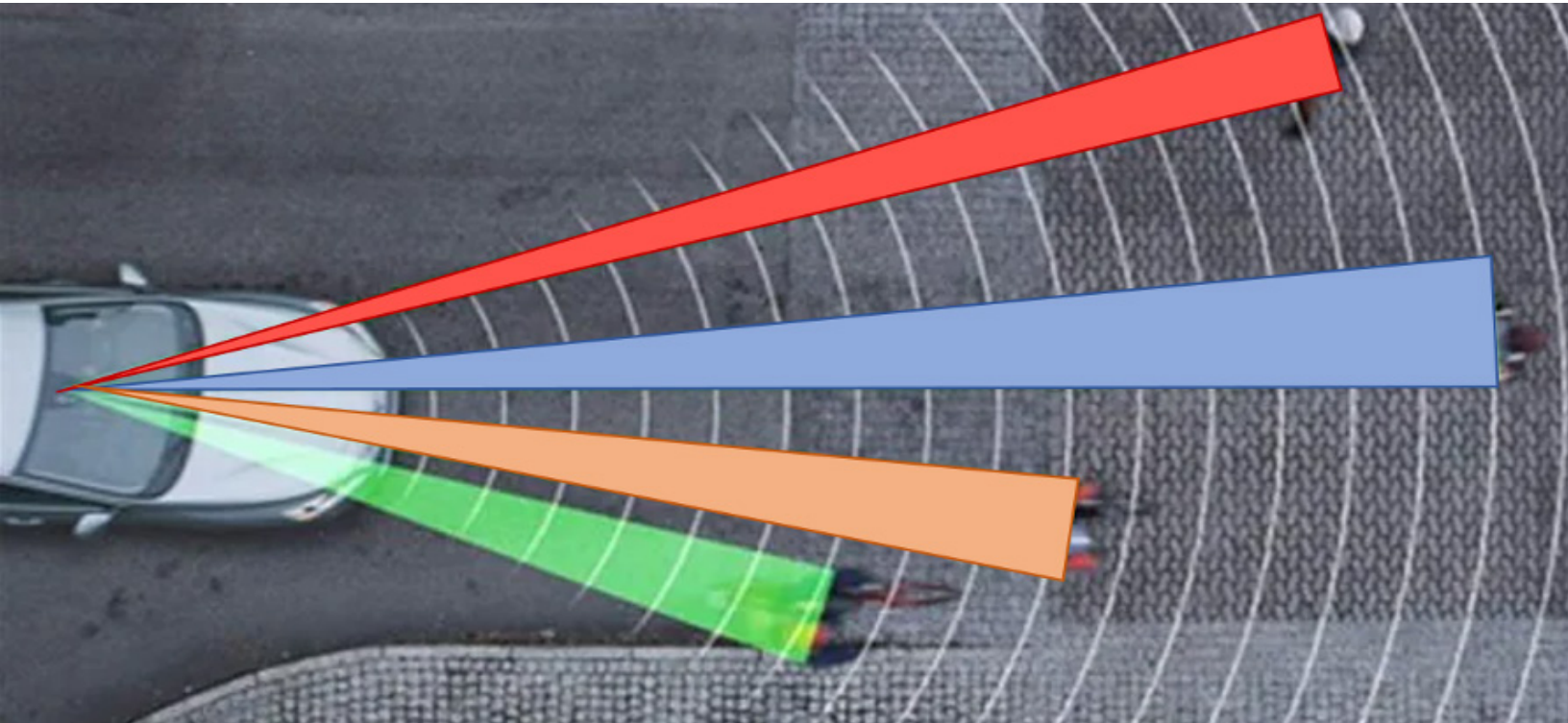


# AI-based Pedestrian Detection and Avoidance at Night Using an IR Camera, Radar, and a Video Camera

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## Introduction

Pedestrian fatalities have been surging in the United States over the past decade. Pedestrian fatalities have increased by 46%, from 4,302 in 2010 to an estimated 6,301 deaths in 2019. The number of pedestrian fatalities at night grew by 54%, while daytime pedestrian fatalities climbed by just 16% during that same period. Of these fatal accidents, about 75% of them occurred after dark. In addition, an American Automobile Association (AAA) research study that tested pedestrian detection in current vehicles found that the evaluated pedestrian detection systems—consisting of radar (radio detection and ranging), image sensors (cameras), LIDAR (light detection and ranging), and ultrasonic sonar—were ineffective during nighttime conditions. The goal of this project is to reduce the number of nighttime pedestrian fatalities by combining data acquired from three separate sensors in real-time and using machine learning algorithms to detect pedestrians at night to

alert a driver of the possibility of a collision with a pedestrian. The project also has applications in autonomous vehicles where a signal can be developed to engage the automatic braking system if necessary.

## Study Methods

This project focuses on an AI-based pedestrian detection and avoidance at night using an infrared (IR) camera, RGB (red, green, and blue) video camera, and a micro-Doppler RADAR. Specifically, this project will use machine learning with deep learning algorithms to detect humans at night using information from three different sensors to alert the driver of a possible accident with a pedestrian. This research proposes one possible improvement to pedestrian detection mechanisms, which involves using a video camera, a radar system, or a LIDAR system in a vehicle. More recently, the advancement of

thermal IR cameras has shown potential in detecting pedestrians at night.

Still, the research on pedestrian detection and avoidance is in its infancy. Several methods have been explored to detect a pedestrian and avoid an accident. The main contribution of this research lies in utilizing three different sensors (i.e., a thermal infrared camera, radar sensor, and a visible camera) combined with advanced Machine Learning (ML) for pedestrian detection and avoidance. Therefore, the team believes that this research exploration could lead to new artificial intelligence-based application tools for drivers that can save lives. The team will explore state-of-the-art ML techniques combined with data fusion to achieve this objective.

Experimental results of a pedestrian detection scheme using multi-sensor data collection along with machine learning are implemented and show an average accuracy of 99.6% during the day and 97.3% at night.

Using this multi-dimensional data could enable the developed system to autonomously make intelligent decisions during different conditions of the road, be it during the day or at night. The proposed system can be embedded into a smart vehicle system that provides real-time pedestrian detection and alerting mechanisms by vibrating the driver's wheel and displaying a message on a monitor/dashboard to warn the driver to avoid colliding with the pedestrian. The developed system can be used both during the day and at night using the combination of a thermal infrared camera, a radar system, and a video camera. It could also be installed in an autonomous vehicle.

### Findings

After developing the pedestrian detection system, the research team conducted actual experimentation in a vehicle using a video camera, an IR thermal camera as well as a micro-Doppler radar sensor combined with machine learning algorithms. The developed system using the trained machine learning algorithms was able to successfully detect and alert the driver

in real-time whenever a pedestrian was in front of the vehicle. This developed multi-sensor detection scheme deployed in real time will have real value as a safety measure in future smart vehicles.

### Policy/Practice Recommendations

Future intelligent vehicles can deploy the proposed system to provide an additional safety feature to avoid pedestrian collision during the day and at night, potentially saving lives.

### About the Author

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Dr. Hovannes Kulhandjian is an Associate Professor in the Department of Electrical and Computer Engineering at California State University, Fresno. His current research interests are in applied machine learning, wireless communications, and networking with applications to Intelligent Transportation Systems (ITS). Dr. Kulhandjian has received numerous awards and research grants while at Fresno State including: four research grants from Fresno State Transportation Institute (FSTI); the Claude C. Laval III Award for Commercialization of Research, Innovation and Creativity 2021; and the Claude C. Laval Award for Innovative Technology and Research 2020.

### To Learn More

For more details about the study, download the full report at [transweb.sjsu.edu/research/2127](https://transweb.sjsu.edu/research/2127)



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