Modern technologies have improved the capability of design activities to develop and select optimal solutions by digitally replicating some product features. Their integration inside a design process relies on the knowledge of the users to extract from the simulations the required information. The data used in creative industries are mostly images and 3D models that are abstracted so as to make the result impossible to distinguish from a real product. This approach suffices when the design session deals with inexperienced users for the interpretation of the outputs’ physical properties; furthermore, current design supporting software tools are not friendly enough and offer low support to collaboration. As a result, a large number of design iterations and high development costs affect the design process in the initial development stages. The use of early prototypes can partially mitigate these risks by providing, at the expense of higher resource consumption, tangible interactions to multiple users. On the other hand, the immutable nature of the prototypes implies to manufacture a new variant for each modification, and it prevents to have real-time visualization of the results. A more effective and rapid prototyping method is to simultaneously transfer in a single environment the useful properties that are owned by the digital and real worlds.

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Introduction

MeccPhD Doctoral Programme in Mechanical Engineering
Programme Coordinator prof. Daniele Rocchi

Projector-based Spatial Augmented Reality for Collaborative Design Activities: Application and Interaction

Doctoral Programme in Mechanical Engineering

Doctoral Thesis of Federico Morosi - Supervisor: Prof. Gaetano Cascini
XXXII Cycle - Methods and Tools for Product Design

Projector-based Spatial Augmented Reality
Application and Interaction

Objectives

Since the applicability of P-SAR is still limited to modify superficial details of objects, this thesis aims at investigating which are the technical features necessary to promote the technology integration in the design process of real operational environments. The research, thanks to the use of a working SAR platform, intends to identify a proper interaction modality with the augmented contents that enable fast and intuitive modifications on the product layout. This task is accomplished by considering the requirements of collaborative sessions where all the participants need to efficiently communicate and visualize the ideas as mixed prototypes. In addition, thanks to test campaign involving professional designers and their clients, the activity points to recognize those design fields where the technology can benefit the most, as well as to measure its impact on the efficiency of a complete design project.

Results

The major outcome of the research is the development of a customizable and scalable platform based on P-SAR technology. The system is made up of front-end elements, i.e. mixed prototypes and interaction device, that can be manipulated by all the actors of the co-creativity session and back-end technologies, i.e. desktop computer, standard projectors, infra-red camera sensors and web database application, that support the functionality of the system. These components are arranged in three modules (right figure i.e. interaction, visualization and tracking) that allow having a white tracked prototype, without shape constraints, digitally augmented with the external finishing thanks to a multi-projection system. Several interfaces and devices have been integrated with the platform in order to explore different interaction modalities (left figure): (i) a standard desktop setup and (ii) a handheld touch device for precise and personal interactions, (ii) a wide touch display for increasing the shared and interactive environment and (ii) a tabletop tangible user interface for improving the user’s engagement and the system immersivity.

Conclusions

Thanks to this research, an interaction paradigm based on touch and tangible interfaces has been successfully integrated with real design activities in the field of packaging, interface designs, ergonomics and product look (right figure), where mixed prototypes are proven to be effective working tools. Testing activities, in fact, revealed the accuracy and usability achieved by non-expert users in manipulating the projected contents is comparable with more professional software. The simplicity to use the HCl, jointed with the capability of a P-SAR system to render in real-time interactive features of a real-like product, facilitates the idea sharing and the early evaluation of design requirements that are usually considered in the final stages with a huge risk of large impact on the project finances. An early analysis, where a packaging project developed with the use of the SAR in a single collaborative session after the initial brief is compared with a traditional design workflow, demonstrated a considerable reduction of the total lead time (~70%), the number of iterations (~50%), the men hours (~33%), the direct costs incurred by the agency (~20%) and a faster identification of the final selected design solution.

References

Author’s publications and public deliverable related to the research activity can be found in the SPARK project website: http://spark-project.net/