Microsleep Accident Prevention for SMART Vehicle via Image Processing Integrated with Artificial Intelligent

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Abstract. Number of accidents caused by microsleep increases rapidly each day. This is due to the current trend of life, for example high workload, long working hours, traffic jams, having too much caffeine, drinking alcohol, age factor, and many others. This microsleep can lead to major accidents, higher number of deaths, injuries, demolition of property and permanent disability. The creation of SMART Vehicles in the Internet of Things (IoT) increases the technology capabilities in transportation sectors, in addition to reduce the number of crashes on the roads. An integration with Artificial Intelligent (AI) can be a perfect combination on development of a microsleep detection and prevention. While the image processing will be used as the method of detecting the face changes from normal to microsleep symptoms on detecting the eye degree, the head motion and the mouth yawning. This work presented a review of current research that supported the integration of IoT and AI. The analysis and discussion on the best solution and method to prevent microsleep accidents was shown. Lastly, recommendation on development of real sensors for SMART Vehicles will be discussed. A preliminary result on this work also will be shown.

1. Introduction

Microsleep is a situation where the brain becomes shut out from the world for a few seconds which normally range between one (1) to fifteen (15) seconds. This microsleep or drowsiness might happen without any notice and acknowledgement to anyone any-time and anywhere, for example during reading, watching television, working, driving and etcetera [1]. This microsleep can be triggered because of many reasons and factors including a long-distance driving, health status, Obstructive sleep Apnea (OSA), narcolepsy [2], the shape and surface of the road, the weather, and many more but the main reason is when the body is tired or fatigued and not enough rest [1].

There are three categories of microsleep level, which is alert, moderately drowsy and extremely drowsy [3]. There are three types of driving vehicle mode, the first one is alert driving mode moderately drowsy driving mode and lastly is extremely drowsy mode. While in alert driving mode, the driver will show normal face without any drowsy sign and shows focus with high surrounding alertness while driving. The driver is in moderately drowsy driving mode when the driver starts showing symptoms of drowsiness such as restless posture, yawning, rubbing eyes and rigid look forward. The extreme mode is when the driver has symptoms such as struggling to keep awake, change in eyelid movement and the eyes closed for a longer time.

Nowadays accidents by sleepy (drowsiness) drivers have increased in numbers. Based on a research done by the Traffic Safety Foundation study, the percentage of accidents that happen because of microsleep is 37% [4]. New technologies are needed to decrease vehicle accidents caused by microsleep.

2. Internet of Things (IoT) and SMART vehicle

Internet of Things (IoT) defines an interconnected system that is able to gather and transmit data over a wireless network without human interference [5]. IoT is also a modern technological approach that connects devices and people in an intelligent way at anytime and anywhere [5,6].

IoT focuses on building a better world for human beings, where smart objects around us can sense what humans like, what humans want and respond accordingly without precise movement or instruction [7]. One of the greatest evolutions on IoT is the introduction of the SMART Vehicle. SMART Vehicle is the innovation of the transportation sector which, having the combination of sensors and software that target to control, provide smart services relating to different ways of transport and traffic management, and the most important in the safety concern [8]. SMART Vehicle aims to have a smart route vehicle and enhance transportation infrastructure in traffic signals, signage, lanes and more. The benefit of the SMART Vehicle is to optimize traffic flows and fuel economy, avoid collisions; improve public safety and mobility.

3. Artificial Intelligent (AI)

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and imitate their actions. In this new era AI has been used in so many fields, including education, automobile industry, business, medical, agriculture [9]. AI was classified into three (3) types which are supervised, unsupervised and reinforcement learning. Research by [10] claims that AI is really effective to solve computationally challenging problems mainly in solving the microsleep problem.

In this new era, microsleep drivers can be detected by using Machine Learning. The Machine Learning can detect microsleep [11]. Machine Learning is a sub area in AI. In simple words, Machine Learning allows IT systems to identify patterns of current algorithms and data sets and develop sufficient solution concepts [12]. Based on the context of Microsleep, the advantages of AI are the algorithm will be established by learning from data. By using AI, the signal leads to the low errors rate between microsleep or non-microsleep [13].

4. Approaches in Microsleep Prevention

Tons of research done in microsleep prevention. As known, microsleep is one of the factors that contributes to road crashes. Accidents that happened because of microsleep or drowsiness on the roads have given many bad impacts not only to the drivers and passengers but also to the country as mentioned in. Because of this, many approaches have been invented to prevent accidents such as the Orexin System [2], Automated Stand-alone Video-based Microsleep Detection System [14] and Driver Monitoring System (DMS) [15].

4.1 The Orexin system

Research done by Pham et al. [2] introduces the system called The Orexin system. This aims to detect microsleep by observing bio signals from the brain, eye movements, facial muscle diminution and sweat gland activities from behind the user's ears. Figure 1 shows the system done by Pham et al. [2].

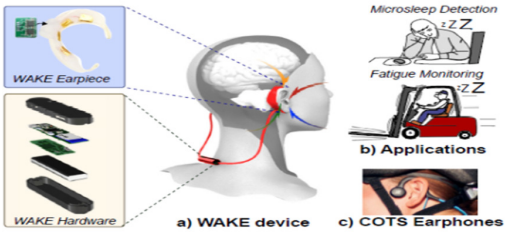

Figure 1. The Orexin system [2].

4.2 Path Planning and Task Assignment

Another project done by [Ngasri et al. [14] introduces a system call as Automated Stand-alone Video-based Microsleep Detection System. Based on this project, the researchers identify the microsleep patterns and the way to give notification to the driver when they fell asleep. In addition, this project also uses a few techniques to make it relevant as a stand-alone device, which is by using python programming, image processing, Raspberry Pi. and Eye aspect ratio (EAR) algorithm. This illus-tration of this project shows in Figure 2.

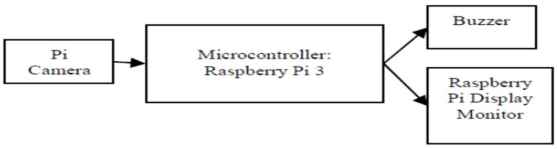

Figure 2. Illustration / overview / flow of the research in [13]

4.3 Driver Monitoring System (DMS).

Driver Monitoring System (DMS) is one of the best projects proposed [15] to prevent microsleep from happening while driving and this project aims to detect micro-sleep by using drowsy driving in a high-fidelity driving simulator and evaluate the abil-ity of an automotive production-ready driver monitoring system (DMS) [15]. Pictures of the NADS-1 dome and interior are shown in Figure 3.

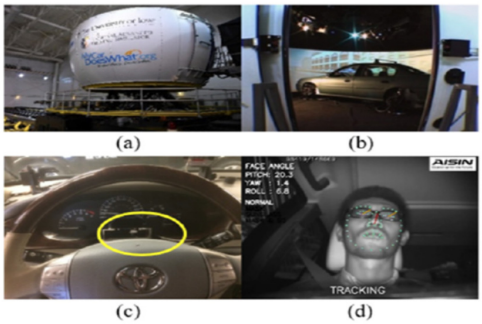

Figure 3. Figures shown above are based on: (a) dome exterior, (b) dome interior, (c) DMS location, and (d) DMS camera view [15].

4.4 Analysis

From all the systems, the Driver Monitoring system (DMS) proved that the system is better than [2] and [14]. The system [15] is very effective at discerning low levels of sleepiness from moderate to severe. Moreover, the system is conducted using the National Advanced Driving Simulator (NADS) [15], which uses an actual vehicle cab and projects 360 degrees view surrounding the driver on the interior walls of the dome that houses the cab.

5. Challenges in Internet of Underwater Things

Image processing is basically a technique that performs some operations on an image, in order to get an enhanced image or to draw out some useful information from it. It can be used to design a real-time driver drowsiness detection system using facial-based information and real time categorization of driver's [4]. This work will be using Image processing as the method to detect and prevent microsleep. Figure 4 shows the part of coding and programming use in this project. This work will use MATLAB as the software to detect microsleep faces while driving.

```
facedetector = vision.CascadeObjectDetector;
trigger(handles.vid);
handles.im = getdata(handles.vid, 1);
bbox = step(facedetector, handles.im);
hello = insertObjectAnnotation(handles.im,'rectangle',bbox,'Face');
imshow(hello);
end
guidata(hObject, handles);
```

Figure 4. Coding to detect objects by using MATLAB.

In the coding state in Figure 5, the "cascadeobjectdetector()" will create a detector to detect objects using the Viola-Jones algorithm. While, "insertObjectAnnotation()" will return a truecolor image annotated with shape and label at the location specified by position.

```
bodyDetector = vision.CascadeObjectDetector('UpperBody');
bodyDetector.MinSize = [60 60];
bodyDetector.ScaleFactor = 1.05;
trigger(handles.vid);
handles.im = getdata(handles.vid, 1);
bbox = step(bodyDetector, handles.im);
hello = insertObjectAnnotation(handles.im,'rectangle',bbox,'UpperBody');
imshow(hello);
end
guidata(hObject, handles);
```

Figure 5. Coding to detect body movement by using MATLAB.

The coding in Figure 5 shows how to handle the upper body movement through the installed camera in the devices.

6. Primary Result

Upon the completion of this project, the autonomous vehicle will have a good micro-sleep detection to prevent accidents from occurring especially for drowsiness drivers by using Artificial Intelligence (AI) integrated with the Internet of Things (IoT) system. Figure 6 is the preliminary result from the project done by this research.

Figure 6. Example of image processing result: Face Detection.

7. Conclusion

Several researches have been done in this review. Based on the research conducted by previous researchers [2,13-14] it can be concluded that the research done by Ngasri at al. [14] is the best among the rest because this research was done on Observer Ratings of Drowsiness (ORDs). This research also using ground truth as their classification model and they can evaluate the ability of an automotive production through Driver Monitoring System (DMS). This model intelligent in discriminating the low levels of sleepiness from moderate to severe. The researcher was using National Advances Driving Simulator (NADS) to conduct the research. Although this research has come out with an excellent solution, the system will become non-functional without camera-based monitoring and will cause the task of identifying microsleep become more challenging [15]. To solve this and improve the research, it is crucial to integrate the research with IoT due to the unique attribute Internet Protocol that IoT use such as recognize, control and transfer data to individual and databases.

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