Human-Centric Advanced Driver Assistance Systems

The thesis focuses on enhancing driver safety and comfort through the development and validation of Human-Centric Advanced Driver Assistance Systems (ADAS). These systems integrate physiological monitoring, driver behavior analysis, and adaptive feedback mechanisms to address driver drowsiness, a critical safety issue.

Key highlights of the thesis include:

1. **Problem Statement and Objectives**:
   - Addressing driver drowsiness through two approaches: Prevention and Prediction. Prevention involves monitoring a driver's health status during sleep hours, and Prediction involves real-time physiological monitoring to detect drowsiness.
2. **Literature Review**:
   - Comprehensive analysis of existing techniques for predicting driver drowsiness, categorized into vehicular-based, behavioral-based, physiological-based, and hybrid techniques. This review establishes the need for robust, non-intrusive prediction methods.
3. **Development of Novel Algorithms**:
   - Introduction of several new algorithms using physiological signals to predict sleep onset and detect drowsiness, including a raw PPG-based approach, data from Garmin smartwatches, and a radar-based sleep prediction method.
   - An innovative hybrid approach was also developed combining data from various sources (cameras, smartwatches, radar).
4. **Experimental Validation**:
   - The algorithms were validated in laboratory settings and through dynamic full-motion driving simulations, showing high accuracy in predicting drowsiness with sensitivity, specificity and accuracy over 90%.
5. **Prevention Techniques**:
   - Utilization of sleep analysis methodologies to analyze Obstructive Sleep Apneas (OSAs) and other sleep patterns, facilitating the development of rule-based algorithms for sleep quality enhancement.
6. **Future Directions**:
   - Future research will focus on refining the algorithms for broader population applications, integrating the systems into commercial devices or vehicles, and exploring non-contact technologies like radar or camera-based systems to enhance non-intrusiveness.

The thesis contributes significantly to the field of automotive safety, providing innovative solutions for real-time drowsiness detection and sleep onset prediction, which are crucial for the development of reliable autonomous driving systems.