센서 기반 혼합현실

SMART on ICT Forum

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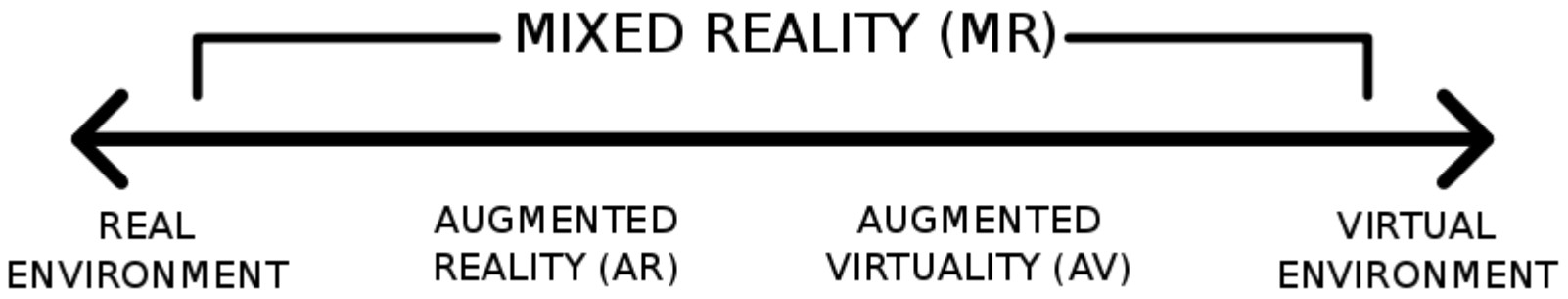
수원대학교

이명원

Mixed Reality (1)



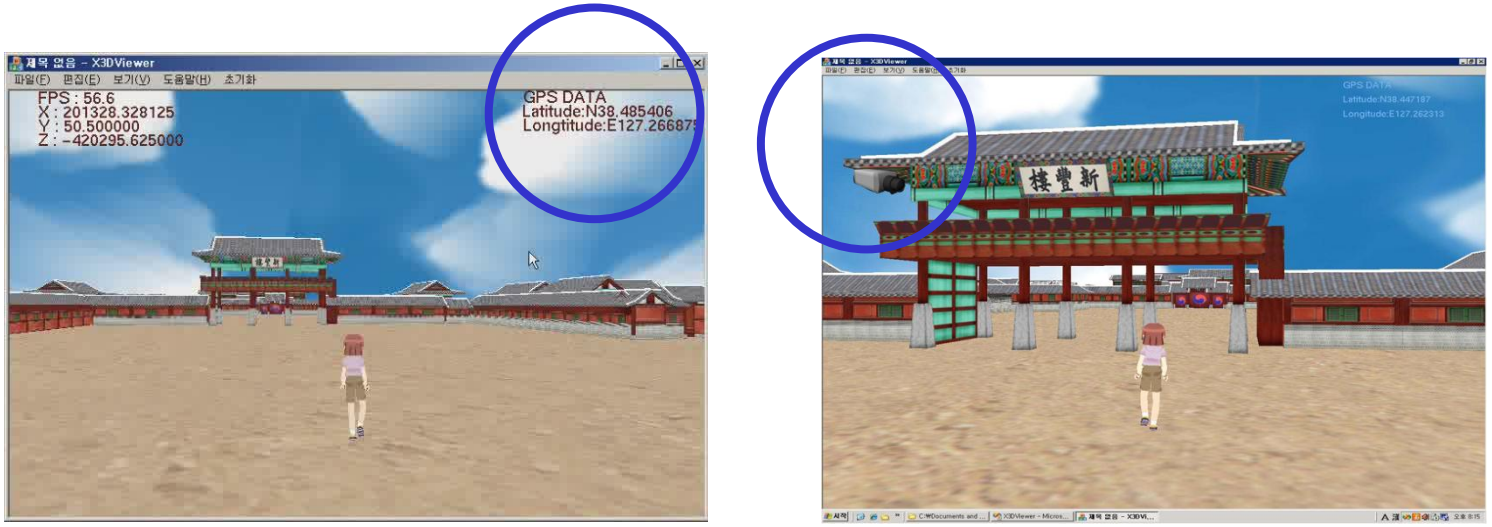
- Paul Milgram and Fumio Kishino, 1994
  - A mixed reality as “anywhere between the extrema of the virtuality continuum
  - The Virtuality Continuum extends from the completely real through to the completely virtual environment with augmented reality and augmented virtuality ranging between.

An example mixed reality, Wikipedia, 2012

Mixed Reality (2)

- Merging real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist, and interaction in real time
- A mix of reality, augmented reality, augmented virtuality and virtual reality

GPS **CCTV**



An Example Sensor Based Mixed Reality

Mixed Reality (3) – GPS Sensor

Mixed Reality (4) – GPS & CCTV

Sensor Based Mixed Reality (1)

- Definition
  - Integration of real physical sensors and a virtual world
  - A mixed reality world that physical sensors are represented precisely with their physical properties in a virtual world.
  - 3D convergence of physical sensors and virtual worlds

- Objectives
  - Exchange AR/MR application data in heterogeneous computing environments
  - Manage and control physical sensors with their physical properties in 3D virtual environments

Sensor Based Mixed Reality (2)

- System functions for MR applications
  - 3D Representation of Physical Sensors and Virtual Worlds
  - Location of physical sensors in a 3D scene
  - Representation of physical properties of each physical sensor in a 3D scene
  - Representation of functional properties of each physical sensor in a 3D scene
  - Control of physical sensors in a 3D scene
  - Interface of physical sensors in a 3D scene

Sensor Type

- Acoustic, sound, vibration
- Automotive, transportation
- Chemical
- Electric current, electric potential, magnetic, radio
- Environment, weather, moisture, humidity
- Flow, fluid velocity
- Ionizing radiation, subatomic particles
- Navigation instruments
- Position, angle, displacement, distance, speed, acceleration
- Optical, light, imaging, photon
- Pressure
- Force, density, level
- Thermal, heat, temperature
- Proximity, presence
- Video sensor technology

Video sensor –wikipedia 2012

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Video sensor –wikipedia 2012

3D Physical Modeling

- Definition
  - 3D Modeling with physical properties
- Comparison with 3D Modeling
  - 3D Modeling
    - Geometric representation
    - Visual graphical attributes
    - Interfaces and control for 3D objects
  - 3D Physical Modeling
    - Geometric representation
    - Visual graphics attributes
    - Interfaces and control for 3D objects
    - Physical properties
    - Physical functions
    - Interfaces and control for physical sensors

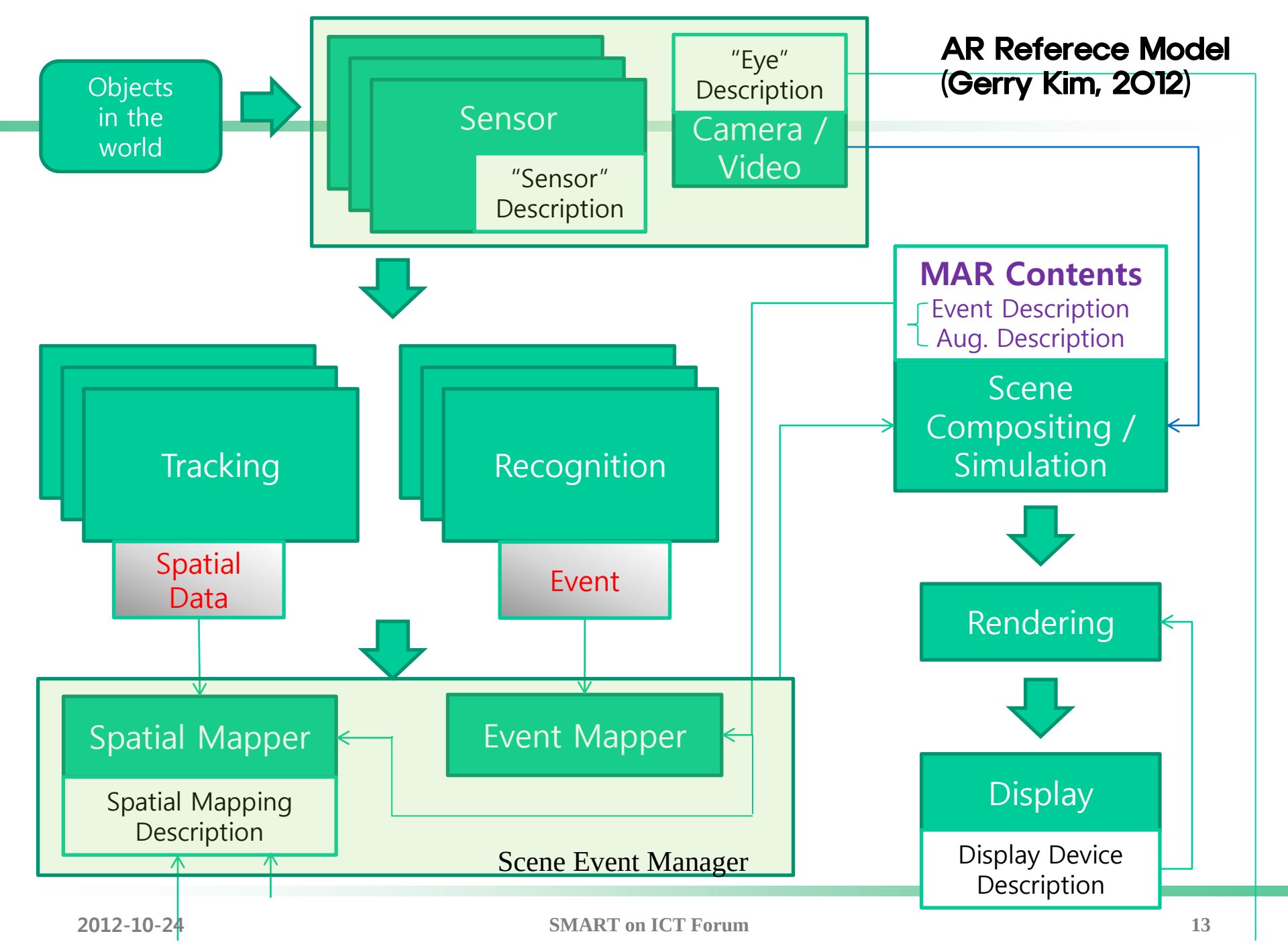
Physical Sensor Representation in a 3D World

A 3D copied world of a real world including physical sensors

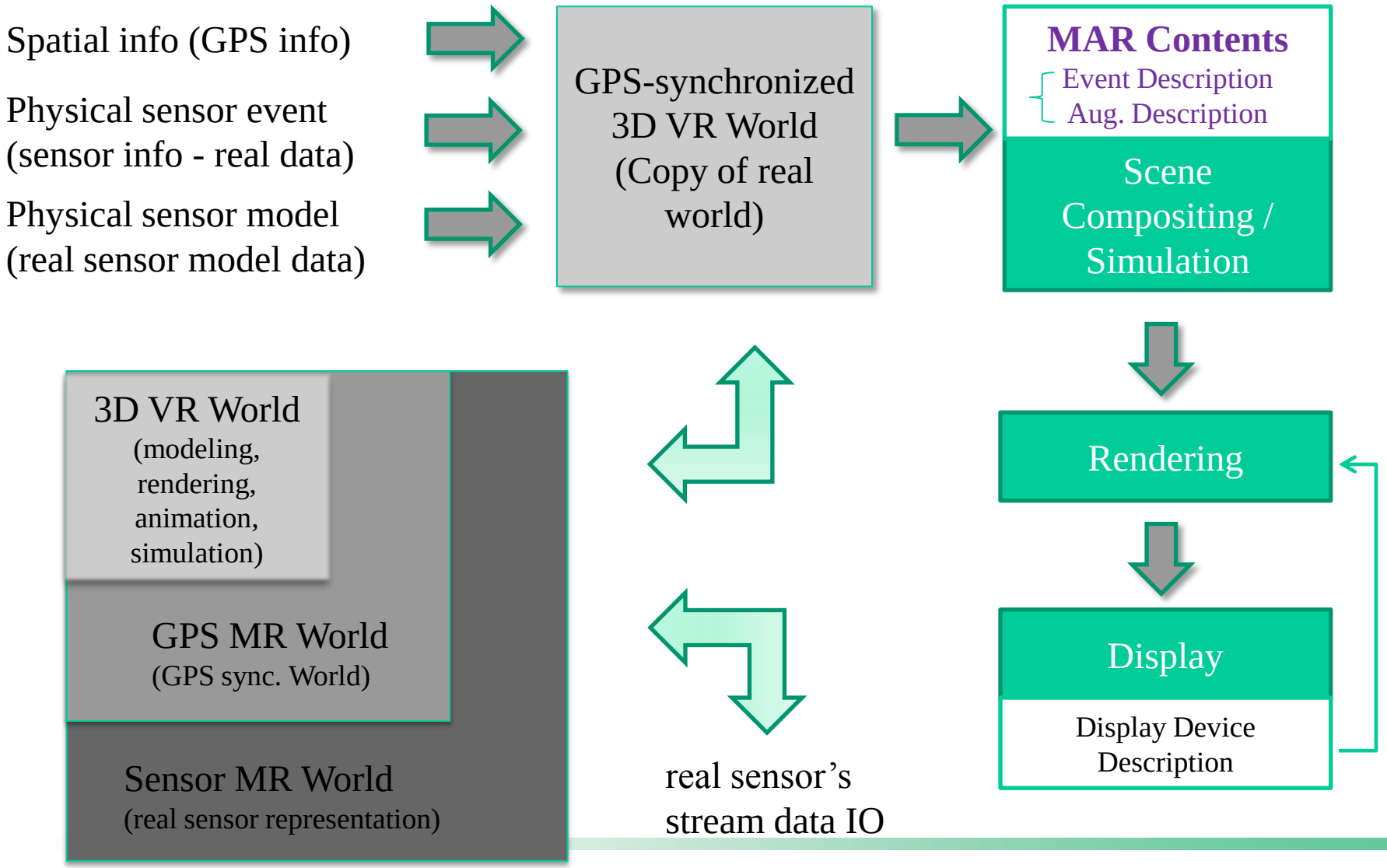
- GPS sensor
- Camera sensor
- Light sensor
- Sound sensor
- RFID sensor
- CCTV sensor
- Security sensor
- Temperature sensor
- Humidity sensor

MR Physical Sensors

- Scope
  - Geometric representation
  - Visual graphics attributes
  - Interfaces and control for 3D objects
  - Physical properties
  - Physical functions
  - Interfaces and control for physical sensors
- Types of MR physical sensors
  - Camera
  - Light
  - GPS
  - Security devices
  - CCTV, IP camera
  - RFID
  - Sound
  - Temperature
  - Humidity
  - Other physical sensors


AR Referece Model
(Gerry Kim, 2012)
Objects in the world
Sensor
"Sensor" Description
"Eye" Description
Camera / Video
MAR Contents
Event Description
Aug. Description
Scene Compositing / Simulation
Tracking
Spatial Data
Recognition
Event
Rendering
Spatial Mapper
Spatial Mapping Description
Event Mapper
Scene Event Manager
Display
Display Device Description

Physical Sensor Representation Module

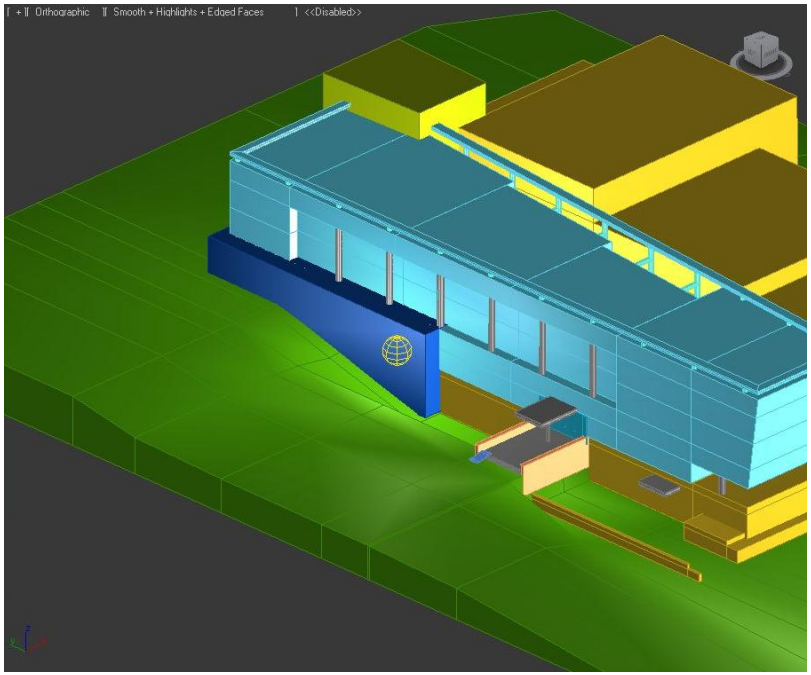


Sensor-based Mixed Reality (Mirrored world)

- **Required function**
  - 3D worlds representation
  - GPS synchronization with the geometric coordinates and attributes of a 3D world
  - 3D representation of real sensors
  - Interfaces with real sensors:

    IO interfaces from/to sensors

    (real streaming data)

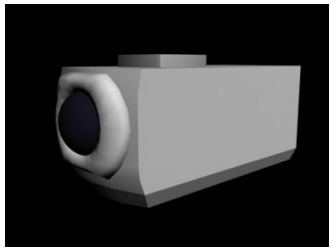


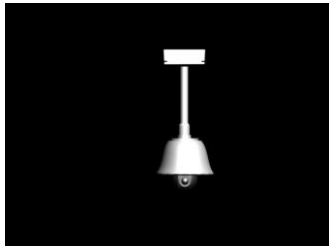
Physical Sensor Reference Module

- Real sensor representation module for ARC
  - Define a 3D representative framework for real sensor information processing in VR worlds
- GPS synchronized VR world
  - Define the method of generating a GPS synchronized VR world, augmented with GPS real location information
- Sensor devices and attributes
  - Define the method of representing sensor devices and their attributes
- Sensor interfaces
  - Define interfaces for sensor information processing using sensor stream data

1. Physical Sensor Representation

- Real sensor representation module for ARC
  - Modeling and rendering of a 3D world
  - Modeling and rendering of physical sensor devices
  - Exchange format of physical sensors in a 3D world





2. GPS Synchronized VR World

- GPS synchronization between a 3D world and a real world
- Representation of a 3D world with GPS
- Representation of a physical sensor with GPS

- Example
  - A scene is arranged with its GPS information and orientation after modelling.
  - A GPS sensor is operated in the scene.
  - All objects can have their own GPS information if necessary.
  - All sensors can be defined with GPS information.

3. Attributes of a Physical Sensor

- Representation of the attributes of physical devices
- A framework for physical sensor information processing in a 3D world

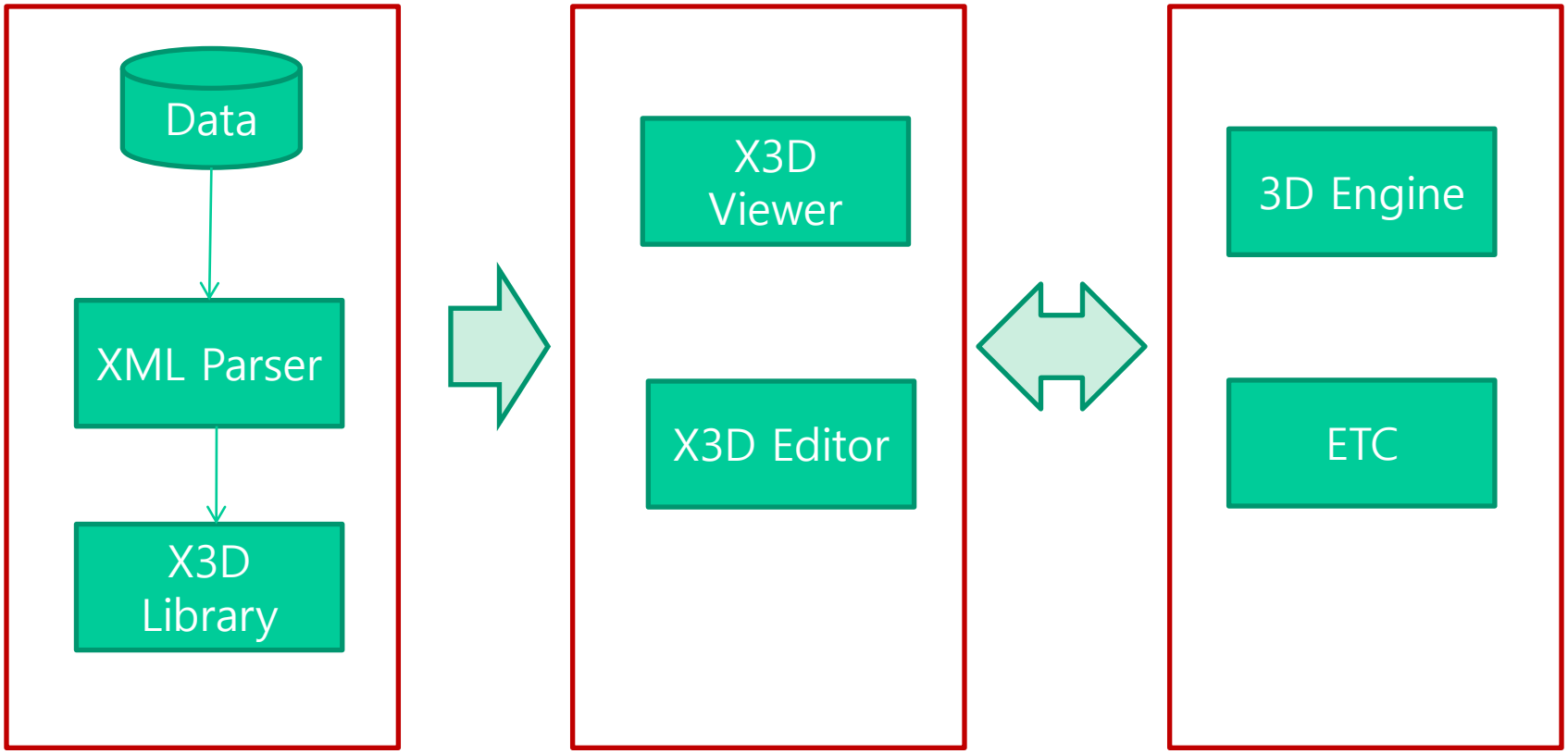
- Example
  - Represent the type and attributes of a physical device.
  - The physical device is managed visually managed in the 3D scene.
  - All functions of a physical device can be controlled in the 3D scene.
  - Define a framework for processing the information generated by each physical device.

4. Interfaces for a Physical Sensor

- Representation of interfaces for physical sensors
- I/O data streaming interfaces for physical sensors
- Sensor information control interfaces in a 3D scene

- Example
  - Represent the interfaces for controlling physical sensors: I/O interface and GUI.
  - Represent visual interfaces for I/O data streaming in the scene.
  - Represent necessary GUI for controlling the attributes and their information

Implementation - GPS MR System



- X3D document parsing
- Generate X3D geometric data for 3D representation using X3D library

- Display X3D geometric data
- Edit GPS X3D

- Include all libraries for displaying X3D data
- Physical sensors interface
- UI library

GPS Node Definition (1)

```
GpsSensor:PhysicalSensorNode {
    SFString        [out]       data_changed        " "   // NMEA 0183
    SFBool          [in, out]   enabled                       FALSE
    SFVec3f         [out]       position_changed
    SFRotation      [out]       orientation_changed
    SFFloat         [out]       latitude
    SFFlaot         [out]       longitude
    SFFloat         [out]       altitude
}
```

GPS Node Definition (2)

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<!--VrmlMerge ver. 0.5. Copyright (c) Michal Drapiewski <mdk@gazeta.pl> (c) 2005-->
<!--<!DOCTYPE X3D SYSTEM "x3d-3.0.dtd">-->
<X3D profile="Immersive" version="3.0">
    <Scene>
<GPS-Node available="true" latitude="38.436234" longitude="127.260313" speed="0" trakAngle="0.0" checkSum = "0"/>
        <Transform DEF="ID3584967_0" translation="0.0 0.0 0.0">
            <Shape>
                <Appearance>
                    <Material ambientIntensity="1.0" diffuseColor="0.5882 0.5882 0.5882" shininess="0.145" specular0
                    <ImageTexture url="cctv.bmp"/>
```

GPS Info in 3D Mesh data

```
class MeshData
{
public:
	MeshData()
	{
		Latitude = Longitude = 0;
		Translate.x=Translate.y=Translate.z = 0;
		Scale.x = Scale.y = Scale.z = 1;
		Rotate.x = 0; Rotate.y = 1; Rotate.z = 0;
		RotateValue = 0;
		ScaleOrientation.x = 0; ScaleOrientation.y = 1;
					ScaleOrientation.z =
	0;
		SOValue = 0;
	}
	~MeshData()
	{
		delete []Vertices;
		delete []ChangedVertices;
		delete []Indices;
		delete []TexCoord;
	}
	MeshData* prev;
	MeshData* next;

	BBox bbox;
```

```
		GLfloat *Vertices;
		GLfloat *ChangedVertices;
		GLubyte *Indices;
		GLfloat *TexCoord;
		GLfloat *Normal;
		GLuint Tex;

		GLuint count;

		GLfloat Latitude;
		GLfloat Longitude;

		Vector Translate;
		Vector Scale;
		Vector Rotate;
		GLfloat RotateValue;
		Vector ScaleOrientation;
		GLfloat SOValue;

		CString texFileName;
};
```

X3D Parser for GPS Nodes (1)

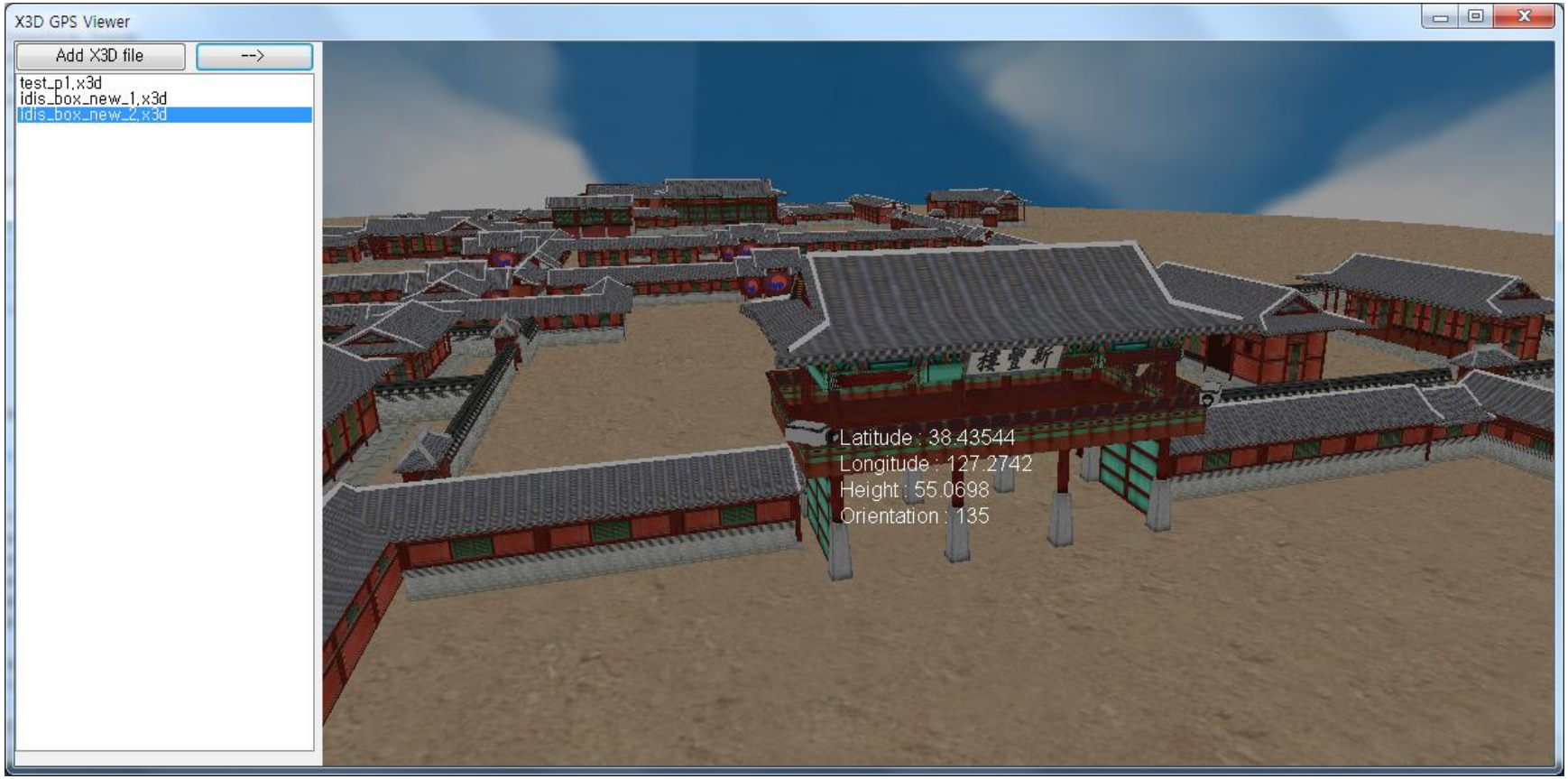
```
Node* XMLParser::CreateObject(int element)
{
	Node *node;
	X3DChildNode *X3DChild;
	switch(element)
	{
	case X3DID_X3D:
		node = new X3DNode();
		node->setID(X3DID_X3D);
		break;

	case X3DID_SCENE:
		node = new Scene();
		node->setID(X3DID_SCENE);
		break;
	case VMLID_GPS_NODE:
		X3DChild = new GPSNode();
		node = X3DChild;
		node->setID(VMLID_GPS_NODE);
		break;

	case VMLID_Transform:
		X3DChild = new Transform();
		node = X3DChild;
		node->setID(VMLID_Transform);
		break;
```

```
case VMLID_Shape:
		X3DChild = new
Shape();
		node = X3DChild;



		node-
>setID(VMLID_Shape);
		break;

	case VMLID_Appearance:
		node = new
Appearance();
		node-
>setID(VMLID_Appearance);
		break;

	case VMLID_Material:
		node = new Material();
		node-
>setID(VMLID_Material);
		break;
```

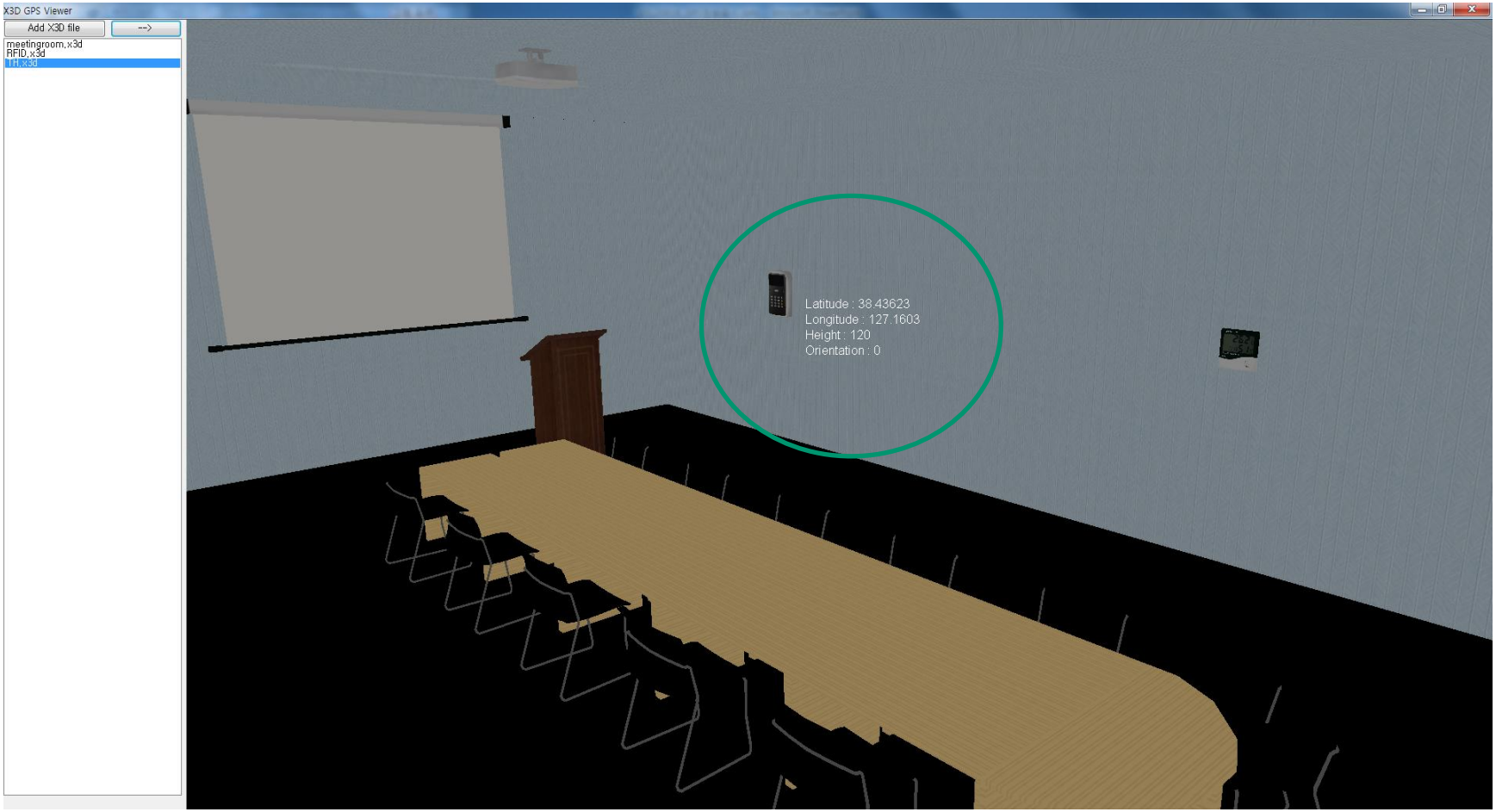
X3D Parser for GPS Nodes (2)

```
            case VMLID_Box:
                        node = new Box();
                        node->setID(VMLID_Box);
                        break;
              case VMLID_ImageTexture:
                        node = new ImageTexture();
                        node->setID(VMLID_ImageTexture);
                        break;

            case VMLID_IndexedFaceSet:
                        node = new IndexedFaceSet();
                        node->setID(VMLID_IndexedFaceSet);
                        break;

            case VMLID_Coordinate:
                        node = new Coordinate();
                        node->setID(VMLID_Coordinate);
                        break;

            case VMLID_TextureCoordinate:
                        node = new TextureCoordinate();
                        node->setID(VMLID_TextureCoordinate);
                        break;

            }

            return node;
}
```

GPS MR Viewer - Heritage



GPS MR Viewer – Meeting room



Conclusions

- A Representation Module for Physical Sensors in 3D Worlds
- Scope
  - A representation model of all kinds of physical sensors that can be included in a 3D world.
  - 3D modeling and rendering of physical sensors in a 3D scene
  - Representation of the attributes of physical sensors in a 3D scene
  - Representation of I/O data streaming of physical sensors in a 3D scene
  - Representation of the interfaces for controlling physical sensors in a 3D scene
- Implementation & Test
  - Testbed for a a Sensor MR reference model
  - Mobile Sensor MR in the ARC reference model