LICENSE PLATE BLOCKER

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DESCRIPTION & GOAL

Project Description
1. Colorado License Plate Detector (Target Finding)

2. License Plate Censoring with Mask (Templating)

3. Car-to-Camera Pose Estimator (Pose Estimation & Camera Calibration)

Implementation
• Python 3.7.4
• OpenCV 4.1.1

HISTORY & PREVIOUS WORK

History
- First Attempted in 1976
- Became widely used in 1990s

Research
1. 1990s – 2016
   - Edge detection using various techniques
     - Sobel edge detector - vertical edges or rectangles
     - Filter edges based on width-to-height ratio
     - Filter based on number of objects within potential license plates
   - Search for Color Features
     - Sets of Hue, Saturation, Intensity
     - Color patterns common in specific plates
   - ~96% success rate
2. 2017 - Present
   - Training deep CNNs using over 20k images
   - 100% success rate

APPROACH

Colorado License Plate Detector (Target Finding)
1. Convert to Black & White
2. Thresholding
   - Blur Background
   - Detect Edges
3. Find Edge Contours and min & max (x,y) for each contour
4. Filter contours to find License Plate Character (LPC) contours
   - LCP Width-to-Length ratio
   - Minimum Y-Position of LPCs
   - Similar area of bounding boxes around LPCs
   - 6 LPCs in a row
5. Box LPCs
   - Save min (x,y) for left LPC
   - Save max (x,y) for right LPC
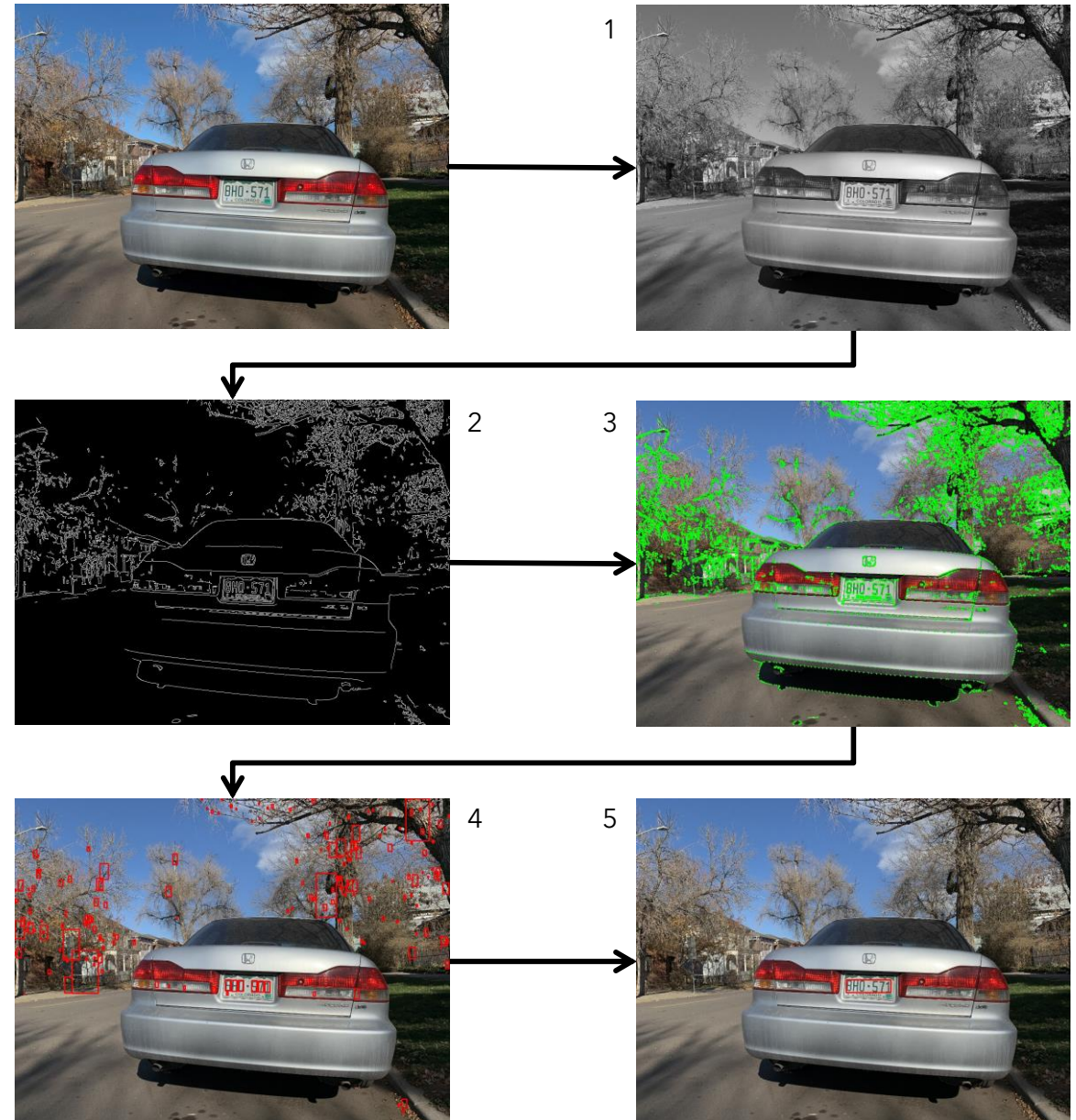
APPROACH CONT.

Issues with Approach
1. License Plate contours blend with Car contours
    • Cannot separate License Plate from Car features
2. Min & Max (x,y) of License Plate Character are not the correct points
    • Finding P1A & P4A
    • Want P1 – P4
        • Characters edges (ex: "A" or "V") are not always parallel to License Plate edges

P1A: min (x,y)
Also P1 & P3

V . . . . A

↑ y
└→ x

P4A: max (x,y)
Also P2 & P4
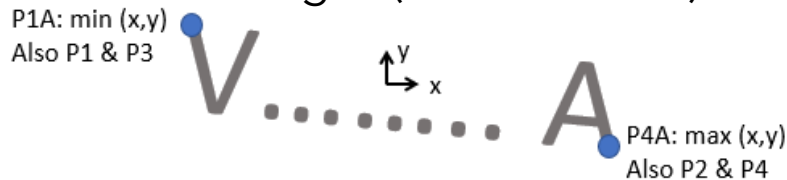
    • Causes problems with License Plate Censoring & Car-to-Camera Pose Estimator

P1: min y

P1A: min (x,y)

P2: max x

↑ y
└→ x

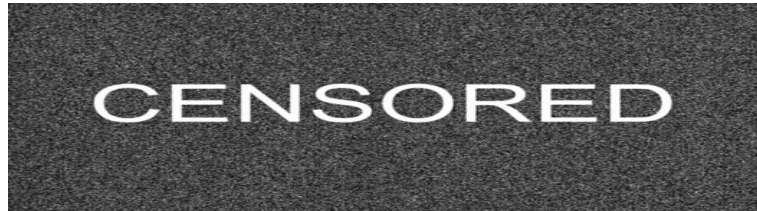License Plate Characters

P3: min x

P4A: max (x,y)

P4: max y

APPROACH CONT.

License Plate Censoring with Mask (Templating)
1. Select photo for Mask

2. Select corners of Mask to map to corners of License Plate Characters (LPCs)
3. Warp Mask to LPC corners
4. Place warped mask onto LPCs

NOTE: LPC corners are not true corners so mapping is not perfect.

APPROACH CONT.

Car-to-Camera Pose Estimator (Pose Estimation & Camera Calibration)
1. Measure Avg LPC dimensions & define world axis
    - Avg Colorado LPC dimensions = 10.25" x 2.5"
2. Find Homogeneous Transformation Matrix between LPC corners in World coordinates & Camera coordinates
    - OpenCV → solvePnP()
    - Camera Intrinsic Parameters needed
        - Found using MATLAB Camera Calibration
3. Project (x,y,z) axis points to Camera Coordinates
4. Plot axis to image

NOTE: LPC corners are not true corners so axis are not accurate.

EXPERIMENTS & RESULTS

- Tested on:
  - Different views of cars
  - Difference State/Country License Plates
- License Plate Detector not very robust
  - Works on 70% of tests (10 photos)
  - Research has ~96% success
  - Must be parked directly in front or behind (6 ft max) License Plate to detect
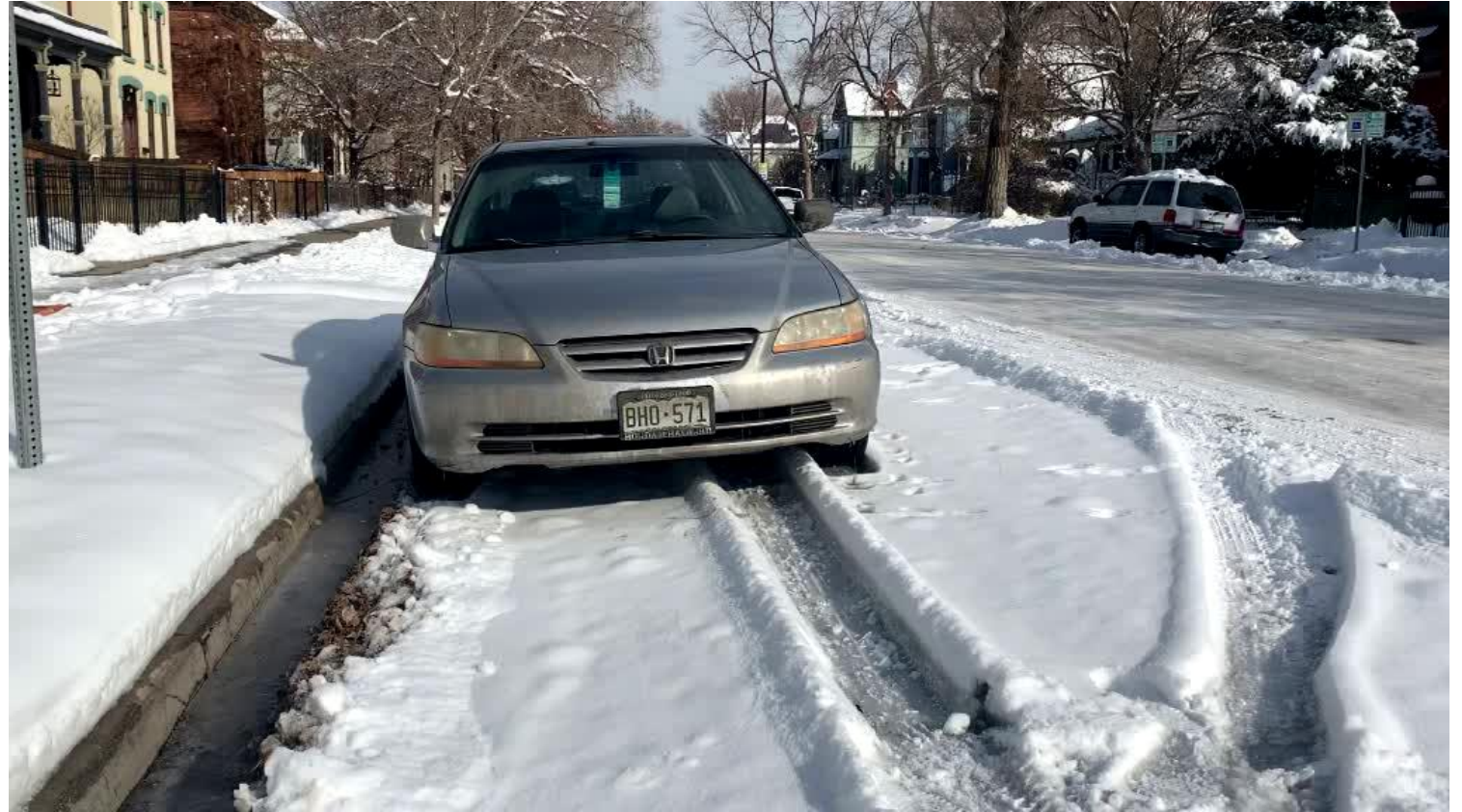
Success

Fail

EXPERIMENTS & RESULTS CONT.

- License Plate Detector not very robust (see demo)
    - ~82% of frames found LPCs
    - Research has ~96% success
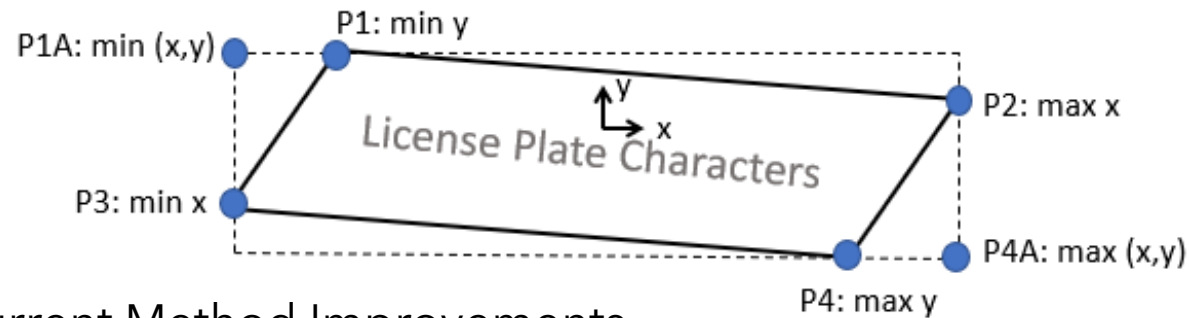   - Must be parked directly in front or behind (6 ft max) License Plate to detect

DEMO VIDEO HERE

IMPROVEMENTS & FUTURE WORK

Limitations
- Real time detection is extremely slow
- Cannot find correct License Plate Corners

Current Method Improvements
- Use camera zoom to detect from further than 6 ft away
- Implement other techniques to find License Plate Corners:
  - Find vertical edges or parallel edges with OpenCV Sobel()
  - Search for Color Features

Future Work
- Use ML to read License Plate Characters

QUESTIONS?