1. PROBLEM STATEMENT

Driver fatigue is a leading cause of many vehicular accidents, resulting in many fatigue-related crashes being left unreported. Awake-Pilot is designed to overcome this problem by improving driver awareness and implementing accident prevention measures. By observing a driver's behavior, Awake-Pilot aims to reduce the associated risks a driver may experience when fatigued.

1.1. Need Statement

According to the Centers for Disease Control and Prevention, approximately 1-in-25 adult drivers admit to having fallen asleep behind the wheel, while even more responded to driving despite being sleep-deprived [1]. In 2022, reports indicated that over 1,261 drowsy drivers were involved in fatal crashes, accounting for approximately 2.1% of all deadly vehicular accidents [2]. Studies reveal that lack of sleep impairs cognitive function similarly to alcohol intoxication, with 24 hours of sleep deprivation being comparable to a blood alcohol concentration (BAC) of 0.1% [3]. Drowsy driving is an extremely dangerous problem, and there needs to be a solution to prevent driver drowsiness and ensure road safety.

1.2. Objective Statement

The objective of Awake-Pilot is to monitor the driver's behavior for drowsiness and send a responsive alert whenever fatigue is detected in the driver to ensure safer driving. The device utilizes RGB and an HD infrared camera to track the driver's eye and facial movements to detect hazardous drowsiness. Awake-Pilot uses a dual alert system with sharp noise and seat-installed vibration alerts to reawaken the user. The device is designed to be installed on the dashboard of the vehicle and powered through the car's auxiliary port to automatically turn on once the user starts the vehicle and remains operational until the vehicle is turned off.

1.3. Background and Related Work

Earlier methods of detecting fatigue rely on physiological signals such as the percentage of eyelid closure over the pupil over time (PERCLOS), while more modern approaches use computer vision with RGB and infrared (IR) cameras to detect signs of drowsiness through other bodily movements, such as prolonged eye closure, yawning, and head nodding [4]. Current fatigue detection devices utilize a single-modal system. Single-modal systems that only use RGB or IR cameras have limitations—RGB struggles in low light, while IR excels in low-light conditions but lacks detailed color quality. The multimodal system of the Awake-Pilot compensates in the areas where both cameras fall short by allowing for both cameras to be utilized at once, ensuring reliable detection across varying lighting conditions. Patented technologies support a multimodal approach. US Patent US20210241011A1 details facial landmark analysis with image sensors and neural networks, while EP1418082A1 focuses on eye closure measurement via video processing. These highlight the value of multimodal imaging for accuracy [5]. By combining RGB and IR imaging, Awake-Pilot offers a robust, real-time driver monitoring solution, enhancing road safety by deducing drowsiness-related risks.

References

[1] National Safety Council, “Fatigued Driver - National Safety Council,” [Online]. Available: *www.nsc.org*. https://www.nsc.org/road/safety-topics/fatigued-driver

[2] L. Thomas, “Drowsy Driving 2021 Facts & Statistics,” *Bankrate*, Mar. 02, 2022. [Online]. Available: https://www.bankrate.com/insurance/car/drowsy-driving-statistics/.

[3] E. Suni and A. Rehman, “Drowsy Driving” *Sleep Foundation*, Feb. 17, 2022. [Online]. Available: https://www.sleepfoundation.org/drowsy-driving#references-78787

[4] H. Li and M. Xu, "Drowsiness detection system and method," U.S. Patent 20210241011A1, Aug. 5, 2021. [Online]. Available: https://patents.google.com/patent/US20210241011A1/en

[5] A. Agarwal *et al.*, "Attention is all you need for iris presentation attack detection," *arXiv preprint arXiv:2206.07489*, Jun. 2022. [Online]. Available: https://arxiv.org/pdf/2206.07489.