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Hypo-Driver: A Multiview Driver Fatigue and Distraction Level Detection System

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Abstract: Traffic accidents are caused by driver fatigue or distraction in many cases. To prevent accidents, several low-cost hypovigilance (hypo-V) systems were developed in the past based on a multimodal-hybrid (physiological and behavioral) feature set. Similarly in this paper, real-time driver inattention and fatigue (Hypo-Driver) detection system is proposed through multi-view cameras and biosignal sensors to extract hybrid features. The considered features are derived from non-intrusive sensors that are related to the changes in driving behavior and visual facial expressions. To get enhanced visual facial features in uncontrolled environment, three cameras are deployed on multi-view points (0°, 45°, and 90°) of the drivers. To develop a Hypo-Driver system, the physiological signals (electroencephalography (EEG), electrocardiography (ECG), electro-myography (sEMG), and electrooculography (EOG)) and behavioral information (PERCLOS70-80-90%, mouth aspect ratio (MAR), eye aspect ratio (EAR), blinking frequency (BF), head-titled ratio (HT-R)) are collected and pre-processed, then followed by feature selection and fusion techniques. The driver behaviors are classified into five stages such as normal, fatigue, visual inattention, cognitive inattention, and drowsy. This improved hypo-Driver system utilized trained behavioral features by a convolutional neural network (CNNs), recurrent neural network and long short-term memory (RNN-LSTM) model is used to extract physiological features. After fusion of these features, the Hypo-Driver system is classified hypo-V into five stages based on trained layers and dropout-layer in the deep-residual neural network (DRNN) model. To test the performance of a hypo-Driver system, data from 20 drivers are acquired. The results of Hypo-Driver compared to state-of-the-art methods are presented. Compared to the state-of-the-art Hypo-V system, on average, the Hypo-Driver system achieved a detection accuracy (AC) of 96.5%. The obtained results indicate that the Hypo-Driver system based on multimodal and multiview features outperforms other state-of-the-art driver Hypo-V systems by handling many anomalies.

Keywords: Internet of things (IoT); intelligent transportation; sensors; multiview points; transfer learning; convolutional neural network; recurrent neural network; residual neural network; multimodal features