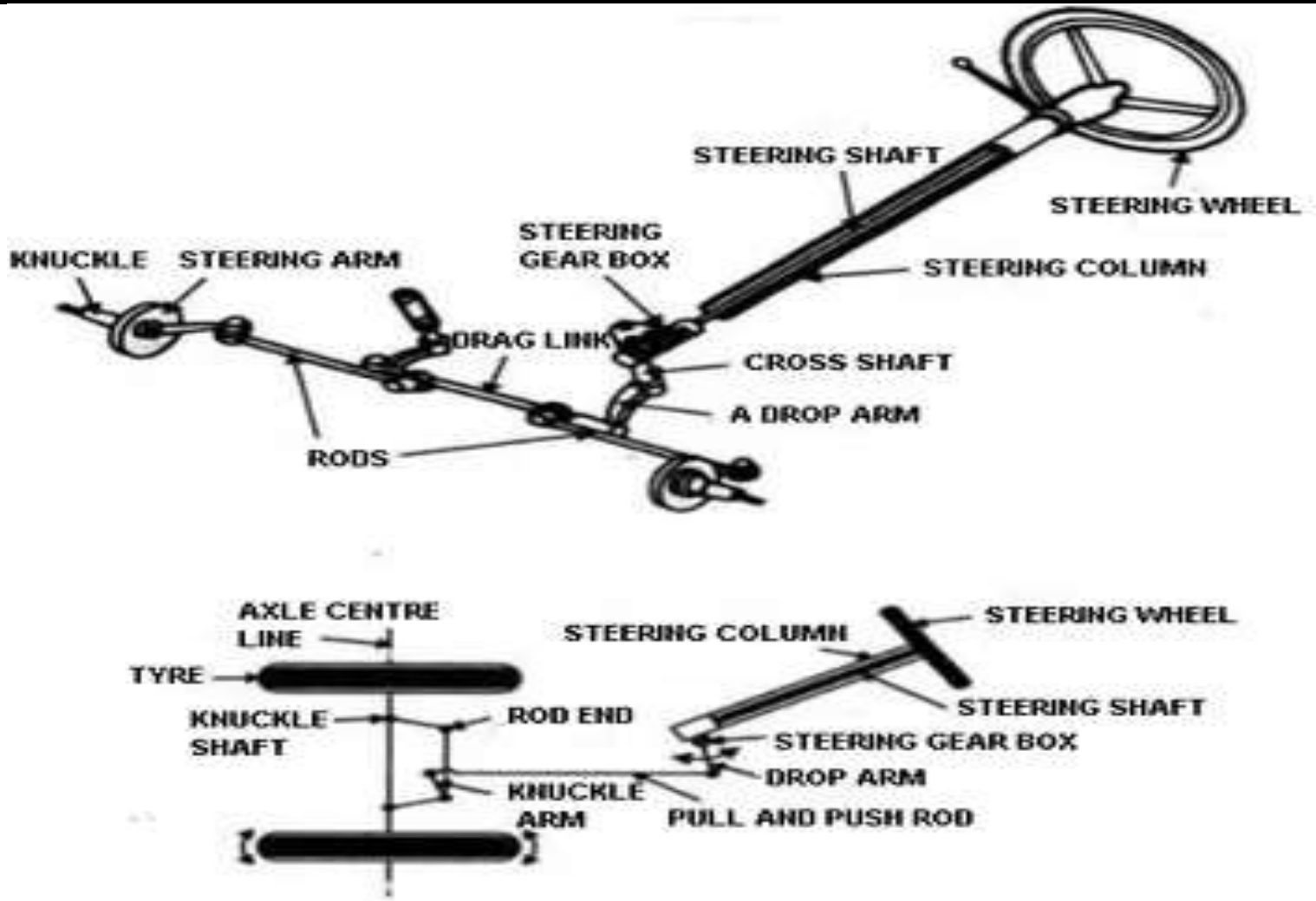
- Future of driver safety
- Communication with the vehicle
- To make safer and more efficient
- Reduce road crashes

Motivation

- Avoid accidents
- Unintentional lane departure accidents
- Human errors account for more than 90% of car accidents
- Move more safely and the road will be safer

Road Crashes

Working on the steering wheel



LAYOUT OF STEERING SYSTEM

What is the steering of the vehicle?

•Steering wheel rotates the steering column.
•The steering gearbox is fitted to the end of this column. Therefore, when the wheel is rotated, the cross shaft in the gearbox oscillates.
•The cross shaft is connected to the drop arm. This arm is linked by means of a drag link to the steering arms.
•Steering arms on both wheels are connected by the tie rods to the drag link.
•When the steering wheel is operated the knuckle moves to and fro, moving the steering knuckle are connected to each other.
•One end of the drag link is connected to the tie rod. The other end is connected to the end of the drop arm.

My Problem Statement

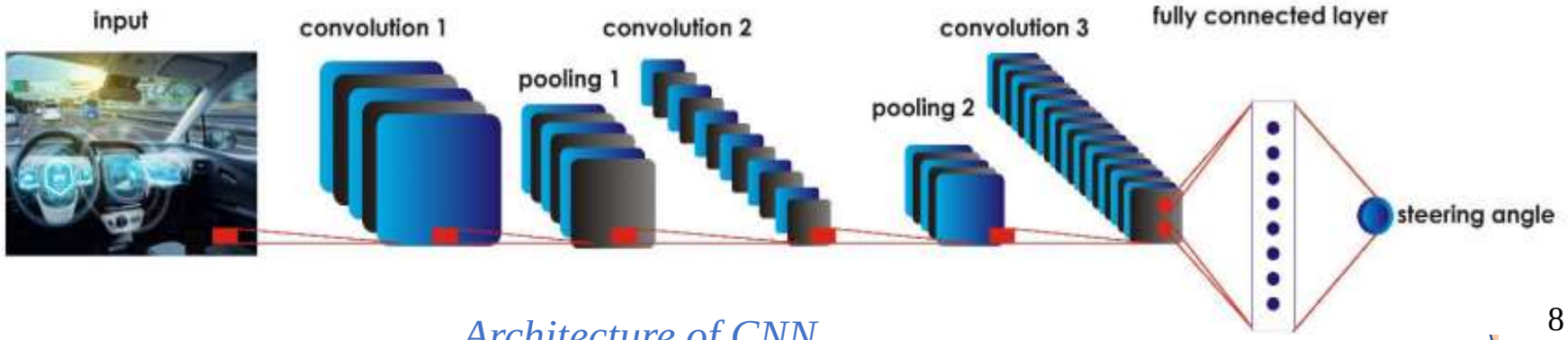
- Developing the smart steering control system for vehicle reverse parking

Reverse Parking

What did My Senior do?

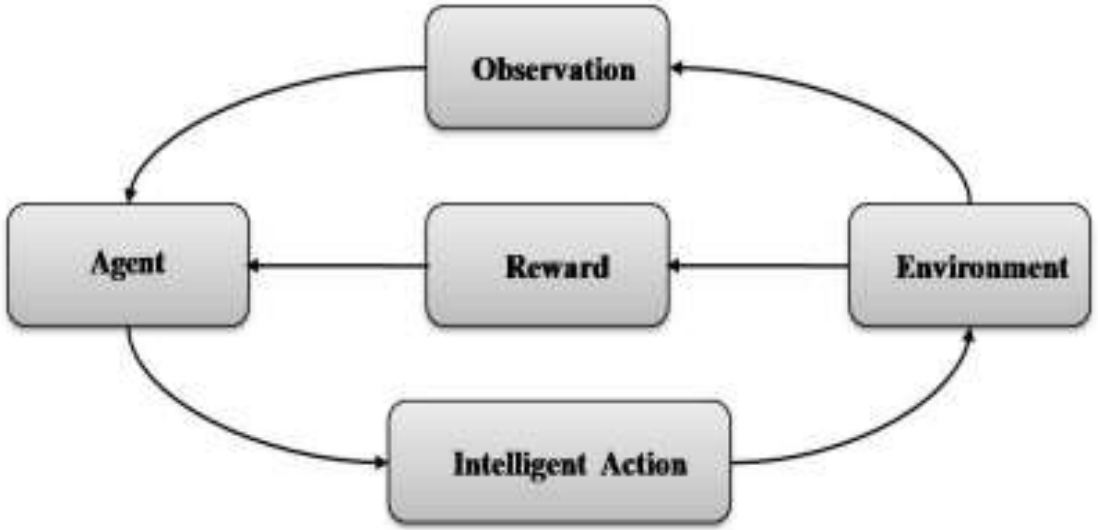
Different technique

- **Using Deep Learning**
  - Effectively processed unlabeled raw data
  - Insensitive to variation of environmental condition
  - It has tolerance for the mistake and quickly identifies errors
- **Using Convolution Neural Network**
  - It consists of three layers
    - Convolution Layer, ReLU Layer, and the Pooling Layer
    - It learns all the essential images
    - Performs well in the classification of images and object detection and steering angle prediction

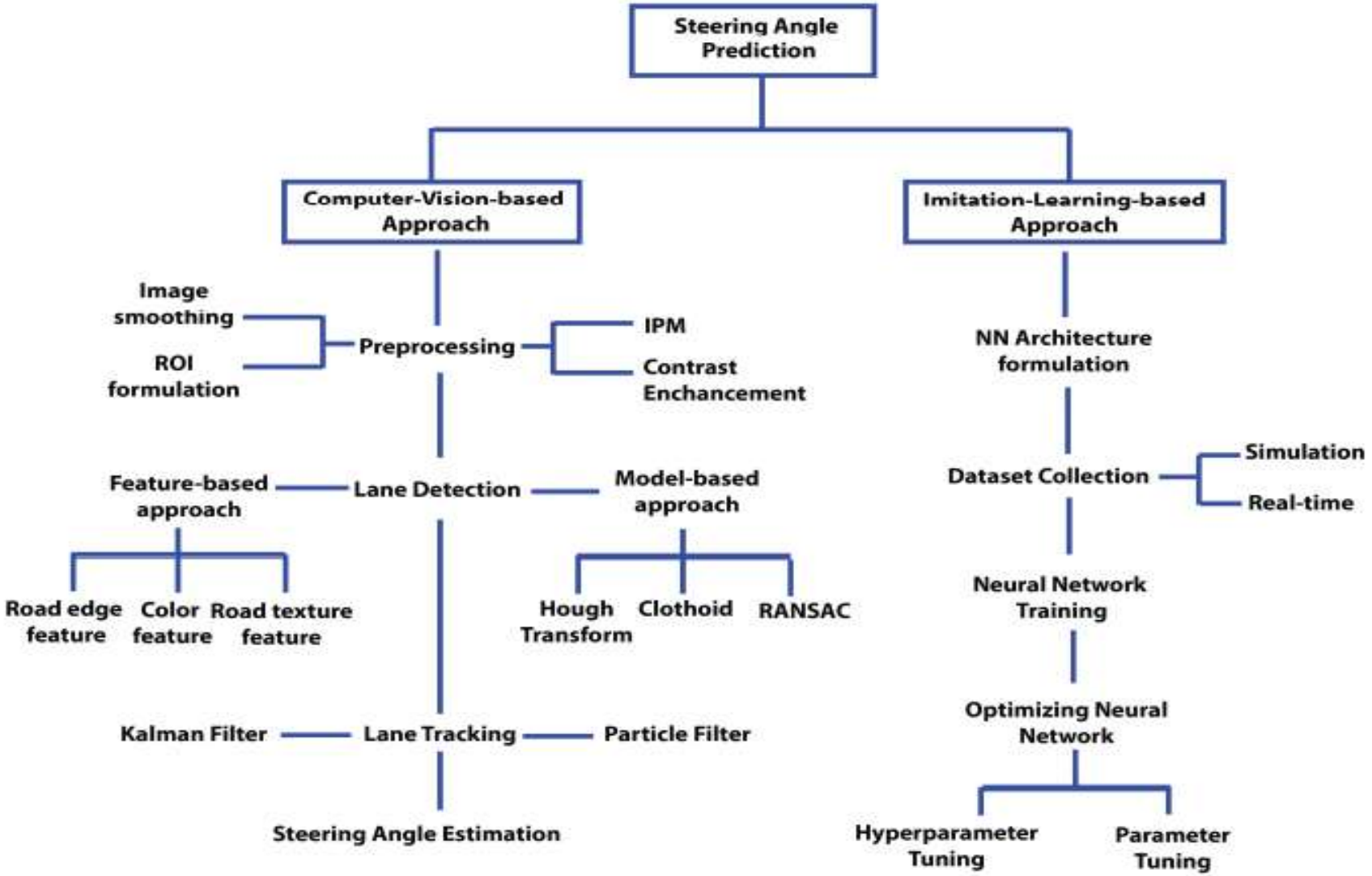


Architecture of CNN

- **Using Deep Reinforcement Learning**
  - Deals with sequences of complex decision making
  - Constitutes a reward-driven process
  - Used to self-develop the vehicle's path following



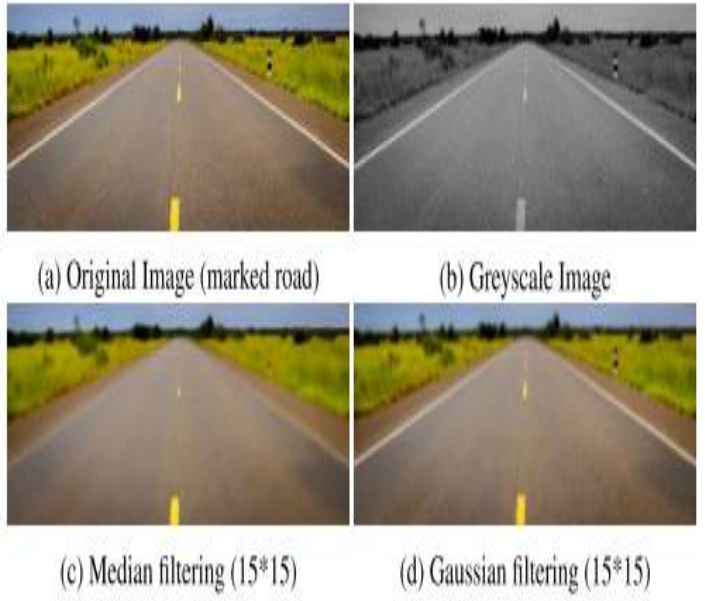
STEERING ANGLE PREDICTION USING A COMPUTER VISION APPROACH



STEERING ANGLE PREDICTION USING A COMPUTER VISION APPROACH

- PRE-PROCESSING
  - Calibration of the camera, illumination changes, poor visibility due to bad weather conditions, shadows, and light reflections
  - Methods- downsampling the image, image segmentation, image smoothing, extraction of Region of Interest
  - ROI – Important information taken, covers left and right lanes, can be determined prior to the road or roughly chosen lower portion of the images, improve computation efficiency and lane detection accuracy

  - IMAGE SMOOTHING, SHARPENING, AND SHADOW REMOVAL
    - blur the noisy details diminishing the impact of pixels
    - Most widely used filter- Gaussian and Median Filter

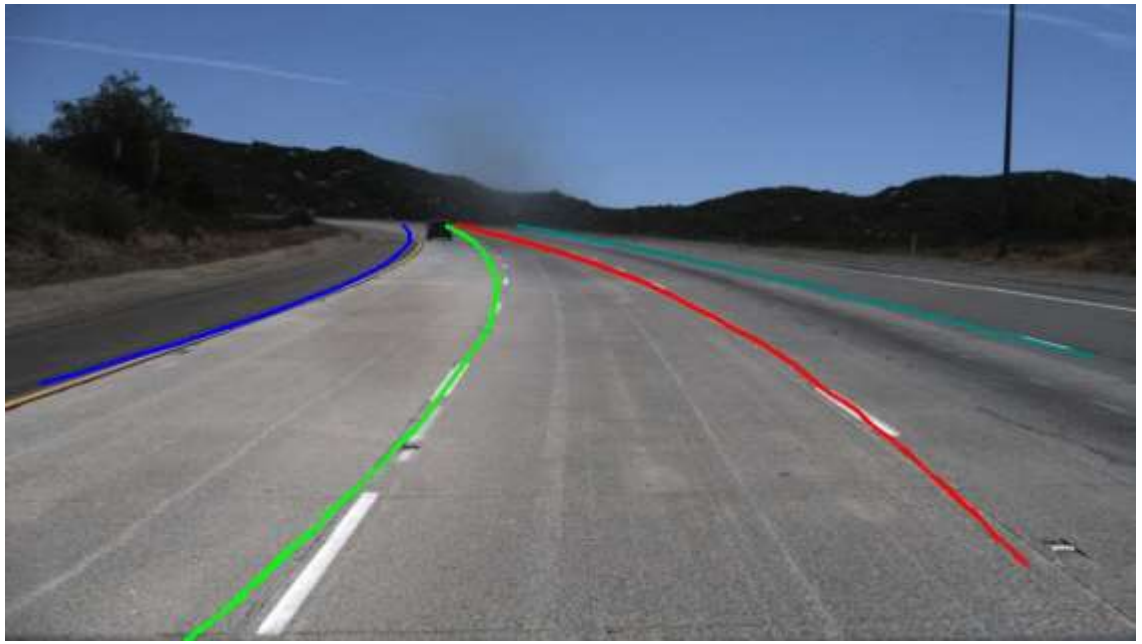


Inverse Perspective Mapping

- Top view or bird’s eyes view
- Mapping process of a 3D scene to 2D images
- To avoid the non-target edges exterior to the lane boundary

ROAD BOUNDARY DETECTION & TRACKING

- Identify derivable region on the road
- Ability to classify image pixels as belonging or not belonging(vision-based road area)
- Almost every lane detection algorithm follows three essential steps:
  - Lane feature extraction
  - Outlier removal
  - Lane boundary representation
- Lane Tracking
  - Kalman Filters
  - Particle Filters
  - Predict lane coordinate position



Lane Detection

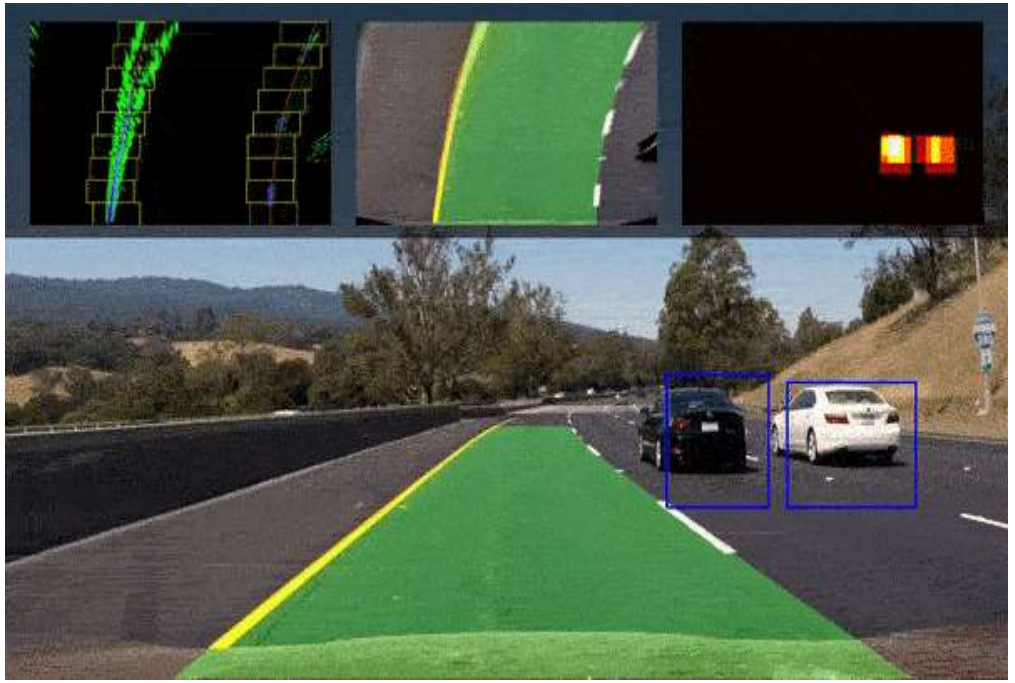
FEATURE-BASED TECHNIQUES FOR DRIVABLE ROAD AREA DETECTION

- Such as the geometric shapes, edges, color, gradient, and road texture
- **TECHNIQUES USING LANE EDGE OR GRADIENT INFORMATION**
  - Road lanes have brighter intensity
  - Gradient of dark-bright-dark
  - Canny edge detector
- **TECHNIQUES USING ROAD TEXTURE FEATURE**
  - Texture information is threshold intensity
  - Whole road region has darker than the surrounding
  - First applied IPM on acquired images frames and followed by intensity thresholding values
- **TECHNIQUES USING COLOR FEATURE**
  - All techniques involve in color feature
  - Typical image in RGB format
  - Illumination condition varying whole day

Canny edge detection

MODEL-BASED APPROACHES FOR ROAD AREA DETECTION

- Road boundaries points are matched with templates such as parabola, hyperbola, spline, and linear line
- **Hough Transform**
  - Works by finding the slope at each edge point and proposing a single line
  - Lane boundaries can be represented in coordinate
  - Connected dotted or disconnected lane edges
  - Not work in curve lane detection
- **Random Sampling Consensus(RANSAC)**
  - Separating inliers from the outliers
  - More effective in a curve as well as straight line detection

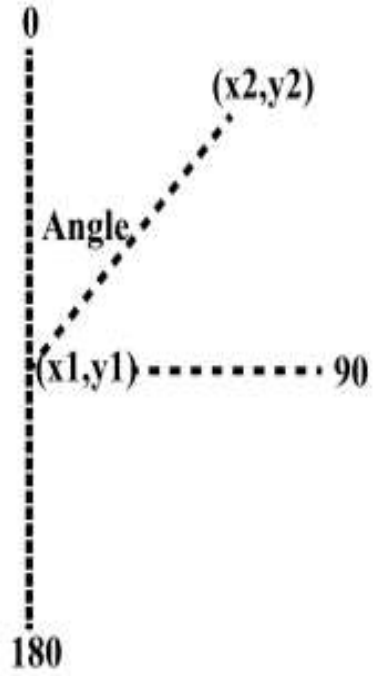


STEERING ANGLE ESTIMATION

- After the road boundary extraction process
- Extracted boundary points and heading direction of the vehicle
- Angle between the point of intersection and the heading direction of the vehicle
- PoI is (x, y) coordinate
- If the PoI and center point of the road are aligned, then the required angle for AV is zero

$$slope_{c1} = (s_l * b_r) - \frac{s_r * b_l}{b_r - b_l}$$

$$slope_{c2} = (s_l * b_r) + \frac{s_r * b_l}{b_r + b_l}$$



- If slopec1 is greater than slopec2 then choose slopec1 as the slope of the center line

Steering angle computation method proposed by Dev et a

Reverse Parking

- Automatic parking technology can complete parking operations safely and quickly without a driver and can improve driving comfort, while greatly reducing the probability of parking accidents
- Currently research is based on two methods:
  - Ultrasonic sensor
  - Based on Visual Sensor
- Existing automatic parking systems have two major problems
  I. Parking scene recognition less intelligent
  II. Vehicle control has a low degree of automation
- The advantages of ultrasonic sensor ranging, and machine vision target detection and identification are combined to improve both the parking scene recognition of automatic parking systems and the utilization rate of parking spaces

Future Work

- Vision-based lane detection
- Sensor fusion for lane detection and obstacle detection
- Steering angle calculation in reverse parking
- Implementation of the algorithm in a virtual environment
- Implementation of hardware (4^{th} sem)

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Thank you