Drowsiness Detection and Management

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Drowsiness disrupts work performance and increases the risks of accidents substantially, especially for performance-critical tasks, such as driving and piloting. Each year, 100,000 police-reported crashes are directly caused by driver drowsiness, which results in about 1,550 deaths, 71,000 injuries, and $12.5 billion financial losses, according to an estimation by the National Highway Traffic Safety Administration [1]. The National Sleep Foundation estimated in 2002 that 51% of adult drivers had driven a vehicle while drowsy and 17% had fallen asleep behind the wheel. Pilot drowsiness is an important factor in pilot performance and aviation accidents [2]. Pilot drowsiness can reduce alertness and attention and cause longer response times [3]. Drowsiness is also concerning because people’s own judgment of their susceptibility to drowsiness is poor [4].

To mitigate the risks of drowsiness on driving and piloting, drowsiness detection technologies and drowsiness management programs are demanded. This article introduces existing and emerging technologies for drowsiness detection and drowsiness management strategies and calls for more research into the effects of drowsiness on task performance.

Drowsy drivers and pilots manifest their fatigue states in various ways, such as heart rate, respiration rate, blood pressure, head and eye movement and task performance. For a drowsy driver or pilot, the delta and theta components of electroencephalography increase significantly [5]; heart rate decreases [6]; respiratory rate decreases; blood pressure increases [7,8]; blood oxygen concentration is lower (under 18%) [9]; blink rate and eye closure exceeding 1 second increase [4,5,10]; head nods more often [11]. Moreover, drowsy drivers and pilots perform poorly and make more errors [3,11].

Drowsiness can be detected using a variety of sensors, including electroencephalograph (EEG), electrocardiogram (ECG), polygraph, accelerometer sensors, and oculographical measurements. The relative strengths of the EEG components, such as (θ+α)/β, (α+β)/θ, (θ+ α)/ (α+β) and θ/ β, are commonly used to predict drowsiness [12]. Three-axis accelerometers can be used to detect head movements, such as head nods. Infrared cameras or smartphone cameras can be used to monitor oculographical measurements, such as eye blinks and PERCLOS (Percentage of Eye Closure).

Different sensors have their own advantages and disadvantages. EEG is one of the most predictive and reliable techniques for drowsiness detection [13,14]. However, EEG sensors are often expensive, time-consuming to setup, and intrusive. Camera-based drowsiness detection often does not require users to wear a device, therefore less intrusive. However, it is hard to develop computer vision algorithms robust enough to detect faces and eyes of different skin colors, and under various weather and lighting conditions. Accelerator sensor is cheap but can only detect head movements.

New advancements in mobile technologies and sensors make drowsiness detection more feasible and affordable in real-world tasks. For example, Dr. He and his coworkers used Android and iPhone smartphones to detect visual indicators of driver fatigue, such as head nods, head rotation, and eye blinks. The increasing popularity of dry EEG sensors, such as Emotiv and Neurosky, makes it more affordable and convenient to collect EEG brain waves. Future research should consider predictability, reliability, affordability, and intrusiveness to detect drowsiness using various sensors or their combinations.

Besides the above-mentioned technologies for drowsiness detection, some management strategies can also be used to combat drowsiness [15]. For example, drivers and pilots should take a break or should take turns after working for a long period of time. However, temporary breaks from driving can only reduce time-on-task fatigue but not sleepiness [16]. Drivers and pilots can take caffeine, specifically slow-release caffeine, if they have to continue their work and there is no opportunity to take a break [17]. Long-time drivers and pilots should be informed about their tendency toward drowsiness and provided drowsiness management techniques. Future research should evaluate the effectiveness of different counter measurements to reduce drowsiness and improve task performance.

References

1. Rau PS (2005) Drowsy driver detection and warning system for commercial vehicle drivers: Field proportional test design, analysis, and progress. National Highway Traffic Safety Administration, USA, 05-0192: 1-7.
2. Goode JH (2003) Are pilots at risk for sleepiness? J Safety Res 34: 309-313.
3. Bourgeois-Bougrine S, Carbon P, Gounelle C, Mollard R, Coblentz A (2003) Perceived fatigue for short- and long-haul flights: a survey of 739 airline pilots. Aviat Space Environ Med 74: 1072-1077.
4. Verwey WB, Zaidel DM (2000) Predicting drowsiness accidents from personal attributes, eye blinks and ongoing driving behavior. Personality and Individual Differences 28: 123-142.
5. Lai SK, Craig A (2002) Driver fatigue: electroencephalography and psychological assessment. Psychophysiology 39: 313-321.
6. van den Berg J, Neely G, Wijkund U, Landström U (2005) Heart rate variability during sedentary work and sleep in normal and sleep-deprived states. Clin Physiol Funct Imaging 25: 51-57.
7. Snyder F, Hobson JA, Morrison DF, Goldfrank F (1964) Changes In Respiration, Heart Rate, And Sympathetic Blood Pressure In Human Sleep. J Appl Physiol 19: 417-422.
8. Tochikubo O, Ikeda A, Miyajima E, Ishii M (1996) Effects of insufficient sleep on blood pressure monitored by a new multimbiomedical recorder. Hypertension 27: 1318-1324.
9. Sung EJ, Min BC, Kim SC, Kim CJ (2005) Effects of oxygen concentrations on driver fatigue during simulated driving. Appl Ergon 36: 25-31.
10. Stern JA, Boyer D, Schroeder D (1994) Blink rate: a possible measure of fatigue. Hum Factors 36: 285-297.
11. He J, Fields B, Peng J, Cielocha S, Coltey, et al. (2013). Fatigue detection

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using smartphones. International Conference on Psychology and Application, Beijing, China.

12. Japa BT, Lala S, Fischer P, Bekiaris E (2009) Using EEG spectral components to assess algorithms for detecting fatigue. Expert Systems with Applications 36: 2352-2359.

13. Home JA, Reyner LA (1995) Driver sleepiness. J Sleep Res 4: 23-29.

14. Lal SK, Craig A (2001) A critical review of the psychophysiology of driver fatigue. Biol Psychol 55: 173-194.

15. Gander PH, Marshall NS, Bolger W, Girling I (2005) An evaluation of driver training as a fatigue countermeasure. Transportation Research Part F 8: 47-58.

16. Phipps-Nelson J, Redman JR, Rajaratnam SM (2011) Temporal profile of prolonged, night-time driving performance: breaks from driving temporarily reduce time-on-task fatigue but not sleepiness. J Sleep Res 20: 404-415.

17. De Valck E, Cluydts R (2001) Slow-release caffeine as a countermeasure to driver sleepiness induced by partial sleep deprivation. J Sleep Res 10: 203-209.