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AutoExp: A multidisciplinary, multi-sensor framework to evaluate the acceptability of self-driving cars

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Abstract

Introduction: The arrival of self-driving cars (SDC) in our daily lives is imminent. However, research on the adoption of this technology is still an ongoing topic. Existing work focuses on situations where the driver may be asked to take back control of the vehicle. Therefore, we currently lack tools and studies to analyze the behaviors of the occupants of SDC beyond driving-related activities in real-world situations. For instance, most datasets devoted to evaluating methods to monitor the cockpit of self-driving cars consist of synthetic data or are laboratory-based recordings [1, 2, 3]. Moreover, in human and social sciences, such as economy of transport and cognitive sciences, studies are usually focused on declarative surveys and evaluations on dedicated infrastructures, like a car cockpit simulator [4, 5]. **Contribution:** We propose a multidisciplinary, multi-sensor framework to evaluate the changes in the internal states and behaviors of SDC’s occupants in real-world situations. **Materials and methods:** The proposed framework is composed of a sensor setup to record the typical postures, gestures, and actions of passengers in the cockpit, and a sequence of surveys to assess changes in their internal states (IT) and their acceptance of this new means of transportation (ASDC), before and after its usage. The cockpit activity is recorded by two RGBD sensors (Intel RealSense D435) and a GoPro video camera. RGBD sensors are attached to the top corners of the windshield and capture a lateral view of the body of people at the rear seats. The GoPro camera records a close view of the upper body of the person in the driver seat. The surveys are applied before, during, and after the use of the vehicle. **Experiments:** To test the proposed framework, we carried out a four-day long experiment in July 2021 using a Renault Zoe car (electric supermini urban model). The experiment took place in the parking of the campus of Ecole Centrale de Nantes (ECN) in France. The vehicle was robotized by the LS2N-ARMEN laboratory to behave as a SDC of level four (high driving automation). The vehicle traveled for nearly eight kilometers over a predefined circuit in the ECN campus. Participants occupied the driver seat vehicle. A safety driver was present in the passenger rear seat using a dedicated interface to take back control of the car in case of need. An experimenter was also present in the back seat to guide the experimentation, whenever needed. We decomposed the circuit into five laps. For the first three laps (4.8 km in average), namely free scenario, we asked participants to behave freely, as if they were in a daily travel from domicile to work. This scenario aimed to evaluate the acceptance of SDC. During the last two laps (3.2 km in average), namely guided scenario, the experimenter instructed participants to carry out a series of activities using objects put at their disposal. We defined the list of actions based on previous studies in the context of autonomous vehicles [2, 6]. For instance, take a call, read a magazine, play a game on the tablet, drink, read a newspaper, listen to music on the smartphone. The experimenter has chosen randomly the order of guided activities, as well as their duration. This scenario objective was to create a novel dataset composed of a varied number of human actions in the context of autonomous vehicles for further development of computer vision algorithms. We applied the IT and ASDC surveys before starting the vehicle, and just after the use of the SDC. The IT survey was also carried out between free and guided scenarios. Participants were recruited based on their declared interest to test a novel technology during a former survey on people attitude towards SDCs [6], or in their response to recruitment announces made to the employees and students at the university. **Results:** We

acquired a multidisciplinary, multi-sensor dataset composed of 29 people (18 men/11 women) carrying out a daily domicile-work travel. Recruited participants presented a variety of body sizes, human traits, ages, and education levels. Video recordings are 1-hour long and are accompanied by surveys about participants' internal states and acceptability of the SDC. The acquired dataset will enable us to carry out disciplinary and inter-disciplinary studies ranging from methods to automatically monitor occupants of SDCs, as well as studies about the acceptance of this new means of transportation. This experiment also enabled LS2N laboratory to test intensively their SDC for four consecutive days and opened new avenues for future collaborations between their team and the project consortium. **Conclusions:** we have proposed a novel framework to study the acceptability of SDC by analyzing the internal states and activities of its occupants. We acquired the first, multi-sensor dataset depicting the use of SDC in real situation. We hope that the proposed framework and the acquired dataset will encourage interdisciplinary research between AI and Human and Social Sciences on the study of the acceptance of SDC, and of the transformations that our society is undergoing. **Funding:** The proposed framework is developed in the context of the AURA AutoBehave project 2019, a French project devoted to developing novel methods for the evaluation of the acceptability of autonomous vehicles using a multidisciplinary approach. We thank the Region Auvergne-Rhône-Alpes for funding this research.

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