

LMS-1 Customer Meeting 10/23/20

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Background:

- Graduated in 2017 from MSU
- Worked at GM for three years as a software developer - > AIML (super and ultra-cruise features on GM now, hands-free driving)
- Carnegie Mellon – MS Business Analytics Class of 2022

Summary from LMS-1 Questions

- How does the system respond when the driver is making a lane departure?
 - Lane departure treated as just crossing the line. The system should detect if it is an illegal exit of the lane.
 - An illegal exit is not using the turn signal.
 - If the driver uses their turn signal, the system temporarily turns off and will just warn the driver as they cross lanes.
 - Collision avoidance is not part of the system. Another system is responsible for making sure there is no car/object in the other lane.
- What happens if lines are indistinguishable whilst driving?
 - In subdivision/ dirt roads or where there are no lines, the system does not work. It will be turned off and inform the driver.
 - Anytime there is not a visible set of lines on each side of the vehicle the system will turn off and the driver will be notified.
- How does merging lanes work?
 - System is active if lane lines are there. When merging, the system can use GPS and camera/sensors to know if it should temporarily disable itself.
 - Under normal circumstances, the driver should signal when merging, which would by default disable the system temporarily.
 - For a freeway passing-lane merge, the system knows where these are thanks to mapping. It may (optional) be able to go into the other lane. Collision avoidance is not a part of this system so it may have to interface with other systems.
- How does manual override work?
 - Use a torque threshold of force for turning the wheel. When this threshold is met, system correction actions will disengage but warnings will remain enabled.

- What are the speed thresholds for the system?
 - Maximum: no limit
 - Minimum: 35 MPH
- How independent are the lane keeping, lane departure, and lane-centering systems?
 - Lane centering allows the system to be active
 - Warning system will always go off unless temporarily disabled via driver input (turn signal, manually turned off)
 - Lane keeping is triggered by a warning system
 - All have to work together, but the automatic corrective actions can be disabled independently.
 - If not working correctly, the system will not be able to turn on and will notify the user it is off, likely via a display on the dashboard.
- Is the system customizable from the user side?
 - Lane management will know the vehicle's center. The driver will not be able to customize this.
 - They can change the type of warnings. They will do this in the system settings on the console (optional).
 - Seat vibrations, alarm, wheel vibration, lights, etc.
- How should the system behave if lane lines intersect at an intersection?
 - The system should be able recognize when lines are intersecting, and ignore the intersecting lines.
 - The vehicle should continue following the original set of lines.
- How is customer satisfaction considered?
 - When on, it should work well but not be overbearing to the customer.
 - Not engaged, should let the driver know, should be disengaged if the driver wants it to be.
 - If the user finds alarms are annoying and intrusive, drivers can customize types of warnings. There is a minimum of some audio warning.

Summary from other team's questions

- How does the system react in heavy weather conditions?
 - There is a GPS component to find the lanes and cameras that are part of this system. We determine how these should be included. Should self-detect if it does not have enough information, and will turn off and let the driver know.
- What exact signals are used for lane departure?

- Always warn them with an audio warning. Optionally, detect the severity of how bad, and add more intense warnings. It should be a visual indicator of the status of the system if the system is engaged or disengaged.
- Controlling LMS in itself, can LMS be shut off by the user (only send warnings)?
 - Enable/disable for both warnings and for actual corrective.
 - How turned off? Some buttons or switch by driver console. If corrective action is enabled, the warnings are always enabled.
- Best way to engage/disengage the LMS system?
 - If there is enough force on the wheel (seems intentional), the system will disengage. This is measured in torque. The system knows when the limit is crossed. The warning will be issued, but no corrective action. Once re-centered in a lane, the centering system will re-engage
- Warnings in general – if quite windy, how often do lane correction warnings occur? Distractions to drivers?
 - The warning will be issued WHENEVER crossing the lane, no matter what.
 - We can determine the severity and issue different types of warnings.
- If barriers are too close or no lane lines, can we add proximity sensors?
 - We can add proximity sensors if we see fit (optional)
 - If lines are not painted lines on the road, the system will not work.
- What happens if the lane management system and going in lane currently, if the car merges into YOUR lane?
 - This would be part of the braking system, only affects you if the driver starts swerving out of the lane.
 - We do not need to worry about crashing into another vehicle.
- System should only be engaged if the system can detect lines on both left AND right and if these lines are painted lane markers. Nothing else is necessary
 - Map system provides coordinates; the system should cross-reference that and make sure it is matching. If unable to validate that, then disengage the system.
- Is the system able to predict users is going to change lanes, predict future moves?
 - Add another system to LMS, can add another component to predict something about to happen, may not issue warning then (optional).
- How should LMS react when approaching an accident or end of the highway, etc.
 - Is there a pause state for the system, or is there an on/off?
 - We can add additional systems if we want too, or if it will enhance current systems.
- How does the system detect intentionality?
 - Turn signals and the amount of torque on the wheel.

- How much can the system move the steering wheel?
 - Assume a limit to the curvature. The system cannot make sharp turns for the driver, however the system can adjust to natural curvature in roads and lines.
- How many cameras, location?
 - At your discretion! As vehicle size changes, the number of cameras will change as well. Use a midsize car for your design, Chevy Cruze is a solid choice for this.
- Any alternative reasons LMS should be activated when the car is in automatic drive mode?
 - MUST BE in forward drive mode, this means no neutral, reverse, or park. Overdrive and gears on a manual transmission it will work.
- Separate algorithm for braking on curves. Braking and acceleration are handled by another system, which our system can interact with only briefly. We can assume any algorithm for this is handled.
- Think about integrity and quality check on all cameras etc. Every single time the car turns on. If any of these sensors are not performing their duties properly, how do we accommodate this? We can design to have a backup as well for this.
 - If there are any issues keeping any part of the system from performing then the entire system should be disabled and the driver notified.
- There are no wipers on the camera, but you can design an internal camera that's protected from debris.
- If one of the cameras is not working, will turn off and notify, might be worth having something in place to notify the driver about which camera is not working if possible.
- Best locations: behind the rearview mirror at the top of the dash, to the right and front at the top of the car

Follow-up Questions

- Does the system save if it has been turned off in the last drive? Is this different for lane departure warnings versus lane keeping?
- How does this system interface with other systems on the car? Are these cameras shared with other systems?