EXECUTIVE SUMMARY

Drowsy driving is one of the leading causes of vehicular-related accidents, accounting for more than 1,200 fatal crashes and roughly 90,000 police-reported accidents in the United States each year. Commercial and passenger vehicles are lacking in an affordable, reliable means of accurately detecting drowsiness before it turns fatal. Awake-Pilot aims to address this problem by providing real-time alerts to the user once signs of fatigue are detected. Upon starting the vehicle, the dashboard-mounted device continuously monitors for changes in the driver's face and upper body for any indicators of drowsiness in order to issue an alert to the driver if needed. Figure 1 shows the camera-and-radar module, powered by the vehicle's auxiliary port, and the connected seat-cushion alert unit for both auditory and vibration alerts.

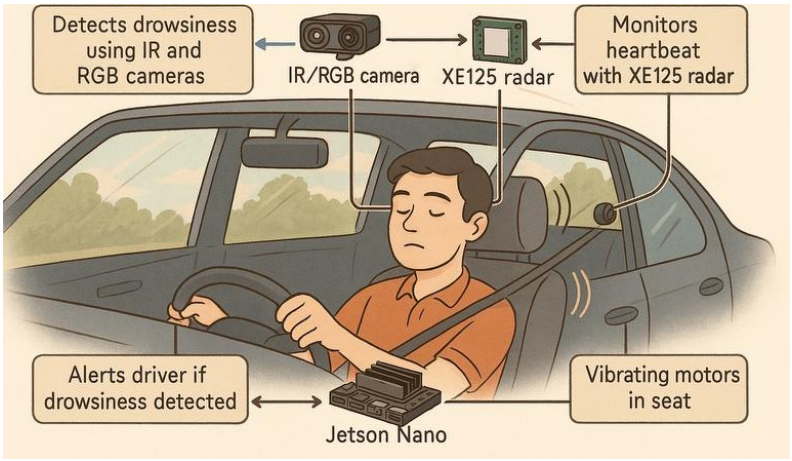

Figure 1: Awake-Pilot

To ensure the device is highly accurate and reliable in providing real-time driver fatigue detection, several requirements were considered to ensure all constraints are met. Core engineering requirements include real-time imaging processing video, capturing at a minimum of 30 fps and 640 × 480 px, drowsiness detection time below 150 ms, vibration amplitude ≥ 2G at 250 Hz, and acoustic output of 80 dBA at 1 m. The system operates from the car battery's 12–15 V supply while each subsystem remains within a 3–5 V logic, while remaining within a $1000 budget and a two-semester timeline. All hardware and software components align with ISO 16750-2, ISO 26262, IEEE 1857, and ISO/IEC 25010 to assure electrical robustness, functional safety, efficient video handling, and software quality.

The device consists of a plug-and-play architecture that allows for installation in less than fifteen minutes. The design integrates a Logitech C270 RGB camera and an Acconeer XE125 60 GHz pulsed-coherent radar whose data are fed into an NVIDIA Jetson Nano. A lightweight CNN built with OpenCV and CUDA monitors and detects eyelid closure, yawns, and head nods, while the radar tracks respiration-rate changes to minimize false positives in poor lighting. As the device is powered on, it automatically sets predetermined fatigue thresholds and begins monitoring the user to see if the thresholds are crossed. If drowsiness is detected, the Jetson triggers the piezo buzzers and a USB three-speed vibration motor enclosed within a seat cushion, delivering alerts under 0.15 seconds from detection.

Future work will include full software capability integration, a compatible chassis designed for easy installation between the steering wheel and seat, along with a visual aesthetic housing to enhance the appearance inside the user's vehicle for customer satisfaction. Since the system architecture is comprised of parts that can be easily interchangeable, additional sensors or software can be quickly added, leaving open the possibility monitor driver health or improve how people adapt with vehicle controls, showing the platform's flexibility for any future research and development that allo.