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**CS10427**

# Virtual-Augmented Reality for Construction, utilizing Gear VR
**(To exploit VR glasses in order to augment virtual reality in the field of construction)**

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## Learning Objectives

At the end of this class, you will be able to:

- Augment virtual reality to visualize and experience a 3D model, 360-degree panorama picture, virtual mock-up
- Convert BIM model or panoramic photographs into a suitable data format for Android OS
- Take panoramic pictures and set camera equipment, and how to use a software to stitch and publish them into exe format with information
- Learn how to export Revit files in fbx format, import into 3ds Max, and render with appropriate materials and settings for virtual space
- Exploit virtual reality in the realm of construction-utilizing VR glasses.

## Description

- Exploring virtual sites through VR glasses and Imagining of yourself or your clients are walking on construction sites without actually being there is a forte. As General Contractor, this simple but indescribable experience of virtual reality inspired us to make a deep study of how to utilize it better and efficiently in Construction fields.
- There are 2 approaches to generate virtual reality during construction phases. One is building Information Modeling (BIM) model and the other is actual pictures taken after completion of construction. 2 approaches will be determined by VR usage circumstances
- In order to generate VR, you need to be proficient with software such as Revit and 3ds Max for visualization and rendering works and game engines like Unity pro or Stingray. These softwares will help you to navigate BIM models in the virtual worlds. Besides mastering software, setting up camera equipment in specific ways will be required, as well.

## About the Speaker(s)

**Juhee Rho** received her bachelor's degree from Seoul National University and master's degree from University of Pennsylvania in Architecture and now is practicing specialized engineer in BIM at Samsung C&T. In the BIM department, she is in charge of technical applications of BIM such as 3D visualization, 4D construction simulations and clash detection, using AutoCAD, Revit, SketchUp, Navisworks, and Synchro. Before joining Samsung C&T, she had built her career mainly on the architectural design field for the past several years working in KPF New York, Beyond Space Seoul, and etc. Also she was a part of a R&D project of Developing Korean Traditional House as a Digital Project specialist.
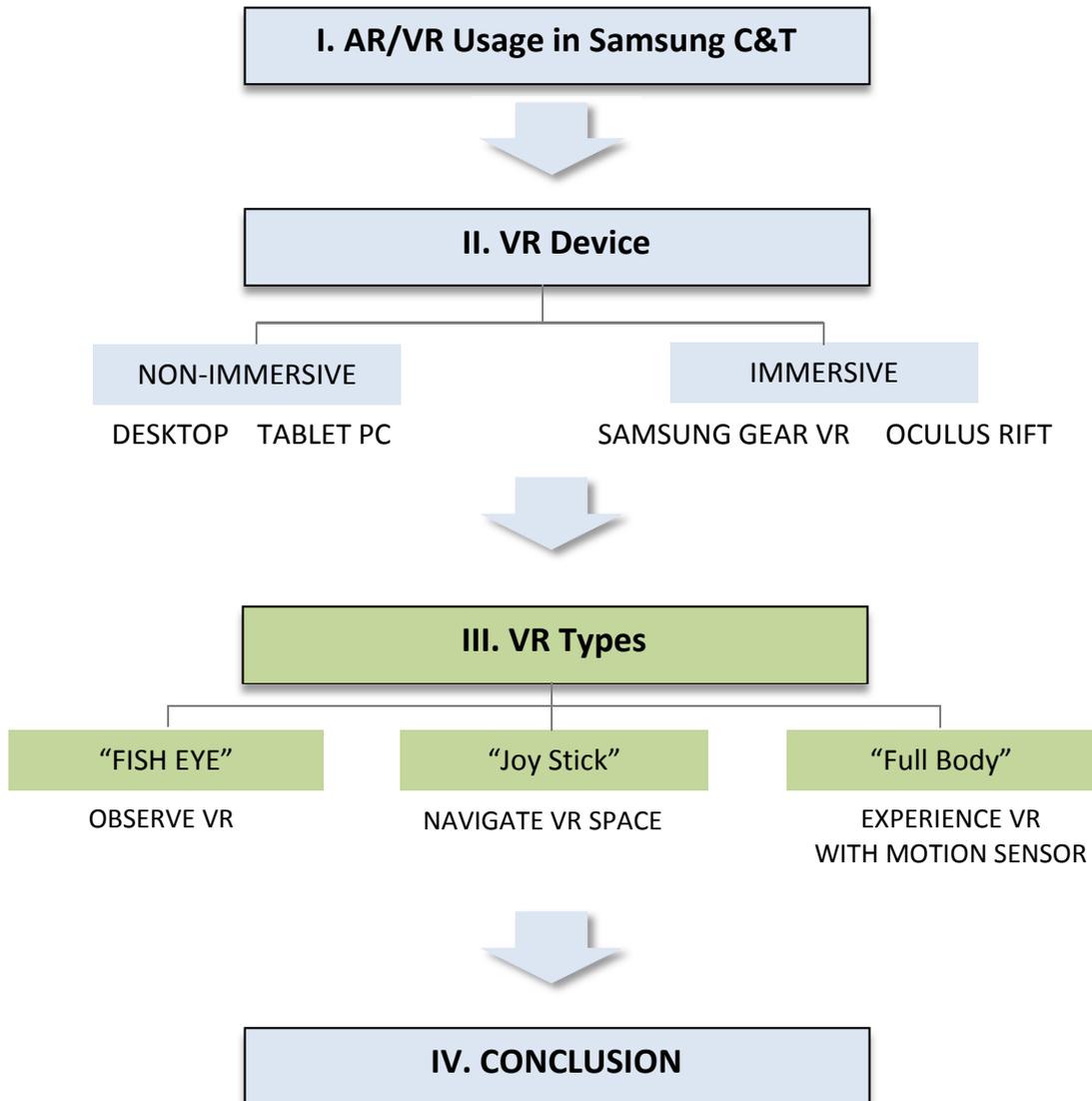
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**Jonghoon Kim** is the Head of BIM department in Samsung C&T. Since joining Samsung, Jonghoon has been involved in BIM implementation and innovative construction technology adoption on various projects including health care, hospitality, manufacturing facility, and office buildings. Prior to Samsung, Jonghoon worked for DPR Construction as a senior BIM project manager. He received a PhD degree in Civil Engineering from Stanford University. At Stanford, he experienced a wide variety of R&D projects on Virtual Design and Construction. He worked with industry company members and academic institutes to advance the research in Building Information Modeling. His works were published in various academic publications. He also acted as an assistant consulting professor at Stanford to teach a class and advise research projects. Jonghoon was an active participant in Digital Building Lab at Georgia Institute of Technology and teaching classes for Virginia Tech and the AGC Certificate of Management-Building Information Modeling (CM-BIM). In 2012, at Autodesk University, Jonghoon Kim also presented a class called 'Why Clash Today When You Can Clash Tomorrow? which is, a discrete Event Simulation Case Study Using Autodesk Navisworks'.

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# CLASS AGENDA

**I. AR/VR Usage in Samsung C&T**

**II. VR Device**

NON-IMMERSIVE

IMMERSIVE

DESKTOP   TABLET PC

SAMSUNG GEAR VR   OCULUS RIFT

**III. VR Types**

"FISH EYE"

"Joy Stick"

"Full Body"

OBSERVE VR

NAVIGATE VR SPACE

EXPERIENCE VR
WITH MOTION SENSOR

**IV. CONCLUSION**

**Virtual-Augmented Reality for Construction, utilizing Gear VR (To exploit VR glasses in order to augment virtual reality in the field of construction**

# I. AR/VR Usage in Samsung C&T, Construction.

In Samsung C&T, Virtual Reality and Augmented Reality technologies have been applied to construction projects for various purposes.  AR/VR data is utilized to help property manager for more efficient facility maintenance purposes,  to assist clients' making better decision and most importantly, to improve constructability.

**Virtual Reality for Maintenance Control and Facility Management**

When construction is completed, it is the right time to compile VR-panorama picture set. Especially for MEP rooms with all the equipment are installed, VR-panorama pictures and manuals linked on pictures for each machine became very essential when machine was broken and needed instant inspection and repair. You don't need any specific software to open the panorama data when it is saved in exe format. All you need is a pc or tablet pc to open the file by tapping with two fingers. Or VR-panorama can be viewed HTML, Flash and QTVR format.

**Augmented Reality for Maintenance Control and Facility Management**

When a MEP system is broken down, in general, you need to find out where exactly all pipes, ducts are located , then inspect the systems. Then, you would open up a wall or take a ceiling off to start with, based on MEP drawing sets. If you have well-equipped drawing sets, you are very lucky. However, in many cases, drawings are not the same as current building conditions. To avoid this discrepancies, we have been applying Augmented Reality to manage facilities, efficiently.

By attaching a marker or bar code on the walls and ceilings which will lead you to a specific 3d model data, when you scan it with your smartphone or tablet pc to see what's installed behind walls and ceiling. In this way, you can detect where system-mal function happened and react to fix, much faster without any demolishment. (You need to install AR-related application in advance)

**Virtual Reality for Decision Making**

Virtual Reality can assist clients  to make better decisions and to foresee what final outcome will be before construction finishes.

Specifically, in healthcare, operating room's layout of all equipment will be followed by surgeon's specific operating procedures. Since the layout of equipment are dictating where MEP system such as gas pipes, ducts, wires, should be, as well, during installation. Therefore, inspecting the rooms with Virtual mock-ups and making all related-decisions in advance is very crucial and became very important process during construction. Early decision making by owners will help narrow down a number of change orders and it will save construction period.

**Virtual Reality for Improving Constructability**

As much as early decision making, improving constructability is an important aspect for time and cost saving in construction. We provide general contractors with a VR glasses with Virtual Mock-ups(3D models) or mobile devices with 3D models/3D Shop drawings/3D PDFs for critical points or complicated area. Then  contractors can easily preview the completed condition of certain rooms with 3D models or check the constructability by viewing 3D shop drawings with these devices. On the

contrast of the traditional way of thumbing through page by page of drawing set, 3D data is helping contractors, sub-contractors to understand the area where they are about to work, precisely .

# II. VR Device

**-PC vs VR Headsets**

| Non-Immersive VR | Immersive VR | |
|---|---|---|
| Desktop | VR Headset (*HMDs) | |
| | SAMSUNG Gear VR | Oculus Rift |
|  |  |  |

*HMDs – Head Mounted Displays

**-Oculus Rift vs Samsung Gear VR**

There are two types of VR glasses tested for VR application,-one is Oculus Rift and the other is Samsung Gear VR. While both of them are using the same oculus engine to realize virtual reality, some aspects such as location of data storage(oculus rift-pc, gear vr-smart phone), file operations and power supply, are distinguishing features. These are due to the different usages of the two devices.

| VR Headset | |
|---|---|
| <OCULUS RIFT> | <SAMSUNG GEAR VR> |
| HIGH RESOLUTION | REQUIRE GALAXY NOTE4 OR S6 IN ADVANCE |
| LARGE DATA HANDLING CAPACITY | LIMITATION OF DATA HANDLING CAPACITY |
| STABLE RUNNING | RELATIVELY UNSTABLE RUNNING |
| WORKS IN PC/ POSSIBILITY SHARE MONITOR | WORKS WITHOUT PC/BETTER PORTABILITY (NO PC) |

# III. VR Types

**-Application Stage of VR Glasses**

| | **1. Fish Eye** | **2. Joystick** | **3. Full Body** |
|---|---|---|---|
| **Description** | <OBSERVE VR> | <NAVIGATE VR SPACE > | < EXPERIENCE VR WITH MOTION SENSOR> |
| **Pictures** |  |  |  |
| **Immersion** | Immersion VR | Immersion VR | Total Immersion |
| **DEVICE** | VR GLASSES | VR GLASSES + Flying Mouse | VR GLASSES + MOTION SENSOR |
| **VR GLASSES** | Gear VR, Oculus Rift, Cardboard | Gear VR, Oculus Rift | Oculus with motion sensor |
| **Media** | JPEG | Game Engine | |
| **Software** | 3ds MAX Panoweaver | Unity Pro Stingray | |

## 1.1 'Fish Eye' – How to Generate 360° VR

In this chapter, we will cover how to generate 'Fish Eye', 'Observing VR'.

To browse 360°view at one point, the output of VR data should be spherical form and JPEG format. Either picture taken with fisheye lens or 3d model rendering can be considered

 **A. Picture-Based 360° Panorama View Generating**
  1. Set shooting points and take pictures
   - Tools: Fisheye lens for digital camera, tripod with panoramic head
   - S/W: Panoweaver from Easypano
  2. Import original pictures into Panoweaver to stitch
  3. Save images as jpeg format
  4. Same process for other views
 **B. 3D Model-Based 360°View Generating**
  1. Export Revit file
  2. Import the file into 3ds Max and create settings
  3. Render and save file

4. Export rendered image as sphere space
5. Save image as jpeg.
6. Import image to Panoweaver and save it as jpeg.

## 1.2 'Fish Eye' – How to Browse 360° VR

**A. Browse 360°View with VR Glasses with Low Data**
  1. Check panorama pictures with Gear VR
**B. Browse 360°View with Linked Instruction and Manual on PC**
  1. Import panorama images into Tourweaver
  2. Add keymaps
  3. Add hotspots where scenes located
  4. Check locations and orientations of the scene
  5. Add hotspots and link manuals
  6. Link manuals for each hotspots
  7. Publish file as proper format(html, exe)

## 2. 'Joy Stick' – How to Generate 360° VR

In this chapter, we will cover how to generate 'Joy Stick', 'Browsing and Space-Navigation'.

There are various game engines which will help to generate the Virtual Space that you can navigate througj..

The Unity Pro is the one, the other is Stingray.

The Unity Pro was applied to build an android application for Gear VR. and courtesy of Skonec IT company where develop VR contents and the game Metal Blitz, we were able to build our VR Contents that are part of shown VR.

And same as Unity Pro, Autodesk Korea helped us to build a another Virtual Reality by using the Stingray(brand new game engine for Autodesk) for the same project.

**A. Using Unity Pro(Gear VR)**
  1. Set the area and flow of camera
  2. Export Revit file as fbx format
  3. Import fbx file into 3ds Max and delete unseen faces and objects
  4. Export revised file as fbx. Format
  5. Import files into Unity pro (game engine)
  6. Control scale factor
  7. Add Materials and shader
  8. Draw bounding box (in order to give a gravity and obstacles)
  9. Set animator controller
  10. Set the background with billboard components
  11. Build setting and build

12. Install android application just built on a smartphone and navigate/browse a virtual space with Gear VR

**B. Using Autodesk Stingray(Oculus Rift)**
1. Export Revit file as 3ds Max Design Exterior Rendering
2. Check the 3ds Max file and Optimize the file
3. Import the file into Stingray (change made with 3ds Max will be reflected in Stingray)
4. Plug in the Oculus Rift
5. Navigatd and browse a virtual space with Oculus Rift

# IV. CONCLUSION

VR in Construction

High Level of Satisfaction from client, property manager, general contractor, and sub-contractor .

Compliment references from client would lead us to next potential winning project

Class

How to make VR: each software has pros, and cons. You will need to determine the purpose of VR, then choose which software to use.

Many 'trial and error' process will be needed to achieve the most optimized and satisfactory outcome, procedures shown in this class can be considered the best options for construction field use purposes after our deep study.