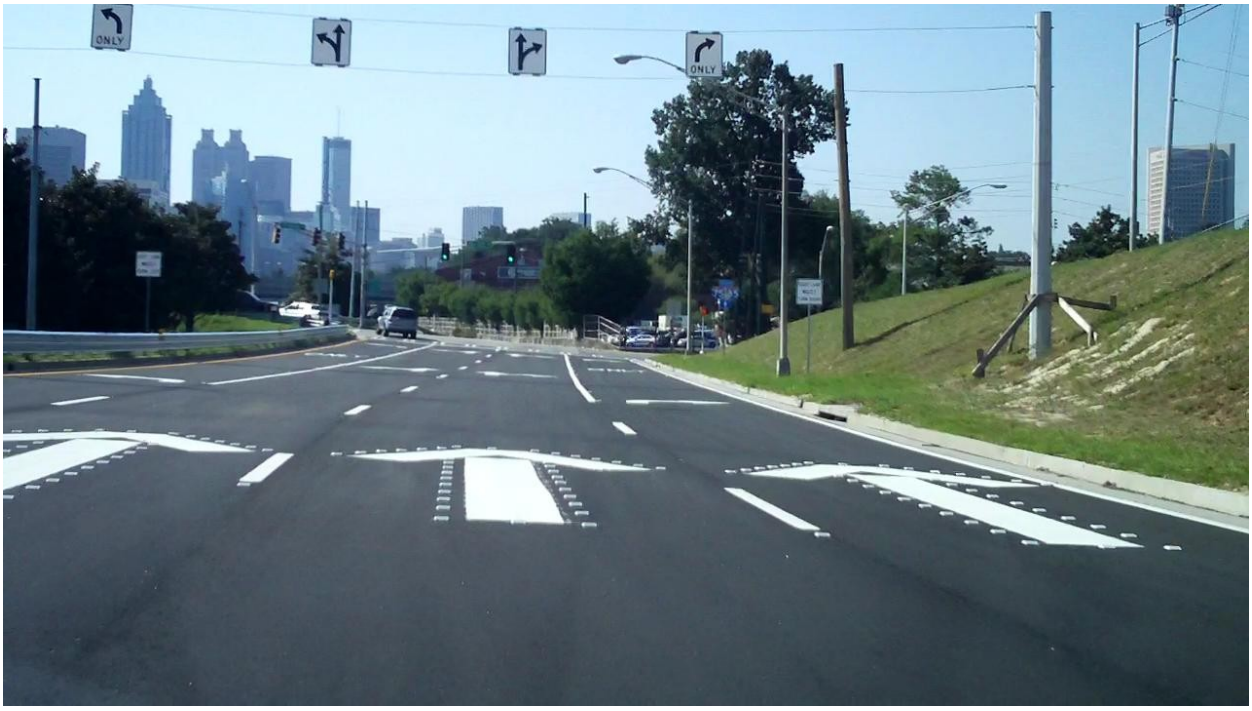


Summary: Embedded video surveillance is starting to play a role in automotive operation and safety. A small embedded camera can be positioned to monitor lane markings. If the wheels begin to leave the lane (lane departure) without lane change signaling, the driver is alerted. In some systems, braking or steering automatically returns the car to the lane unless the driver is actively turning the wheel.

At typical automobile cruising speeds, scene geometry for side mounted cameras prohibits normal capturing of clear images. At this near distance (less than 1 meter), the road blurs by. Lighting can also be problematic. Often supplemental IR lighting must be used.

But alert people can assess their vehicle's lane position using the more favorable viewing angle out the front windshield. In the frame above, we can quickly discern our position in the second lane from the right. This view also provides greater anticipatory data on impending lane paths.

The goal of this project is to define, implement, and evaluate (at the functional level), an advanced lane monitoring system that can provide automobiles with improved data using low cost embedded imaging components.

The task is to analyze a video sequence collected from a forward-facing camera positioned in the bottom center of an automobile windshield to determine the location of lanes, to determine when the vehicle is leaving its current lane, and to generate a report summarizing the position of detected lanes and lane departure events. The output report must contain a frame by frame summary of identified lanes and departure events. In particular, for each frame, the report must specify exactly one "departure event entry" and any number (≥ 0) of "lane entries". A **departure event entry** is of the form: "DE: n" where n is one of:

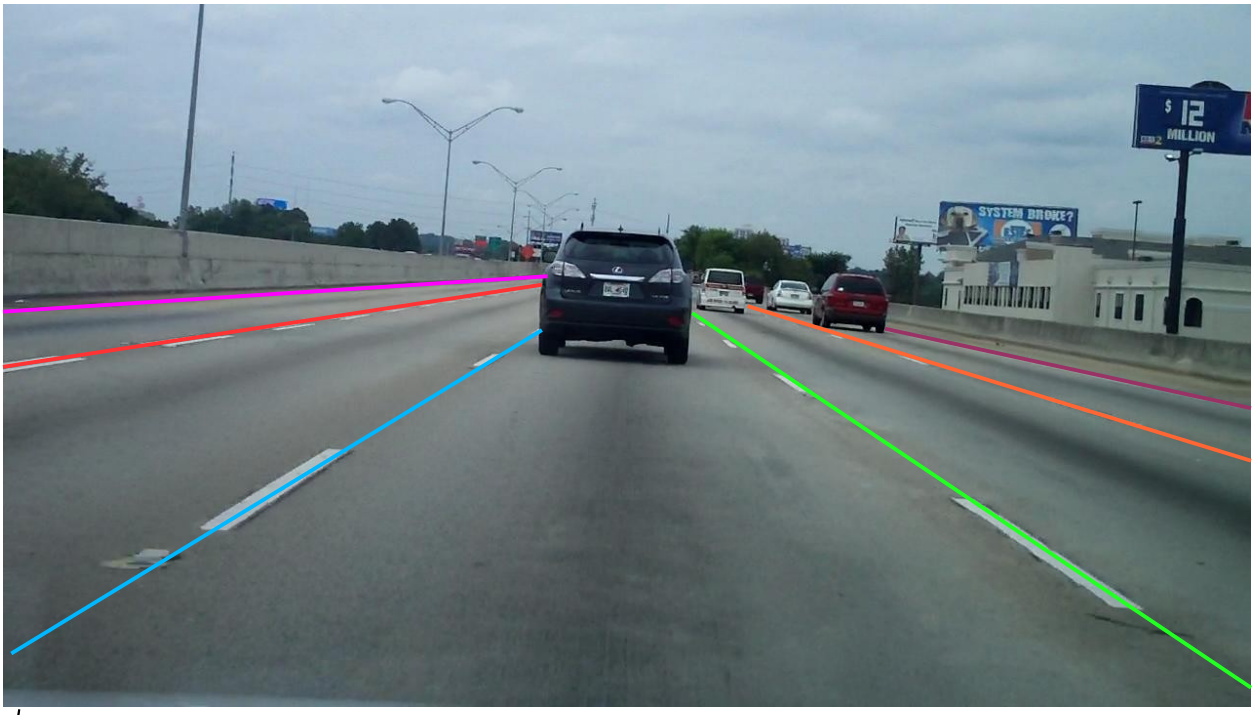
- -1 if the vehicle is moving left into another lane
- 0 if the vehicle is maintaining the same lane
- 1 if the vehicle is moving right into another lane.

A **lane entry** is of the form: "LE: (X0, Y0), (X1, Y1), (X2, Y2)…", where the ordered pairs represent points on the lane boundary. A lane entry must have at least two points. All reported positions are in pixels and are relative to the upper left hand corner of the frame as (X, Y) where X in the row offset and Y is the column offset. The points in the lane entry must be given in the order in which they appear on the lane boundary from bottom of the image to top (i.e., maximum Y to minimum Y).

A report also contains a preamble with the sequence name, start frame and end frame number. Here's an example:

```
Seq:        20090825-10a

Start:      16

End:        1000


FN: 00016

      DE: 0

      LE: (1278, 647), (603, 388)

      LE: (280, 719), (503, 388)


FN: 00017

      DE: -1
      LE: (1278, 675), (602, 388)

      LE: (279, 719), (502, 388)
```

The images are collected at 60 frames per second. The video sequences must be processed in order. ***A program must not look ahead in the sequence***.



√ **Checkpoint Deliverable 1**: Part of the project grade is scholarship: finding and using published related research. *Each member of the team* must identify a paper in the literature that is related to this project and must prepare a short presentation, using the template found at

http://users.ece.gatech.edu/~scotty/8893/Fall09/P2-1_Checkpoint_Template.odp.

The paper should be a research paper (from a refereed journal or conference) that addresses some aspect of the problem (e.g., moving camera video analysis, autonomous lane following, multiple object tracking, dealing with occlusion, large scale changes, and/or rapid environmental changes). Each team member should prepare a 10 minute presentation that summarizes:

- the paper's key contributions
- its technical approach
- which parts may be applicable to your project (e.g., what can you borrow, build on, or extend?)
- whether the approach is amenable to an embedded implementation in a real-time system (e.g., consider its computational/storage requirements, typical frame rates, and applications for which it has been developed and experimented with).

Email a pdf of the paper and your presentation to linda.wills@ece.gatech.edu before the meeting. Be sure to include a full citation of the paper in your presentation.

Schedule your team for a Checkpoint meeting through T-square's sign-up tool (https://t-square.gatech.edu/portal) during the week of **28 September 2009.** Only one person per team (preferably the contact person) should sign up the team for a slot, but all members of the team should participate in the checkpoint. To communicate via Skype, connect to "scott.wills".

√ **Checkpoint Deliverable 2**: Schedule your team for a Checkpoint meeting through T-square's sign-up tool (https://t-square.gatech.edu/portal) during the week of **25 October 2009.** Only one person per team (preferably the contact person) should sign up the team for a slot, but all

members of the team should participate in the checkpoint. The team must prepare a short presentation on the status of your project, using the template found at http://users.ece.gatech.edu/~scotty/8893/Fall09/P2-2_Checkpoint_Template.odp. This presentation should include an illustration of your approach, *a description of how the work is partitioned among team members*, and a summary of preliminary or intermediate results. Bring a hardcopy of your presentation to the meeting (if it is a Skype meeting, please email the presentation to linda.wills@ece.gatech.edu beforehand). To communicate via Skype, connect to "scott.wills".

Final Submission: The final submission consists of three parts, two of which are prepared as a team and one is prepared individually:

1. **P2-3.zip** (submit one zip file per *team*): this zip file must contain all source code for solving the project task and it should contain a textual report file for each input video sequence provided for this project. The report file for a given sequence (e.g., 20090825-10a.mov) must be named <sequence-name>.txt (e.g., 20090825-10a.txt). It must contain a departure event entry and 0 or more lane entries for *each* frame.
2. **P2-4.pdf** (submit one pdf file per *team*): Team Project Write-up, *co-authored by all members of the team*. It should contain the following:
    a. Team member names and project number.
    b. **Challenges Addressed**: summary of the technical issues that you focused on and the insights you had in addressing them.
    c. **Approach**: Brief description of your approach, including workflow diagram and a description of the algorithms used.
    d. **Results**: Summary of results, including example annotated images at points of interest in the sequences.
    e. **Discussion** of results, including when does your approach work well and what are its limitations.
    f. **Real-time Embedded Issues**: discuss to what extent your approach is amenable to an embedded implementation in a real-time system (e.g., consider its computational/storage requirements, frame rate, application constraints or features you can take advantage of to realize an efficient implementation).
    g. **Bibliography**: paper citations and URLs for related work and for algorithms or code you are using that you did not develop.
3. **P2-5.pdf** (submit one pdf file per *student*): Student Project Write-up, ***written individually by each student***. It should contain the following:
    a. Your name and project number.
    b. **Responsibility**: Describe the part of the project you were responsible for. How does your part fit in with the overall team project? What is the interface to and from your work (i.e., what data do you use as input from other parts, what data do you provide as input for other parts)?
    c. **Scholarly Connection**: Select a paper in the literature that is related to your part of the project and describe what elements of the paper relate to your part. For example, did you build on or extend an algorithm? Did you create an algorithm or

representation that is a complementary approach? What did you extract and use from the paper?

d. **Insights**: What technical problems did you solve? Did work that you are building on work as advertised? Did you improve upon it? What did or didn't work?

e. **Bibliography**: paper citations and URLs to work related to your part of the project.

2. These submissions must be properly uploaded to the submission site before the scheduled due date, **9:00pm on Tuesday, 3 November 2009**.

Demo Day Deliverable: Each team should prepare an *eight-minute* presentation to share with the class during Demo Days, scheduled for the week of **9 November 2009**. The presentation should summarize your approach, results, and insights.

Project Submission Instructions:

When you are ready to submit a file as your answer to a part of the project, use your web browser to go to the web site: http://www.ece.gatech.edu/~scotty/8893/projects/index.html.

Click on FILE UPLOAD which will take you to the ECE 8893 File Upload page. This contains a form for you to enter your GT ID (e.g., gtgeopb) and the name of the file to upload (e.g., C:\My Documents\FrameWork\GeorgeBurdell.jpg).

Double check that the name of the file uploaded is the one you intended to submit.

If you submit a file as the answer to part of the project and later you would like to submit an improved answer, you may submit the more recent version of the file. Only the most recent one will be graded. However, versions submitted after the due date will not be graded.