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*Make Harmony Between Technology and Nature, and Your Mind will Fly Free as a Bird*
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# AN APPROACH TO AN AUGMENTED REALITY INTERFACE FOR COMPUTER AIDED DESIGN

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***Abstract:*** *In this paper a multimodal interface based on Augmented Reality technology that can be used as an alternative to the classical interface composed from 2D display, keyboard and mouse is presented. This approach enables modeling of solid 3D objects by coupling advantages from the AR technologies with available legacy 3D CAD software. First it will be described the architecture of the multimodal interface and afterwards is illustrated an experiment related to augmented reality based design. The presented solution offers the following advantages compared to the traditional CAD interface: better perception of the 3D model by using co-location, natural and intuitive interaction modalities by using of the voice recognition and gestures.*
***Key words:*** *Augmented Reality, Computer Aided Design*

## 1. INTRODUCTION

Current Computer Aided Design (CAD) systems offer extremely rich modeling features and functions which increase the productivity of new products design. The user interaction with CAD systems has not been significaly changed although the geometrical database has been 3D for a long time. Nowadays CAD tools use standard WIMP (Window, Icon, Menu, Pointer) desktop-based graphical user interfaces (GUI), and the interaction is made through keyboard, mouse and CRT/LCD display which are only 2D devices. Such interaction does not “aid” the designer to transform his ideas into a formal geometrical model. Therefor new interfaces and interaction metaphors should be developed in order to help the designer in the modelling process of CAD parts.

Augmented Reality (AR) is a relatively new research direction derived from Virtual Reality (VR), which allows the creation of interactive virtual space embedded into the physical word. Unlike VR systems, in which users are completely immersed in the virtual environment, AR users perceive the virtual objects and the real world coexisting in the same space (co-located).

Augmented Reality provides new perspectives for user interaction with Computer Aided Design (CAD) tools. AR enhances the perception of 3D objects by co-location, leading to information with less perceptive ambiguities. This opportunity is important for a CAD application where users must have a direct and thereby a better appreciation of the object dimensions. Also the user is able to manipulate both real objects, and the virtual ones. In addition, devices like 6 DOF trackers, voice command or data gloves offer the possibility to interact with more natural gestures than the mouse and keyboard input of workstations.

Relatively little work has been reported on the integration of AR-CAD modelling systems. In most of the AR design applications developed AR technologies have been used as a tool supporting review process (Fiorentino et al., 2009; Shin et al., 2005), assembly virtual prototypes (Valentini, 2009) or for collaborative applications (Shen et al., 2008). In (Shen et al., 2008) is presented an AR-CAD based system which offers the users the possibility to visualize the 3D CAD models, but the users cannot directly create or modify models without leaving the AR environment.

This paper presents a research carried out at Transilvania University of Brasov with the aim to develop a multimodal interface based on Augmented Reality technology that enables modelling of 3D CAD objects co-located in the real environment, without leaving the AR based environment. The aim of this paper is to find out if AR multimodal user interface can be used as an alternative to the classic interface that uses keyboard, mouse and 2D display menus and widgets.

## 2. ARHITECTURE OF THE DEVELOPED AR INTERFACE

A multimodal interface based on Augmented Reality technologies provides an alternative to the traditional interface that uses 2D display, keyboard and mouse. Various interaction tools are used: a Trivisio Head Mounted Displays (HMD) stereo video see-through for visual output, an optical tracker system for spatial tracking of user hand position and orientation; data gloves for fingers gesture recognition and voice recognition for input commands (Figure 1). The solution enables modeling of solid objects by combining advantages of the AR technologies with available well-established Solidworks 3D CAD software. The chosen approach is to keep current CAD functions implemented by the software vendor and augment them with an AR user interface for an intuitive and natural way of interaction. The architecture of the system is presented in figure 1.

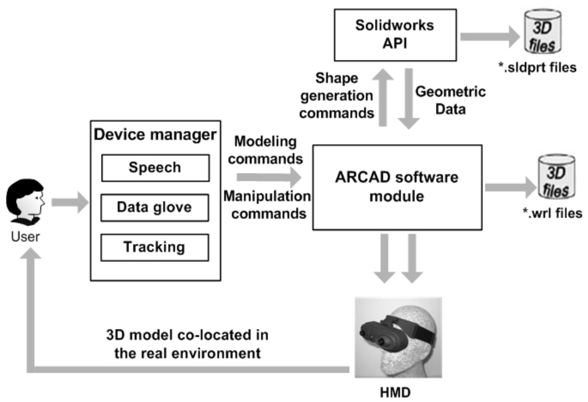


Fig. 1. Arhitecture of the AR interface

The essential component of the distributed software architecture is the ARCAD module. The ARCAD module retrieves and interprets command data from input devices, translates them in shape generation commands to Solidworks, retrieves model data from Solidworks, generates VRML files and sends them to the visualization system HMD. For the co-location of the 3D models in the physical environment is used a Mixed Reality framework called Instantreality. A bi-directional flow of information between CAD and AR environment was implemented. When the user creates an entity in the AR environment, the data is sent to the CAD solid modeler that executes the appropriate modeling command and the geometric and surface identification topological data is sent via network to the AR database. The result is the VRML file which contains geometric information of CAD models entities, discretized as triangle mesh, and the topology structure which is stored as hierarchical relationships between parts, surfaces and tessellations. In this way to each tessellation corresponds only one surface and to each surface corresponds only one part. Each entity of the CAD model is treated as an individual object and has a unique identity that corresponds with the entity name from the CAD database. The multimodal interface provides functions for creation of solids primitives (box, cone, cylinder, and sphere), extruding 2D closed profiles and revolving a 2D profile around an axis.

## 3. INTERACTION TECHNIQUES

Replacement of the 2D mouse in the VRCAD multimodal interface has been made by using gestures needed to emulate various commands (select entity, edit dimensions, delete entity), identified with lightweight Pinch Gloves tactile gloves, ARTrack optical tracking system attached to an interaction stylus and voice commands.

Keyboard is still used in the CAD conventional system for input of alphanumeric data. In the ARCAD system this device has been replaced with voice commands. Voice commands are words (for example "profile","circle","extrude" etc.) that are transmitted by the user through the use of a microphone. Microsoft Speech Recognition API was used for the implementation of voice commands. Speech direct control is used to activate function for modelling, manipulation (rotate, pan, zoom in / out), edit or delete an entity. The ARCAD module interprets these words and generates the appropriate action.

The conventional CAD systems use for generated CAD model visualization a traditional CRT/LCD 2D display. In order to overcome this disadvantage of traditional CRT/LCD 2D display (e.g lack of depth cues and co-localisation) stereo video see-through HMD AR display was used to augment human's visual sense (see Figure 2). The advantages of this type of display are the portability and the possibility to place it directly on the users' visual range.

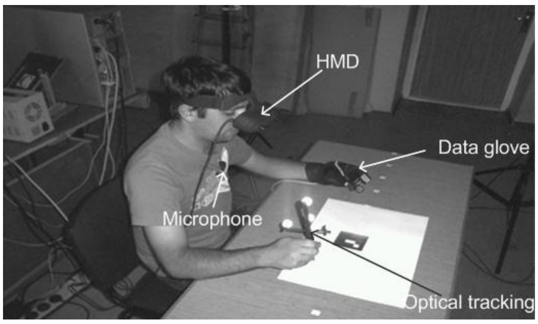


Fig. 2. AR devices used for the interaction and visualisation with the 3D models

## 4. EXPERIMENT

The experiment consists of modeling a simple part, composed from two rectangle features, a cylinder and a blind pocket. The sample part was modelled using the multimodal AR interface described above in the following steps: the first box entity is created using the voice command "Rectangle" which activates of a 2D rectangle drawing feature. The 2D entity is draw according with the movements of the tracked hand. Insertion of control points is made by voice command "Enter" or by a finger gesture (touching one of the glove fingers). Then, the user extrudes the 2D sketch by using the voice command "Extrude". After, the box is selected and the dimension is edited by moving the hand position or by specifying an alphanumeric value with the aid of "Number" vocal command followed by the specific digits and "Enter" vocal commands. The steps are repeated for the second box and cylinder feature (see figure 3). This simple experiment described above demonstrates that the ARCAD approach is possible with real time interaction and communication with the user. Augmented reality interface is used just as a user interface to the CAD database. The user can generate 3D models from scratch and as a result of his/her commands the virtual scene is enriched or edited. These actions are reflected instantly in the CAD software database as well as in the AR system.

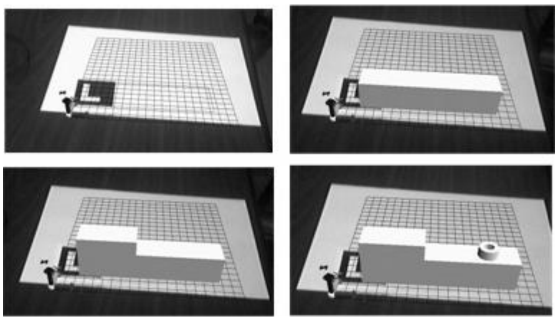

Fig. 3. Generation of a 3D model using ARCAD

## 5. CONCLUSION

Augmented reality technologies represent very useful tools to interact and visualise 3D models. In this paper a multimodal AR based interface was presented that enables the generation of 3D CAD objects co-located in the real environment. The difference between this approach and the previous research consist in the integration of the AR technologies with legacy CAD database. In the experiment conducted within this research a good synchronization was achieved between the CAD legacy database and the virtual environment, allowing natural interaction of the user with the 3D model and improving the operator perception. This approach proves that the alternative to use multimodal AR interface for CAD modelling is feasible. Future work will focus on extending the current work for CAD assemblies.

## 6. ACKNOWLEDGEMENTS

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