Toward a Digital Ecosystem: International Symposium on Ubiquitous Virtual Reality 2010

Hyoseok Yoon, Anton van den Hengel, Gerhard Reitmayr, Joshua Lifton, Sung-Hee Lee, and Woontack Woo

The International Symposium on Ubiquitous Virtual Reality (ISUVR) 2010 was held in Gwangju, Korea, from 7–10 July 2010. ISUVR 2010 marked the fifth year of this international event since the domestic workshop turned into a student-organized international symposium. The ISUVR series continues to provide an interdisciplinary forum for leading researchers and graduate students, especially in the areas of ubiquitous computing, virtual reality, and augmented reality. The 2010 symposium's theme, "Toward a Digital Ecosystem," emphasized the roles of end users in actively creating and maintaining content in a managed systematic way, referred to as the digital ecosystem. The four-day conference consisted of tutorials, invited talks, paper and poster presentations, a panel talk, and a social event. Approximately 60 researchers and students from Europe, Asia, and the US attended.

MODELING REALITY

In the digital ecosystem of augmented reality, resources provided by content providers can be kept up to date and enriched through user participation. However, technical challenges arise from not having enough useful and realistic models. Several presentations discussed different approaches for tackling this issue by making it easier for nonexperts to model and author content both cheaply and effectively.

A common argument throughout the symposium was that simpler and more intuitive 3D modeling interfaces were needed. In his keynote talk, Anton van den Hengel from the University of Adelaide focused on image-based modeling for augmented reality. He pointed out the importance of user-created 3D content in the digital ecosystem. Using a 2D image is indeed a viable start, but he argued that achieving ubiquitous augmented reality would require 3D user-created content (UCC). However, he also identified shortcomings of current tools and practices, in that they are neither fun nor easy for users. For example, 3D content requires users to position objects in a 3D space, which is not an easy task. Furthermore, current 3D modeling tools fail to attract end users because of the lack of intuitive and easy interfaces. van den Hengel introduced Videotrace, in which images serve as the interface for modeling cars and complex architectures. He also envisioned the next step being live modeling, where users generate models in situ using live camera tracking.

The increased adoption of mobile devices offers opportunities for modeling outdoor areas on constrained devices. To this end, Gerhard Reitmayr and his colleagues from Graz University of Technology presented possible uses of simultaneous localization and mapping (SLAM) in places that have not yet been mapped and modeled. SLAM is compelling for augmented reality applications because it lets users generate maps and content for unknown environments. Furthermore, it lets users create and position rich 3D content within mobile augmented reality applications in outdoor settings—for example, annotations composed of text, photos, and videos placed in certain locations. These resources can be part of social network objects shared between users, and can be pulled in from other content sources through mashups—for example, linking a place to a Flickr image stream. Reitmayr presented several applications, such as panoramic mapping and tracking on smartphones, annotation browser, panorama guidance, and image-based ghostings for visualizing hidden infrastructure.

The scope of authoring and modeling can be extended to cover objects and characters to facilitate the creation of

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richer augmented reality applications. Sung-Hee Lee from Gwangju Institute of Science and Technology (GIST) presented an interesting application with physics-based character animation. A physics-based approach can ease the burden for designers to create realistic character animation that can also respond to various environmental conditions and user inputs that are not predefined. Some challenges in adopting this approach for augmented reality applications include seamless integration and augmentation of virtual objects to the real world—for example, having real objects occlude and interact with virtual objects in a manner that obeys physical principles such as Newton's Laws. The challenges in adopting this approach for augmented reality applications include recognizing the physical information of the real world and generating suitable behaviors of virtual characters. Alongside this topic, Lee introduced numerous attempts to model realistic virtual characters such as physics-based key-frame animation, balance control of biped characters, biomechanical modeling of humans, and dynamic simulations of spline-type joints.

Two presentations discussed advances in end-user authoring of augmented reality content. Youngho Lee from Mokpo University and colleagues from GIST presented ARtalet, an authoring tool for digilog books. By providing a tangible user interface and simple programming techniques, ARtalet allows people to easily create new content for augmented reality books. The team demonstrated various authoring techniques, including 3D object trajectory manipulation, real-time deformation, and audio/vibration feedback authoring to enhance traditional analog books with rich digital content.

Hyeongmook Lee and his colleagues from GIST made a case that the next level of authoring in the digital ecosystem would include four major components: a sensor manager, context-aware computer vision, an intelligent augmented reality agent, and in situ tangible interfaces. Using these four components, he proposed and outlined a preliminary architecture that can overcome some inherent technical challenges of augmented reality—namely real-time 3D reconstruction, multiple object recognition and tracking, robust perception, and adaptation to unknown environments.

CONNECTING THE VIRTUAL AND REAL WORLDS

As with previous years' ISUVRs, several presentations addressed realizing ubiquitous virtual reality by connecting the virtual world to the real world. The potential benefits of making this connection are enormous, most notably in the sheer quantity of digital content that could be introduced as augmented assets into the real world.

A related theme was cross-reality, which refers to combining sensor networks with virtual worlds such as Second Life. Joshua Lifton of the MIT Media Lab shared the cross-reality concept as well as the results of some experiments. He observed that just as TV trivialized media consumption and the Internet trivialized distribution, combining sensor networks and virtual worlds could trivialize production. He presented several projects from the Media Lab that highlight this concept. For the sensor networks, plug-based hardware was used to sense electrical current, light, and sound. Then an in situ sensor network browser, which was inspired by *Star Trek*'s tricorder, would present to the user sensed data along with alerts for special states. Lifton also presented examples of the expressive power of a virtual world for visualizing distortions, exaggerations, and metaphors of the sensed information. Lifton concluded by remarking that the next step of dual reality has huge potential in building upon existing consumer technology.

Two presentations from the Korea Institute of Science and Technology (KIST) discussed interesting use cases of connecting the virtual and real worlds. Changhyeon Lee presented a networked collaborative group cheerleading technology. In this system, users at home or work can enjoy baseball games streamed to the virtual world and use a Wii Remote and other haptic devices to animate their corresponding avatars in the virtual world. Muhammad R. Syamsuddin presented a project on integrating the virtual and real worlds for batting practice. This system uses real pitching data of Major League Baseball players to set various parameters of pitched balls used by their physics engine. The real pitcher's pitch is visualized through animation in the virtual world, and a user can practice batting with WiiMote and WiiMotionPlus devices.

INTUITIVE AND NATURAL AUGMENTED REALITY INTERACTION

Another important aspect of ubiquitous virtual reality is compelling user experiences. On the first day of the conference, Andreas Duenser from HIT Lab New Zealand gave a tutorial on evaluating augmented reality interfaces. He gave an overview of several techniques for evaluating augmented reality systems as well as current challenges. For evaluating augmented reality interfaces, we could start from traditional evaluation methods used in human-computer interaction, but some methods are more suitable than others to the augmented reality domain. He also presented an interesting survey showing that in the domain of augmented reality research, only about 8 percent of papers present a formal user study. Duenser identified four popular evaluation types in his survey: perception, user performance, collaboration, and usability. However, the community needs to publish more and better evaluations to meet user demands. The participants and presenters discussed the lack of attention being paid to evaluation, despite its importance in determining social acceptance

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by users. Duenser also presented his work on the evaluation of interfaces for desktop augmented reality, in which he compared physical sliders, tracked paddles, and traditional mouse input for a system control task to see the value of the proposed user interface.

Augmented reality interfaces can also benefit by being combined with other types of interfaces, such as tangible interfaces. Juan Diego Tascón Vidarte and his colleagues from Konkuk University presented a tangible interface for learning recursion and functional programming. He demonstrated the proposed interface with examples in augmented reality for natural and intuitive interaction. The presenter and participants agreed that using augmented reality in conjunction with tangible interfaces can bring huge effects, especially for e-learning.

DIGITAL ECOSYSTEM

Several presentations offered bold approaches for defining a digital ecosystem for ubiquitous virtual reality. Choonsung Shin and his colleagues emphasized the use of unified context and roles of users. Shin presented their unified context-aware augmented reality application framework for digital ecosystems based on an example of a user-driven tour guide. In this work, users can participate and generate content to be reused in the ecosystem. Sébastien Duval presented a conceptual framework covering microscopic to macroscopic ecosystems. He introduced different levels based on nanobots, implants, smart artefacts, wearable computers, domestic robots, smart buildings, smart cities, smart territories, and interplanetary systems. He suggested 13 foundations. One foundation he emphasized was the need to consider nonhuman-scale systems—a currently neglected and overlooked aspect.

Many open questions, comments, and discussion were picked up again in the panel talks. Panelists were selected from the participants, and included Anton van den Hengel from the University of Adelaide, Gerhard Reitmayr from Graz University of Technology, Joshua Lifton from MIT, and Sébastien Duval from GIST. Participants and presenters shared thoughts and ideas on defining and building healthy digital ecosystems.

One participant viewed the digital ecosystem much like the current Internet, but claimed that what we lack in the ecosystem is a cohesive connection between components. We could improve the digital ecosystem by providing a good connection between components, such as mashup activities through well-defined APIs, processes, interfaces, and interdisciplinary practices. In this aspect, augmented reality can serve as another modality and expression to connect the real world to the virtual.

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Others noted that the current ecosystem lacks features such as scalability, as well as features to support rich human and social interaction. Eventually, participants formed a consensus that content and technology can have different meaning and impact depending on the culture, such as the penetration rate and usage of mobile phones governed by regional policies. For example, developing countries with lower penetration rates of mobile phones and government censorship would suffer from low local user participation but, once the content is created, it would have a high impact. In comparison, in countries with high penetration rate, many casual UCC could be generated and carry different meanings. An audience member asked panelists an interesting question regarding current content-production activities: Are we (technical-minded people and IT researchers) producing and consuming content on a regular basis as much as pro-sumers? Panelists' answers varied from "no activity at all" to "casual digital content creation" in the form of pictures, GPS logs, and blog articles, which revealed the wide range of participation even in our own community. As such, a good digital ecosystem should encompass a wide range of activities and situations.

For designing the ecosystem, Joshua Lifton identified some problems. He pointed out that people are bad at designing prototype systems and cannot verify them unless we create technology to experiment with them. As we deploy technologies and create dependencies between components, our initial designs most likely will need to be changed. Participants agreed that we are at the early stage of defining and building a digital ecosystem. So, iterating on this process of creating technology, creating dependencies, and seeing what happens will lead to more concrete design and implementations of the digital ecosystem.

Panel members also offered concluding remarks describing their vision of the intelligent digital ecosystem. Salient characteristics included:

- seamless—one application to connect and access others in the ecosystem;
- connected—ecosystem components have intrinsic value and become even more valuable when they are connected;
- clever—the ecosystem solves problems on its own by learning from the available information;
- intuitive—user has to learn as little as possible;
- equal—provide useful, fun, and usable experience to everyone; and
- sustainable—lasts for a long time.

For more information on ISUVR 2010, check out the online proceedings at http://doi.ieeecomputersociety.org/10.1109/ISUVR.2010.1. More

discussion and ideas on digital ecosystem will be shared through ISUVR 2011 in Jeju, South Korea. For more information, visit www.isuvr.org.

Hyoseok Yoon is a PhD candidate at the Gwangju Institute of Science and Technology in Korea. Contact him at hyoon@gist.ac.kr.

Anton van den Hengel is the director of the Australian Centre for Visual Technologies (ACVT) and a professor of computer science at the University of Adelaide. Contact him at Anton.vandenHengel@adelaide.edu.au.

Gerhard Reitmayr is a professor of augmented reality at Graz University of Technology. Contact him at reitmayr@icg.tugraz.at.

Joshua Lifton works as an independent technology consultant. He completed his PhD at the Massachusetts Institute of Technology's Media Laboratory. Contact him at lifton@media.mit.edu.

Sung-Hee Lee is a full-time lecturer at the Gwangju Institute of Science and Technology. Contact him at shl@gist.ac.kr.

Woontack Woo is the director of the Culture Technology Institute (CTI) at the Gwangju Institute Science and Technology and a professor at GIST. Contact him at wwoo@gist.ac.kr.

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