Virtual World in Real Environment

Heikki Palomäki
Seinäjoki University of Applied Sciences
Seinäjoki, Finland
heikki.palomaki@seamk.fi

Tapio Hellman
Seinäjoki University of Applied Sciences
Seinäjoki, Finland
tapio.hellman@seamk.fi

***Abstract*— There are existing technologies allowing us to locate objects in our environment and also technologies allowing us to see virtual objects around us, near and far away. Those technologies include both navigation devices and eyeglasses with integrated display, known as HUD (heads up display). More advanced virtual scenery may be obtained using specific virtual reality hardware. The vision of this presentation is to combine these two technologies to add virtual reality in our real environment.**

The idea is to see high quality virtual objects located in certain places on the terrain by using eyeglasses, such as Google glasses. User may be able to travel between these objects, exchange data with them, modify them or activate specific tasks. Accurate navigation is essential to define the exact location and to provide directions for the user to be able to see virtual objects in correct locations with eyeglasses. Network connection with virtual object database is also needed as well as high performance computing equipment for 3D data calculation for the eyeglasses.

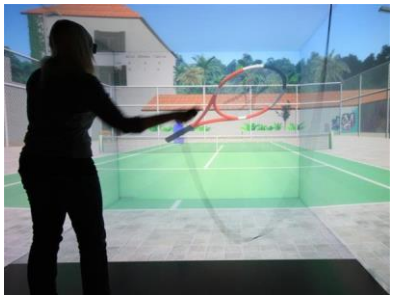
This project idea opens a huge number of opportunities for new applications. Novel virtual reality adventure games or geocaching may be developed. Dangerous rescue operations can be trained virtually. The idea makes it possible to explore tourist attractions in virtual reality without actual traveling. Architectural design or factory layout may be available for walkthroughs in early design stage.

Co-operation of multidisciplinary experts is essential for this kind of concept and it is therefore suitable for an internationally organized project. Since none of the current eyeglasses with integrated display have yet hit a breakthrough, there is still room for further scientific research. Manufacturers of such devices are still in early prototype phase and inexpensive user friendly end customer products are yet to be seen.

Keywords: Virtual reality, Google glasses, HUD, eyewear display, locationing, co-operating, MEMS

I. Background

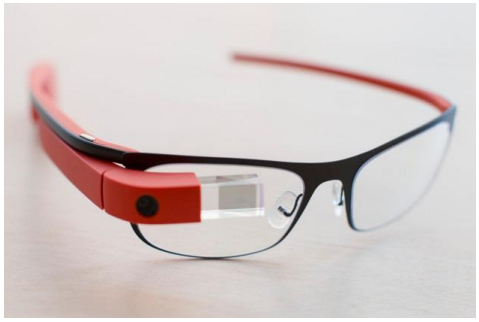
Virtual reality (VR) is a fast developing technology used in many various modelling tasks and in advanced computer games. You can visit significant buildings virtually and have adventures in almost real role play environments. Anyway, virtual reality is limited mostly into laboratories, computers or in wearable equipment.



Picture 1: Virtual reality play (©SeAMK)

Another kind of technology is to use GPS mobile phones to see our environment virtually. One example is Nokia City Lens, which allows pointing the phone to different directions and seeing needed services around you. Also, plans exist to get advertisements and offers automatically in your mobile phone, as you are travelling near the shops.

The novel development area is to get the virtual reality data in front of your eyes automatically, as you are walking. Numerous companies have developed head-up displays (HUD), head-mounted displays (HMD) or eyewear displays. They use micro-size displays and optics to show video via or alongside a normal-sized eyeglasses. The most knows HUD among over 15 developers is Google glasses, including camera, GPS and some audio user interface. [1] [2]



Picture 2: Google Glasses [2]

II. The Idea and State of Project

The idea of this presented project is to have a virtual world in real environment, which is visible by using a HUD or compatible displays. The user can walk between virtual objects and have a real feeling of features and functions of virtual model. The user can also exchange data with objects, start

various actions, execute defined tasks or perhaps modify object layouts. Also, it is possible have team activity i.e. games or exercise tasks.

As virtual objects are visible in your environment by using HUD, it is necessary to see these in certain static places in environment, staying in their locations while moving your head. In addition to GPS positioning it requires three dimensional acceleration and gyro sensors with a compass to sense your head movements. If HUD includes a camera, high performance image processing can also sense your movements and locate the objects in certain locations in your environment.

It's also possible to develop a low-cost version of virtual reality. It means that a hand-held module with indicator LEDs replaces the display. It communicates wirelessly with physical objects hidden on the terrain.

This project is mostly in concept level. Knowhow exist to realize all parts of projects in collaboration between international institutes. Some tests are realized with wireless modules, for example one game for children. Anyway, the most important resource is in search: funding.

Horizon 2020 program seems to be able to fund this project. We need experience in EU funded project coordination and human and financial resources to prepare financing applications.

III. Project Areas

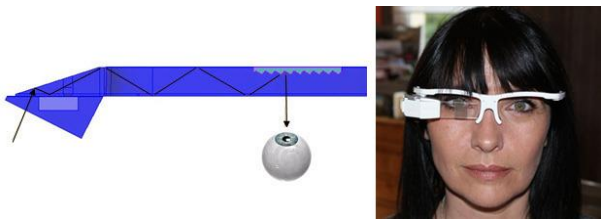
The project concept includes several areas, which have clear interface between each other. These areas can be executed by several cooperation parties depending on the knowhow of each. Seinäjoki University of Applied Sciences has knowhow of object modelling in virtual reality and also knowhow of short-range and low-cost wireless technology.

A. *Coordination*

Depending on the sponsor, the aim of the project must be focused in the funding call. One possibility is Horizon 2020 FET-Open calls (FET = Future and Emerging Technologies). The coordination of the project requires a lot of experience and resources to write and collect all documents needed for funding search.

B. *HUD selections and tests*

A key technology of this project is high quality visualization of virtual world. The possibilities are depending on the HUD equipment, if it has enough features and sensors to achieve the goals. Therefore selections and tests of variety HUDs need a lot time and know-how. The challenge is a large set of new, unfamiliar HUD's from large variety of manufacturers. [3]



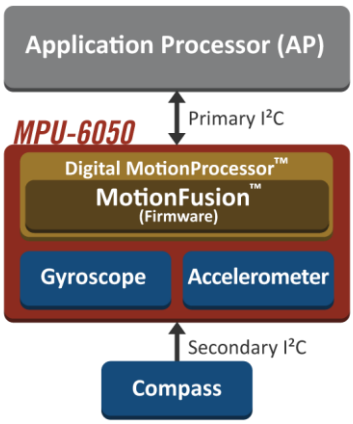
Picture 3: Optinvent's HUD technology [3]

C. *Computing device selection and test*

Correct sense of virtuality is achieved by fluent image and quick database processing. It requires a lot of computing power and memory, high-speed network communication and high-end display controller to render virtual models. The mobile phone and tablet computer technology develops fast. Finding adequate equipment for this purpose requires planning.

D. *Positioning with MEMS sensors*

Many mobile phones and tablets include GPS and acceleration sensors. Some HUD equipment includes acceleration and gyro sensors and also a camera. There are also many easy-to-use MEMS (Microelectromechanical systems) sensor modules with 3D acceleration and gyro sensors and compass [4]. Acceleration sensor, calibrated online by GPS data, gives an accurate position in the environment and direction of HUD. Gyro sensors, calibrated online by a compass give the right orientation of HUD. All this requires computing power and algorithms to accomplish.



Picture 4: Motion sensor example [4]

E. *Image processing*

Computing equipment must update the position of 3D virtual objects on the display very fast depending on the HUD position. This requires a lot of computing power. If camera is in use to sense the position of HUD and to embed objects into view, also fast image pattern recognition is required.

F. *Virtual object database and communication*

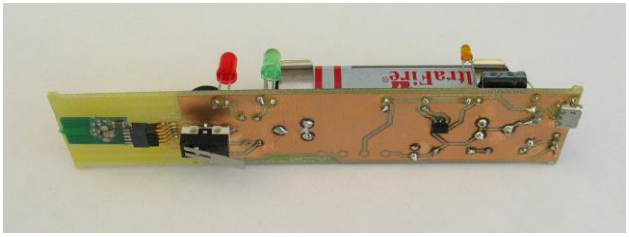
Virtual object database provides the content for every application. It contains all required virtual objects with relative positioning data. There are two alternate ways to use the

database: In online use only neighboring locatable objects are downloaded in real time and the virtual model can have nearly unlimited size. In offline use the whole virtual environment is downloaded to the local memory. Online use requires a fast communication channel to update the local virtual environment in real-time, while offline use requires a lot of memory in terminal equipment.

Picture 5: Virtual Seinäjoki city (© SeAMK)

G. *Wireless modules*

Using short range wireless modules it is possible to develop low-cost and simple to use applications. Handheld modules with indicators replace the HUD. Wireless targets on the terrain replace the virtual objects. User commands can be executed by acceleration sensor. Very challenging strategy game applications are possible as also very simple ones.



Picture 6: Example of hand held module proto (© SeAMK)

IV. APPLICATIONS

This project concept opens a huge number of opportunities for new applications. Computer games can be applied on the terrain. Architectural designs can be tested in real size and in real dimensions on the site. Unattainable targets can be reached virtually. One important additional value is that walking on the terrain replaces surfing on the computer.

A. *Virtual geocaching*

Geocaching requires physical targets on the terrain. Targets are fixed. The found targets are no more interesting and you must travel far to find new interesting ones. In virtual geocaching, target positions and types may alternate depending on the competence of the user. The geocaching content may be used for a limited time or it may be tailored for a special target group. The course of the task is automatically updated without manual reporting. It's also simple to add new features such as educational information or exercise.

B. *Virtual tourism*

Our world includes plenty of resorts worth seeing. Some of these need expensive travelling and some are not even reachable. As you download virtual model of one resort, you can experience it privately without any rush. By this way you can also test interesting resorts to find out, which of them would be worth of real travel. By virtual tourism you can visit on the bottom of the deepest ocean, walk in Titanic [5], walk on the moon or search the craters on the planet Mars.

Picture 7: Virtual Titanic [5]

C. *Adventure games*

Gaming technology is one of the most growing technologies today. However, you must sit in front of your computer, tap your mobile phone or, as its best, wave your pointing device in your living room. It doesn't provide a real feeling of the game because of limited exercise environment. Especially, it is not very healthy to use your computer inside as you need experiences and physical exercise.

Adventure game environment may exist virtually on your backyard, field or forest. You can be the hero yourself and run through challenges. Almost every strategy or role adventure game is suitable to be played virtually on the terrain. Also many types of hunting tasks may be carried out this way.

Picture 8: Virtual hunting example (© SeAMK)

In the most advanced application you can follow the movie story as an invisible ghost. You may possibly have an influence on the plot of story and spur peoples in the movie.

D. *Virtual architechture*

Testing an architectural design is an important way to test whether it is appropriate in reality also. Testing the model in laboratory doesn't provide real feeling of reality though. Only as you walk through the virtual model, you understand better the functionality of design. As you locate the virtual model in the real prospective position on the terrain, you can find out if it acts correctly fits in its environment.

E. *Training in virtual environment*

In crisis it is very important to act correctly in relation to situation. In some cases it is impossible to train beforehand in real environment though. Training can disturb the important tasks and routines at the hospital. It is impossible to train a real accident in a nuclear power plant. Some places may be otherwise unreachable until emergency case. Chance to pull through a crisis is better when it is possible to train it beforehand in virtual environment with real structures and distances.

Picture 9: Virtual model of power plant (© SeAMK)

Another application example is learning agricultural tasks. Virtual farming environment may simulate the real plant growth depending on practiced fertilization or random weather conditions. By this way the future farmer can train real farming and understand better agricultural tasks.

F. *Wireless modules*

Many parts of virtual environment idea mentioned above can also be realized by using short range wireless modules. This platform is suitable for gaming related applications, as geocaching and adventure games. The terrain can be equipped with small radio buttons, which function as virtual objects: targets, treasures, castles, material sources etc. The range can be also very short depending on the application. The handheld modules function as a user interface with LED bar as display and 3D acceleration sensor as input device. The form of the handheld module can be some tool or weapon. Very natural behaving of tool controls all actions in the application.

Wireless modules are very cheap and simple to put into operation. Users may be private households, schools or nursing homes. The application strategy may be challenging or it may be very simple to suit best for children and disabled people also.

Picture 10: Handheld modules (© SeAMK)

V. Conclusion

The idea of virtual world in real environment is now 'in air'. We can bring it down, let it fly away or do something about it. This kind of technology develops quickly. Applications described above will be realized sooner or later.

One problem is to be in the picture about HUD and MEMS sensor technology, which are the heart of most applications above. Also mobile phones and tablets regenerate now and again. This all means that all software developed in project must be as universal and device independent as possible to be usable also in the future.

If this kind of project realizes, it is a challenging training environment of international cooperation and project administration of high technology development. If the project starts to develop basic technology and tools to realize virtual world in real environment and it reaches results, the application development generates next numerous new projects at institutions and in companies.

References

[1] Hill Simon, "Digital Trends, A look at all Google Glass competitors in development," August 22, 2013, [Cited September 26, 2014], http://www.digitaltrends.com/mobile/google-glass-alternatives/#!bKX0Td

[2] Nazarian Robert, "Google Glass coming to AT&T stores," June 9, 2014, [Cited September 26, 2014], http://www.talkandroid.com/209434-google-glass-coming-to-att-stores/

[3] Kayvan Mirza & Khaled Sarayeddine, "Key challengen to affordable see through wearable displays: The missing link for mibile Ar mass deployment," Optivent S.A., Rennes, France, [Cited September 26, 2014], http://optinvent.com/pdf/optinvent_position_paper_2012_AR_standards.pdf

[4] PRWeb, "InvenSense Announces Commencement of High Volume Shipments of Its 6-Axis MPU-6050 MotionProcessor to OEM/ODM Customers," Sunnyvale, California, September 14, 2011 [Cited September 26, 2014], http://www.prweb.com/releases/2011/9/prweb8793032.htm

[5] TitanicHG, "Titanic: Honor and Glory – A Video Game," [Cited September 26, 2014], http://titanic-honor-and-glory.tumblr.com/page/3