VISUAL REQUIREMENTS ON AUGMENTED VIRTUAL REALITY SYSTEM

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Abstract: Paper describes basic fundamentals about image registration in augmented virtual reality with common errors, which occurs in such system. As well as basic requirements on motion tracking system, that can be used for object tracking. Consequently it introduces an optoelectronic system for motion tracking, which seems to be the best possible solution for motion tracking in augmented virtual reality systems.

Keywords: virtual reality, optoelectronic system, motion tracking

1. INTRODUCTION

Term virtual environment gains nowadays great attention in wide public. Main idea is immersion of user into artificially generated environment, which was created by computer. However, this goal should be achieved using different approaches, all of them suffer with one same factor that user is cut out of real environment, which is outside of Virtual Reality (VR) environment. Far less attention is focused to area of augmented virtual reality, which potential as great as it is at virtual reality.

Augmented virtual reality dynamically merges objects of real world with computer generated models. This technology allows user to observe his environment together with computer features added into scene. Instead of effort of virtual reality of replacing the whole environments with one, which computer generated, augmented reality only expand real world with artificial features. Such systems require highly capable head and object trackers to create an effective illusion of virtual objects coexisting with the real world. For ordinary virtual environments that completely replace the real world with a virtual world, it suffices to know the approximate position and orientation of the user's head. Small errors are not easily discernible because the

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user's visual sense tends to override the conflicting signals from his vestibular and proprioceptive systems. But in augmented reality, as I mentioned, virtual objects supplement rather than supplant the real world. Preserving the illusion that the two coexist requires proper alignment and registration of the virtual objects to the real world. Even tiny errors in registration are easily detectable by the human visual system.

For correct scene generating it is very important to choose appropriate system of user tracking and by its integration into system of augmented virtual reality consider its errors and boundaries to avoid mistaken expectation laid on system.

2. PICTURE REGISTRATION

Augmented virtual reality at the present time is in initial phase of its development. Usage of whole potential of this technology is limited with several technical difficulties. One of them is picture registration. Real and virtual world has to be aligned correctly with regard to their specifics. This problem is very complicated because of several reasons. Human eye perception is very high and able to capture very small mismatches in perceived environment. Resolution of human eye highly extends possibilities of graphic technology we currently have. With this issue are connected some technological limitation. One of them is restricted field of view. A complete and accurate sense of space requires a very wide field of view. Our understanding of the world around us is generally built up, one piece at a time, using the relative arrangements of each item to help solidify our percepts. When, due to an unnaturally narrow field of view, we are unable to see important parts of the world, such as the floor and our body within the world, we lose a great deal of confidence in our understanding of the world. Simple actions, like walking around a corner, can be quite difficult when the user is wearing a head-mounted display with a very limited field of view. The larger the field of view, in general, the more complete and accurate depth perception will be. The next issue is limitations and mismatches of resolution and image clarity. Objects that are displayed on a HMD, monitor, or projector necessarily have less resolution, or spatial frequency, than directly viewed objects. This means that correspondingly less texture is provided than a real object in the same position would possess. If this lack of detail is inappropriately interpreted as texture perspective, the imaged object may appear to be farther away than the real world object would appear.

Other serious problems related with picture registration are erroneous parameter of projected scene. Mistakes show in HMD by tracking subsystem as well as other mistakes, which rise in such systems, does not have to remarked in case of virtual reality, because user do not have any base point, however in systems of augmented virtual reality, where virtual object should be aligned with real world, these mistakes should regard like serious problem, because of the whole scene should disintegrate. By incorrect constrains of virtual and real object, these errors are immediately visible. The following problem connected with picture registration is system latency, which cause delay in object rendering. High system latency by quick movement or position change
should look like object blurring during his movement, what in some cases consequence discrete change of object position instead of continuous.

![Diagram of position scanning and scene rendering mutual connection.](image)

**Fig. 1.** Position scanning and scene rendering mutual connection.

### 3. POSITION TRACKING

System of position tracking should be able to locate user position and head orientation in real environment in order to build correct view of virtual scene as well user position in it. Ideal system for user tracking should have infinite accuracy and zero error rate. These systems work on different principles. For example: magnetic, ultrasonic, infrared, hybrid etc. Ideal is if sensor is able to obtain data with the highest possible accuracy (degrees, minutes). Errors occurred by incorrect head orientation measurement usually causes bigger problems that errors occurred by incorrect object orientation. The next important task is to achieve the lowest possible combine latency between sensor and graphical part of system. Combine latency represent time delay between point of user locating in environment and point of rendering resident view of scene.

Many HMD-based systems have a combined latency over 100 ms. At a moderate head or object rotation rate of 50 degrees per second, 100 milliseconds (ms) of latency causes 5 degrees of angular error. At a rapid rate of 300 degrees per second, keeping angular errors below 0.5 degrees requires a combined latency of less than 2 ms.

At last the tracker must work at long ranges. When the environment is completely virtual, long-range trackers aren't required because we can create an illusion of flight by translating all the objects around a stationary user. But in augmented reality, flying is not a valid means of locomotion. The virtual objects must remain registered with the real world. Since we cannot translate real objects around a user at the touch of a button, the user instead must move himself or herself and the display devices worn. Thus, many augmented reality applications demand extended-range trackers that can support walking users. No existing system completely satisfies all of these requirements. Systems commonly used to track airplanes, ships and cars have sufficient range but insufficient accuracy.
Fig. 2. Components of Picture registration and position tracking.

Fig. 3. Data glove position tracking (left picture) and hand alignment in virtual scene (right picture).

Many different tracking technologies exist, but almost all are short-range systems that cannot be easily extended. Feasible compromise of above mentioned requirements seem to be an optoelectronic system developed by UNC Chapel Hill that can be extended to arbitrary room sizes, while still providing reasonable tracking performance. Optical sensors mounted on the head unit view panels of infrared beacons in the ceiling above the user. The known locations of these beacons and the measurements taken by the sensors provide enough information to compute the position and orientation of the user's head. The system can resolve head motions of under 2 mm in position and 0.2 degrees in orientation, without the distortions commonly seen in magnetic trackers. Typical values for the update rate and latency are 70- to 80 Hz and 15- to 30 ms respectively. The existing ceiling covers can be in case of need extend the range by simply adding more panels to the ceiling grid.
While this system is suitable for augmented reality applications, it is far from ideal. There is need for reducing weight of the head unit and increase the restricted head rotation range. Due to line-of-sight constraints, this system is not well suited for object tracking. Research is needed to develop long-range trackers that require far fewer modifications to the environment. Perhaps the most effective solutions will be technology hybrids. For example, inertial trackers have infinite range, but lose accuracy with time due to accumulated drift. Occasional measurements from several accurate but short-range trackers might control that drift. These and other potential improvements must be explored to meet the stringent requirements of augmented reality.

4. CONCLUSIONS

System of augmented virtual reality system demands for achieving impression of real and virtual world coexisting highly performer head sensors or object sensors. For common virtual reality, which substitute real world with computer generated images it is sufficient to designate approximate position and orientation of user. Small errors which can occur during process are hardly recognizable because user visual perception has tendency move off this fact. In stead of augmented virtual reality, where
objects extend real world it is very important to ensure correct coexistence of these objects by achieving right picture registration as well as user position tracking.

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