

---

---

# Autonomous Vehicle Edge Detection Project Plan

—— Yue Wang, Jae Woo Ok, Leanna Hue ——  
(Team 3)

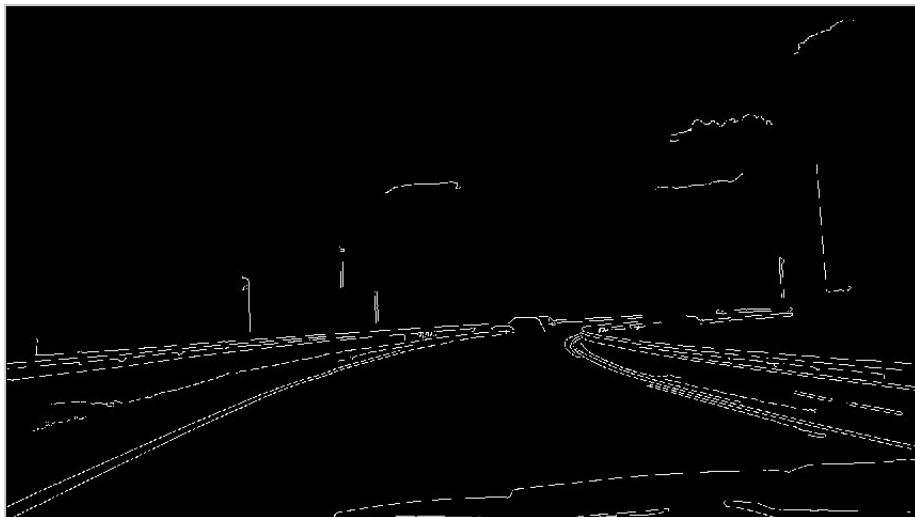
---

---

**START DEMO**

# Overview

Canny Edge Algorithm

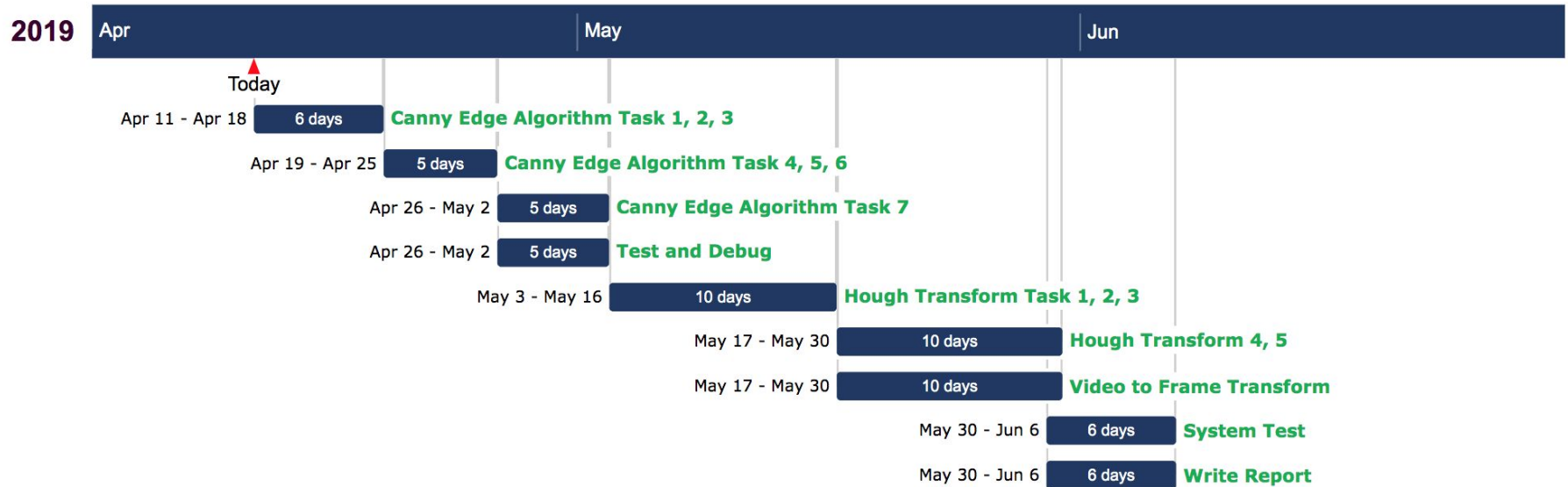


Hough Transform



# Development Plan

## Autonomous Vehicle Edge Detection



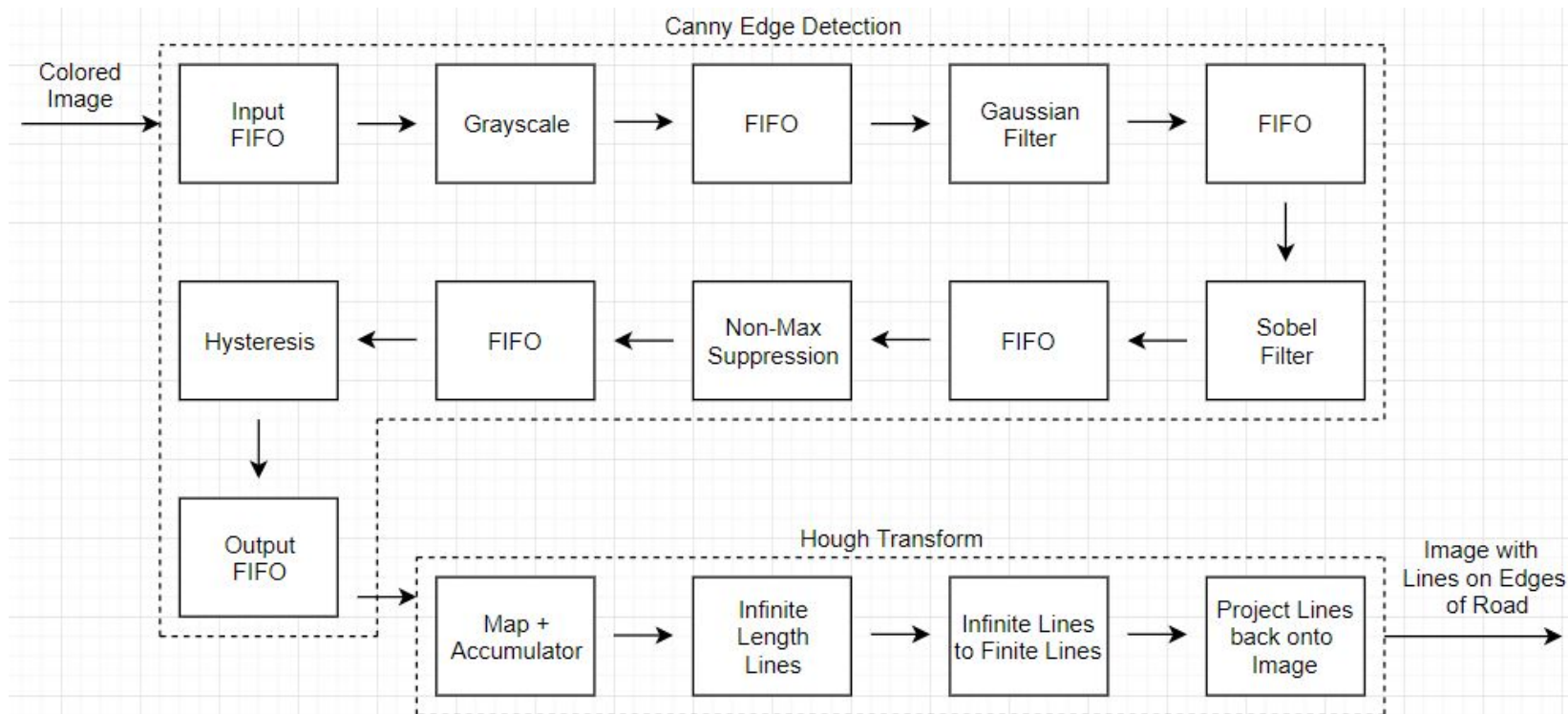
# Major Components

1. FIFO: Memory buffer to temporarily store data
2. Grayscale: Convert colored image into grayscale
3. Gaussian: Blurs image using 5x5 matrix
4. Sobel: Calculates gradients using a 3x3 matrix
5. Non-Maximum Suppression: Fixes thick white lines so they aren't as thick
6. Hysteresis: Keeps pixel if pixel exceeds high threshold, or if pixel exceeds low threshold value and there is one adjacent pixel

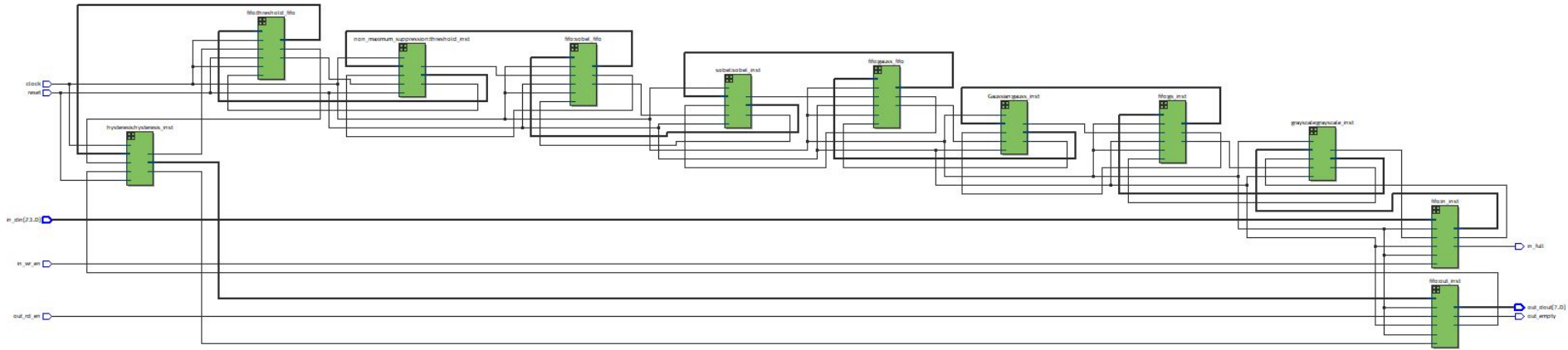
# Major I/O (For FIFO streaming architecture)

- Inputs: rd\_clk, wr\_clk, reset, rd\_en, wr\_en, din\_data
- Outputs: dout\_data, full, empty

# Block Diagram

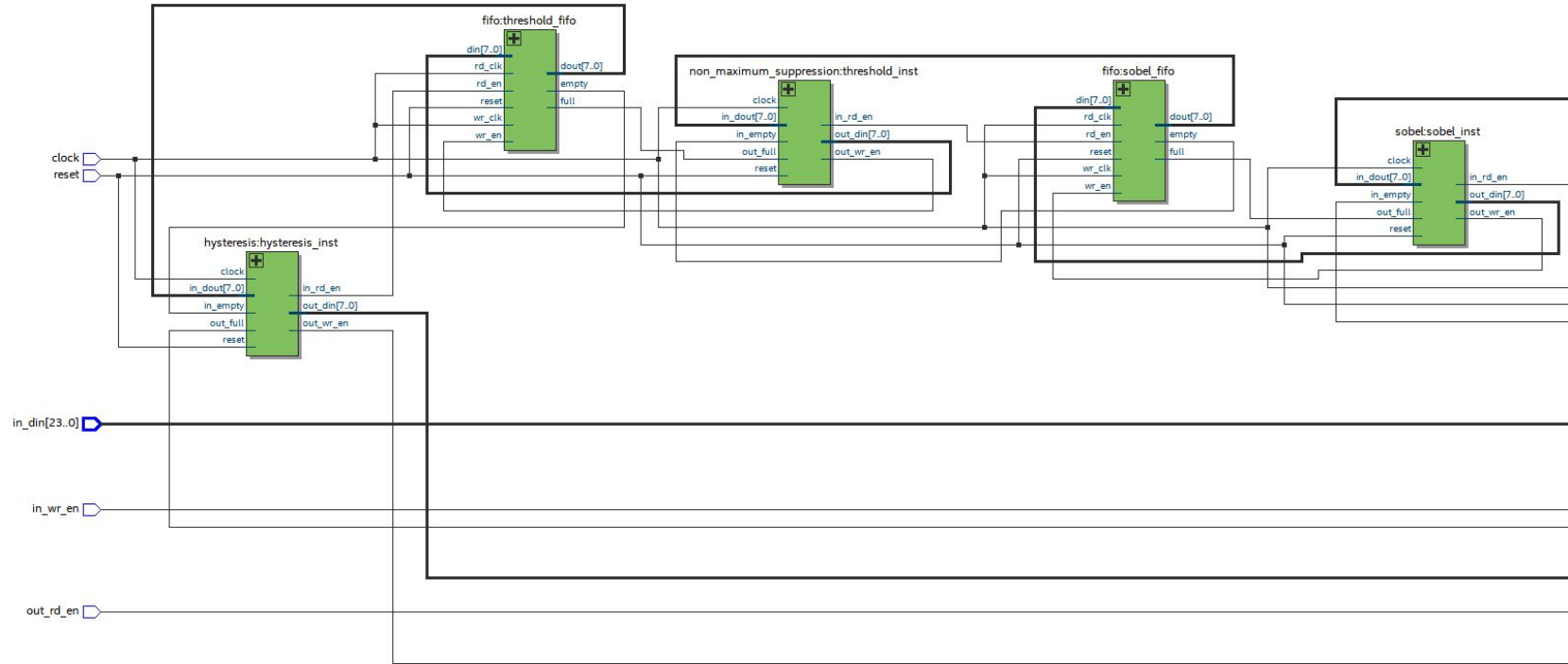


# Overall Component Block Diagram

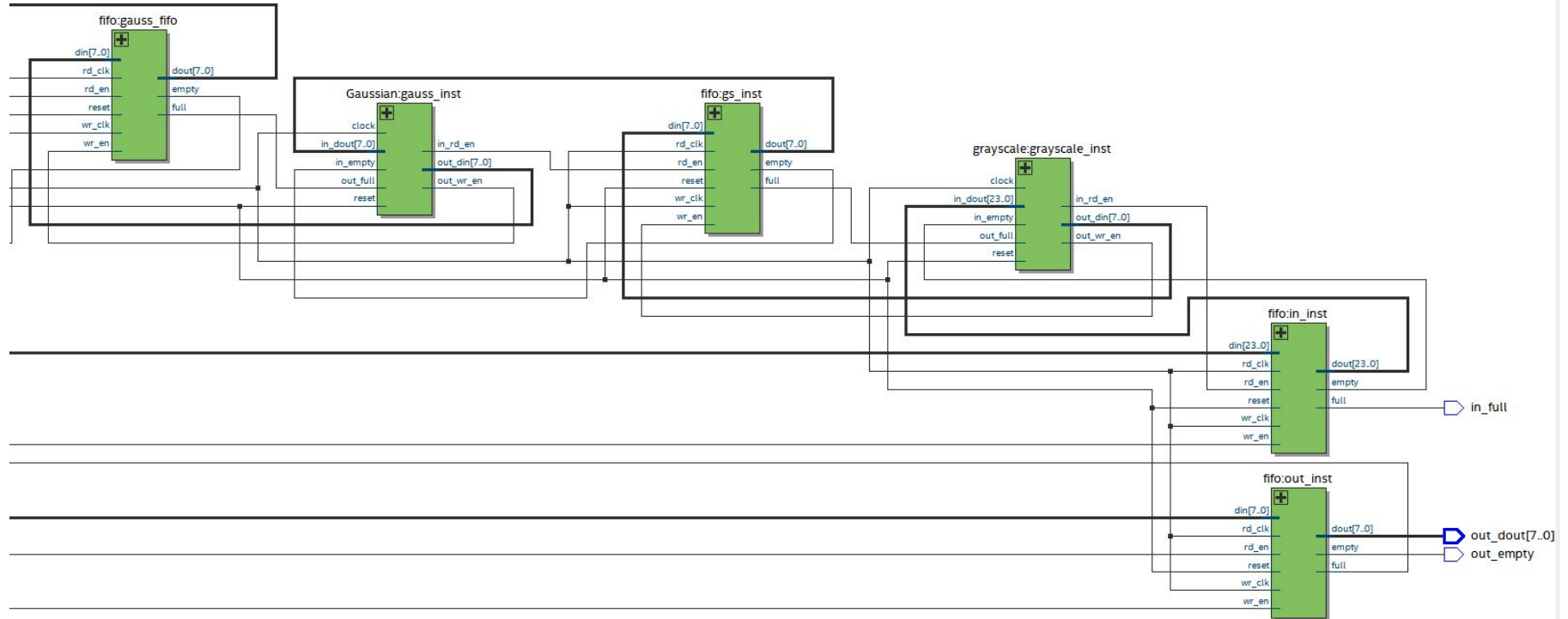




# First Half Component Diagram



# Second Half Component Diagram



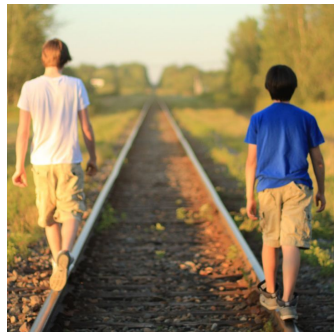
# Flow Summary

## Flow Summary

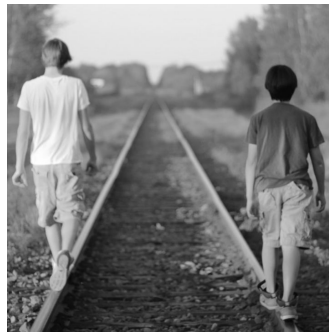
 <<Filter>>

Flow Status	Successful - Mon Apr 29 21:23:35 2019
Quartus Prime Version	18.1.0 Build 625 09/12/2018 SJ Lite Edition
Revision Name	AVED
Top-level Entity Name	AVED_top
Family	Cyclone IV E
Device	EP4CE115F29I8L
Timing Models	Final
Total logic elements	61,184
Total registers	58242
Total pins	38
Total virtual pins	0
Total memory bits	16,384
Embedded Multiplier 9-bit elements	16
Total PLLs	0

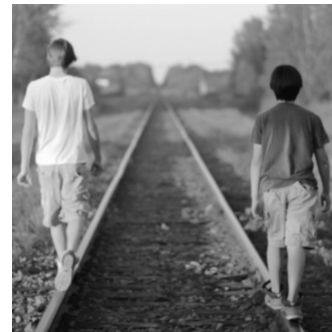
# Deliverables



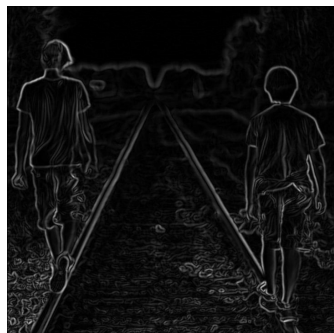
Original Image



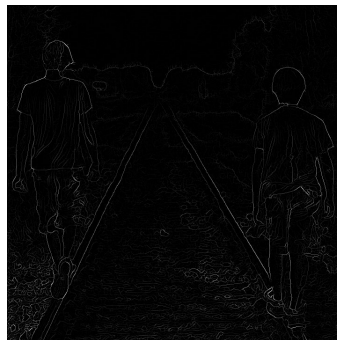
Step 1: Grayscale



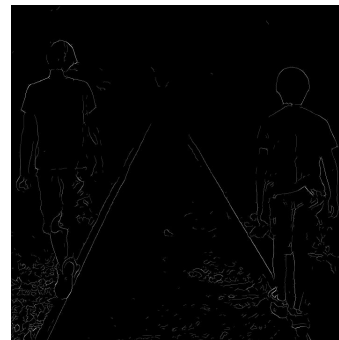
Step 2: Gaussian Blur



Step 3: Sobel Filter



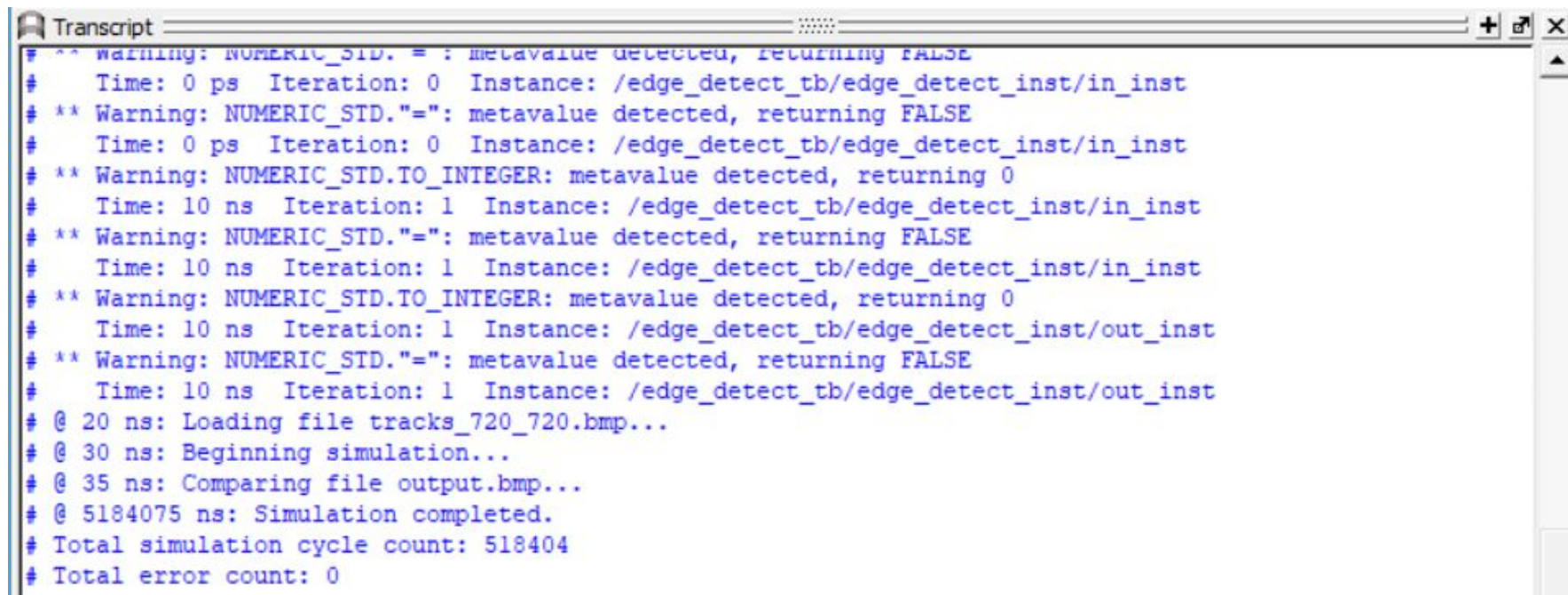
Step 4: Non-maximum  
suppression



Step 5: Hysteresis

# Performance and Testing

## Grayscale Sim. Output

A screenshot of a transcript window from a simulation tool. The window has a title bar with a small icon on the left and standard maximize, zoom, and close buttons on the right. The text inside is a log of simulation events, including warnings about numeric standard deviations, iteration and time logs for different instances, file loading, simulation start, comparison, completion, and final cycle and error counts.

```
Transcript
# ** Warning: NUMERIC_STD. = : metavalue detected, returning FALSE
#   Time: 0 ps   Iteration: 0   Instance: /edge_detect_tb/edge_detect_inst/in_inst
# ** Warning: NUMERIC_STD."=": metavalue detected, returning FALSE
#   Time: 0 ps   Iteration: 0   Instance: /edge_detect_tb/edge_detect_inst/in_inst
# ** Warning: NUMERIC_STD.TO_INTEGER: metavalue detected, returning 0
#   Time: 10 ns  Iteration: 1   Instance: /edge_detect_tb/edge_detect_inst/in_inst
# ** Warning: NUMERIC_STD."=": metavalue detected, returning FALSE
#   Time: 10 ns  Iteration: 1   Instance: /edge_detect_tb/edge_detect_inst/in_inst
# ** Warning: NUMERIC_STD.TO_INTEGER: metavalue detected, returning 0
#   Time: 10 ns  Iteration: 1   Instance: /edge_detect_tb/edge_detect_inst/out_inst
# ** Warning: NUMERIC_STD."=": metavalue detected, returning FALSE
#   Time: 10 ns  Iteration: 1   Instance: /edge_detect_tb/edge_detect_inst/out_inst
# @ 20 ns: Loading file tracks_720_720.bmp...
# @ 30 ns: Beginning simulation...
# @ 35 ns: Comparing file output.bmp...
# @ 5184075 ns: Simulation completed.
# Total simulation cycle count: 518404
# Total error count: 0
```

# Performance and Testing

## Gaussian Sim. Output

```
Transcript
# @ 5198465 ns: gaussian_output.bmp(518397): ERROR: 80 != 83 at address 0x0007E8FC.
# @ 5198475 ns: gaussian_output.bmp(518398): ERROR: 80 != 83 at address 0x0007E8FD.
# @ 5198485 ns: gaussian_output.bmp(518399): ERROR: 80 != 83 at address 0x0007E8FE.
# @ 5198495 ns: gaussian_output.bmp(518400): ERROR: 80 != 83 at address 0x0007E8FF.
# @ 5198505 ns: Simulation completed.
# Total simulation cycle count: 519847
# Total error count: 356997
```

# Performance and Testing

Sobel Sim. Output

```
# @ 20 ns: Loading file stagel_gaussian.bmp...  
# @ 30 ns: Beginning simulation...  
# @ 35 ns: Comparing file sobel_output.bmp...  
# @ 5191295 ns: Simulation completed.  
# Total simulation cycle count: 519126  
# Total error count: 0
```

# Performance and Testing

Non-Max. Suppression Sim. Output

```
# TIME: 10 ns ITERATION: 1 INSTANCE: 711
# @ 20 ns: Loading file stage2_sobel.bmp...
# @ 30 ns: Beginning simulation...
# @ 35 ns: Comparing file nms_output.bmp...
# @ 5191295 ns: Simulation completed.
# Total simulation cycle count: 519126
# Total error count: 0
```



# Performance and Testing

## Hysteresis Sim. Output

```
# @ 20 ns: Loading file stage3_nonmax_suppression.bmp...  
# @ 30 ns: Beginning simulation...  
# @ 35 ns: Comparing file hyst_output.bmp...  
# @ 5191295 ns: Simulation completed.  
# Total simulation cycle count: 519126  
# Total error count: 0
```

# Performance and Testing

Top level Canny-Edge Sim. Output

```
# @ 5220235 ns: 518399: 00  
# @ 5220245 ns: Simulation completed.  
# Total simulation cycle count: 522021  
# Total error count: 11725
```

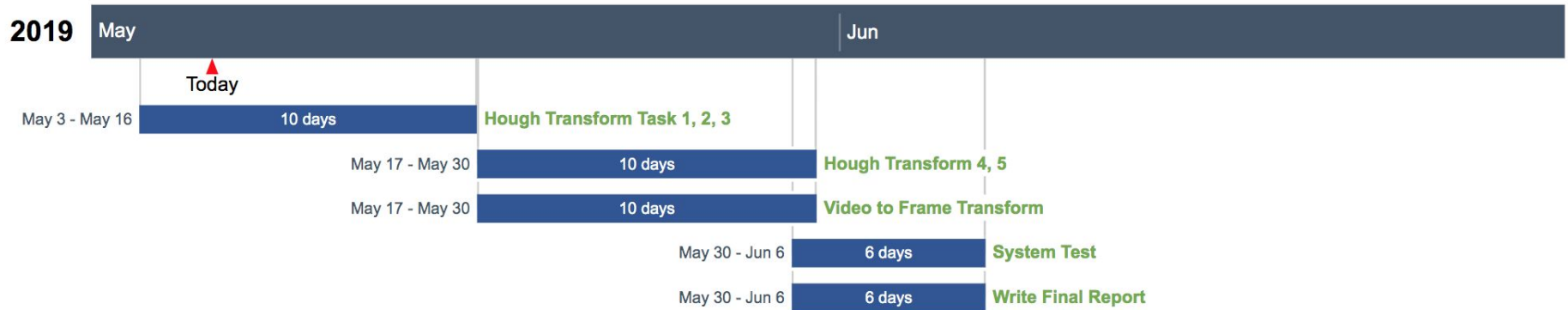
# DEMO RESULTS

# Challenges

Gaussian Filter



# Autonomous Vehicle Edge Detection



# Next Steps

Hough Transform

