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INTEGRATION OF WEARABLE BIOMETRIC SENSORS AND INTELLIGENT TRANSPORTATION SYSTEMS FOR ENHANCING ROAD SAFETY

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Introduction. In today's world, safety in road transportation is of utmost importance. Driver distraction is a known cause of accidents. Many devices and technologies have been developed and utilized over the last several decades. These range anywhere from steering assistance to voice commands for the vehicle.

This is an important topic because with all the advancements in mobile technology comes many distractions. It has been reported in some studies from 2019 and 2020 in the United States that nine percent of fatal car crashes of drivers ages 15-20 were due to distracted driving. In addition, the highest percentage of distracted drivers were found among drivers of ages 25-34. It was also reported that there were 11,654 drunk driving deaths in 2020 in the United States alone. Technology could be used to help prevent those individuals from operating motor vehicles.

This paper aims to discuss the components, design, and current use cases of wearable biometric sensors and intelligent transportation systems for the betterment of road and driver safety. How this technology can be further used to significantly increase transportation safety will also be discussed. These technologies are used with the idea to better the human tasks for which they were designed [9].

Biometric devices have been greatly refined to aid the user in multipoint analysis of their bodies. These devices consist of items such as smart watches, respiratory rate sensors, and measurement of tightness of grip on steering wheels. The technology has improved driver and roadside safety by making sure the vitals of the wearer are appropriate for driving. The driver's ability to breath and think correctly and the driver's fatigue levels can also be inferred from this information.

Computing and processing the data from these biometric sensors can be done by intelligent transportation systems. Though there have been several d Artificial Intelligence (AI)-driven vehicles developed, the purpose of the intelligent

transportation systems discussed in this paper is not to take over the driving control of the vehicle but to ensure that the human is still in control and functionally operational to perform the proper safety tasks while driving [5; 6]. Current intelligent or "smart" systems within vehicles, with some exceptions, is limited to using driver data to make the driver experience more comfortable. The future lies with the integration, creation, and improvements on intelligent transportation systems with biometric sensors. These systems, when combined with biometric sensors, allow a great many possibilities when it comes to roadside and driver safety.

One of the most promising technologies we have access to that follows in the field of biometrics and aids in roadside safety is that of eye tracking software as well as augmented reality displays with that software. This new implementation of technology would allow the intelligent transportation system to aid the driver if they are becoming fatigued, not paying attention, or are practicing unsafe driving. The software would be synced to the vehicle's intelligence system and be able to display important information and updates so that the driver would not need to look away from the road [2]. Intelligent transportation software could also be able to aid the driver in directions and help them to get to a rest stop, increase the brightness, or change the temperature or sound to alert the driver to safe levels if needed when the driver is experiencing fatigue [4]. If drivers are becoming distracted or fatigued during driving, the biometric eye tracking system and software, which is paired to the vehicles intelligent transportation system, would aid heavily in the driver and roadside safety [1].

History of the technology. The integration of biometric sensors in roadside safety began in the early twenty-first century. These sensors were designed to capture the biometric data from the driver and/or passengers. These devices grew in significance and began to be used for identifying passengers within the vehicle (through fingerprints, for example). Intelligent transportation systems began a little earlier than biometric sensors. These included cruise control and different visual gauges for the driver. Since then, intelligent transportation systems have continued to increase in processing power. Eventually, intelligent transportation systems and biometric sensors began to be combined to give personal transportation systems the tools needed to exponentially help drivers. Some more advanced systems now in use include smart global positioning system (GPS), heads-up displays, and voice control. These systems have already been implanted into artificial intelligence (AI) powered vehicles for self-driving. They aim keep the driver alert to their surroundings. These systems and sensors are being implanted to ensure roadside safety.

Engineering design for Technology. If biometric sensors had the ability to both provide safety and potential solutions to unsafe situations that drivers are in, the sensors would become extremely more useful. This is where intelligent transportation becomes important. Intelligent transportation is the use of biometric systems to provide helpful and safe solutions to the driver [1; 4]. The integration of intelligent transportation with biometric sensors has been experimented with, but not developed to its full capacity. Adding a smart biometric sensor to measure the driver's eye movements would be one way to significantly improve the safety of drivers and decrease the frequency of collisions due to driver distraction or drowsiness. Examples

of this include a camera in the vehicle or a camera embedded within the glasses that the driver uses. The camera would have the ability to use data from the driver's eyes to accustom itself to what their normal eye patterns are while driving. If the eyes begin to show signs of sleepiness, the intelligent transportation algorithm within the automobile would trigger a specific series of actions. Examples of these reactions to driver drowsiness triggered by the intelligent transportation system include primarily directing the driver to the nearest rest stop to sleep. This is because the safest option in the situation of driver drowsiness is to simply sleep. Other reactions could be used for the purpose of keeping the driver as alert as possible until the rest stop. Examples of this include sounding an alarm, vibrating the chair of the driver, brightening the lights within the vehicle, and cooling the air within the car to keep the driver alert [2;5]. Successfully combining all these components together into one integrated safety system is what has never been done before. Another option for a biometric sensor to measure the driver's eye movements is using a cell phone. Instead of a camera embedded in the car or glasses, the phone's camera could measure the eye movements of the driver. An app could be used to both interpret the data from the driver's eyes and trigger an alarm if the driver is beginning to fall asleep. This type of safety system would be much cheaper and easier to use than the previous example. Safety systems such as these have the potential to greatly increase road safety [6].

Biometric sensors that measure aspects of the human body such as drowsiness and heart rate do exist. There are also smart vehicles that adjust to the needs of the driver. There are augmented reality systems that can be used in glasses while driving to display information such as weather information and route information. However, these technologies currently are not sufficiently blended to create a safer transportation environment on the roads. Combining all these technologies together into an "integrated safety system" would significantly decrease the number of crashes and injuries due to driver unawareness or sleepiness.

To combine these systems together into one "Integrated Safety System (ISS)," one would need to have some way to connect the device to the car and send information between them. This could be done through Bluetooth or Wi-Fi. There would also need to be an algorithm of code that processes the data taken from the glasses and decides whether the driver needs stimulation and guidance to a rest stop or not. This would be most easily done through placing the intelligent computing system within the automobile's computing system [3]. It would need to have a quick processing time to alert the driver if he or she is falling asleep in a timely manner. With an algorithm and the connection between the devices, the ISS would be able to successfully mitigate the danger of distracted or drowsy driving [4; 5].

The combining of biometric sensors and intelligent transportation systems in the future would aid in driving automation which will help to avoid crashes and small human errors while driving. This would aid drivers and not replace the drivers. Although this increase in safety does not make up for the lack of all human error, it would greatly help them be safer drivers, especially when it comes to distraction or drowsiness while driving. Some of the possible limitations of this technology include the augmented reality (if augmented reality is a part of the ISS) being a distraction to the drivers, especially if it over-stimulates the driver. In addition, the cost of

integrating a safety system with biometric sensors can be very expensive. This is because it is complicated to seamlessly integrate these different technologies effectively. Finally, having precision and accuracy of the information being measured by the biometric sensor is difficult to achieve. It is very important to minimize this error because the safety of the driver depends on accuracy of the readings of the biometric sensors. If there would be a false positive or a false negative from the biometric sensor, this could result in a collision.

Conclusion. The future holds many promising advancements for roadside safety. By continuing to expand on the current technologies and coupling that with integration of new systems, the road could become much safer for the drivers, passengers, and pedestrians. There are many different technologies that have already been developed for use in the transportation industry. These include augmented reality, biometric sensors, and intelligent transportation systems. Augmented reality decreases the distraction of drivers from looking at their phone for directions or weather information. Biometric sensors measure the biological information of the driver, such as their heart rate or eye movements. Intelligent transportation systems use driver patterns to customize the driver's experience to fit the patterns of specific drivers. These advancements will realistically lead to more driving automation and systems, while still requiring a physical driver to be present. To decrease the number of casualties that occur due to distracted or drowsy driving, it would be very beneficial to combine all these technologies into an Integrated Safety System to enhance safety and road conditions.

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