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Detecting Driver Drowsiness with Multi-Sensor Data Fusion Combined with Machine Learning

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According to the National Highway Traffic Safety Administration (NHTSA), 91,000 police-reported crashes involved drowsy drivers in 2017 alone. These crashes led to an estimated 50,000 people injured and claimed 795 lives. However, these numbers are presumed to be underestimated, and as many as 6,000 fatal crashes each year may be caused by drowsy drivers. According to a study by the Centers for Disease Control and Prevention (CDC), 1 in 25 drivers surveyed reported that they had fallen asleep while driving in the past 30 days. Studies have shown that not having enough sleep, hence being drowsy, can impair your ability to drive the same way as drinking too much alcohol. "Drowsy drivers put themselves and others at risk through a slower reaction time and the inability to pay attention," said California Highway Patrol (CHP) Commissioner Warren Stanley at a press release. He went on to add, "[a] sleepy driver can be just as impaired or dangerous as one under the influence of alcohol or drugs". In addition, in the same press release, California Department of Transportation (Caltrans) Director Toks Omishakin said, "[i]n a state the size of California, long drives between cities are common. Without enough rest, all of us may feel drowsy behind the wheel". According to the California Office of Traffic Safety, the main signs of driver fatigue include yawning, blinking frequently, and daydreaming. Drowsiness impairs mental alertness, making it difficult to drive safely, and increasing the risk of human error, which can lead to fatalities and injuries. Drowsiness has also been shown to slow reaction time, decrease memory, and impair judgment.

Study Methods

One possible solution is to enable the vehicle itself to detect drowsiness or discrepancies in the driver's behavior and then alert the user when it occurs. The research on detecting drowsy drivers and alerting them is still in its infancy. To the best of our knowledge, no prior research work has explored or experimented with the idea of using data fusion (DF) from multiple sensors (i.e., video camera with night vision capabilities and micro-Doppler radar)

combined with machine learning (ML) to create a drowsy driver detection and alerting mechanism. Therefore, we believe that this research exploration could lead to new Artificial Intelligent-based application tools for drivers that could potentially save lives. In this research study we explore the state-of-the-art ML techniques combined with DF to achieve this objective. The goal of this research work is to maximize the detection accuracy of drowsy driving and alert drivers by effectively data fusing the information gathered from a video camera with night vision capabilities and micro-Doppler radar along with the use a trained Deep Convolutional Neural Network (DCNN) system to classify and identify drowsy driving features in real-time. Using this multi-dimensional data, the DCNN can make intelligent inferences about the driver behavior and alert drowsy driver to prevent them falling asleep and having or causing a fatal accident. The proposed system can be installed in a smart vehicle and can provide real-time drowsy driving alerts by vibrating the driver's steering wheel and displaying a message on a monitor/dashboard (e.g., "Stay Awake to Stay Alive") to warn the driver not to fall asleep and recommend they pull over to have some rest. The proposed system can be used both during the day and at night using the combination of video camera with night vision capabilities and micro-Doppler radar sensor.

Sensors that can detect drowsy drivers will be a valuable safety measure in future smart vehicles.

Findings

After developing the drowsy driver detection system, we conducted experiments in a vehicle using the camera and micro-Doppler radar sensor system 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 the driver was about to doze off while driving.

Policy/Practice Recommendations

Future intelligent vehicles can deploy the proposed system to provide additional safety feature in case a driver falls asleep while driving, and thus could save lives.

Figure 1. Experimentation of the Drowsy Driver Detection System.

About the Author

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 Transpiration Systems (ITS).

To Learn More

For more details about the study, download the full report at **transweb.sjsu.edu/research/2015**

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