Gesture Control of 4D building models with Microsoft Kinect

Software Lab Project 2012

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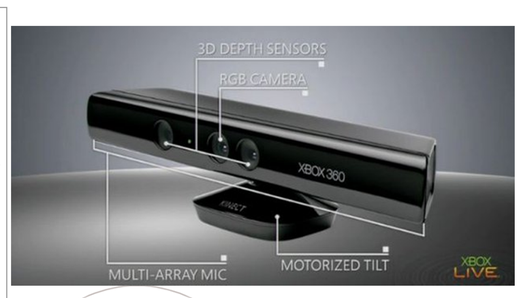
Abstract

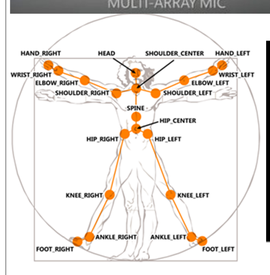
Within the scope of this Software Lab Project a software tool to navigate 4D building models using the gesture recognition tool Microsoft Kinect was developed. The plug-in for Autodesk Revit enables the user to control a three-dimensional semantic building model with few intuitive gestures.

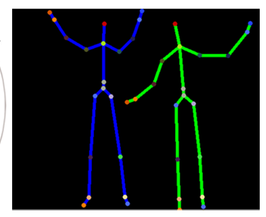
Soft- and Hardware

The Microsoft Kinect

Kinect is a motion sensing input device by Microsoft for the Xbox 360 video game console and Windows PCs. Based around a webcam-style add-on peripheral, it enables users to control and interact with the Xbox 360 or the PC without the need to touch a mouse, a keyboard or a game controller, through a natural user interface using gestures and spoken commands. [1]







Autodesk Revit

Autodesk Revit is Building Information Modeling software for architects and engineers. It allows users to design a building and its components in 3D, annotate the model with 2D drafting elements and access building information from the building models database. Revit is 4D BIM capable with tools to plan and track various stages in the building's lifecycle, from concept to construction and later demolition. [2]

Development Process

The first step in the development process was to get to know the Software Development Kit (SDK) of the MS Kinect. Therefore several sources on the web were taken into account, to create and modify a small program able to control a Power Point presentation just by moving the hands.

The next step was to decide which Building Information Modeling (BIM) software could be used to view the model and had the possibility to modify the active view by using the appropriate Application Programming Interface (API).

Revit proofed to be the only software to match those requirements. After deciding on the software a plug-in for Revit had to be created. It's task was to enable interaction between gestures recognized by the Kinect and the API's abilities to control the active view.

After communication between the Kinect and Revit was successfully enabled, the control gestures were implemented in the plug-in. As thoughts and ideas concerning intuitive control gestures were collected throughout the entire development process, those only had to be translated into commands understood by the Kinect SDK. After recognition of a specific gesture by the Kinect, the corresponding view-controlling function of the API had to be triggered to perform the desired change in the active view.

After the general gesture recognition was successfully implemented the last step to a usable software consisted of a tuning process to achieve a most suitable user experience.

Challenges

During the entire development process the project team was met by several challenging problems:

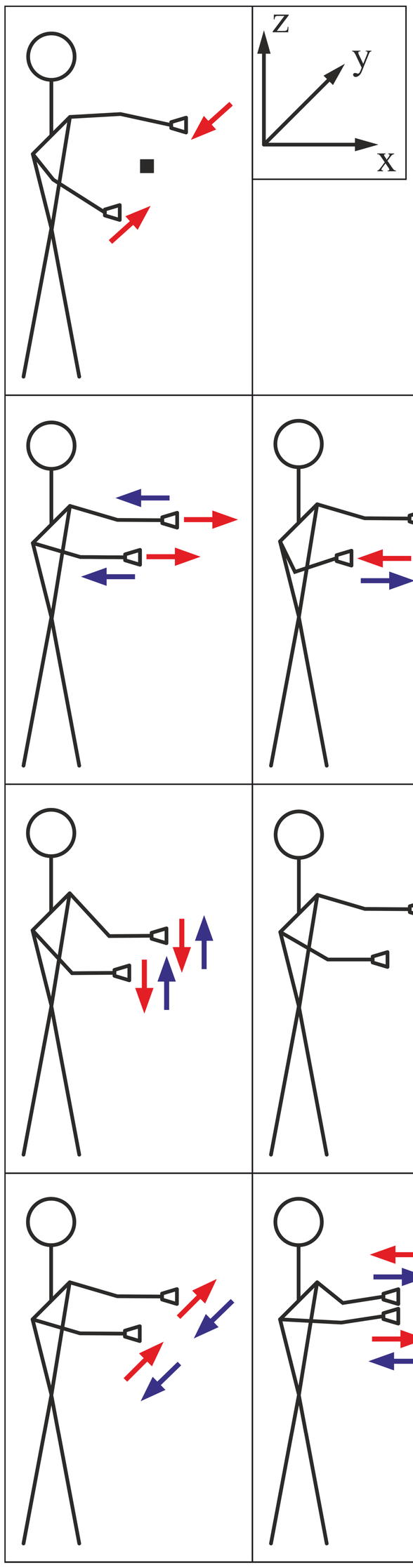
- Decision which BIM software to use
- Combination of the Kinect SDK and the Revit API
- Implementing the gestures in a geometrically correct way (see below)

In order to set a turning angle of the model two unit vectors had to be defined. One vector with the name "forward" is directed to the viewer and second one called "up" defines the top of this view. The values of both vectors are three-dimensional coordinates and they are calculated on the basis of sphere parameterization:

$$x = sin\alpha * cos\beta, \qquad y = sin\alpha * sin\beta, \qquad z = cos\alpha$$

Where α and β are turning angles of vertical and horizontal surface, respectively.

Gestures to Control the Model



Grabbing the Object

By performing the motion of grabbing an object and holding it in front of the body the user tells the software, that he wants to control the object.

Movement in x-Direction (Zooming)

By moving the hands closer to or away from the body, the user is able to zoom.

Rotating around z-Axis

By moving one hand away from the body and the other one closer to it, the user may rotate the object around the z-axis.

Movement in z-direction (Up and Down)

If the user whishes to move the object up and down he has to move both hands in the corresponding direction.

Rotating around x-Axis

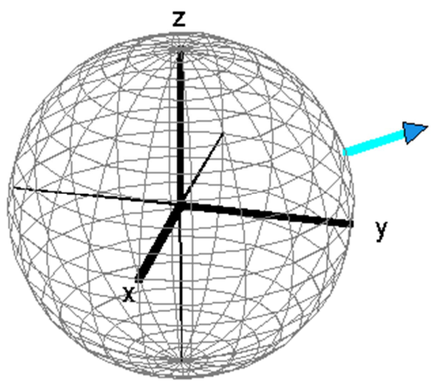
To rotate the object around the x-axis the user has to move one hand up and the other hand down.

Movement in y-direction (Left and Right)

By moving the hands to the left or to the right the user can shift the object in those directions.

Rotating around y-axis

The user may rotate the object around the y-axis by holding his hands over each other and bringing one hand closer to the body while moving the other away.



Conclusions / Outlook

While the development of Autodesk Navisworks continues, the view modification possibilities might get updated to match the Revit API.

Hence a building progress - change gesture can be implemented to provide full 4 D navigation features.

References

[1] http://en.wikipedia.org/wiki/Autodesk_Revit
[2] http://en.wikipedia.org/wiki/Kinect