

Re:creation

Virtual and Augmented Reality Laboratory

White Paper

September 2016



Introduction

Re:creation is a laboratory within MEKTORY Innovation and Business Centre¹ of Tallinn University of Technology committed to research and development of Virtual and Augmented Reality applications. As a scientific establishment, our main goal is to do research of Virtual Reality, its physiological and psychological aspects, applications, and its impact on emerging innovative products and services aimed at providing immersive experiences. The laboratory has grown out of Alpha Control Systems Research Laboratory², the members of which have diverse academic backgrounds and experience, including, but not limited to, Computer Science, Dynamic System Modeling and Identification, Control Design, Artificial Intelligence, Global Optimization, Fuzzy Logic, and Computer Graphics.

¹ Official website, <http://www.ttu.ee/mektory-eng>

² Official website, <http://a-lab.ee/>

Why Consider using Virtual Reality

The distinctive and most attractive feature of Virtual Reality is the real effect of immersion (“Being there”) possible due to advanced user positional tracking, a 360 degree viewport, and special controllers for manipulating objects in VR. This provides a vast array of possibilities for creating rich interactions between the user and the artificial world. Augmented Reality, on the other hand, makes it possible to integrate VR into the real-life environment.

Our Goals

Having diverse backgrounds and experience, our team is ready to tackle the challenges put forth by the emerging field of VR and AR applications. As we have deep roots in the academia, we also aim to develop and enhance existing Information Technology university study programs. This is made favorable by the fact that we are based in Estonia—a country with a very strong IT sector³.

We also want to allow involved students, university personnel, as well as laboratory visitors to experience Virtual Reality and to encourage and improve their creative skills. We envision that this will lead to development of synergy between different research and development groups and will enhance interdisciplinary collaboration and improve promotion of emerging technologies.

³ The Economist article, “How did Estonia become a leader in technology?”, <http://www.economist.com/blogs/economist-explains/2013/07/economist-explains-21>

Business Relations

We highly value relations with business establishments. We expect that existing companies will find VR a very attractive tool for developing cutting-edge real-life business applications.

What we offer is consulting services and assistance with fulfilling your business needs by means of this novel technology. We also offer academic collaboration, in case your current VR or AR related projects demand it.

Please see the *Current Projects* section where some ideas for possible R&D projects are presented.

How You Can Benefit

If you represent a *business*, then you could consider the following general possibilities offered by the Virtual Reality technology⁴:

- Enhance visualization-intensive parts of your business. Virtual Reality gives the opportunity to enhance almost all types of visualizations (medical, industrial, statistical, and financial).
- Consider remote monitoring applications and telepresence. Application examples include industrial process monitoring, security, remote navigation in hazardous environments, terrain and housing analysis, remote participation in events.
- Discover the novel educational value in personnel and/or customer training through various VR or AR simulations. An optimal learning state is achieved through *flow*⁵, which is an inherent part of VR experiences.
- Create rich experiences for your clients, such that involve traveling to certain virtual and/or remote locations.
- Utilize the advanced 3D object manipulation opportunities, revitalize the way your engineers or designers interact with rich visual content, make them more productive and provide them with an unprecedented level of creative freedom.
- Artistic applications can particularly benefit from using VR⁶.

It is expected that many more applications will arise with further development of VR and AR applications, especially in the field of mobile technologies.

⁴ Not to mention the obvious applications in the entertainment and game development industries.

⁵ Wikipedia article, "Flow (psychology)". [https://en.wikipedia.org/wiki/Flow_\(psychology\)](https://en.wikipedia.org/wiki/Flow_(psychology))

⁶ A good example is Google's Tilt Brush, <https://www.tiltbrush.com/>

If you represent an *academic institution*, then all of the above applies, and in addition you can

- Participate in state-of-the-art research of human perception, cognition, creativity, and interaction in the virtual world.
- Experience visualizations of simulations of various studied phenomena, processes, objects and environments.
- Build truly virtual study laboratories in VR that provide exceptional educational quality through management of *flow* and are accessible to anyone possessing a VR headset and related rendering hardware.

We are actively looking for collaboration with businesses and academic institutions both domestically and internationally. Please see the *Contact Information* section for details on how to reach us.

Current Projects

In what follows, we provide a brief overview of some of our ongoing projects for your reference.

Synesthesia in Virtual Reality

The aim of this project is the development of a system for inducing synesthetic experiences. *Synesthesia* is the act of experiencing one sense modality as another. For example, a person may vividly experience flashes of colors when listening to a series of sounds. Virtual Reality allows to achieve this transition easily, since it can be used to present the spatial whereabouts of the sound source as well as visualize the sound content in a meaningful way.

A more general approach involves Leibniz' Monad theory⁷.

In the scope of the project we are developing a prototype for sound localization and processing. Our initial approach is documented in a scientific paper⁸ and involves using microphone arrays and efficient sound source localization techniques.

This project has artistic and medical applications. The former can provide artists with new creative grounds, while the latter can be used to help people with sensory deficiencies.

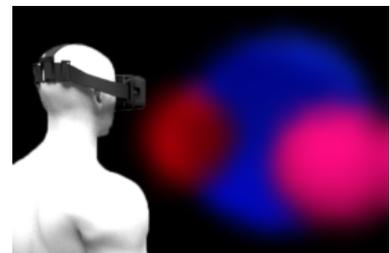


Figure 1: User experiencing a visualization of a nearby sound source

⁷ G. Leibniz, "La Monadologie", 1714. C. Delagrave, 1881.

⁸ A. Tepljakov *et al.*, "Sound Localization and Processing for Inducing Synesthetic Experiences in Virtual Reality". Accepted for presentation at the Baltic Electronics Conference 2016, Laulasmaa, Estonia.

Virtual City Modeling

The long-term goal of the project is to model large-scale housing and transportation environments with a specific focus on Virtual Reality applications, namely: virtual driving and urban orientation courses, architectural walkthroughs, virtual traveling guides.

The initial contribution seen in Figure 2 was done by a group of students for their B.Sc. theses whereby a part of a district in Tallinn, Estonia, was recreated in Unreal Engine 4. In addition, a tool for automating the task of modeling complex roads with respect to the landscape is currently being developed.



Figure 2: Part of Tallinn city district recreated for VR applications. Video walkthrough: <https://www.youtube.com/watch?v=iJWU0M11BdI>

Control Objects in Virtual Reality

The project is dedicated to creating virtual control objects for real-time control experiments. Initially, we model laboratory objects, because this allows us to obtain highly accurate mathematical models of these dynamic systems. Thus, the educational value of the complete visualization should be high. A specific goal is to mathematically model and implement physically accurate interactions between the user and the control objects

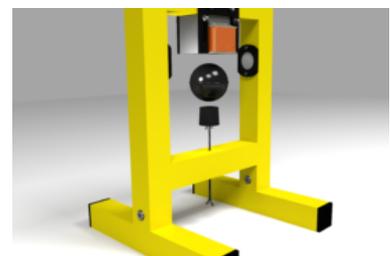


Figure 3: Magnetic Levitation System recreated for VR applications. Real-life object developed by INTECO, Official website <http://www.inteco.com.pl/>

So far, three objects have been modeled: The Magnetic Levitation System (see Figure 3), the 3D Crane, and the Inverted Pendulum. Future goals include modeling real-life industrial objects for implementing specialized virtual training.

Augmented Reality and Remote Monitoring

The goal of this project is to develop an infrastructure for Remote Monitoring applications in Virtual Reality including industrial process monitoring and accessing remote hazardous locations. In the context of this project, we are also developing efficient video stream transmission approaches.

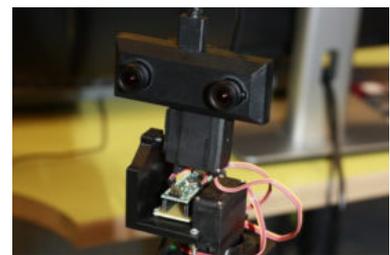


Figure 4: Two degrees of freedom pan/tilt platform for OVRVision Pro stereo camera: first prototype

Augmented Reality applications are also considered. In this case, the camera is attached to a VR headset and provides a see-through stereo video stream, onto which we can project 3D objects and text.

Acknowledgments

The activities of the laboratory are partially supported by HITSA⁹.

The laboratory is also partially supported by Crytek through the VRFirst program¹⁰.

We are grateful to Samsung Electronics for providing several Gear VR devices¹¹ for evaluation and testing.

⁹ Official website, <http://www.hitsa.ee/en>

¹⁰ Official website, <https://www.cryengine.com/vrfirst>

¹¹ Official website, <http://www.samsung.com/global/galaxy/gear-vr/>

Contact Information

Re:creation Laboratory

MEKTORY Innovation and Business Centre

Tallinn University of Technology

Raja 15, 12618 Tallinn, Estonia

Website: <http://recreation.ee/>

E-mail: info@recreation.ee



Administrative Contacts

Dr. Aleksei Tepljakov

Research Scientist at DCC, TUT

VR R&D project management

aleksei.tepljakov@ttu.ee



Dr. Eduard Petlenkov

Associate Professor at DCC, TUT

Financial and accounting management

eduard.petlenkov@ttu.ee



Dr. Kristina Vassiljeva

Associate Professor at DCC, TUT

VR R&D project management

kristina.vassiljeva@ttu.ee





Copyright © 2016 Re:creation Laboratory, a division of Alpha Control Systems Research Laboratory

Re:creation Laboratory White Paper (September 2016)

Edited by Aleksei Tepljakov, <http://starspirals.net/>, <http://atdesign.ee/>