Research Title:

Smart Wearable Sensors for Monitoring Stress and Load in Driving Tasks

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This research investigates a novel collaboration between chemical engineering and applied psychology, focusing on the development of non-intrusive, real-time chemical sensors for detecting volatile organic compounds (VOCs) to assess driver stress levels. The project progresses through a series of cognitive tasks and driving simulator experiments designed to validate the tool's ability to measure stress under various conditions. Three distinct cognitive tasks - PAM-test (24 participants), Anagram (18 participants), and Tetris (22 participants) - were employed to induce stress, followed by a driving simulator experiment (30 participants). Each experiment compared performance, subjective stress and cognitive load measures (assessed with NASA-TLX), and VOCs from participants' exhaled breath, which were collected and analyzed using the Snniphone tool, in two different experimental conditions. In one condition, task difficulty remained low and fixed, while in the other, difficulty increased progressively across trials. The results indicated a recurring trend whereby the Snniphone tool's chemical sensors measured stress effectively, with significant changes generally observed as task difficulty increased. Additionally, machine learning models were applied to predict subjective workload perceptions, as assessed by NASA-TLX, using VOCs in the sensors' data. While the models showed moderate success in predicting subjective workload, they also exhibited a higher false positive rate. The findings suggest that cognitive stress induced by task difficulty can be detected through VOCs. Specifically, in the driving simulator study, stress induced by traffic congestion appeared to be a stronger indicator of physiological stress than more complex driving challenges. Future work will involve further chemical analysis of saliva samples and refinement of machine learning models to enhance predictive accuracy. Although the chemical tools for measuring stress still require further development and fine-tuning, this approach holds significant potential for stress measurement via VOCs and for the future integration of this system into in-car systems and broader real-time stress assessment applications.