Night Vision Intelligent System (NVIS)

Darkness and inattention are the main enemies of safe road traffic, which often cause accidents. If in the first case the driver and pedestrians need a more responsible attitude to how they behave on the road, then the dark is a natural cause that cannot be eliminated.

Most luxury cars have an NVIS device as standard. For example, the car itself can recognize an obstacle and warn about the danger in time or even prevent a collision if the driver does not react in time. This increases the safety of the vehicle. In short, NVIS is a device that can recognize a large object (it can be a pedestrian, a pole or an animal). Special sensors display an image of the road on the screen like a conventional camera, only in most models the picture has a black-and-white inversion of colors, and more expensive options show a color image.

The night vision system allows the driver to see an obstacle in advance and avoid an accident.There may be foreign objects on the road that do not reflect the light of cars in the same way as a road sign. Due to the speed of transport, the range of headlights may not be enough for the motorist to react in time. This is especially acute when a person is walking along the side of the road, and another car with a bright light is driving in the opposite lane.

Even if the driver drives the car carefully, it is especially difficult at dusk, when daylight has not yet disappeared, but complete darkness has not come either. Under such conditions, the headlight of the vehicle may not emit enough light to allow the driver to control the boundaries of the roadway. The device allows you to more clearly determine where the road ends and the curb begins.

The modern smart light system aims to achieve a balance between illuminating the road for the motorist and preventing dazzle of oncoming traffic participants, as well as pedestrians. Some car models have special warning light signals for pedestrians, which are integrated into the night vision system (you can read about it here).

Assignment

Using the Systems Engineering approach based on a Model-Driven methodology (SYSMOD), design, implement and verify a SysML model of a Night Vision Intelligent System (NVIS).

The NVIS has:

1. **Two headlights with infrared emitters.** The first scatters the rays near the front of the car at a distance of about 80 m. The second directs the beam into the distance at a distance of about 250 m.
2. **A high-resolution video camera** whose lens also picks up reflected infrared rays.
3. **A Monitor-device screen**. Instead of the standard one, you can use almost any screen compatible with video surveillance systems, which is used in cars.

4. **An Infrared filter.** It looks like a small screen for a camera lens. Its purpose is to filter out interference that light waves create.

5. **Control unit** that processes the received signals.

The NVIS implement the following functionality:

1. **Distance 50m.** In the headlights, the driver notices only silhouettes, but during slow movement they can be avoided. The device screen clearly shows that there are people on the road.

2. **Distance 100m.** The silhouettes have become almost invisible. If the car is moving quickly (about 60 km / h), then the driver has little time to react to slow down or prepare for a detour. The picture on the screen does not change. The only thing is that the figures have become a little smaller.

3. **Distance 150m.** The assistants are not visible at all - you need to turn on the high beam. On the monitor of the device, the picture is still clear: the quality of the road surface is visible, and the silhouettes have become smaller, but they are clearly visible against the displayed background.

4. **The maximum distance is 200m.** Even the high beam headlights do not help to notice foreign objects on the road. The infrared camera still recognized two separate objects. The only thing is that their size has decreased.

Also, the NVIS controls the automatic light in the car in five modes, which are triggered depending on weather conditions and road conditions. So, one of the modes is triggered when the car speed does not exceed 90 km / h, and the road is winding with various descents and ascents. Under such conditions, the light beam is lengthened by about ten meters and also becomes wider. This allows the driver to notice danger in time if the shoulder is poorly visible in normal light.
When the car starts to drive at a speed in excess of 90 km / h, the track mode is activated with two settings. At the first stage, xenon heats up more, the power of the light source increases to 38 W. When the threshold of 110 kilometers / hour is reached, the setting of the light beam changes - the beam becomes wider. This mode can allow the driver to see the road 120 meters ahead of the car. Compared to standard light, this is 50 meters further.
When road conditions change and the car finds itself in a foggy area, the smart light will adjust the light according to some of the driver's actions. So, the mode is activated when the vehicle speed drops to 70 km / h, and the driver lights the rear fog lamp. In this case, the left xenon lamp turns slightly to the outside and tilts so that a bright light hits the front of the car, so that the canvas is clearly visible. This setting will turn off as soon as the vehicle accelerates to a speed above 100 km / h.

To successfully model the NVIS system using SysML, follow the following approach:

1. Understand the problem and project contexts
2. Gather and model the requirements of the NVIS using SysML Requirement Diagrams. Group the requirements in different packages.

3. Create a System Context Diagram of the NVIS; decide which actors (systems) interact with the NVIS (ex. Electricity, users) and use a SysML Block Definition Diagram of Internal Block Diagram to represent the context of the system.
4. Create a structural model of the NVIS - the architecture of the NVIS, using SysML structured diagrams.
5. Model the services of the NVIS using Use Case Diagrams. Create an essential description for every Use Case.
6. Model the behavior to the NVIS using: Activity Diagrams, Sequence Diagrams, or State Machine Diagrams
7. Populate the NVIS structure (the architecture) block components with values, operations, and relationships.
8. Create a GUI in NVIS Rhapsody, which emulates a touch panel, presenting how a user can interact with the NVIS.
9. Execute and test the model in IBM Rhapsody (use your Visual Studio tool) and integrate it with Unity Game Engine Environment, which is provided to you.
10. Create a short presentation in PowerPoint presenting your results. Don't forget to add your group's number and group members, including ids.
11. Upload the IBM Rhapsody project (Zip it) together with the video(s), PowerPoint presentation, and Canvas report.