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PCAS1: Requirements List

1. The autonomous vehicle will have the following properties:
   1.1. The autonomous vehicle shall have a normal steady state speed of 50 kph.
   1.2. The autonomous vehicle shall have an acceleration to steady state speed of 0.25g.
   1.3. The autonomous vehicles width is 2m.
2. The pedestrian will have the following characteristics and shall be detected and avoided by the PCAS system:
   2.1. The pedestrian can be static or in motion. While the pedestrian is in the static state they will have a speed of 0 kph. While the pedestrian is in motion they will have a speed of 8kph.
   2.2. The pedestrian can change velocity with infinite acceleration.
   2.3. The size of the pedestrian in the x-y plane shall be considered a circle with a 0.5 m diameter.
   2.4. When the pedestrian is in motion they shall only move perpendicular to the vehicle's path.
3. When the autonomous vehicle is put into drive the PCAS system shall activate within 0.25 seconds.
4. The PCAS system shall communicate with a stereo camera positioned on the front of the autonomous vehicle.
   4.1. The stereo camera shall have a view that encompasses the front 180 degrees of the autonomous vehicle.
   4.2. The stereo camera shall be able to recognize and track pedestrians giving the pedestrians location relative to the vehicle with an accuracy of +/- .5m
   4.3. The stereo camera shall be able to detect the pedestrian’s speed and direction with a +/- 2m/s and +/- degrees respectively.
5. When the autonomous vehicle is in drive a stereo camera shall send the PCAS system a packet of information every 100ms (the cycle time of the stereo camera).
   5.1. The packet of information given to the PCAS system by the stereo camera shall include: pedestrian recognition and tracking, Pedestrian location (x,y) relative to vehicle with accuracy +/- .5 m, Pedestrian velocity (speed & direction). Speed +/- .2 m/s. Direction +/- 5 deg
6. After the pedestrian has been picked up by the stereo camera the PCAS system shall determine when the vehicle needs to brake using the stereo camera outputs.
   6.1. The PCAS system shall determine if the vehicle needs to brake by calculating the time it will take for a collision to take place with the vehicle and the pedestrian.The PCAS system shall ensure that the vehicle decelerates such that the autonomous vehicle does not exceed 10mph within 15 ft of the pedestrian.

The PCAS system shall also calculate the deceleration needed to bring the vehicle to a stop 5 feet before the vehicle would collide with the pedestrian.

6.2. The PCAS system will send a signal with the declaration speed to the Vehicle Brake by Wire System which will then reduce the velocity of the autonomous vehicle as requested. The Brake by Wire system shall:

6.2.1. responded to requests from our system

6.2.2. override the steady state velocity of autonomous vehicle when commanded to brake

6.2.3. apply brake torque using electro-mechanical actuators on all four wheels of the autonomous vehicle

6.2.4. have a deceleration accuracy within +/- 2%

6.2.5. have a response time to decelerate within 200ms

6.2.6. have a release time within 100ms

6.2.7. have a maximum deceleration is .7g (1g = 9.81 m/s^2)

6.2.8. allow the autonomous vehicle to return to steady state velocity after the break command ends

7. When the autonomous vehicle begins to break due to the Vehicle Brake by Wire System the PCAS system shall continue to recalculate and evaluate the output from the stereo camera. This will account for the conditions of the road. If the car is not stopping as expected from the first calculations it will continue to recalculate based on the new conditions every 100ms.
8. After the vehicle comes to a complete stop the system shall keep the car in a complete stop until the pedestrian is no longer in the path of the autonomous vehicle.
9. Once the pedestrian is no longer in the path of the autonomous vehicle the PCAS system shall no longer notify the Vehicle Brake by Wire System to stop the car and allow the car to accelerate at a steady rate of 0.25g until the autonomous vehicle reaches its steady state speed of 50kph. This shall happen within 5s of the pedestrian not longer being in the path of the autonomous vehicle
10. The system shall monitor every 5 minutes to see if the stereo camera is obstructed.

10.1. If the stereo camera is obstructed the system will alert that user that it needs to be cleaned and that the system shall not be activated until the camera is cleaned off. When the system is not activated we will not be legally responsible for any collisions.

11. When the vehicle is no longer in drive the system shall turn off within 0.25 seconds.
12. If there's a problem with the main system (software failure, malicious attack), switch to the failsafe system

12.1. The failsafe system has a slower response time than the normal system (200ms to 900ms) and will need to be considered

Global invariants:

1. Once the autonomous vehicle is put into drive the system shall activate within 0.25 seconds and shall remain on the duration the vehicle is in drive.

2. While the PCAS system is activated it shall read the output of the stereo camera every 100ms to check for a pedestrian in the vehicle's trajectory.
3. When the autonomous vehicle is approaching a pedestrian the vehicle shall stop within 5 feet of that pedestrian.
4. The PCAS system must meet performance requirements despite weather, lighting, and poor road conditions.
5. The autonomous vehicle's normal steady state speed is 50kph
6. The pedestrian sensor is active and must be connected to the Vehicle Brake by Wire System actuator.
7. The PCAS system must avoid collisions in emergency situations
8. The autonomous vehicle must slow down to avoid hitting pedestrians, speeding back up to the autonomous vehicle's steady state speed once risk is gone.
9. The PCAS system must minimize lost time
    9.1. "Time difference (in seconds) between system on and system off to reach a common point beyond the pedestrian with controlled vehicle back again at steady state velocity"
10. The vehicle shall not exceed 10 mph if an obstacle is detected within 15 ft.

Questions:

1. How do you want the PCAS system to behave in the case where the driver is overriding steering and/or acceleration/breaking?
2. How do you want the PCAS system to behave in the case where slowing the autonomous vehicle down would lower the distance between the pedestrian and their path relative to the vehicle? (for example, when people stand in the road or are walking slowly perpendicular to the road)
3. Can you go into more detail about the desired positioning and quantity of cameras we will use for the system?
4. Can you go into detail about possible security breaches that have the potential to endanger pedestrians?
5. After the PCAS system detects that there is a pedestrian ahead of the autonomous vehicle and needs to brake, how would you like the system to interact with the user? Would you like the system to alert the user?
6. After the autonomous vehicle stops for the pedestrian and the pedestrian is no longer in the way of the autonomous vehicle what do you want the system to do?
7. If the user tries to override the PCAS system what would you like the system to do?
8. As a customer, what is the most important requirement that would ensure your safety?
9. As a customer, what is the most effective way to enhance this system?
10. As a customer, what are your biggest challenges and doubts in this system?
11. When would the failsafe PCAS system need to be activated?
12. Why is there such a difference in response time between the normal and failsafe systems?
13. What would happen if a pedestrian walked out in front of the autonomous vehicle without enough time for the vehicle to slow down?