Automotive and Transportation Alert (TechVision)

Driver Monitoring Technology

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Driver Monitoring Technology Innovations
Eye and Pupil Tracking System
Harman International Industries, USA

Unmet Needs

- According to the National Highway Traffic Safety Administration, since 1994, motor vehicle crashes have claimed between 32,800 to 43,500 lives every year. Driver distraction is a leading cause of fatal or serious crashes.
- There is complexity in extracting and analyzing data from sources such as steering wheels, seats, and biometric sensors and in addition, the driver needs to be in contact with the sensors physically.

Competitive Aspect

- Easy to deploy
- Easy to integrate into existing cars
- Does not require any physical contact
- Reliable and accurate

Market Entry Strategy

The company is expected to license its technology to major OEMs in the automotive domain. At a later stage, the company is also expected to target the after market.

What

HARMAN develops audio and infotainment systems and enterprise automation solutions. The company addresses the rising importance of connected products for automakers and enterprises worldwide. The company is focused toward innovating smart products to enhance customer value while providing a safe driving experience.

Who

HARMAN International Industries has developed an eye and pupil detection system to eliminate the complexities of the current systems and in addition measure driver cognitive load and multitasking behavior to minimize fatalities.

Where

HARMAN International Industries is based in the US with offices across the globe.

Tech Profile

Tech Profile

HARMAN develops audio and infotainment systems and enterprise automation solutions. The company addresses the rising importance of connected products for automakers and enterprises worldwide. The company is focused toward innovating smart products to enhance customer value while providing a safe driving experience.

Working Principle

A driver facing camera is installed behind the steering wheel. The camera extracts information about the driver's pupil dilation. The pupil reflexes are further analyzed with the help of algorithms and perform advanced filtering and signal processing. The filter helps to identify the response generated by cognitive load. The output gained is further used to adjust the user interface, for instance, turning on the do not disturb mode in cell phones. The system helps the driver to stay focused inside the car.

Trends / Opportunity

- Government Initiatives
- Adoption of in-cabin cameras and biometrics
- Connected vehicles

Unmet Needs

Consumer demand for additional safety features in vehicles and the new vehicles launched by key OEMs with advanced driver monitoring systems are expected to generate higher ROI. OEMs will employ driver monitoring systems, including enhanced camera systems, to maintain competitiveness.
ECG Sensors for Monitoring Driver Alertness
Plessey Semiconductors, UK

Unmet Needs/Trends

- Various technologies are being investigated for monitoring driver drowsiness levels. Some of the challenges posed for the different technologies are:
  - Visual: Accuracy gets compromised if drivers are wearing headgear/spectacles
  - Wearables: Driver might not wear it all the time

Potential Applications

- Driver Alertness
- Occupancy Detection
- Slow Speed Collision Avoidance
- Driver Fatigue

Competitive Features

- The EPIC sensors can be integrated into the seats from where they can be used to monitor the occupant’s vital signs, such as heart rate, respiration or even determine the occupancy of the car.
- Though the targeted applications currently are for driver alertness monitoring, it could potentially be used for advanced healthcare solutions in automobiles, machine operators, and so on.

The EPIC capacitive sensor measures electric potential or an electric field and provides electrocardiogram (ECG) measurements through clothing. The heart rate of a fatigued driver becomes slower, which the sensor is able to pick up.

TechVision understands that though ECG sensing provides effective driver monitoring, the technology can face stiff competition from other driver monitoring solutions, such as wearables or biometric sensors in the steering wheel.

The ECG monitoring sensing technology is expected to be integrated into automobiles within the next 2 years or so.
Driver Drowsiness Detection Using Steering Angle Sensor
Robert Bosch GmbH, Germany

Unmet Needs/Trends

- Driver drowsiness can be caused by monotonous driving, especially on expressways. The loss of concentration arises due to exhaustion from driving for long stretches.

Convergence Potential

- The technology can potentially converge with other technologies, such as navigation and GPS to notify the driver of available options for taking a rest.

Robert Bosch is an engineering and electronics company and one of the leading suppliers of automotive components. The company focuses heavily on technology development, and in 2014, invested about 4.9 billion Euros (about 5.6 billion USD at the current exchange rate) in R&D.

The company is headquartered in Germany and has a global presence.

Technology Features

- The technology uses indirect data to indicate a driver’s state of concentration, unlike other biometric technologies, such as vision sensors for eye monitoring, or ECG sensors for heart rate monitoring.

- The data collected from the steering angle sensor, along with other relevant information, is used to develop a tiredness index score. If the value exceeds a predefined threshold, an alarm is sounded to alert the driver.

Analyst Insights

Eye tracking technology can result in false positives or false negatives as eye/eyelid movement can differ for different people. Similarly, heart rate monitoring can lead to false triggers of alarm. Bosch’s system can provide accurate results by detecting the actual action of drivers.

Driver drowsiness detection uses data collected from steering angle sensor--the system identifies instances where the driver steers abruptly after a period of no activity. Other parameters taken into account include vehicle speed and time of day.

The technology has already been commercialized. The company has supplied the system to Volkswagen.
Eye Glasses to Help Detect Driver Drowsiness
Optalert Pty Limited, Australia

Unmet Needs/Trends

- Driver drowsiness and fatigue have been identified as one of the major causes of road accidents, and can lead to severe injuries, death, and significant economic losses.
- The National Highway Traffic Safety Administration has estimated that drowsy driving was responsible for 72,000 crashes and 800 deaths in the US in 2013. However, the Centers for Disease Control has cited sources indicating that up to 6,000 fatal crashes annually in the US may be due to drowsy drivers.
- Early driver drowsiness detection technologies is highly needed to prevent such incidents.

Potential Applications

- Optalert's glasses are suitable for all types of transportation sectors including aviation and road transportation, including coaches, and busses.

Innovation Attributes

- JDS™ defines the exact level of drowsiness on a 10-point scale, where 0 signifies 'very alert' and 10 indicates 'very drowsy' states.
- Scores are displayed on the indicator or processor placed inside the vehicle.
- The technology can be adopted for all prescription lenses.

The Next Step

- The company is developing a new Android application that can be paired with Optalert's glasses technology so drivers can accurately measure their drowsiness levels using their own Android-based smart phones.
- Optalert will soon introduce Bluetooth glasses for customers in the mining and transportation industries.

Product Features

- The scratch-resistant polycarbonate lenses come with lightweight frames, providing all day comfort.
- All three available shades provide protection against ultra-violet (UV) radiation.
- Interchangeable lens design to adjust shades with outside light for comfortable viewing.

Analyst Insights

Equipped with smartphone-based software applications, Optalert’s glasses are an intriguing addition to the wearable technology market for personal safety monitoring.
Wearable Sensor to Make Roads of Japan Safer
Fujitsu Limited, Japan

Unmet Needs/Trends

• Drowsiness is a serious driving hazard globally and has been the major cause of fatal road accidents in Japan.
• A major concern for fleet managers in Japan and across the world involves the safety of drivers.
• Automated identification at the onset of drowsiness can help prevent accidents by eliminating the risk of misjudging when it is no longer safe to drive.

Potential Applications
FEELythm is a compact fleet management system that has application potential in a variety of businesses and environments including long-haul driving of buses, trucks, and taxis.

Innovation Attributes
FEELythm can be connected with digital tachographs or other onboard devices, and linked to fleet-management systems in real time so that fleet managers can provide helpful guidance to the drivers and prevent mishaps.

Future Plans

• Though the company has initially launched the product in the Japanese market, the product will soon be available in major global markets including the US and UK.
• In the future, the company has plans to improve its safe driving management system by incorporating a hazard map based on accumulated sensor data indicating fatigue, stress, and tension of the drivers.

Analyst Insights
Fujitsu’s FEELythm is well-suited for haulage companies to strengthen their fleet safety management.

Fujitsu is a leading Japanese information and communication technology (ICT) company.

Fujitsu Laboratories, where the original algorithm was developed, is located at Kanagawa, Japan.

In 2015, the company launched FEELythm—a wearable sensor that monitors driver’s pulse via a sensor attached to the earlobe, measures drowsiness, and sends a sound and vibration alert to the driver and the respective vehicle fleet manager. The system uses a proprietary algorithm developed by Fujitsu Laboratories. The device was designed with battery capacity for five continuous days of operation.

The FEELythm primary unit (left) and receiver (right).
Facial Movement Recognition-based Driver Sleep Monitoring System
Xilinx Inc., USA

Unmet Needs/Trends

- End-users are looking for very reliable means of fatigue or drowsiness detection.
- Driver drowsiness monitoring systems have the capability to reduce crash rates attributed to drivers’ sleeplessness and inattentiveness to driving.
- There is a need for the development of a monitoring system which can detect the drivers’ attention level and monitor whether the driver is sleepy.

Potential Applications

- Passenger Cars
- Heavy Vehicles
- Aeroplanes
- Advanced Driver Assistant Systems
- Smartphone application development

Xilinx focuses on the development of all-programmable hardware and software solutions enabling smart and connected networks and applications.

Xilinx is headquartered in San Jose, California, USA and has corporate offices and authorized dealers across the globe.

Competitive Features

- Driver alert monitoring using video-based optical cameras
- Facial muscle monitoring
- Sleep level estimation
- Sleep detection capability during night and through sunglasses

Product Development

logiDROWSINE is developed by Xylon d.o.o (developer of IP cores for Xilinx Inc., programmable solutions). The solution is developed in such a way that it is suitable for Xilinx® Zynq®-7000 AP SoC (System On-Chip)

Analyst Insights

TechVision, expects the driver drowsiness monitoring system developed by Xilinx Inc., to have realistic opportunities, due to the capability of the system to monitor various facial behaviors or movements that capture information about the user’s drowsiness.

logiDROWSINE, is a computer vision IP core based on a camera’s video input which has the capability to identify the driver’s attention and somnolence levels. This is achieved by the constant monitoring of the driver’s facial behaviors and movements of the driver’s eyes, gaze, head, and so on.
**Eye Monitoring for Drowsiness Detection Using a Wearable Device**

Vigo Technologies, USA & Wichita State University, USA

### Key Challenges

- Drowsiness detection using vision sensors can lose accuracy under varied lighting conditions or with the presence of obstacles, such as headgear.
- Electrode-based monitoring of drowsiness can pose challenges, such as the need for a reliable body worn sensor, which causes discomfort to the driver, and high cost of implementation.

### Potential Applications

- Passenger Cars
- Heavy Vehicles
- Advanced Driver Assistant Systems
- Smartphone Application development

### Technology features

- An infrared sensor monitors blinks, which along with head movement data is used to monitor the drowsiness of the driver.
- When the device detects the drowsy state of the drive, it vibrates and provides audio and visual alerts (such as flashing of lights).
- The device also works as a hands-free headset for answering calls. This feature enhances the capabilities of the headset.
- The key features of the technology are:
  - Non-intrusive Device
  - Low Cost
  - Works under varied lighting conditions
- The device comes with iOS and Android apps, to pair with a smartphone.

### Analyst Insights

The product is not specific to any automobile model. As an aftermarket solution, the Vigo Smart Headset shows potential to be adopted by both drivers as well as fleet managers.

### Who

- Human Automation Interaction Lab of Wichita State University (WSU)
- Vigo Technologies

### Where

- Wichita State University is located in Kansas, USA
and Vigo Technologies is based in California, USA.

### Product Availability

Vigo Technologies has commercialized the headset and it is available for consumers at a price of $129.
Driver Drowsiness Detection System
Nissan Motor Company Limited, Japan

Unmet Needs/Trends

- There is a strong need for reliable systems that detect the drowsiness of drivers while on the road. The National Sleep Foundation has noted that data from Australia, England, and other European nations indicates that drowsy driving represents 10-30% of all vehicle crashes.
- Drowsiness/sleep detection technology is currently mainly limited to cars in the premium segment.

Potential Applications

- The drowsiness detection system can be used in light cars and trucks for both urban and highway use.
- The technology can also be applied to heavier autonomous highway vehicles, plus off-highway vehicles.

Analyst Insights

TechVision finds that the Driver Attention Alert is an effective drowsiness detection system. As this system is being incorporated into mid-range sedans, more such systems in different types of cars will be possible in the near future.

Innovation Attributes

Drowsy drivers often stop or use their steering wheels slowly, whereas alert drivers make quick and small adjustments of the steering wheel as they drive. This is the key principle behind the operation of Driver Attention Alert (DAA) system, which alerts the drivers through a chime sound and by displaying a “coffee cup” picture on vehicle information system.

Future Plans

This reflects the opportunities for drowsiness alert systems in non-luxury vehicles. Nissan plans to introduce driver attention alert systems in many other mid range cars in the future.

YEAR OF IMPACT

The Driver Attention Alert (DAA) system will have a medium-to-long term impact on the design of cars across the globe.

Funding

The research was funded internally by Nissan Motor Company Limited.

“Driver Attention Alert” is a drowsiness detection system for drivers featured in Nissan’s latest Maxima Platinum and 2015 Murano SL and Platinum models.
Strategic Insights
Strategic Insights

- Biometric driver monitoring systems can have various configurations, including:
  - Vision-based systems, employing a camera focused on the driver. These systems determine the head and body position of drivers, along with blinking of the eyes to determine drowsiness.
  - Wearables monitoring body parameters that can be related to the driver's state.
  - Sensors embedded into the seats to monitor, for example, ECG, breathing rate, brain waves.
  - Sensors in the steering wheel to monitor parameters such as heart rate, facial temperature, skin conductance, and so on.

- Hyundai Motor Company, Toyota Motor Corp., and Robert Bosch GmbH are amongst top assignees.
- Most patents have been filed in USA, followed by the APAC countries such as China, Japan, and South Korea.

Drivers
- Passenger and pedestrian safety
- Reduced number of accidents
- Push from automobile OEMs
- Availability of developed technologies

Challenges
- Cost
- Accuracy of sensors in challenging environments
- Distraction for drivers

- In the near future, most OEMs are expected to have automobiles equipped with driver monitoring technologies as they greatly increase driver safety,
- Aftermarket solutions will also experience wider adoption by owners of fleets as well as budget segment vehicles, which will not likely be factory-fitted with driver monitoring.
Key Contacts
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