

# Virtual and Augmented Reality for Mechanism Motion Modeling in Technical Applications

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*Abstract:* - This paper presents the activities of our team to study and to establish a configuration for technical applications of a mechanism motion modeling using virtual and augmented reality. It is also presented a constraint-based methodology for reconstructing the 3D motion given image observations. For that we used the virtual and augmented reality to modeling and to analyze the moving of a mechanism in education and technical applications.

*Key Words:* - virtual, augmented reality, modeling, control, motion.

## 1 Introduction

Virtual Reality (VR) refers to a technology that is capable of shifting a subject into a different environment without physically moving him/her.

To this end the inputs into the subject's sensory organs are manipulated in such a way, that the perceived environment is associated with the desired Virtual Environment (VE) and not with the physical one. A computer model that is based on the physical description of the VE controls the manipulation process. Consequently, the technology is able to create almost arbitrarily perceived environments.

Practical applications of virtual reality are normally in the simulation of engineering process, product design, and skill rehearsal. Users enter into a virtual environment in order to learn something new about the real situation, to which the simulation corresponds, or to improve or learn a skill set.

Four technologies are crucial for Virtual Reality (VR)

- the visual (and aural and haptic) displays that immerse the user in the virtual world and that block out contradictory sensory impressions from the real world;
- the graphics rendering system that generates, at 20 to 30 frames per second, the ever-changing images;
- the tracking system that continually reports the position and orientation of the user's head and limbs; and
- the database construction and maintenance system for building and maintaining detailed and realistic models of the virtual world.

Four auxiliary technologies are important, but not nearly so crucial:

- synthesized sound, displayed to the ears, including directional sound and simulated sound fields;
- display of synthesized forces and other haptic sensations to the kinesthetic senses;
- devices, such as tracked gloves with pushbuttons, by which the user specifies interactions with virtual objects;
- interaction techniques that substitute for the real interactions possible with the physical world

Motion synthesis of mechanisms relies on the designer's ability to specify desired locations of an object and visualizes relative motion of the resultant mechanism.

Traditionally, mechanism design has concentrated on synthesis of planar motion mechanisms.

Planar mechanism synthesis involves two-dimensional ~2D!

Display and interaction, and this are well suited to the traditional human-computer interface (HCI) of a computer monitor, keyboard and mouse.

However, designing spatial mechanisms requires the designer to visualize and interact with the mechanism in three dimensions, which is difficult using the traditional HCI.

Virtual Reality (VR). Technology provides a three-dimensional environment in which to interact with digital models.

Thus, this research focuses on the use of VR for the design of spatial mechanisms.

Models using a traditional HCI are not drawn in real size and cannot be manipulated in a natural way.

VR allows the user to view the real size models and interact with the models with a position sensor to track head motion and a wand or instrumented glove, which would also be equipped with a position sensor.

The head position and orientation are used to compute the viewing perspective for the computer display.

This is in contrast to the traditional HCI where the user manipulates a desktop mouse and types on a keyboard to interact with digital models.

## 2 The motion modeling system

Motion modeling is an attractive method for creating the real systems to establish the position of the objects or of virtual spaces used to study and to simulate different technical or medical applications. In this application we used an optical set of sensors, a video-cam and a marker.



Fig.1. The markers and illumination system

To establish a practical configuration in modeling action we use also the system TriVisio with stereoscopic feature for Augmented Reality.



Fig.2. TriVisio system

With this system and using an acquisition board (Pinnacle) for stereoscopic images we develop a technical application for simulate a moving of articulate bars into a mechanism.

To use this device for AR function, the signal from video-cam must send to a computer, using the USB cable 2.0.

The video signal suppress stereoscopically received from a computer can be redirect in the mean unit using two cables VGA.

The resolution of computer display must be 800x600 at 60 Hz and to connect these two cables VGA we can use a few possibilities: the most chip solution it is that the computer has a video board with two exits

VGA and the second it is the solution that the computer use two video board in SLI and CrossFire. To adjust the convergence of the small video-cam of the head mounted device (HMD) it is necessary to rotate correctly around itself axes or to rotate a little wheel on the front of the device.

The optimal position for using the two displays can be obtains by the movement of the optical systems of the video-cam into right or left direction.



Fig.3. The connection structure

## 3. Developing the software modules

In operation for modeling or simulation of mechanical motion we're using the programming language, software **ARToolKit**, which it is software that allow researchers to develop easier the applications in Augmented Reality.

The most important and difficult part of the developing the applications in Augmented Reality it is the very precise calculus of the visualization point in such way that the visual images could be in line with the real world and the object from environment.

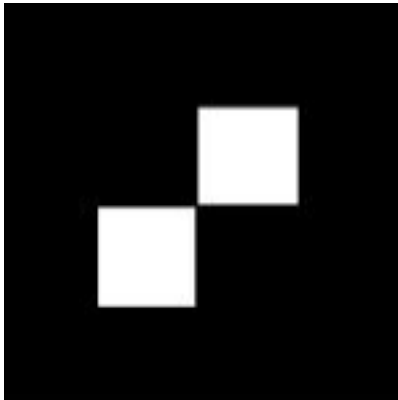
**ARToolKit** uses the visual technique through computer interface to compute the visualization point of the human visual system, in real time, to put in the same line, the virtual objects with the real objects.

**ARToolKit** uses techniques to compute the right position of the video-cam and the orientation to the marker, allowing to the user to suppress the virtual object on these markers.

**ARToolKit** must offer a rapid developing of an application in AR or to improve at different sort of platform like SGIIRIX, PC Linux and PC Windows.

#### 4 Calibration of the optic system

To obtain a good stereoscopic vision it is necessary to configure the optical system “see-through”, then it is necessary to measure the right distance between the users eyes and the distance to mini TFTs.



*Fig.4. The shape of marker and the position of user when calibrate the video system TriVisio*

All these are made by an auto-calibration method, in which the user takes the marker in his hand, looks with each eye and use an image of a virtual target presented on the display of device “see- through”. To maintain the stereoscopic capabilities must provide a new re-calibration for each user that will use the Augmented Reality applications.



*Fig.5. Marker with 6x4 pointsfor calibration*

For a good calibration operation, the marker must be put it at 80 cm distance from user eyes and after that it must held very stabile and in vertical position. In standard method using ARToolKit we find necessary to virtual calibrate the video-cam with a real target-pattern with 6x4 points having 40 mm distance between them.



*Fig.6. Marker calibrated by ARToolKit*

After a 5-10 images taking the system must stop the calibration and compute the value of video-cam optical distortions.

#### 5. AR application developed into a testing stand

The application is to suppress a virtual mechanism onto a stream video recording with system TriVisio. This virtual mechanism is an articulated bars system and its command it will be made by UDP port and, also, to obtain a continuum and variable signal we use the command line from LabView software.



Fig.7. Mechanical system with uncalibrated marker

This application uses a mechanical stand with two motors.

The signal is send to the stand, then to the ARToolKit and the virtual elements receiving the same signal will have the same movement with the mobile elements from the stand.

If the calibration and stereoscopic parameters are not established correctly, in his virtual movement, the articulated bars system will have the initial point in another position (not in the center of the marker) and it will not work properly (will not follow the movement of the user head).

To implement the HMD it was necessary to implement the virtual elements into the system and to oblige to stay in a fix position in the same time with the moving of the vide-cam.



Fig.8. The system calibrated and corect rendering

For that was implementing also a video-stereo signal to the TriVisio system. This signal was develop with the help of C++ and with the drivers NVIDIA.

The virtual element must be sending it to each displays of the system with a different visual angle.

But there are other problems with the light used in the experiment time, because the calibration of ARToolKit was made with a certain illumination and if this will change, the testing must be restart once again with the calibration operation and with a constant illumination.

The result of this experiment is presented in fig.8.

And we can observe that, after the implementation, the virtual element (in red color) remain in the center of the marker and the marker remain in the center of the video-cam and the marker is recognized.

The rendering operation was made with the help of a capturing video-board.

## 6. Conclusions

By this system we develop a structure to study and to simulate the moving of the articulated bars in different conditions (speed, positions, time period). For that was necessary to implement a new AR system with TriVisio component and special compute line in ARToolKit software. This system will be useful in understanding and modifying existing or design future mechanical structures.

### Acknowledgements

This work was a part of a Research Grant A1088/2005 - 2007 financed by CNCSIS Romania.

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