Industrial & Systems Engineering
Seminar Announcement

The Vehicle: A Diagnostic Device

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Abstract: The Vehicle: A Diagnostic Device covers a series of studies that develop vehicle-based algorithms for drowsy driving and untreated sleep apnea detection. The drowsy driving studies discuss the development of a contextual and temporal algorithm for detecting drowsiness-related lane departures. While algorithms exist for this purpose, many are limited by their impracticality and high false positive rate. The approach in this work uses steering and pedal input behavior along with vehicle speed and acceleration to develop a set of measures for indicating driver state and road context. These measures are integrated into a Hidden Markov Modeling algorithm that considers the time dependencies in transitions between drowsiness and awake states. The approach is validated with data from the National Advanced Driving Simulator. The contextual and temporal algorithm has a higher area under the receiver operating characteristic curve (AUC) and a significantly lower false positive rate than the current gold standard percent eye closure (PERCLOS) algorithm. The algorithm also highlights the validity of Symbolic Aggregate Approximation (SAX) time-series analysis as a method for detecting relevant patterns in vehicle speed and acceleration. The final study extends the application of SAX to vehicle-based sleep apnea treatment adherence detection algorithms. In this study, naturalistic driving and treatment adherence data were collected from a sample of 75 drivers. Speed and acceleration behaviors were converted to symbols using SAX and then combined into word frequencies using a sliding window. A random forest model was trained on the data and evaluated using a held-aside test dataset. The evaluation showed that algorithm detects lapses in treatment adherence. An assessment of variable importance suggests that the important patterns of driving in classification correspond to route decisions, and navigational errors. Together these studies illustrate the power of the vehicle as a diagnostic device for both safety and chronic health issues and present a platform for extensions into other health conditions and domains.

Bio: *Dr. Anthony McDonald* received his PhD in Industrial and Systems Engineering from the University of Wisconsin-Madison with a focus on Human Factors and a minor in Computer Science. He also holds a Master of Science in Industrial Engineering from Wisconsin and a Bachelor of Science in Mechanical Engineering from M.I.T. His research focuses on applying machine learning to relevant problems in human factors in the transportation and healthcare domains. Specifically he is interested in using knowledge generated from machine learning algorithms to improve existing models of human behavior and improving machine learning algorithm performance by combining traditional approaches with novel data analysis and domain expertise.

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