Preliminary Study on Visualization of Building Standard Laws by HoloLens
- A Case Study in Kanazawa City -

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1. Introduction

Contribution of our research is to use SketchUp, Unity3D and HoloLens to visualize the image of the planning regulations applied for building and sought ways to help consensus between stakerholders and planners. Meanwhile, we can visualize the conflicts between existing non-qualified buildings and Building Standard Law(BSL), and visualize their comparison with the 3d virtual model based on the BSL law, which aims at improvement of stakeholders' understanding of the BSL in planning practice.

When building a new house, it is necessary to make a building plan that complies with the many regulations under the BSL. At present, there are many regulations on buildings according to the BSL. The BSL is the main law that regulates buildings and their equipments. The BSL was established in 1950 and has been amended many times to meet new technologies and to cope with new demands, as the latest version of it was established in 2016 (Takeichi, N., Hagiwara, I., et al., 2003).

In the BSL, Building Form Regulation (BFR) plays a quite important role on limiting the architectural design according to the zone restrictions implemented in a parcel of urban planning area in Japan. Nogawa et al. (2004) analyzed the usable space of building under effect of oblique line, height limit and so on, which are designated in BFR. Kawakami and Ohnishi (2013) find effect of BFR based on analyzing the relation between parcel area, shape, and width of its front road when consider deregulation of Setback and Application Distance. Besides, Fujita and Kawakami (2008) defines a free degree to evaluate the effect of BFR by means of visualization of usable space of building. Chen and Shen created a planning support tool for visualization of building form regulation and building form legality checking tool (Chen and Shen, 2017).

Although such researches enhanced planning efficiency and people's understanding of Building Form Regulation, it could be enhanced with the help of advanced devices to show information in virtual place more realistic, such as augmented reality (AR), virtual reality (VR), mixed reality (MR).

Such technologies were tested in large number of researches. Wang, X. (2007) used augmented reality to plan virtual construction site, by a prototype of an AR-based construction planning tool named AR Planner. Tang, C. H., Wu, W. T., et al. (2009) used virtual reality to determine how emergency signs facilitate way-finding, which was doing experiment in virtual environment. El-Shimy, H., Ragheb, G., et al. (2015) used mixed reality as a simulation tool in urban planning that helps to build a community and support citizen's participation. However, such researches did not concern building standards or building regulations, which is the theme of this research.

Therefore, by using HoloLens's MR (Mix Reality) properly, the prebuilt model of building regulation in a parcel can be seen in HoloLens, and were used for corresponding to a real-site building in our case study.

2. Methodology

First, we learned how to use HoloLens, which is MR

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device that can use 3d models creadted by SketchUp, the software that creates a stereogram to be introduced into Unity3d and HoloLense. Next, we selected one building that seems to be ineligible from the housing dense area in Kanazawa city, and made a three-dimensional model using SketchUp. Then, we investigated what kind of building regulations are applied in the parcel where the building is located, and made a three-dimensional view, and superimposed it on the model of the building to check whether it was ineligible. At this time, when the building is out of the building regulation, it can be said that the existing building is disqualification. By verifying the model made on HoloLens, we examined whether HoloLens could be introduced into the construction industry.

HoloLens is a computer with a head mounted display. Microsoft announced it in 2015 and supports Windows 10. SketchUp is a 3D design tool developed and provided by Trimble, USA. It is possible to perform sensory 3D modeling as viewed in 3D space.

3. Case study

Using Google maps, we selected one building from the densely populated area in Kanazawa city. In terms of selecting a building, there are two points: a small building that is easy for beginners to create models, and a building that is built along a narrow road and that is not very new, because a building with the two conditions is possible to be an existing disqualified building. According to Kanazawa City Town Development Support Information System, the area with the selected building is the area dedicated to the first-class high-rise dwellings, and the various building restrictions are as shown in Table 1.

We used Google Earth Pro to measure the width, height, depth, and width of the front road in order to get the necessary information to create the image of the building restrictions and the top view of the building with SketchUp. The results are summarized in Table 2. And the three-dimensional model of the building appearance created by SketchUp based on these conditions is shown in Figure 1. Then, a surface representing the building regulation is created, and the building regulation form can be understood as shown in Figure 2.

Table. 1 Building regulation of target property

Floor-area ratio	200%
Coverage ratio	60%
Road slanting limit	1:1.25 Applicable distance:20m
Neighboring slash limit	20m+(1:1.25)
North diagonal limit	10m+(1:1.25)

Table. 2 Measurement result of target property

Building width	5.0m
Height (the top of the roof)	8.5m
Height (the tip of the roof)	6.0m
depth	8.0~10.5m
Front road width	4.0m

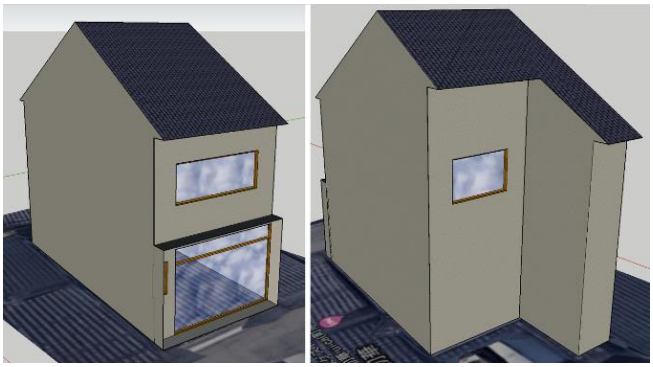

Fig. 1 Three-dimensional model (building only)

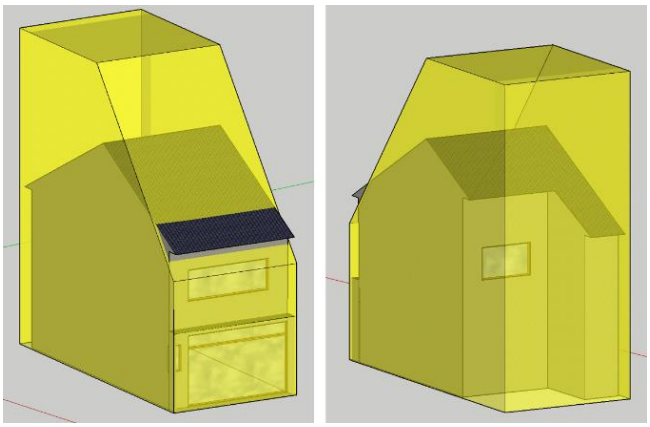

Fig. 2 Three-dimensional model (including building regulation information)

4. Modeling and onsite test

We went to the site and compared it with the actual building as shown in Figure 3. Figure 4 shows the scene

of using HoloLens. As we can see, comparing to usual 3D models that needed to be shown on heavy flat screen, HoloLens can show 3D models on a portable convenient screen. Planners can use this facility to create model in their workroom and bring the models to real site and judge its performance.

Fig. 3 Target property

Fig. 4 Trying to use HoloLens

View in HoloLens is in Figure 5 and 6. In HoloLens' view, what is yellow and transparent is the regulation. It was a little difficult to see if the actual house was jumping out of the model of the house, but it can confirm that the target we selected does not fit the regulation law. We thought it would be easier to understand the illegal situation if the house was projected with the planning regulations with yellow box. It is possible to move it by resizing or gesture when looking at the projected regulation model by HoloLens, for this inputting the model created by SketchUp into software called unity3d is necessary.

Fig. 5 Model Overlay-Part 1

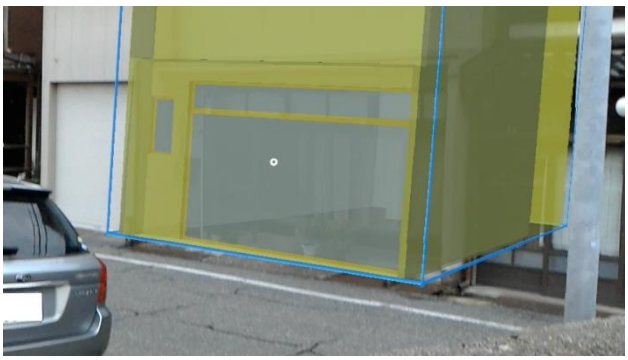

Fig. 6 Model Overlay-Part 2

There were difficulties found when we went to the real site and saw the model overlaid with the real building through HoloLens. The first point is that it is difficult to define the scale of the model. And another point is that it is difficult to fit the model to the proper position. Both were able to adjust to the approximate position in order to change the size of the model with their own gestures and make them fit properly, but they were slightly deviated from that or their height did not match. It is possible to visualize the building code in a rough position, but we felt that it is difficult at this stage to look at the correct position and size correctly.

If the above problems can be ameliorated, it is considered possible enough to be introduced into the building industry. In order to do that, we thought that it

is necessary to make improvements in the functionality of HoloLens. First, regarding the adjustment of the scale of the model, it is considered that the correct size can be obtained by changing the size of the box by numerical input. For fine adjustment to the proper position, move the rough position with a gesture if there is a button that can move in the east, south, east, south and west, and adjust the position more precisely by adjusting the details with the button Think it will be possible.

In this section, we will consider what kind of application there is when introducing HoloLens into the building industry. First, ask the client to see how it can be built compared to the current building when rebuilding a house, and how to understand each other between the stakeholders and the planner. Second, we thought that it might be possible to use it to check whether the building standard law is satisfied by looking at HoloLens .

5. Conclusion and future research

To solve the problem of difficulty of recognition of Japanese Building Standard Law and Building Regulations, by using SketchUp, Unity3d and HoloLens, we built a virtual model standing for building regulations of a selected research target, then went to the real site and experienced to show the regulation overlaid with the real building. Finally, we gave some suggestions on using HoloLens and updating possibilities of it.

There are still problems did not solve. We select the target on Google Earth Pro and measured its information, then create model manually. As HoloLens has the function to measure length information by its multi cameras, it could get the information of the target building by its own camera and on-site planners, then it maybe could automatically create building regulation models based on such information. By such process, planners can show building regulations faster to the land owner, and building regulations will be easier to be understood by stakeholders

Beside this, other researchers may also research on improve HoloLens performance in such on-site condition, by which HoloLens can work better outside, and show building regulations with better quality.

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11) https://www2.wagmap.jp/kanazawa-mss/Portal *Kanazawa City MSS(Machizukuri Support System*