**System Uncertainties**

1. System is not guaranteed to be active while the vehicle is moving backwards, only if the vehicle’s transmission is in reverse. Two examples scenarios where this can occur are one, if the vehicle is in neutral and starts to roll backwards, and two, if the vehicle is moving backwards with sufficient speed and then rapidly shifted from reverse to drive, resulting in a lag time where the vehicle is still moving backwards, but the transmission is no longer in reverse.
   1. This source of uncertainty could potentially lead to life threatening events, such as a vehicle to pedestrian collision, as the vehicle is allowed to move backwards freely without the PBAS system being active, even if the PBAS system is not in override mode.
   2. Our current domain model bases the activation decision solely off of which gear the vehicle's transmission is currently in by communicating with the **Gear Position ECU** class.
   3. If Inertial Measurement Unit (IMU) and Global Positioning System (GPS) data were monitored, it would be possible to detect when the vehicle is moving backwards even when not in reverse. These could be added as additional derived classes from the parent **Sensor** class. However, this functionality could introduce greater overhead and potentially large inaccuracies to the system due to the nature of obtaining GPS data.
2. Current weather conditions may impact the system performance, particularly if the conditions severely impact visibility as the object detection functionality is dependent on camera data.
   1. If visibility is reduced to less than 90cm, the will be able to detect objects via the infrared camera and ultrasonic sensors, but the camera will not be able to label these objects as human or not, affecting how they are highlighted on the infotainment screen.
   2. Poor visibility conditions can be detected by analyzing the data stream coming from the **Camera** class.
   3. During these times the system will be more dependent on other sensors, including the **Infrared** and **Ultrasonic** sensors, for detecting obstacles, but will not be able to label the detected obstacles. The detection of obstacles should be enough to avoid collisions, but will not be able to correctly highlight human objects on the infotainment system.
3. Unpredictable, erratic driving behaviour or sharp turns while backing up may impact the systems ability to appropriately react to sudden detections of obstacles. For example, if there is an object near the side of the vehicle, just outside of the detection area, a fast sharp turn towards the object may not give the vehicle adequate time to both detect the obstacle and bring the vehicle to a stop before the minimal distance threshold is reached.
   1. In the worst case, the time between the object coming into the detection area of the vehicle and the vehicle reacting may be small enough that a complete stop cannot be made before a collision occurs. Even in this case braking should be attempted to minimize the severity of the collision.
   2. The detection of such events are dependent on the placement and reaction time of  **Sensor** objects of the system.
   3. By increasing the detection area around the vehicle and reducing the systems reaction time, these incidents can be minimized.

Old

**System Invariants**

1. Under any conditions this system must prevent injuries to the driver and any nearby pedestrians as a result of this vehicle traveling in reverse.
2. The system shall never be distracting to the driver and will never unnecessarily divert their attention from the task of operating the vehicle.
3. The system will never prevent the use of onboard emergency services. In the case of a collision, emergency systems will be given priority to operate freely.
4. The monitoring and warning components of the system will only become active if the vehicle is in reverse.
5. The mitigation of prevention components of the system will only become active if the vehicle is in reverse and the override functionality is not active.

**System Uncertainties**

1. Lack of accuracy in the human detection aspect of the object recognition software may lead to humans being mislabeled as objects and thus highlighted in white on the infotainment screen rather than red.
2. Limits on the ultrasonic sensor performance may lead to inaccuracies in the measurement of distances of the objects and thus results in slightly inaccurate distances to be displayed to the driver.
3. Miscalculation of the time needed to bring the vehicle to stop when an object is detected within 90 cm, may result in the vehicle not completing the stop directly at 30 cm away from the object. For example, the braking time was calculated for a new braking unit, but in certain cases brake pads are worn out causing the vehicle fail to stop in the predicted time.
4. Vision of the camera may be impaired by environmental factors, such as rain or snow, and thus impact the object recognition software’s ability to detect objects.
5. Camera and sensors may fail to detect an incoming pedestrian if there is a physical barrier between the vehicle and the pedestrian.