Advanced Software Engineering Homework 4

1. A List of Requirements
    1.1. Functional Requirements
        1.1.1. The backup collision system is only active when the vehicle is in reverse mode.
        1.1.2. The vehicle has a 4K resolution, 180-degree FOV, backup camera installed in the center (vertical and horizontal) rear of the vehicle exterior.
            1.1.2.1. This assumes a communication connection with sufficient bandwidth to the centralized control system of the vehicle.
        1.1.3. The vehicle contains a visual display interface adjacent to the driver's seat, installed on the front interior dashboard. The interface will always display the backup camera data stream with the exception of when there is no data to display due to a lack of signal, where it will instead inform the driver that the system is inactive through a message on the screen.
            1.1.3.1. This assumes the interior vehicle design has the capacity to house the visual display interface.
            1.1.3.2. The system should give the driver visibility of at least 2 meters behind their vehicle by looking at a screen on their dashboard. If the system cannot provide the driver with at least 2 meters of visibility behind their vehicle, the system should deactivate and inform the driver of the system's deactivation from the screen on their dashboard.
        1.1.4. The system will include multiple sensors for detecting objects and their distances.
            1.1.4.1. Any distance measurements by the system should be initially obtained by a LiDAR sensor at the back of the vehicle.
                1.1.4.1.1. If at any point the system cannot receive a signal from the LiDAR sensor, the system should inform the driver that the LiDAR sensor is inactive with a message on the dashboard screen. Any requirements that need measurements from the LiDAR sensor will also be disabled. The system will reactivate the LiDAR capabilities and remove the warning for the driver once the system receives a signal from the LiDAR sensor again.
                1.1.4.1.2. If the system detects an object that it is more than 95% confident is an object within 1 meter of the vehicle and the vehicle is moving less than 5 kilometers per hour, the system should apply the vehicle's brakes.
            1.1.4.2. A Proximity Sensor Array to serve as a redundant object detection system.
                1.1.4.2.1. A linear array of proximity sensors are installed in the lower-rear exterior of the vehicle, which have a single shared binary 'detection' state of objects within 1 meter of the rear of the vehicle.
                1.1.4.2.2. The sensors are spaced 0.2 meters apart and enough exist to fill the entire rear linear surface area of the vehicle.
        1.1.5. Object Visual Highlighting
            1.1.5.1. The system should place a square over any hazardous objects behind the vehicle that it believes is an obstacle. These squares should be placed in the rearview image based on an internal confidence value that the system

assigns to each object visible from the rearview camera based on an algorithm that determines how likely that object is to be a pedestrian. This confidence value should not be visible to the driver of the vehicle. If the confidence value of an object is greater than 80%, it should place a square over the object.

1.1.5.2. The color of the square for objects should depend on how far the system believes the object is from the vehicle. The square should be red if the object is 0-1 meters behind the vehicle, yellow if the object is 1.01-2 meters behind the vehicle, and green if the object is 2.01+ meters behind the vehicle.

1.1.5.3. If there are any objects with yellow or red squares in the system, then the vehicle should activate a noise to signal the driver to focus on their dashboard's screen. The noise should beep once per second if the closest pedestrian has a yellow square and twice per second if the closest object has a red square.

1.1.6. Automated Braking system

1.1.6.1. While the vehicle is in reverse mode and the proximity sensor array detects any objects within the specified distance, an emergency stop procedure is activated.

1.1.6.2. The emergency stop procedure signals to the throttle control system to prevent any further reverse movement, and the brakes are applied automatically to halt existing movement.

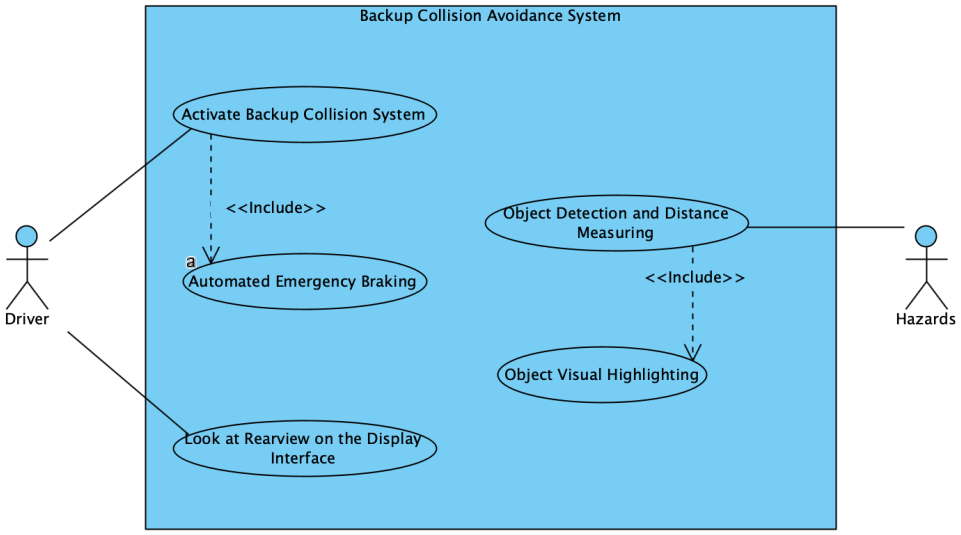
1.1.6.3. If the system detects that a collision with an object is unavoidable to result in injury because the vehicle is moving at any speed and the object is within 0.3 meters of the vehicle, the system should deactivate to avoid liability by the automotive company who created the system.

1.2. Non-Functional Requirements

1.2.1. The system should prioritize the safety of pedestrians over potential damage to the vehicle or other objects.

1.2.2. False positives should be mitigated for the convenience of the driver.

2. UML Diagram



3. Use Cases

Use Case:	Activate Backup Collision System
Actors:	Driver
Description:	The driver switches to the reverse gear, activating the backup collision system.
Type:	Primary
Includes:	N/A
Extends:	N/A
Cross-refs:	1.1.1
Use cases:	None

Use Case:	Look at Rearview on the Display Interface
Actors:	Driver
Description:	The backup camera feed is displayed on the driver's visual display interface.
Type:	Primary
Includes:	N/A
Extends:	N/A

Cross-refs:	1.1.2, 1.1.3
Use cases:	Activate Backup Collision System

Use Case:	Object Detection & Distance Measuring
Actors:	Hazards
Description:	Objects are detected and their respective distances are measured through the vehicle's backup sensors.
Type:	Secondary
Includes:	N/A
Extends:	N/A
Cross-refs:	1.1.4
Use cases:	Activate Backup Collision System

Use Case:	Automated Emergency Braking
Actors:	Driver
Description:	A procedure for halting any existing and preventing further reverse vehicle movement.
Type:	Primary
Includes:	Activate Backup Collision System
Extends:	N/A
Cross-refs:	1.1.7
Use cases:	Object Detection & Distance Measuring

Use Case:	Object Visual Highlighting
Actors:	Hazards
Description:	Objects are visually circumscribed on the driver's visual display interface, with the highlighting color dependent upon the object distance.
Type:	Secondary
Includes:	Object Detection & Distance Measuring

Extends:	N/A
Cross-refs:	1.1.6
Use cases:	Object Detection & Distance Measuring, Rearview via the Backup Camera

4. Individual Requirements Lists
   4.1. Color Key
      4.1.1. Green = Requirement was kept with slight modifications
      4.1.2. Yellow = Requirement was combined with another requirement
      4.1.3. Red = Requirement was scrapped
   4.2. Jacob's List
      4.2.1. The system should have a rearview camera.
      4.2.2. If at any point the system cannot receive a signal from the rearview camera, the system should deactivate and inform the driver with a message on the dashboard screen that the system is inactive until the system once again receives a signal from the rearview camera.
      4.2.3. The system should only be active when the driver is shifted into the "Reverse" gear.
      4.2.4. Any distance measurements by the system should be obtained by a LiDAR sensor at the back of the vehicle.
      4.2.5. If at any point the system cannot receive a signal from the LiDAR sensor, the system should inform the driver that the LiDAR sensor is inactive with a message on the dashboard screen. Any requirements that need measurements from the LiDAR sensor will also be disabled. The system will reactivate the LiDAR capabilities and remove the warning for the driver once the system receives a signal from the LiDAR sensor again.
      4.2.6. The system should give the driver visibility of at least 5 feet behind their vehicle by looking at a screen on their dashboard.
      4.2.7. If the system cannot provide the driver with at least 5 feet of visibility behind their vehicle, the system should deactivate and inform the driver of the system's deactivation from the screen on their dashboard.
      4.2.8. The system should place a square over any objects behind the vehicle that it believes is a pedestrian. These squares should be placed in the rearview image based on an internal confidence value that the system assigns to each object visible from the rearview camera based on an algorithm that determines how likely that object is to be a pedestrian. This confidence value should not be visible to the driver of the vehicle. If the confidence value of an object is greater than 80%, it should place a square over the object.
      4.2.9. The color of the square for pedestrians should depend on how far the system believes the pedestrian is from the vehicle. The square should be red if the pedestrian is 0-3 feet behind the vehicle, yellow if the pedestrian is 3.01-5 feet behind the vehicle, and green if the pedestrian is 5.01+ feet behind the vehicle.
      4.2.10. If there are any pedestrians with yellow or red squares in the system, then the vehicle should activate a noise to signal the driver to focus on their dashboard's screen. The noise should beep once per second if the closest pedestrian has a yellow square and twice per second if the closest pedestrian has a red square.
      4.2.11. If the system detects a pedestrian that it is more than 95% confident is a pedestrian within 2 feet of the vehicle and the vehicle is moving less than 5 miles per hour, the system should apply the vehicle's brakes.

4.2.12. If the system detects that a collision with a pedestrian is unavoidable to result in injury because the vehicle is moving at any speed and the pedestrian is within 1 foot of the vehicle, the system should deactivate to avoid liability by the automotive company who created the system.

4.3. Javen's List

4.3.1. The vehicle contains a rear proximity sensor array, which continuously emits a signal or is put into a binary 'detection' state if an object is detected within 1 meter distance of the sensors. These sensors are installed on the rear lower vehicle exterior, face parallel with the vehicle, are spaced 6 inches apart each, and enough sensors are contained in the array to fill the entire rear linear surface area. a. This assumes a communication connection exists between the sensor array and a centralized control system of the vehicle.

4.3.2. While the vehicle is in reverse mode and the proximity sensor array is in an object detection state at any point, an emergency stop procedure is activated. The emergency stop procedure signals to the throttle control system to prevent any further reverse movement, and the brakes are applied automatically to halt existing movement. a. The emergency stop procedure requires a standard throttle control system to allow for automated braking and the prevention of reverse acceleration.

4.3.3. The vehicle contains a 4K resolution, 180-degree FOV, "backup" camera installed in the center rear vehicle exterior to provide reverse visibility. a. The camera assumes a communication connection with sufficient bandwidth to the centralized control system of the vehicle.

4.3.4. The vehicle contains a visual display interface adjacent to the driver's seat, installed on the front interior dashboard. While in reverse mode, the interface will always display the backup camera data stream. a. This assumes the interior vehicle design has the capacity to house the visual display interface. As well as a centralized control system to interrupt the display with the camera datastream whenever the vehicle is put into reverse mode.

5. Requirements Process Explanation

5.1. To determine which requirements were included or omitted in our final list of requirements for this assignment, we started by taking all of our initial requirements and removing any that seemed redundant or overlapped. In the case of redundant or overlapping requirements, we used the requirement that was more descriptive to better define our system. Once we removed all of the redundant requirements, we went and sought out requirements that could be combined or considered sub-requirements since they were related and had similar purposes. The requirements that were combined were mostly related to the sensors. With that done, we now had a combined list of requirements that we used for this assignment.

References

[1] S. Comments, “Blog Category: Car and Tractor Trailer Accidents Car and Tractor Trailer Accidents,” 2008. Accessed: Feb. 07, 2025. [Online]. Available: https://www.cse.msu.edu/~cse870/Homework/References/Truck-Accident-Prevention.pdf