

Augmented Reality-based Interactive System for Construction

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Based on sources such as

Byungil Kim, Changyoon Kim, and Hyoungkwan Kim (2011). "Interactive Modeller for Construction Equipment Operation Using Augmented Reality" *Journal of Computing in Civil Engineering*, in-press.

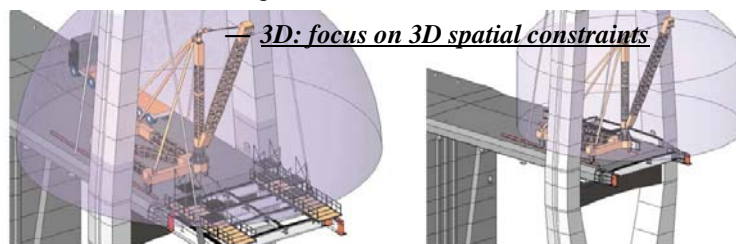
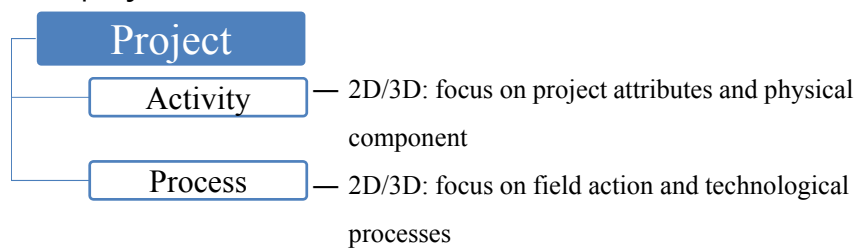
Taekwun Park, Moon Kyum Kim, Changyoon Kim, and Hyoungkwan Kim (2009). "Interactive 3D CAD for Effective Derrick Crane Operation in a Cable-Stayed Bridge Construction" *Journal of Construction Engineering and Management*, 135(11), 1261–1274.

Changyoon Kim, Hyun Su Lim, and Hyoungkwan Kim (2011). "Mobile Computing Platform for Construction site Management" *Proceedings of 28th International Symposium on Automation and Robotics in Construction*, Seoul, Korea.

김창윤, 이원일, 김형관 (2010). "증강현실 기술을 활용한 실감형 시공도면 개발" *대한토목학회 2010년도 정기학술대회 논문집*, 306–309.

Needs for Interactive Modeller

- Hierarchical levels of construction management in a project



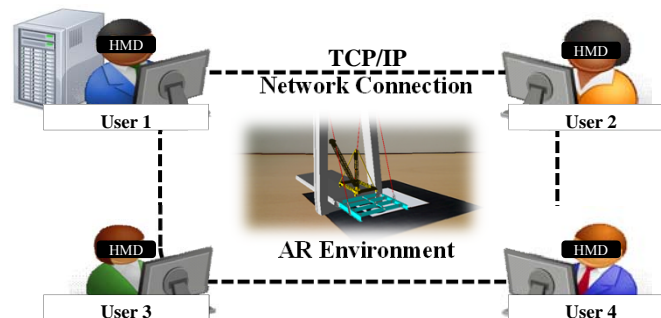
Spatial Constraints Analyses (Park et al. 2009)

Research Objectives and Methodologies

- Research Objectives
 - A system to identify the best scenario of an equipment operation
 - by intuitively operating the equipment
 - in a virtual environment
- Research Methodologies
 - Augmented Reality (AR) technology
 - Transmission Control Protocol/Internet Protocol (TCP/IP) socket programming

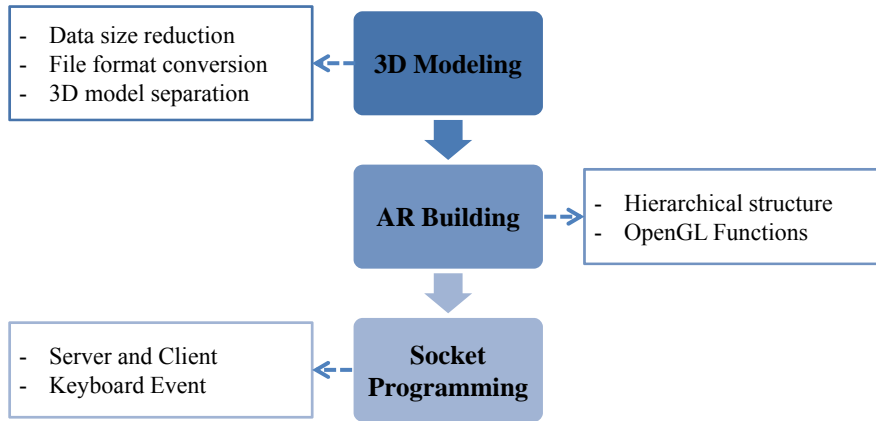
System Design Requirements

- The proposed AR system has four major design requirements:
 - Equipment operation in the context of the project progress.
 - Perspective transition from egocentric to exocentric
 - Multi-views on the same construction operation.
 - Server-client model to minimize data transfer among multi-clients.

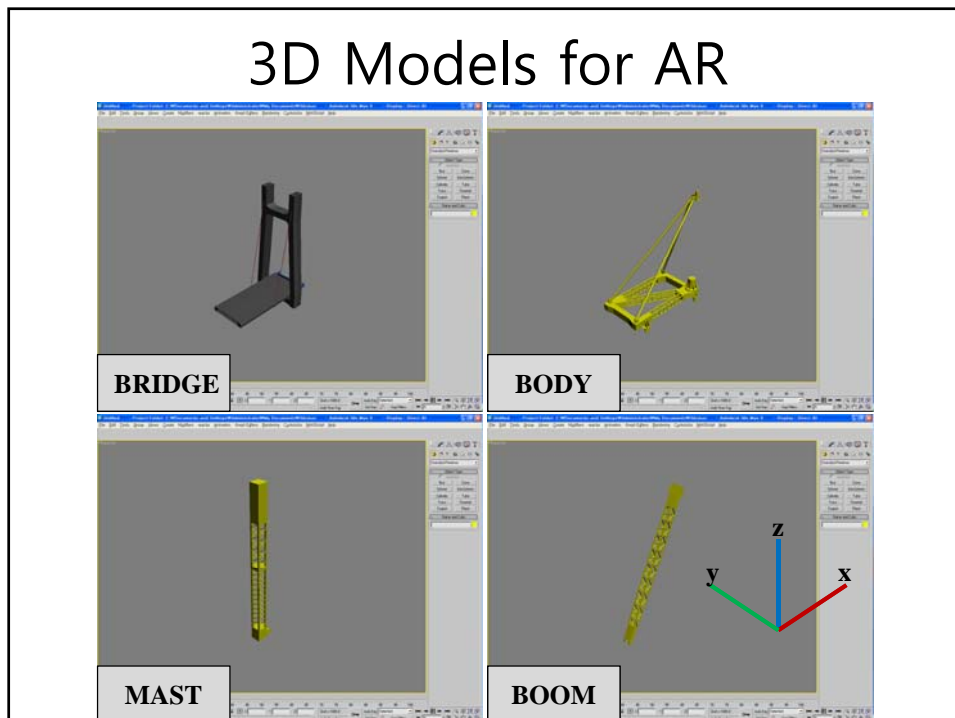


Development Procedure of the Interactive Modeller

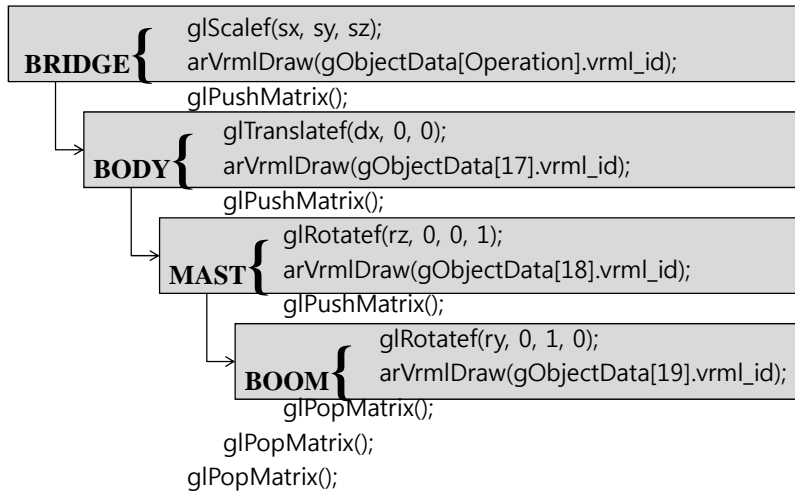
- 3D model data that were developed by a previous research (Park et al. 2009).
- Emphasis was placed on the deck construction of the main span between two piers.



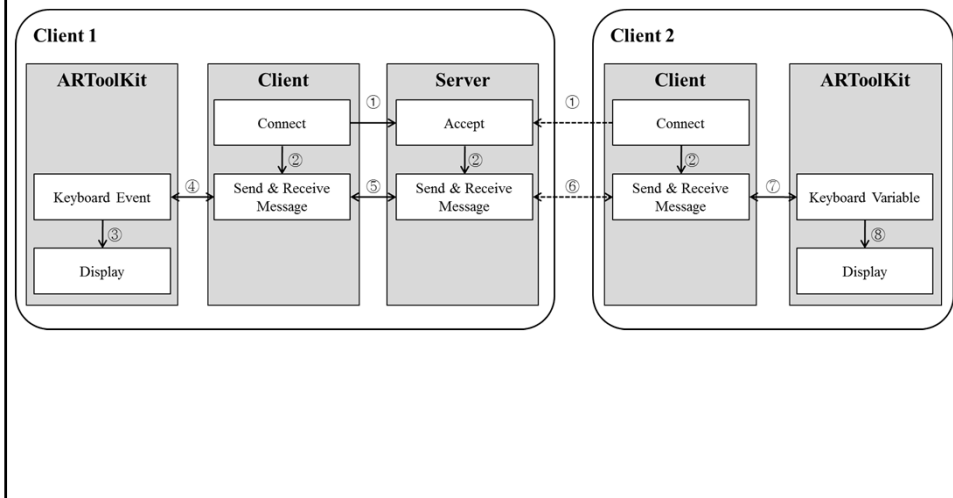
3D Models for AR



Hierarchical Structure of the AR Objects



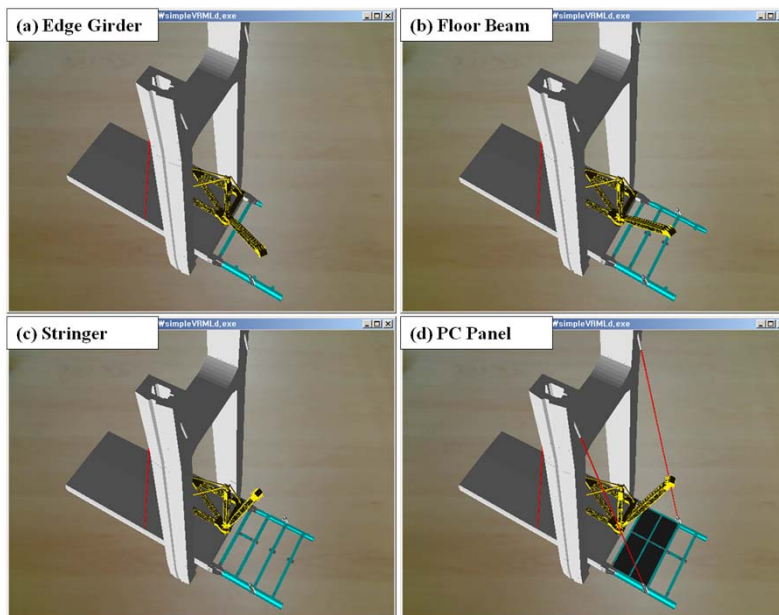
Networking Process of the Interactive modeller



Setup of the Interactive Modeller



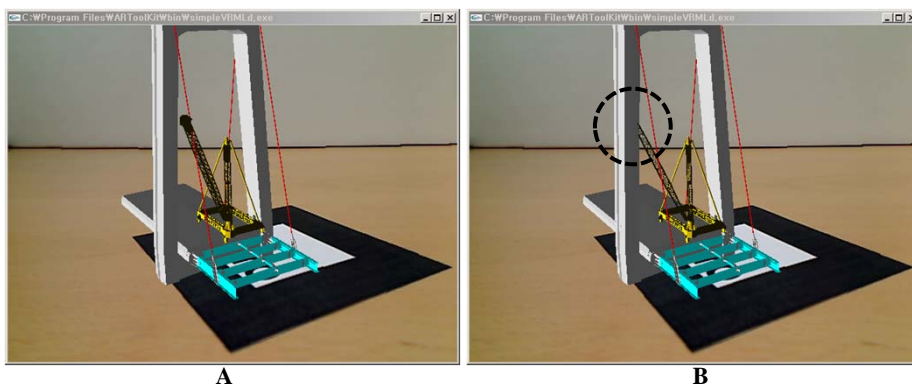
Installation Simulation



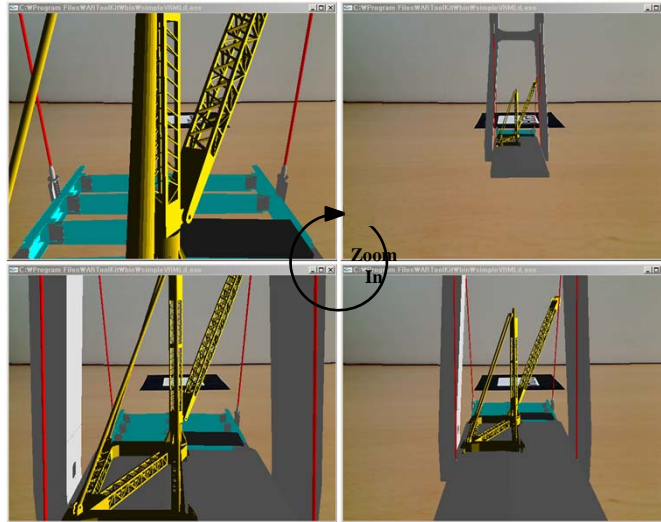
Equipment Operation in the Context of the project progress



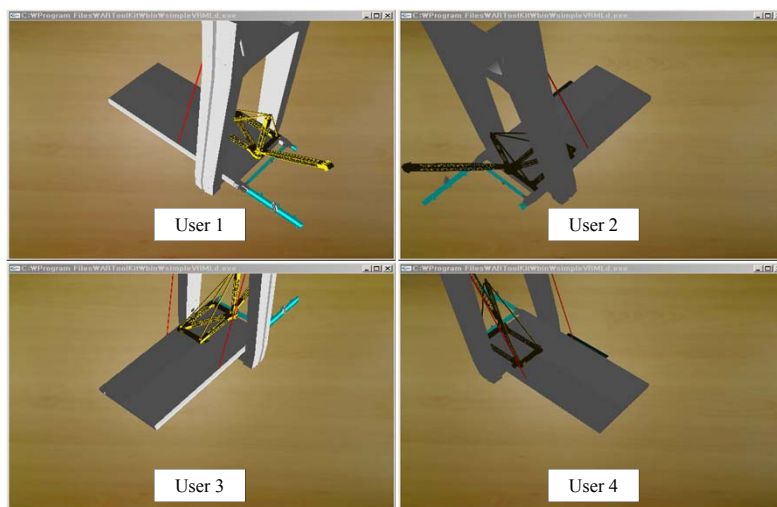
3D Collision Analysis in the Interactive Modeller



Perspective transition from exocentric to egocentric views



Multi-views on the Same Construction Operation



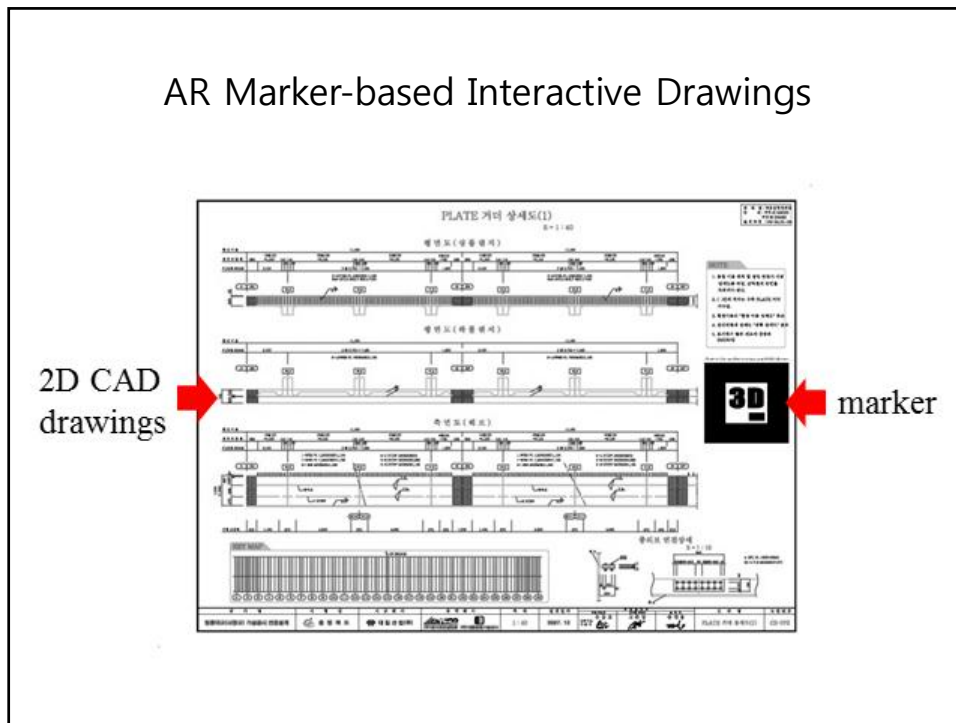
Conclusions & Recommendations

- Interactive modeller provided an interactive construction planning environment.
- Multiple users could interactively suggest and modify 3D-based construction scenarios in the context of the project progress information.
- Further studies are required to provide a more realistic and easy-to-use simulation environment.

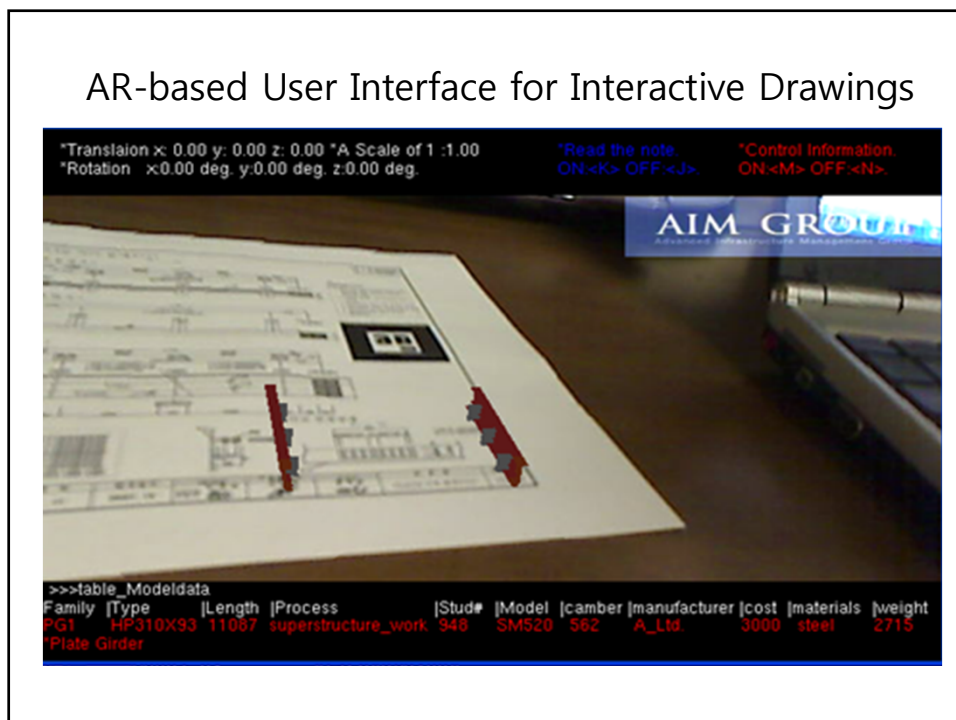
Needs for AR-based Interactive Drawings

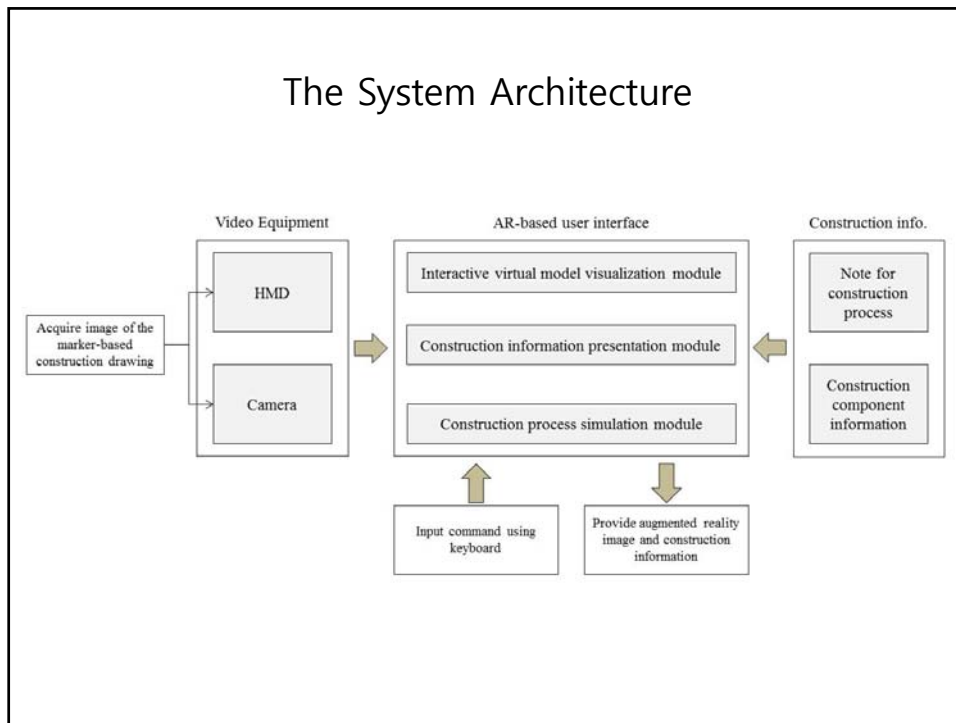
- Difficulties that construction engineers face
 - New construction projects
 - Complex structures
 - New construction methods
 - The fact that 2D drawings are still the dominant medium
 - Difficulty in understanding 2D drawings
- Suggestions
 - AR-based interactive drawings: 2D drawings of which contents are improved using the AR techniques

AR Marker-based Interactive Drawings



AR-based User Interface for Interactive Drawings





Construction Methods Presentation

*Translation x: 0.00 y: 0.00 z: 0.00 *A Scale of 1 :1.00
 *Rotation x:0.00 deg. y:0.00 deg. z:0.00 deg.

*Read the note. ON:<K> OFF:<J>
 *Control Information. ON:<M> OFF:<N>

< NOTE >

1. Please get approval from the Supervisory Board, when you Change welding positions and methods.
2. Plate Girder's Dimensions are in () marks.
3. Please refer to a "field joint detail document" using the in-site joint method.
4. Please refer to a "common detail document" to find detail information of shear connector.
5. Steel members are not marked in this document.

AIM GROUP
Advanced Infrastructure Management Group

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    >>>table_Modeldata
    Family |Type      |Length |Process      |Stud# |Model |camber |manufacturer |cost |materials |weight
    Ref. :This model does not include a detailed description of STUD BOLTS
    *Plate Girder + Floor Beam + Stringer
    
```

Conclusions & Recommendations

- Interactive drawings provided an interactive environment for understanding the 2D drawings.
- Various information such as material specifications, construction methods, construction procedures could be displayed to the user in an interactive manner.
- The proposed system could also be used for educational purposes.

Needs for Interactive Mobile Computing

- Ever increasing size and complexity of construction projects
 - Difficulty in tracking construction resources on site
 - Material
 - Equipment
 - Labor
 - Difficulty in timely and effective exchange of construction information among project participants
 - Difficulty in associating a particular task to specific locations or resources
 - Delivery
 - Construction work at specific locations
 - Specific construction equipment usage
- Suggestions
 - AR-based interactive mobile computing

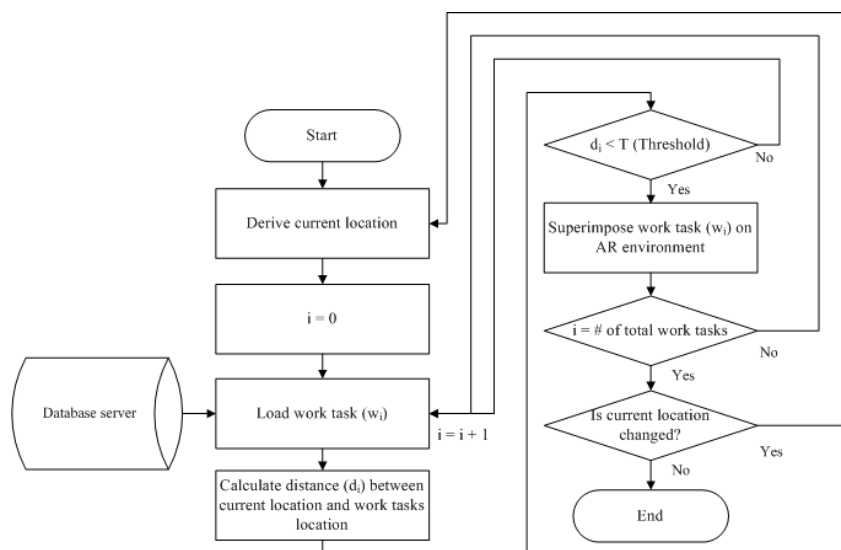
Hardware Component



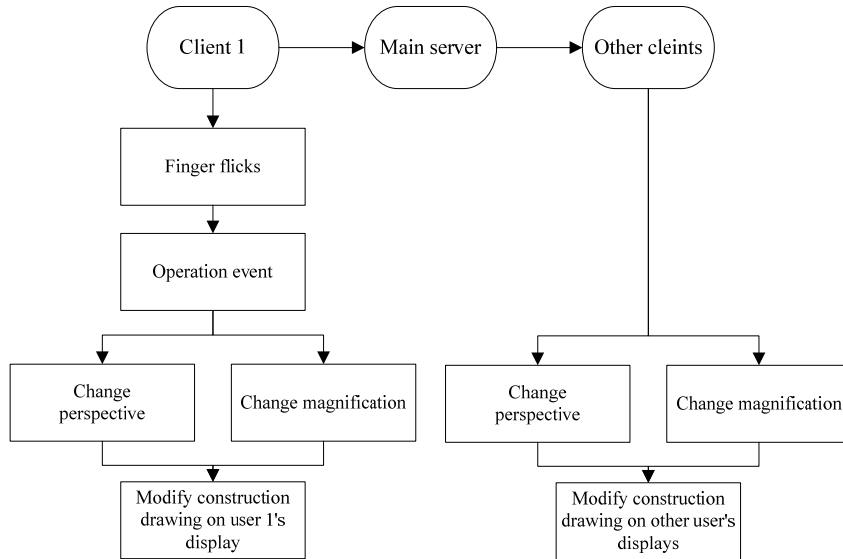
Smart Phone Functionalities

1. Global Positioning System
2. Various Sensors (three axis Gyroscope, accelerometer)
3. Wireless Networking Technology (3G and Wi-Fi)
4. 300 Megapixels Digital Camera
5. Google Map
6. Application Development Kit

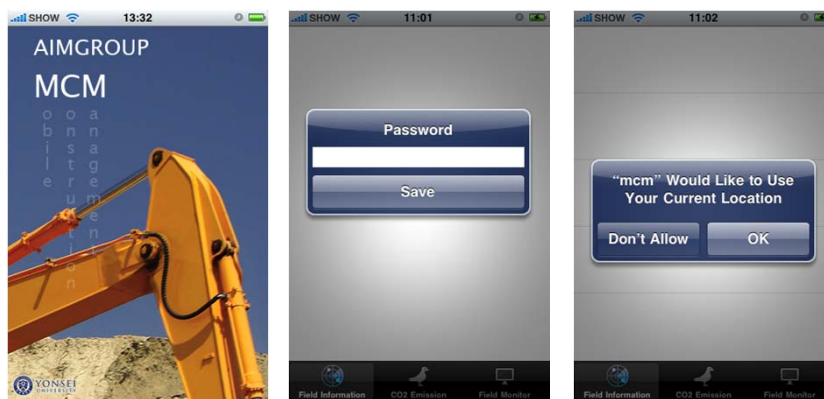
Algorithm for AR visualization



Construction drawing sharing module



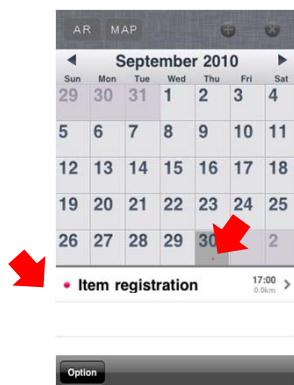
User Registration



Work Task Registration

- Input following work task information:
 - Work task title
 - Description
 - Start and end date of the task
 - Crew in charge
 - Supervisor
 - Location of the work task
- Registered information is transferred to the main server via Wi-Fi or a WCDMA network

Work Task Calendar



- Work tasks are scheduled on the calendar of the mobile device
- Construction engineers on site can easily identify the priority of the work tasks based on the list of the calendar.

Work Task Visualization on Map



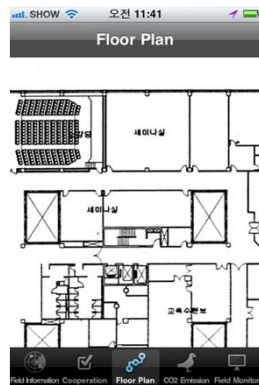
- The mobile system is presenting the location of the work task on the map
- Current location information (blue ball) and work task location (red ball) are visualized on the map
- Engineers on site can deduce the direction and distance to the work tasks on the site

Work Task Visualization using AR



- V shape graphic symbols with text information are superimposed on the real construction site image
- This AR visualization enables construction engineers to easily find the direction and location of the work tasks on site

Construction Drawing Sharing Module



- Construction engineers on site can download drawings from the main server and analyze them on the mobile device
- Two or more construction engineers can share the same view of the construction drawings with their own mobile devices

Conclusions

- The system was composed of two main modules: site management module and construction drawing sharing module.
- Using the site management module, the work task information provided in the system was able to be easily associated with the corresponding location information.
- The drawing module presented the capability of interactive communication among construction engineers by sharing the construction drawing on their own mobile devices.