Defining attributes of an immersive microcar configurator for exploring user requirements

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Abstract

Light electric vehicles (LEV) present a promising solution for sustainable urban mobility but currently occupy a small share of the market. To better understand user preferences and decision-making processes, we developed a Mixed Reality Configurator (MIRCON) for Microcars. Mixed Reality (MR) provides an immersive, interactive environment that allows users to visualize and experience the vehicle customization process—particularly given the compact size of Microcars. MIRCON is designed to present users with a set of configuration options, including seating arrangements, powertrain choices, safety features, and general comfort and design elements. This contribution describes the development of a structured set of attributes and corresponding user guidance for configuring an LEV. The methodology involves literature review, expert workshops, and usability testing to refine the MIRCON's user interface (UI). As a result, key insights led to a structured sequence of categories and selection options, ensuring clarity and ease of navigation.

Introduction and Motivation

LEVs offer sustainable mobility with low energy and material consumption. Mobility data for Germany indicates that LEVs could replace up to 75% of current car trips equaling 50% of passenger car kilometers [1]. However, factors such as vehicle properties, pricing, and subsidy policies hinder the widespread adoption of LEVs. This paper addresses the first aspect: requirements regarding LEV properties. We developed a methodology for intuitively collecting user requirements, as traditional research methods like workshops and surveys are limited due to respondents' lack of knowledge about LEVs. Our approach uses a mixed-reality application, combining virtual and physical elements to create an immersive experience, allowing respondents to express their needs in a realistic context.

Applied Method

The definition of attributes for exploring user requirements with MIRCON is based on a literature review on purchasing decisions for passenger cars (e.g. [2] [3]), identifying

transferable attributes. Interdisciplinary expert workshops validated and refined these. Key focus areas included the structure, sequence, and pricing strategies, as well as knowledge on how users prioritize and how pricing influences decision-making. Internal user tests provided valuable feedback on MICRONs UIs usability and clarity, enabling iterative improvements to enhance the overall user experience. Based on the Technology Acceptance Model (TAM) proposed by Davis [4], we developed a complementing questionnaire designed to assess both the willingness to use a light electric vehicle (LEV) and the acceptance of such a vehicle before and after experiencing it through a MR demonstrator.

Results

The result is a structured set of LEV attribute options integrated in a virtual interface that guides the user through several categories with associated selection options. Thereby, in an immersive virtual environment, an LEV model can be configured. The changes are visualized on the LEV model in real-time and the corresponding costs are displayed at the UI. The UIs categories are divided into two groups: basic configuration and optional equipment. Accordingly, the configuration starts with the basic vehicle shape, represented by the number of seats. Further configuration categories include the maximum speed and attributes such as a panoramic roof, trunk size, a range of interior design options, technical functions such as battery swapping and HMI solutions. Safety-related configurations provide an extensive set of options such as airbags, or an emergency brake assist. This comprehensive range of options ensures a detailed exploration of user priorities and trade-offs in vehicle selection. In initial pre-tests, the structure of the categories and their options were optimized and MIRCON was iteratively improved in terms of user guidance, control in the MR environment and visual design. Complementary pre- and post-study questionnaires were also designed to capture data on participants' VR experience, demographics, and mobility behavior.

Conclusions

The selection of attributes and the development of a structured UI for MIRCON introduce an innovative tool for researching user preferences and decision-making in LEV customization. This approach enables the collection of both quantitative and qualitative data, offering deeper insights into user behavior. The UI, refined through a literature review and expert workshops, ensures clarity, ease of navigation, and accessibility, while the selection options themselves are carefully designed to be highly relevant. Future research will evaluate the effectiveness of the selected attributes and examine how factors like pricing, and trade-offs as well as the immersive application influence user decisions. This work contributes to the advancement of immersive tools for understanding consumer behavior and gaining knowledge regarding the adoption of LEVs for fostering sustainable mobility.

References

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