CSE 435 - Requirements Meetings - Debrief

Our Group - LMS 3 Questions & Answers:

- **Should there be a speed minimum and or maximum for the system to be active at?**
  - **A:** Speed minimum: 35 mph, No maximum speed is necessary
- **How close to the line should the driver receive a warning? How close until torque is applied to the system?**
  - **A:** Deviation from the center line, push alert (10% off center line, send alert). Start applying torque when the lane is crossed
- **How far does the vehicle have to go to start steering back into the lane?**
  - **A:** The lane border has to be crossed. Essentially passing the line. Based on the tires/vehicle border which is provided with the vehicle data
- **Should there be a limit on the frequency of system alerts?**
  - **A:** Primary and secondary alerts. Primary alerts like lane correction and lane leaving need to be as often as they occur as they create safety issues. Secondary alerts that don't cause safety issues can be "soft alerts" like an alert on the dash
- **How should the system handle absent lane markings?**
  - **A:** Priority is to use lane coordinates available via GPS systems. This is to serve as backup. If no GPS coordinates can be found, disable system
- **What should the system do when the lane markings are not detectable?**
  - **A:** Notify the driver that the markings are non-detectable and then disable the system. It can be set to be re-enabled automatically when markings are re-detected. System notifications can vary (lights, sounds, words on dashboard)
- **Does the system need to be turned back on manually when automatically turned off due to error?**
  - **A:** No, the system should be in a passive state in these situations and automatically re-engage. However, if manually turned off by the driver, the system should not automatically turn on
- **How do we ensure that the driver has their hands on the wheel and not just letting the LMS drive the car?**
  - **A:** If the amount of corrections is more than three times in a minute, an alert/warning should be pushed that the LMS is going to be disabled. Then, disable the system
- **What is the maximum amount of torque that the system should apply?**
  - **A:** There is no maximum, if you find an unsafe amount, then upper bound it. Speed should be reduced when correcting as well requiring less torque to be applied
- **Are there any specific legal requirements that need to be followed for this system to be compliant?**
  - **A:** The driver should have hierarchy and full control of the vehicle at all times. There should never be a situation where the driver cannot take control of the vehicle

- **How long does the LMS need to see lane markings in order to start functioning?**
    - **A:** About a second, but this is a soft requirement and can be changed at designers discretion if we find a better or different threshold

Summary of LMS 3 Q&A:

It should be noted that not all of the questions listed above are “word-for-word” the questions we had listed in our requirements document but, due to the round-robin nature of the meeting, many of the questions we wanted to ask were asked by other groups. The recorded questions and answers above are what was discussed during the meeting. To start, we found all of the answers we were looking for. It was useful to have a few clearly defined boundaries for the system, such as knowing what the minimum speed required in order for the system to function is. It was also nice to clear up confusion on how much torque the system would be allowed to apply. We were informed that there was no upper bound on the torque the system could apply, but it was mentioned that if we found in our research a torque that seemed dangerous for the passengers and other vehicles on the road, that we were free to upper bound the torque with whatever number we ended up determining was too dangerous. We were also able to clarify how the system should behave in conditions in which lane markings were absent or unclear along with how long it should take the system to re-engage when it re-detected lane markings. One final thing we wanted to clear up as a group were the legal constraints that the system needed to have in order to avoid potential legal issues pertaining to user and system interaction. We learned that the only legal requirement was that the driver needs to have control over the vehicle at all times meaning that there should never be a situation in which the system has more control over the vehicle than the driver.

Other Group Questions - LMS 1, 2, and 4 Questions & Answers:

- **If one subsystem fails, how should the other systems respond?**
    - **A:** If the subsystems have dependencies and one fails, the other should fail as well. Determine which sensors are critical and uncritical and go from there in order to determine functionality
- **How much control should the system have over the vehicle when the system is active, such as when the vehicle moves the car?**
    - **A:** Steering and Speed control should be what's needed. Thresholds should have an upper limit on how much steering is allowed. Steering torque applied at different speeds needs to vary due to mathematical and physics constraints
- **What’s the confidence threshold for the LMS System (detecting lane markings)?**
    - **A:** 98% should be the confidence level. If below that level, LMS should be disabled
- **How should the LMS be able to distinguish between intentional departure as opposed to unintentional departure?**

    - **A:** Use of a turn signal means intentional departure, no signal means unintentional
- **Should the system disengage because of a sudden “jerk” of the wheel?**
    - **A:** This is considered driver override because of the driver applied torque
- **What should the prerequisites for turning on the system look like?**
    - **A:** Previously enabled on the last drive (“Engine Cycle”), if not, the driver should be able to turn it on or off at their discretion. Secondary option for secondary systems such as and lane centering
    - **A:** If the camera fails and there are no GPS lane coordinates, the system should not be active
- **What are road-side units and how do they interact with the LMS?**
    - **A:** Speed Limits that are marked for certain sections of the road. Info is available for the system to use
- **Are there other systems apart from cameras that are used to detect lane markings and position?**
    - **A:** The GPS information of the vehicle can also be used to gain lane coordinate data in order to figure out the position of the vehicle relative to the lane (whether it is in the lane). These coordinates are one point on the left and right lane every meter
- **What if the opposite turn signal is on and the driver goes right?**
    - **A:** This needs to be corrected by the system as it is opposite the signaled direction
- **Can the LMS control the speed of the vehicle?**
    - **A:** Yes, assume curve calculations. Speed is only controlled for steering purpose, such as road conditions or a curve in the road
- **Should filters be applied to the Images processed by the image processing system in less than ideal conditions?**
    - **A:** Assume the system is just providing the image as it is taking, if unclear, disengage system
- **How often is periodically as it pertains to system checks within the requirements document?**
    - **A:** 10 times per second. Assume this is enough for road conditions for the system and the vehicle path
- **If there is an obstacle in front of the vehicle, how does the LMS react?**
    - **A:** Out of scope if it doesn’t relate to the lanes. The driver is responsible for avoiding objects in the lane
- **Does the system have a connection to the internet or bluetooth?**
    - **A:** System updates happen over the air with vehicle updates which are satellites. No internet or bluetooth connectivity. GPS information comes from satellites as well.
- **How should the system handle differing weather conditions?**
    - **A:** Acceptable weather is full visibility. As long as the lanes are visible, the system is active. If the system cannot detect lanes, LMS should be turned off. In icy zones, corrections can create dangerous situations. Safety measures need to

be added if ice or other potentially dangerous weather based situations are detected, (Weather data).

- **What does the system consider a "lane"?**
    - **A:** Lane markings, when visible, on both sides of the vehicle that are yellow and/or white and dashed/solid. Bike lanes that are green can be taken into account as well.
- **If the vehicle is merging into a lane, and there is a vehicle in the blindspot, should the LMS send a warning or attempt to correct this behavior?**
    - **A:** No, this is out of scope
- **What should the ideal user interface look like? Should UI be customizable?**
    - **A:** There is no ideal UI but the UI should not be customizable
- **Should the driver be able to customize the alerts?**
    - **A:** Only for the secondary alerts, the "soft alerts"
- **With customizable features for automatic lane sensing and such, should there be LMS profiles for different drivers?**
    - **A:** Yes, there can be customizable profiles for different drivers
- **What kind of security measures need to be incorporated with the system?**
    - **A:** Internet connectivity, but there is no connection. Bus controls can be compromised, so there needs to be an encryption on the messages that the LMS is sending
- **How does the supervisory control subsystem work?**
    - **A:** It's the main operation of the LMS. It's working in the background working the system and controlling the logic gates, (if it's on or off, if the vehicle drifts out of lane, whether or not to correct something). Manages the systems data and makes the decisions on whether or not to engage or disengage the system.
- **How does the system react to temporary lane departures?**
    - **A:** The ideal case is that the system treats it as a lane departure and tries to correct it. If this is override, disengage system and then re-engage system when line are re-detected
- **If the vehicle is over a lane marking, what should the system do?**
    - **A:** Disengage because the system won't be able to detect the lane markings as they would be to far away from the vehicle
- **Are each of the three subsystems dependent on each other?**
    - **A:** Centering is independent of the other two. Departure warning goes in hand with the keeping system, they're not dependent on each other but should operate on the same conditions

<u>Summary of LMS 1, 2, and 4 Q&A:</u>

The other group's questions were useful in clarifying other aspects of the system's functionality. To start, we covered more primary requirements to the system's functionality, things such as what should occur when one of the systems subsystem fails or what the confidence level should be in order for the system to make decisions on actually moving the vehicle. We were informed that if a subsystem failed, and the system is dependent on the functionality of that subsystem, the LMS should alert the driver and turn off. Similarly, other

subsystems dependent on the subsystem that failed should fail as well, however they should alert the driver that the LMS is no longer working and the LMS should disengage. We also learned that the confidence level required in order for the system to function properly should be 98%. It was also clarified that a turn signal followed by movement in the direction of the signal signifies intentional movement out of the lane and should be ignored by the LMS. However, a turn signal followed by movement in the opposite direction of the signal needs to be treated the same as accidental lane departure and the LMS should attempt to correct for it.

Next, we covered the prerequisites for the system to be on and functioning. On top of the 35 mph+ speed, we learned that if the system was on during the previous Engine Cycle the system would start on (passively until 35 mph was reached). We also clarified that if the camera system was failing, we could rely on GPS coordinate information gained from the satellite(s) the vehicle is communicating with in order for the system to function. However, if both of the systems fail, the LMS should turn off. The supervisory control subsystem was also clarified for the group. It is essentially the system manager and logic controller for the LMS. Meaning it decides whether or not to engage or disengage depending on the data and information it has and receives.

We also covered a lot of what is considered out of scope for the system, such as avoiding objects in the lane (which we determined is the responsibility of the driver) along with applying filters to the image for image processing. We determined that the image is whatever standard is fed by the camera subsystem and therefore anything that is unclear is considered un-usable and the system should alert the driver it cannot continue function and halt function. It is also the driver's responsibility to be aware of the vehicles around it and in its blindspot as the LMS will not work to avoid other vehicles or objects next to the vehicle or in the vehicles blindspot.

We went over some final scenario clarifications such as what the LMS should do when it cannot detect lane markings or if the vehicle is directly on top of a lane marking. Because the vehicle would be too far away from the markings on the sides of the vehicle, we were informed that the system should disengage when over top of a lane marking. We also clarified what the system should be able to determine is a lane marking. Valid lane markings were defined by the customer for us as yellow or white, solid or dashed lines on each side of the vehicle. It was also noted that green bike lanes can also be considered as valid lane markings if they appear on the side of vehicle.

Finally, we covered secondary requirements of the LMS such as alert and system customization. We established that the system should not be able to be customized by the user; however the "soft alerts" could be customized at the user's discretion. We also established that we could implement customizable driver profiles similar to the types of chair, steering wheel, and mirror positioning driver profiles that exist in most cars today.