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TECHNICAL CHALLENGES IN AUGUMENTED REALITY

Ema NOVÁKOVÁ - MARCINČÍNOVÁ – Anton PANDA –

Ľudmila NOVÁKOVÁ - MARCINČÍNOVÁ

Abstract: Unlike applications in advertising, gaming, fashion, etc., AR applications in manufacturing and design requires a high level of accuracy in tracking and superimposition of augmented information. Outdoor AR systems use GPS and inertial tracking techniques with a combination of gyroscopes, electronic compass, accelerometers, and other types of sensors, together with CV tracking techniques.

Keywords: Augmented reality, virtual reality, CNC simulation

Accuracy

Precision and accuracy are generally lacking in outdoor applications but very often, a high level of precision is not required. In design and manufacturing, such activities are usually indoors, and GPS will not be applicable. In addition, very accurate position and orientation tracking will be needed in operations such as CNC simulation and robot path planning. Computer-vision, inertial and hybrid tracking techniques will be required. CV-based tracking will not be able to handle high frequency motion as well as rapid camera movements. Hybrid systems using laser, RFID and other types of sensing devices will be required.

Fig.1. 3D virtual GPS in reality

Registration

One of the basic issues in AR is the placing of virtual objects with the correct pose in an augmented space. This is also referred to as registration, which is a difficult and much researched topic. As different tracking methodologies possess their own inherent deficiencies

and error sources, it is necessary to study the best tracking method for a particular application which could be subject to poor lighting condition, moving objects, etc.
The first type of errors is referred to as static error which arises from the inaccuracy present in the sensory devices, misalignments between sensors, and/or incorrect registration algorithms. These types of errors can be eliminated quite easily as higher accuracy sensors are available and other sensor alignments can be set up accurately.
The second type of errors is the dynamic errors that are less predictable, which can be due to latency problems between data streams due to off-host delay, synchronization and computational delays. Researchers have been working on methods to resolve the latency issues and some of the solutions are to adopt multithreading programming or scheduling system latency, and predicting the camera motion using Kalman filter.

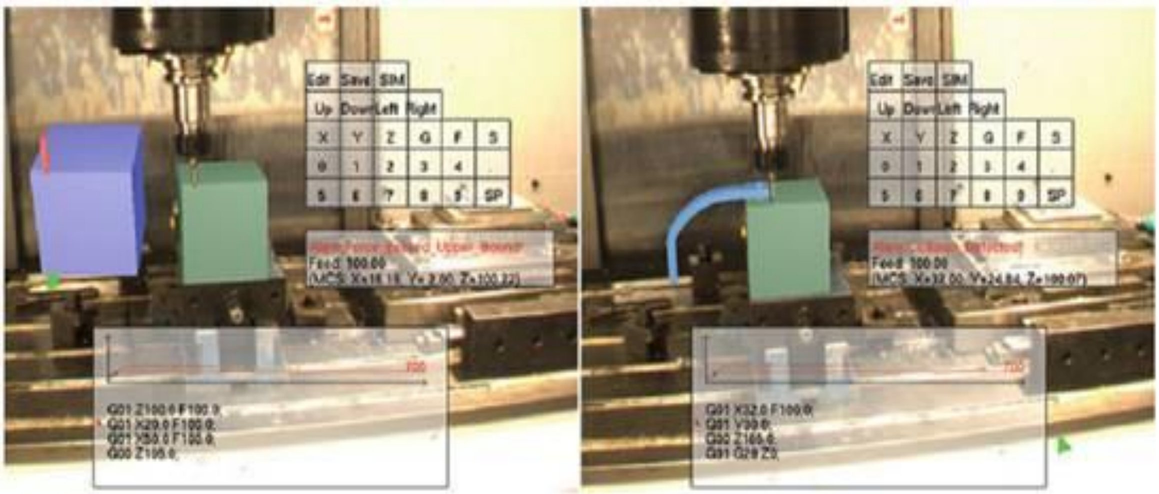

Fig.2. Augumented Reality CNC simulation

Dong and Kamat described a solution which could eliminate these types of errors. They presented a mobile computing framework which provides an integrated hardware and software solution to achieve centimetre level accuracy for AR applications both spatially and temporally. They developed the Augmented Reality Mobile Operation platform (ARMOR) based on the ARVISCOPE hardware platform. A Scalable and Modular Augmented Reality Template (SMART) was developed by Dong and Kamat and it builds upon ARVISCOPE. The registration algorithm of SMART can ensure high accuracy static alignment between virtual and real objects, and reduces dynamic registration errors.

Latency issues

AR displays require an extremely low latency to maintain the virtual objects in a stable position. An important source of alignment errors come from the difference in time between the moment an observer moves and the time when the image which corresponds to the new position of the observer is displayed. This time difference is called the end-to-end latency, which is important as head rotations can be very fast and this would cause significant changes to the scene being observed. It is suggested that the displacement of objects between two frames should not exceed 0.25 of a degree. In terms of latency, this would translate to 5 ms when an observer rotates his head at a speed of 508 per second. Pasman et al. described a method to meet this requirement. Their method used a combination of several levels of position and orientation tracking using varied relative and absolute accuracies, as well as different levels of rendering to reduce the 3D data to relatively simple scenes such that the 3D data can be rendered in a shorter period of time.

Fig.3. 3D visual scan

Augumented Reality interfacing technology

Four essential elements are needed to set up an AR environment, namely, target places, AR contents, tracking module and the display system.

Kim and Dey reported a comprehensive review of AR prototyping trends and methods. They addressed three features for creating an AR environment that are essential for end-user interaction, viz., intuitive observation, informative visualization and immersive interaction, and in the development of Interactive Augmented Prototyping (IAP). These three features are further used to integrate AR technology and develop custom-built 3D simulations.

3D interface and wearable computing devices are popular areas of AR research on interfacing technologies. Poupyrev divided the AR interface design space along two orthogonal approaches, viz., 3D AR interfaces and tangible interfaces. In the 3D AR interface, users interact with virtual contents via HMDs and monitor-based displays and these are not the tools that they would interact with the real world. In tangible interfaces, users would use traditional tools in the same way as they manipulate the physical objects.

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Contact address

(1.) Ing. Ema Nováková-Marcinčínová
Technical university in Košice, Faculty of manufacturing technologies with the seat in Prešov, Štúrova 31, 080 01 Prešov, Slovakia,
e-mail: ema.novakova- marcincinova@tuke.sk

(2.) prof. Ing. Anton Panda, PhD.
Technical university in Košice, Faculty of manufacturing technologies with the seat in Prešov, Štúrova 31, 080 01 Prešov, Slovakia, e-mail: anton.panda@tuke.sk

(3.) Ing. Ľudmila Nováková-Marcinčínová, PhD.
Technical university in Košice, Faculty of manufacturing technologies with the seat in Prešov, Štúrova 31, 080 01 Prešov, Slovakia,
e-mail: ludmila.novakova- marcincinova@tuke.sk