論文の内容の要旨

論文題目　Ubiquitous Projection for Vision-based Augmented Reality
（視覚に基づく拡張現実のためのユビキタス投影に関する研究）

氏　名　シリボーヴォンラタナクン　ティティラット

Augmented reality (AR) is the field trying to combine the physical world with the virtually generated information. Most AR systems share two main abilities, namely, the ability to sense the physical world and the ability to overlay the virtual information onto that physical world. Using a camera to sense visual information of the physical world in the visible light spectrum is one of the popular alternatives for AR, particularly now when camera has become a common device for end users and many free AR toolkits are available based on visual markers. Together with the growth of social network encouraging photo sharing, it might be said that visual information has already become common information for end users.

Although visual analysis costs heavy computational loads and is sensitive to lighting variation, visual sensing is still considered to be very informative and intuitive compared to other sensing methods. Using a single camera, rich information regarding the physical environment can be obtained in the same way as human visually senses the environment. In theory, this richness of information should allow visual understanding of an unknown environment as well as inside objects so that any change in the environment can be realized in real time despite of prior environment setups.

Because projection can overlay the virtual information directly on the physical surface, it is a good alternative for AR systems requiring seamless combination between the virtual and physical worlds. The term ``ubiquitous projection'' refers to intelligent projection that can be performed appropriately everywhere at any time. Ubiquitous projection in AR systems has been studied for more than a decade but has become more prominent recently because of the miniaturization trend of projectors.

Combination of projector and camera is one of the most selected choices for ubiquitous projection. This is because the characteristics of visual sensing encourage absolute ubiquity of the device and setup while providing very rich information of an unknown environment as inferred by the ubiquitous concept. However, in practice, it is still challenging to maintain this ubiquity while operating both devices simultaneously

in an unknown environment and in the same visible light spectrum.

So far several solutions were proposed for ubiquitous projection supporting vision-based AR. Nevertheless, many of them rely on visual or nonvisual markers so that complexity of visual sensing is reduced significantly in real-world scenarios. Some previous proposals take partial advantages of visual sensing and depend the rest of implementation on nonvisual sensing or visual sensing in the invisible light spectrum which is considered to be less informative. Accordingly, it may be said that achieving absolute ubiquity in projection is still difficult in a pure vision-based AR system.

Motivated by limitations of previous studies, our researches try to expand the powerfulness of vision-based AR to the area of projection with absolute ubiquity. Our attempt is pushed toward issues related to geometry-based projection and simultaneous projection and visual sensing in real-time AR systems. The proposed framework contributes device configurations and algorithms that are supposed to maximize the powerfulness of visual sensing whereas least affecting the conventional processes of visual analysis in AR systems.

In other words, the framework encourages top-up development of vision-based AR systems, allowing ubiquitous projection to be easily integrated into the existing vision-based AR systems with least modification to their original implementation. In addition to the compatibility, it contributes improvement and novel possibility to existing and future AR systems, respectively.

We believe that our studies will be useful not only for researchers in this field but also for end-user developers, allowing both the fixed projector and the recent pocket-sized projector to be applied easily for vision-based AR systems in a ubiquitous manner.