Interaction Models for Infrastructure Management Systems Using Virtual and Augmented Realities

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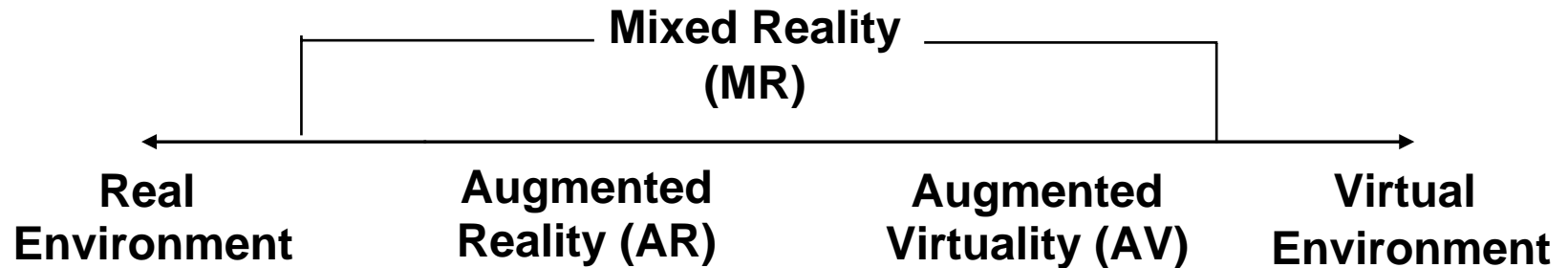
Telegeoinformatics and Infrastructure Management Group

Concordia Institute for Information Systems Engineering (CIISE)

**Concordia University**

Mixed Reality Continuum for LBC-Infra

Mixed Reality (MR)

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Real                Augmented           Augmented           Virtual
Environment         Reality (AR)        Virtuality (AV)     Environment
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VR and AR models are developed to suit the requirements of mobile **L**ocation-**B**ased **C**omputing for **Infra**structure field tasks (LBC-**I**nfra).

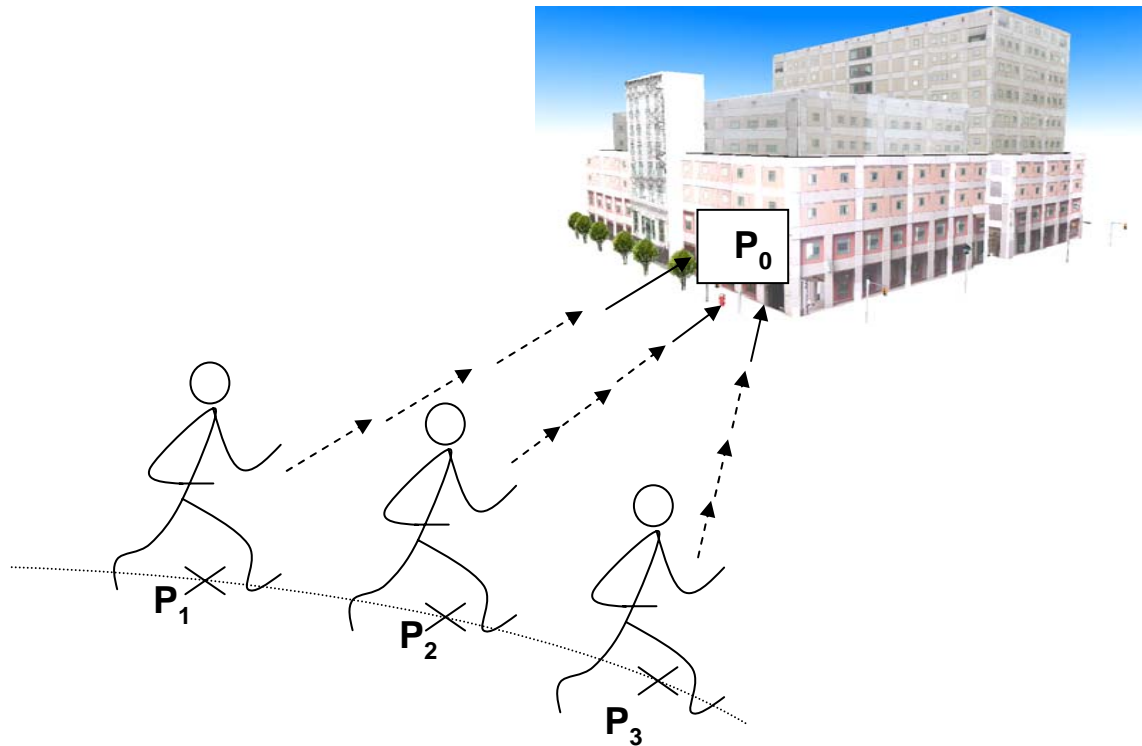# LBC-Infra's User Interface Components

- Visualization and feedback
    - Displaying graphical details
    - Displaying non-graphical information and instructions
- Control
- Access
- Navigation
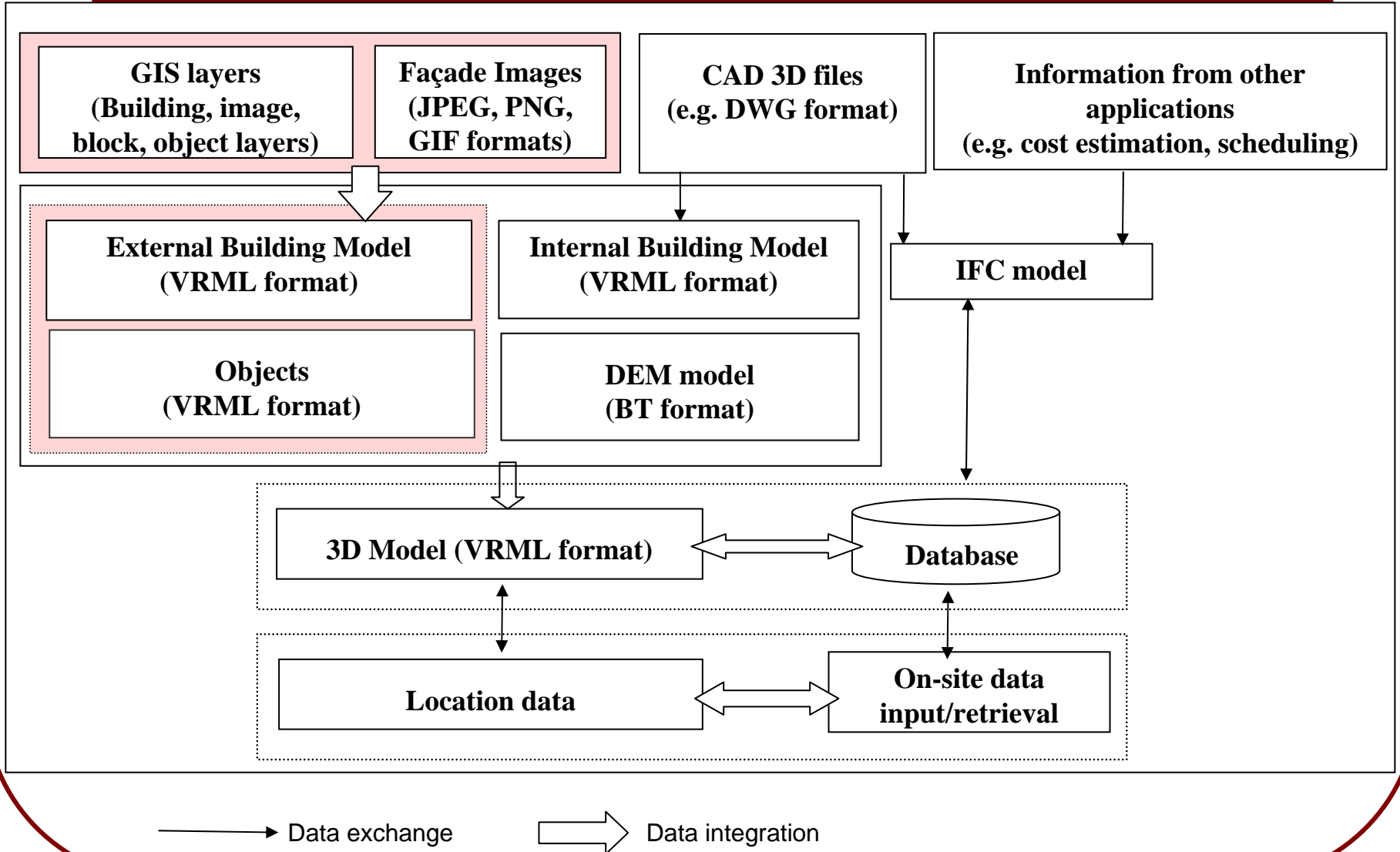- Manipulation
- Collaboration

Interaction Framework
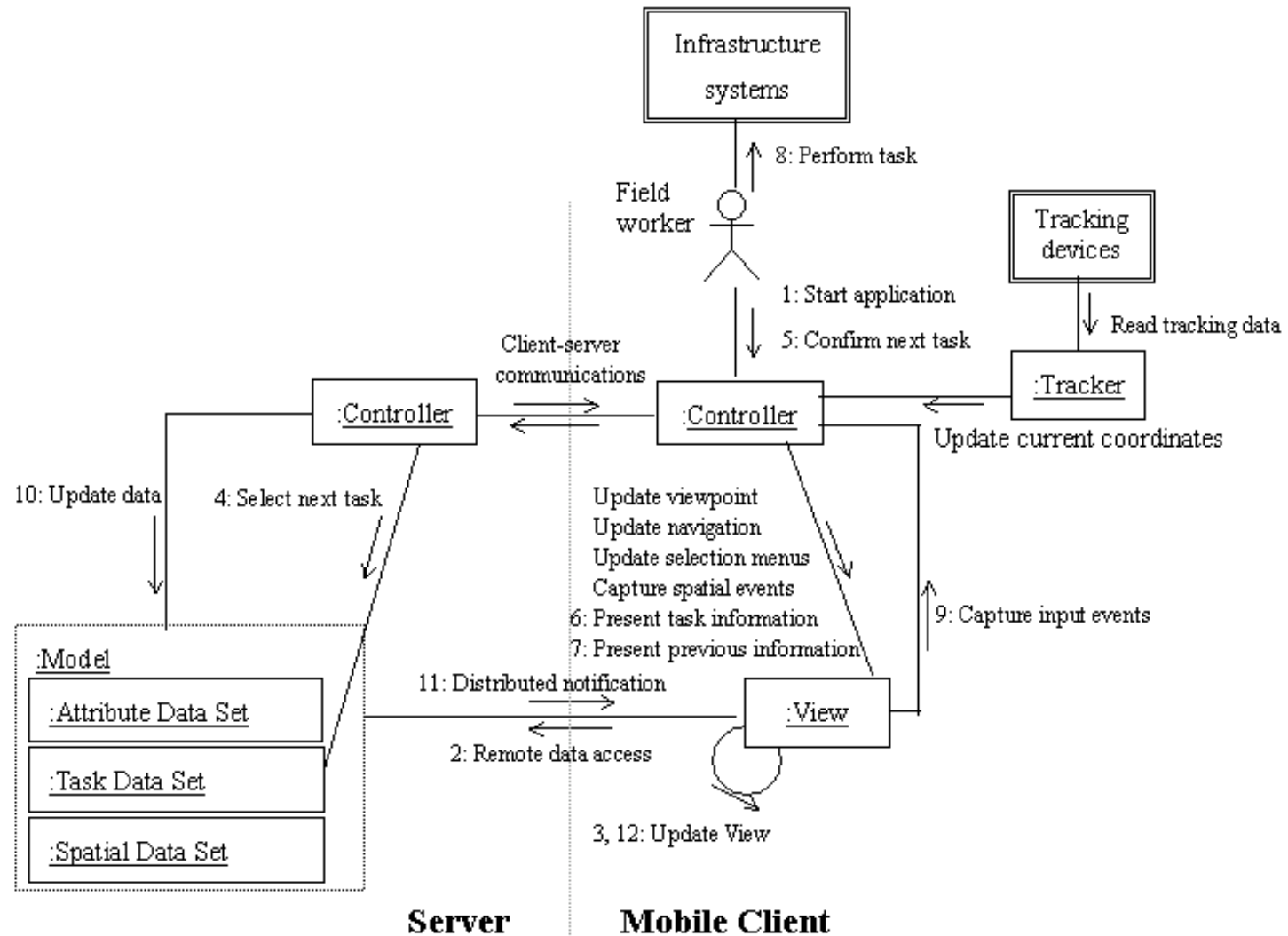
Real-time Navigation Guidance

- P_1, P_2, etc. are locations of the user extracted from tracking devices
- P_0 is the location of the target point of interest based on the task

Data Exchange and Integration Model

| GIS layers (Building, image, block, object layers) | Façade Images (JPEG, PNG, GIF formats) | CAD 3D files (e.g. DWG format) | Information from other applications (e.g. cost estimation, scheduling) |

External Building Model (VRML format)

Internal Building Model (VRML format)

IFC model

Objects (VRML format)

DEM model (BT format)

3D Model (VRML format) ⬌ Database

Location data ⬌ On-site data input/retrieval

→ Data exchange   ⇨ Data integration

Data Integration

- CAD drawings of the buildings
- Small VRML object library of objects embedded in the 3D model
- Orthogonal digital images of the facades of the buildings
- GIS maps of Montreal
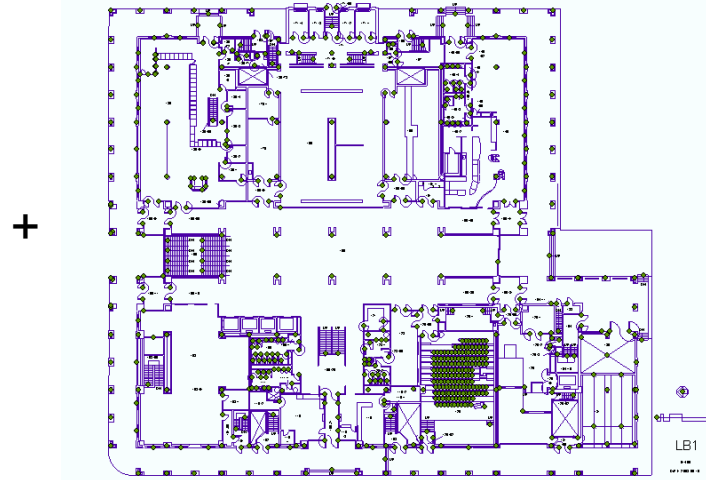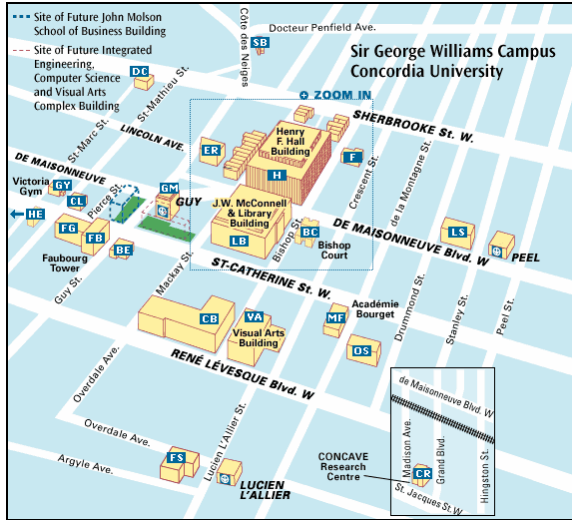- Digital Elevation Model (DEM)
- Tracking (RTK GPS, video tracking…)

Prototype System Development

- Development in Java and Java 3D
- MapObjects Java Edition to integrate GIS
- Integrates 4D model of the campus
- Has a GUI for Tablet PC
- Developing databases for construction, inspection and maintenance

Case Study: Concordia University Downtown Campus

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VR Model

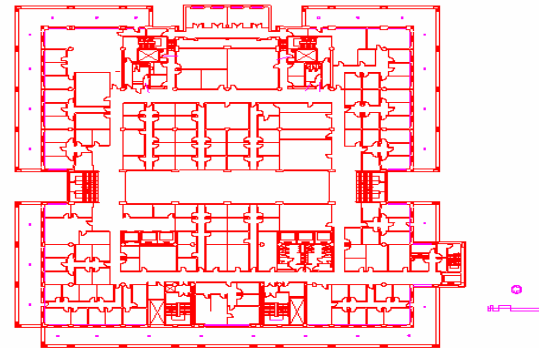# Floor Plans Used for Creating the Model

1st floor plan
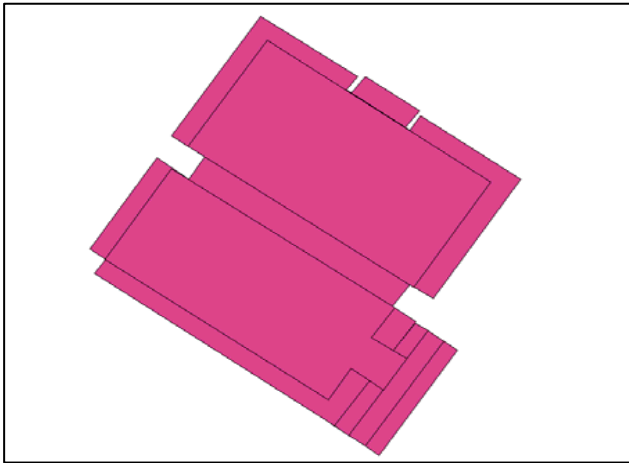**(for extrusion from 1st to 4th floor)**
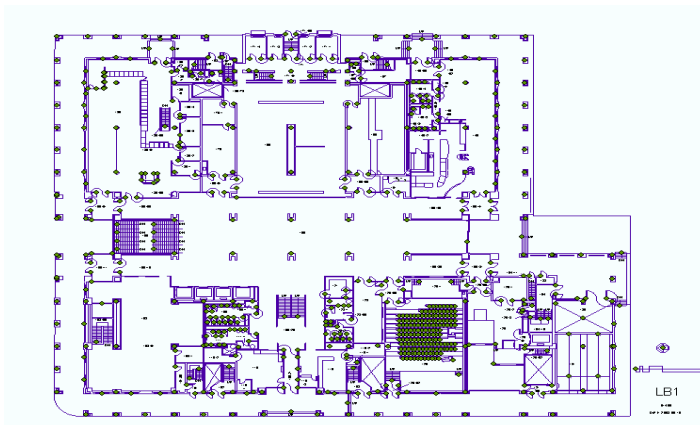
5th floor Plan
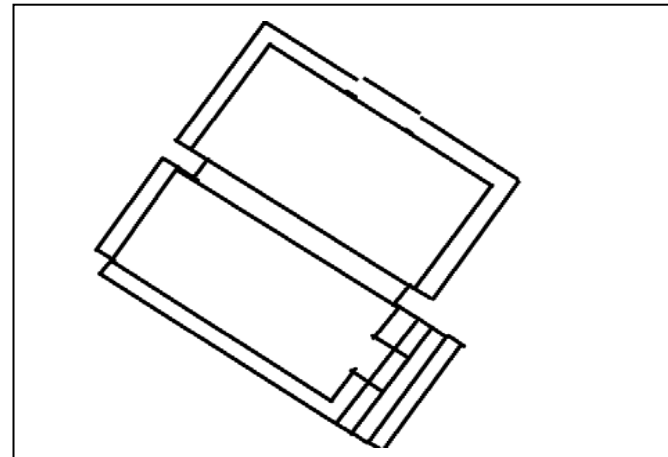**(for extrusion from 5th floor to the top of building)**
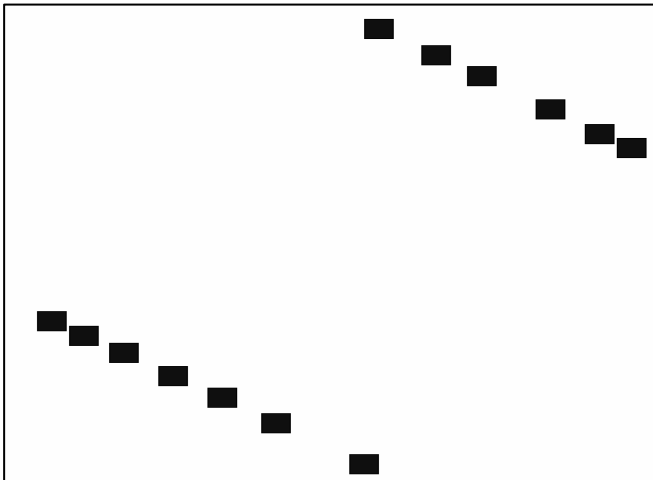
GIS Layers Used in Creating the 3D Model

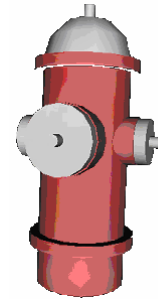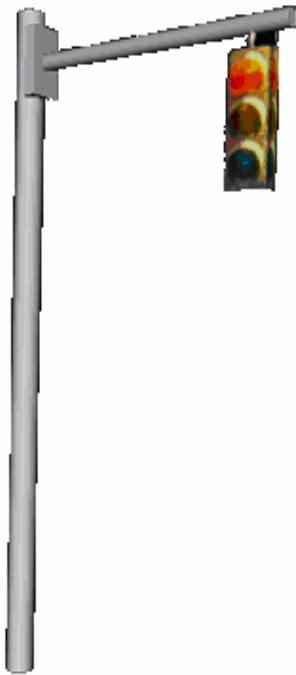**Building Layer (polygons)**

Image Layer (lines)

Object Layer (points)

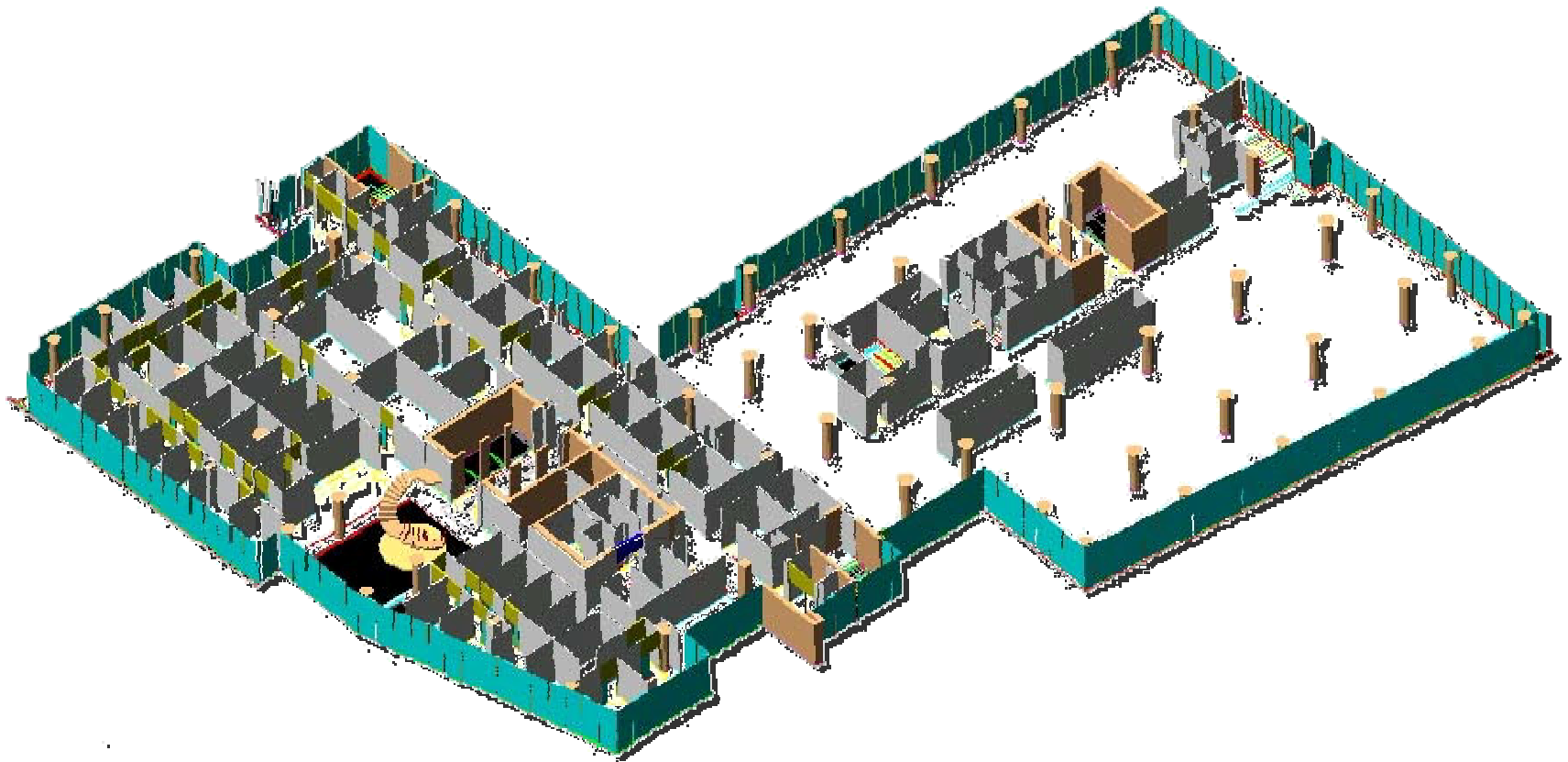**Block Layer (polygons)**

Examples of Objects Around Buildings

Virtual Model of the Library Building

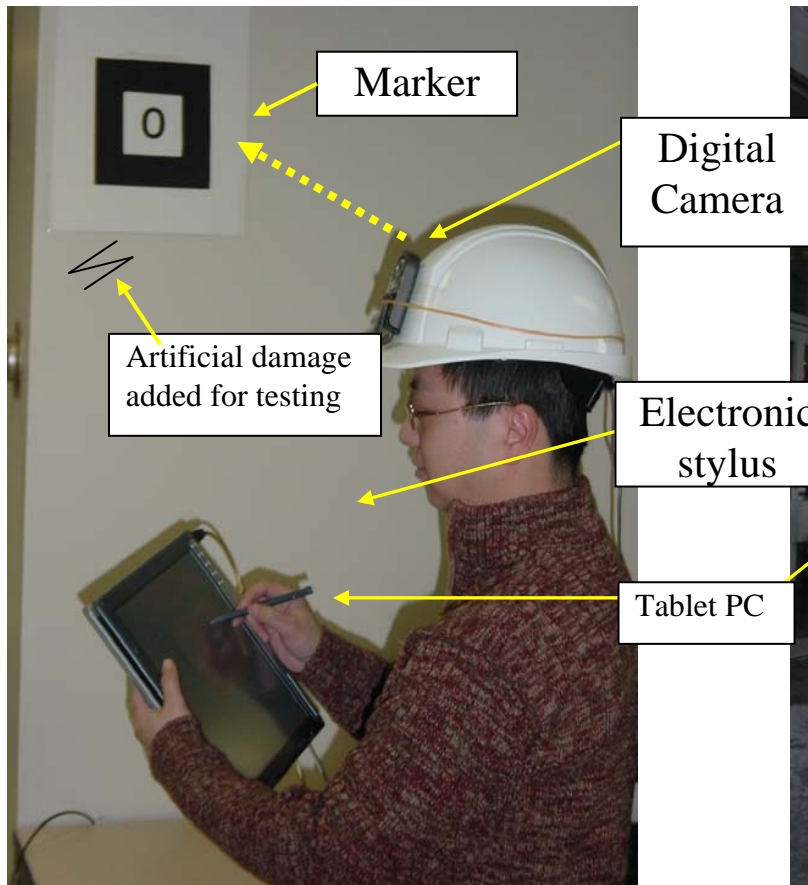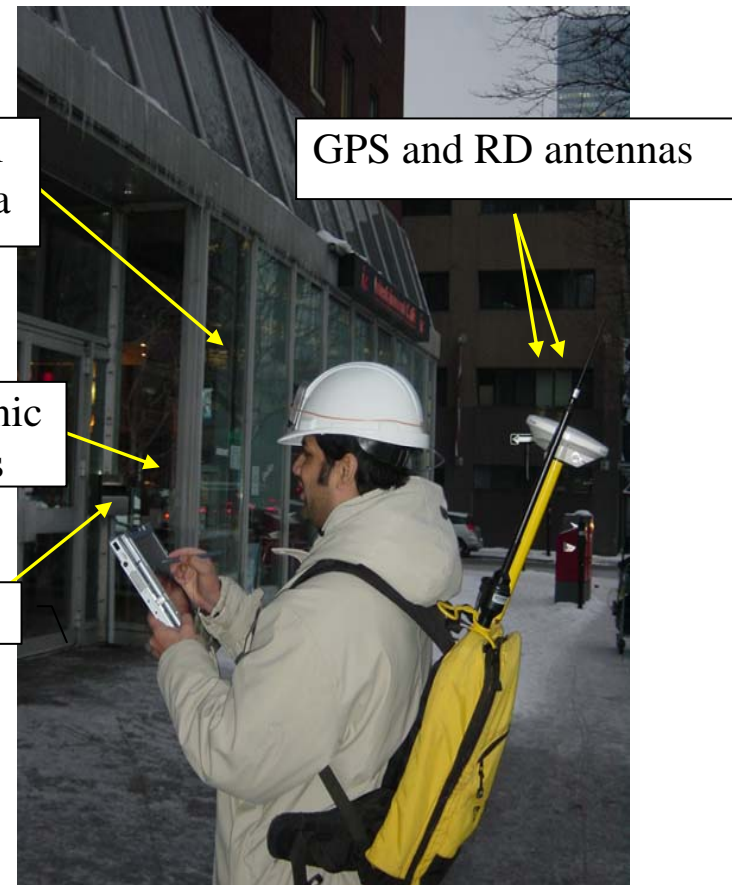# 3D Model of a Floor in the New Building

Tracking Methods
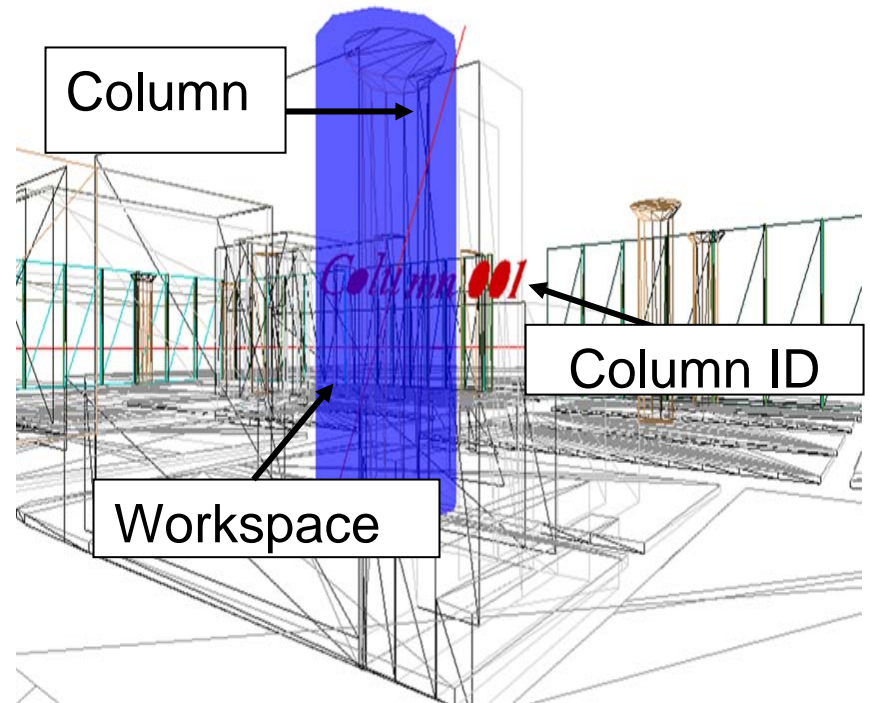

Indoor Video-Based Tracking

Outdoor GPS-Based Tracking

Marker

Digital Camera

GPS and RD antennas

Artificial damage added for testing

Electronic stylus

Tablet PC

AR Application in Building Construction

- Example of construction site

Marker

- Graphical Augmentation

Column

Column ID

Workspace

Augmentation of a Column

Marker

Column ID

Workspace

Video camera

Head Mounted Display
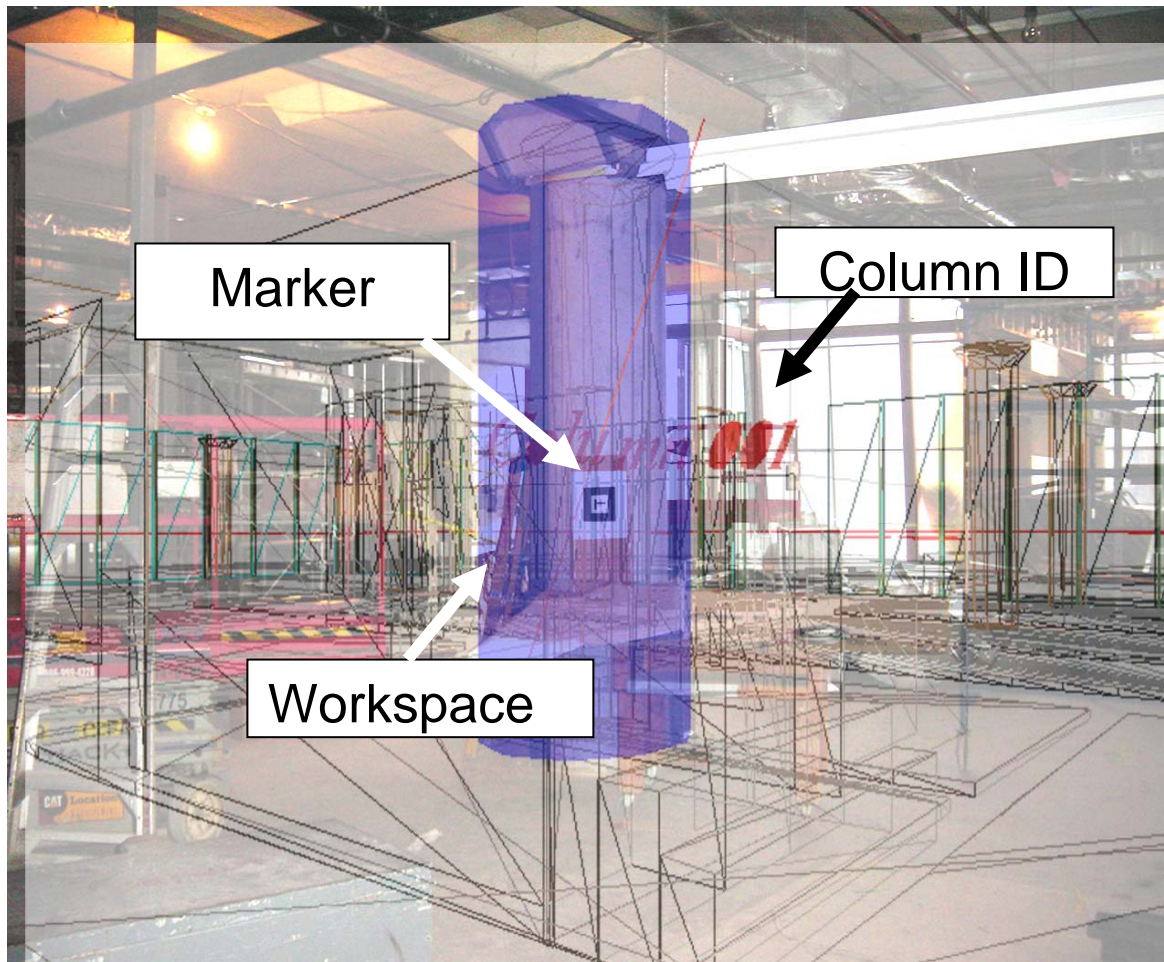
Non Immersive Virtual Reality

Bridge 3D Simulator

Console Help

Login Viewer | Simulation Viewer

☑ 📁 Concordia
  ☑ 📁 Sir George Wiliam Campus
    ☑ ● B
    ☑ ● Bishop Court
    ☑ ● BE
    ☑ ● CB
    ☑ ● CI
    ☑ ● CL
    ☑ ● Concave
    ☑ ● D
    ☑ ● DC
    ☑ ● EN
    ☑ ● ER
    ☑ ● F
    ☑ ● FA

Rendering Attributes

☑ Texturing Enabled   ☑ Objects Enabled

☐ Trees Enabled   ☑ DEM Enabled

☐ Ambient Light   ☑ Direction Light1

☑ Direction Light2

Extended Navigation

Behavior [Drive ▼]

Orbit navigation Speed

[1] [Default ▼]

Display Mode

Display Mode [Solid ▼]

Automatic Camera

Automatic Camera [▼] [...]

Tracking

|| Video Tracking   RealTime Tracking

[< Full Screen >]   GPS Tracking

[bldCamera1] [Moving camera1] [Moving camera2] [Moving camera3] [bldCamera5]

Element Detail

[Show All Records] [Clear All Records] [Clear Selection] [Go to Element]

Trying to locate element...
Trying to locate element...
Trying to locate element...

🏁 Start | 📁 New Folder (3) | 📄 Using Camtasia Studio 2 ... | 🔴 Camtasia Studio - Untitle... | 📘 JBuilder 9 - C:/Document... | 🖥 Bridge 3D Simulator   6:01 PM

Conclusions and Future Work

- The proposed approach facilitates accessing and collecting inspection data by allowing field workers to interact with geo-referenced infrastructure models

- Retrieving information is done automatically in real time based on tracking the location and orientation of the user

- The method would improve the efficiency and safety of field workers by allowing them to concentrate on their job

- Further development and testing of the prototype system

- Study of the system in practical situations and investigating collaboration scenarios among a team of on-site workers