**University of Michigan**

**Clemson University**

**Consent To Be Part Of A Research Study**

**1. Key Information About the RESEARCHERS and This Study**

**Study title:** Predicting Driver Takeover Performance in Conditional Automation (Level 3) through Physiological Sensing

**Principal Investigator:** Carol C. Menassa, Ph.D., Associate Professor, Civil and Environmental Engineering, University of Michigan

**Co-Investigator(s):** Vineet R. Kamat, Ph.D., Professor, Civil and Environmental Engineering, University of Michigan

**Co-Investigator(s):** Da Li, Ph.D., Assistant Professor, Civil Engineering, Clemson University

**Co-Investigator(s):** Julian Brinkley, Ph.D., Assistant Professor, Human-Centered Computing, Clemson University

You are invited to take part in a research study. This form contains information that will help you decide whether to join the study.

* 1. **Key Information**

Things you should know:

* If you choose to participate, you will be asked to do driving simulation for totally 92 mins in a simulation room. Please refer to 4.1 for details of the experiment.
* There will be only very low chance of skin irritation from the sensors and breach of confidentiality.
* There is not direct benefit.

Taking part in this research project is voluntary. You do not have to participate, and you can stop at any time. Please take time to read this entire form and ask questions before deciding whether to take part in this research project.

**2. PURPOSE OF THis STUDY**

This study will allow the research team to understand the correlation between the human physiological responses and their takeover performance (TOP). In addition, the prediction models for the TOP will be established.

**3. Who can Participate in the study**

**3.1** All interested people near Clemson University International Center for Automotive Research (CU-ICAR) (employees or students) aged 18-45 who have valid driving licenses can participate in this study.

**3.2** 50 subjects are expected to be recruited in this study

**4. information about study participation**

**4.1 What will happen to me in this study?**

At the start of the study, we will ask subjects to verbally provide the information for the “General Survey”. Each experiment consists of 18 sessions (about 3 mins for each), the total duration of the experiment is around 92 mins. The subject will be asked to come to the simulation room with the driving simulator. The objective is to allow the subjects to take the autonomous driving simulation and obtain EEG data, GSR signals, heart rate and skin temperature at the same time. We will be using a high-fidelity driving simulator (see Figure 1). A single alert consisting of two modalities (visual and auditory) will be issued as soon as a takeover is needed. Auditory alerts will be displayed through the speakers (cabin noise is set at 50 dB in the simulation). A virtual head-up display (HUD) will be developed to display the current driving mode (automatic vs. manual), speed, visual takeover alert, among other information. To support the transfer of control, an automated driving (AD) button on the steering wheel will be programmed for switching between manual and automated driving. Upon pressing the button, the driver is provided with an auditory tone accompanied by an updated driving mode displayed in the HUD to acknowledge the success of the transfer. We will equip the simulator with a suite of high-resolution cameras to monitor the driver’s face, hands, body pose, and feet during the simulation, which will allow us to analyze the driver’s behaviors (e.g., holding an object) using computer vision algorithms. The cameras will also record the whole experiment for a post-hoc video rating of TOP by the two raters.



Figure 1: Driving Simulator and Takeover Alert Modalities

During the experiment, we will ask subjects to wear Emotiv EPOC+ (EEG headset), GSR+ Electrodes, Optical Pulse Ear-Clip and Skin Surface Temperature Probe (see Figure 2) while performing the driving simulation. Figure 3 shows the placement of the Skin Surface Temperature Probe on a subject. The sensors are distributed over different body locations as shown in Figure 3. The raw physiological data will first be pre-processed through a manual or automated cleaning to remove the artifacts and errors [16]. For example, the galvanic skin response (GSR) signals will be filtered using a wavelet transform to remove high-frequency noise and manually inspected to identify the low-frequency artifacts. A bandpass filter will be applied to the electroencephalogram (EEG) signals and large amplitude data points are removed (i.e., artifacts). Then, we will extract physiological features from the pre-processed data. A sliding window will be used to generate features over specific time intervals. For each window, a set of features will be computed. For example, the mean, standard deviation, minimum, maximum, and first derivative are extracted from the GSR, heart rate (HR), and skin temperature while the fixation, areas of interest, eyes-on-road time will be computed for eye activities.



Figure 2: Emotiv EPOC+, GSR+ Electrodes, Optical Pulse Ear-Clip and Skin Surface and Temperature Probe



Figure 3. Placement of Physiological Sensors

The timeline for the experimental design is described in Figure 4. Before the autonomous driving part, 10 mins will be given for the researchers to setup the device and introduce the details of the experiment. 3 mins of manual driving (MD) will then be given for the subjects to practice the driving simulator, followed by a 5 mins MD before the autonomous driving scenarios. During the MD session, subjects are asked to drive at 70 mph. During the automated driving (AD) sessions, the subject will totally experience 18 sessions (2 traffic densities × 3 secondary tasks × 3 takeover events). Details of the scenarios are listed in Table 2. In each session, subjects will first perform a chosen secondary task for around 2 minutes. For the “observing”, the subjects only need to observe the surrounding environment or the screen without additional tasks. For the 1-back task, there will be different visual patterns shown on the screen and then disappear, the subjects are asked to recall whether the current pattern is the same as the previous one. For the 2-back task, the overall task is similar to the 1-back task, but the subjects need to recall whether the current pattern is the same as the one before the previous one (two patterns back). The alert is issued unexpectedly (5 to 7 seconds of lead time) and subjects are required to stop the secondary task immediately and control the vehicle. The control is transferred back to subjects as soon as the steering wheel detects the presence of hands, or the braking is depressed. However, subjects are also reminded beforehand they should only respond when they feel safe doing so. Once subjects think they complete the takeover, they can re-activate automation by pushing the AD button. The corresponding takeover readiness and quality are logged into a personal dataset. After each takeover, the subject is asked to fill out a short survey to report the self-assessed mental workload and distraction level during secondary tasks, and the perceived performance in the takeover. Then, the next AD session starts in the same manner until the subject completes all 18 sessions.

Table 2: Experiment scenarios and descriptions

|  |  |
| --- | --- |
| **Category** | **Description** |
| Traffic density | Low traffic density |
| High traffic density |
| Secondary task | Observing |
| 1-back task |
| 2-back task |
| Takeover event | Obstacles in front of the car |
| Police by side |
| Fake alert |





Figure 4: Timeline of the experimental design

**4.2 How much of my time will be needed to take part in this study?**

The total duration for the experiment is around 92 mins, you will be asked to come at least 10 minutes before the experiment to receive instructions of the experiment.

**5. information about Study RISKS and benefits**

**5.1 What risks will I face by taking part in the study? What will the researchers do to protect me against these risks?**

One potential risk is the breach of confidentiality. This is rare to happen as your data will be stored and referenced using a randomly generated id. And there will be a very low chance of skin irritation from the sensors. To mitigate this issue, we will sanitize all the equipment before each experiment and provide you with sanitizer to use mitigate the risk of skin irritation. In addition, we recommend that you plan to take a shower and wash your hair after the experiment.

**5.2 How could I benefit if I take part in this study? How could others benefit?**

You may not receive any personal benefits from being in this study. However, others may benefit from the knowledge gained from this study.

**6. ENDING THE STUDY**

**6.1 If I want to stop participating in the study, what should I do?**

You are free to leave the study at any time. If you leave the study before it is finished, there will be no penalty to you. If you decide to leave the study before it is finished, please tell one of the persons listed in Section 9. “Contact Information”. If you decide to withdraw from the study before it finished, any data linked to the subject’s random number will be completely deleted and no record of it will be kept. If the researchers have already used your information in a research analysis it will not be possible to remove your information.

**7. Financial Information**

**7.1 Will I be paid or given anything for taking part in this study?**

You will receive $30 for your participation in the study, which will be paid by a visa gift card. No payment will be given if you decide to withdraw from the study prior to its completion.

**8. Protecting and sharing research information**

**8.1 How will the researchers protect my information?**

The data collected from the equipment will be transmitted directly to our secure and password protected folder on a Dropbox that requires UM account to login. The videos or the audios will also be kept safely in the UM Dropbox protected with a password. Other data except videos and audios will de-identified before transmission. Your data will be stored and referenced using a randomly generated id.

We plan to publish the results of this study. There will be no identifying information in the published work.

**8.2 Who will have access to my research records?**

Only the research team in this project will have access to this your research records. The research records will be securely stored for the duration of the study in the Department of Civil and Environmental Engineering at the University of Michigan, and Department of Civil Engineering and School of Computing at Clemson University.

**8.3 What will happen to the information collected in this study?**

We will store your data for future research studies in a password protected UM Dropbox that is only accessible to the research team working on this project. Your video and audio files will also be protected by the account password. We will only retain the videos and the audio files for two years and they will be completely deleted after two years.

It is possible that other people may need to see the information you give us as part of the study, such as organizations responsible for making sure the research is done safely and properly like the University of Michigan, Clemson University, and government offices.

**8.4 Will my information be used for future research or shared with others?**

It is possible that we might need to use your data for future study. We may also share the data with other researchers if there is a possibility for future research based on the data. We will only use your data if you provide us a clear verbal consent to do so.

**9. Contact Information**

**Who can I contact about this study?**

Please contact the researchers listed below to:

* Obtain more information about the study
* Ask a question about the study procedures
* Report an illness, injury, or other problem (you may also need to tell your regular doctors)
* Leave the study before it is finished
* Express a concern about the study

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**If you have questions about your rights as a research subject, or wish to obtain information, ask questions or discuss any concerns about this study with someone other than the researcher(s), please contact the following:**

University of Michigan

Health Sciences and Behavioral Sciences Institutional Review Board (IRB-HSBS)
2800 Plymouth Road
Building 520, Room 1169Ann Arbor, MI 48109-2800
Telephone: 734-936-0933 or toll free (866) 936-0933

Fax: 734-936-1852

E-mail: irbhsbs@umich.edu

You can also contact the University of Michigan Compliance Hotline at 1-866-990-0111.

**10. Your Consent**

1. By verbally agreeing to this document, you are willingly agreeing to participate in this study and allow the research team to use your data collected in this study. Please provide your verbal consent to this.

2. Please also provide a verbal consent to let us know if we can keep your data for future use and possibly share it with others in a secure way.

Make sure you understand what the study is about before agreeing to the two questions above. You need to agree to question 1 to participate in the study. You do not have to agree to question 2 to participate in the study. If you have any questions about the study after you agree to this document, you can contact the study team using the information in Section 9 provided above. You can print a copy of this consent form and keep for your records. The research team will keep one copy of this document securely stored as indicated above.