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Motion Detection Real Time 3D Walkthrough in Limkokwing University of Creative Technology (Modet-Walk) using Kinect XBox

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Abstract

This research intends to give an interactive communication by implementing the kinect into the 3D walkthrough. The project is based on motion detection which is interacted with virtual 3D walkthrough in the real environment. Now the possibility of combining 3D walkthrough with the kinect Xbox seems to be a success. This paper is simply to emphasize on combining 3D virtual walkthrough with Kinect Xbox to detect the motion. The research is based on how the implementation of motion detection using kinect can help people in understanding/translating and give meaning to the environment displayed around them ubiquitously.

Keywords: Interactive Virtual Walkthrough, Kinect Motion Detection, Real Time, Visual and Ubiquitous

1. Introduction

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 for the Xbox 360 console, it allows users to control and interact with the Xbox 360 without the requirement to touch a game controller, through a natural user interface using gestures and spoken commands. The project is targeted as to extend the Xbox 360's audience beyond its typical gamer base. Kinect to contend with the Wii Remote Plus and PlayStation Move with PlayStation Eye motion controllers for the Wii and PlayStation 3 home consoles, respectively. A version for Windows was released on February 1, 2012 (Mashable, 2012).

The Kinect sensor is a horizontal bar linked to a small base with a motorized pivot and is performed with purpose to be positioned lengthwise above or below the video display. The device features an "RGB camera, depth sensor and multi-array microphone running proprietary software", which gives a full-body 3D motion capture, facial recognition and voice recognition capabilities. At launch, voice recognition was only made available in Japan, the United Kingdom, Canada and the United States. Currently voice recognition is supported in Australia, Canada, France, Germany, Ireland, Italy, Japan, Mexico, New Zealand, United Kingdom and United States. The Kinect sensor's microphone array enables the Xbox 360 to bear acoustic source localization and ambient noise suppression, allowing for things such as headset-free party chat over Xbox Live. (Wikipedia, 2012)

Kinect has transmuted the way people play games and endure entertainment. Now, Kinect for Windows offers the potential to transform how people interact with computers and Windows-embedded devices in multiple industries, including education, healthcare, retail, transportation, and beyond.

Fig 1: End User Experience

A virtual tour is a simulation of an existing location, usually composed of a sequence of video images. They also may use other multimedia elements such as sound effects, music, narration, and text. The phrase "virtual tour" is often used to describe a variety of video and photographic-based media. Panorama indicates an unbroken view, since a panorama can be either a series of photographs or panning video footage (Figure 1). However, the phrases "panoramic tour" and "virtual tour" have mostly been associated with virtual tours created using still cameras. Such virtual tours are made up of a number of shots taken from a single vantage point. The camera and lens are rotated around what is referred to as a no parallax point (the exact point at the back of the lens where the light converges). (Kinect for Windows, 2012)

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A video tour is a full motion video of a location. Unlike the virtual tour's static wrap-around feel, a video tour is as if you were walking through a location. Using a video camera, the location is filmed while moving from place to place. Video tours are continuous movement taken at a walking pace. (Clearmark, 2012)

With the expansion of video on the internet, video-based virtual tours are growing in popularity. Video cameras are used to pan and walk-through subject properties. The benefit of this method is that the point of view is constantly changing throughout a pan. However, capturing high-quality video requires significantly more technical skill and equipment than taking digital still pictures. Video also eliminates viewer control of the tour. Therefore the tour is the same for all viewers and subject matter is chosen by the videographer. Editing digital video requires proficiency with video editing software and has higher computer hardware requirements. Also, displaying video over the internet requires more bandwidth. Due to these difficulties, the task of creating video-based tours is often left to professionals. (Dan Ru, 2009)

Kinect works as a motion sensing device that provides interactivity with the 3D virtual walkthrough environment. Previously it was used to enhance the Xbox 360 gaming device and now it can be applied to various consumer interactions. It can be say that kinect technology is on rise.

Recently it was used in an Auto Show occurred in North America where a massive interaction display was shown. Participants can virtually navigate through the interior of the Nissan Pathfinder by interacting with the Kinect for Windows console, using hand motions to direct the experience. The addition of Kinect for Windows literally transforms the way people engage and interact with computers using natural input including voice and physical body movements. This virtual showroom experience promises to elevate and enable a new breed of vehicle simulation experiences that will allow design concepts to be explored virtually. This Kinect for Windows interactive experience is bridging the gap between next-generation gaps. (Identitymine, 2012)

1.1 Initial Analysis

Initial analysis was carried out to describe work performed at many different sites and explains the issues and problems encountered when using kinect as navigation in virtual walkthrough. These applications require giving the user the ability to walk around large environments, even outdoors.

The result of the study is that one of the most basic problems currently limiting kinect applications is the only control it has which is movement. The objects in the real and virtual worlds must be properly aligned with respect to each other, or the illusion that the two worlds coexist will be compromised. The movement control is supposed to be intuitive and therefore must mirror real life or else be some sort of signal

extraneous to the experience of control within the game, such as, "Let's take a break from playing" or "Select this menu item, please." This is due to the fact that there is no real life analogue (such as when selecting an item off of a menu, where in real life we use rather complicated speech to accomplish this), or, ironically, the real life analogue to these actions is pushing buttons (such as pausing a video). (Pneuma08, 2010)

Since so far we have not come through any virtual walkthrough that uses motion detection as navigation we planned to develop this MoDet-Walk which is known as Motion Detection Real Time 3D Walkthrough application. This applications help to give the user to interact with the virtual environment using their own body movement.

Due to the problem mentioned above it is our responsibility to solve the barrier to provide an interactive way to communicate with the Limkokwing 3D virtual walkthrough. This is because it lets the consumer or user to interact with the environment which makes the application to be more interesting and inviting to be used.

1.2 Problem analysis

Based on the observation and the study done regarding on this 3D virtual walkthrough which is combined with kinect.The lack of interactivity and visualization in virtual 3D walkthrough in the Public Physical Environment leads us to do research on providing the interactivity sense to the walkthrough environment. When they interact using their own body motion, it actually gives a more appealing feeling of the 3D walkthrough environment. Before this users can only navigate into the walkthrough by using the mouse. This of course limits the interaction between the user and the environment. The user is unable to feel and touch the realistic of the virtual walkthrough.

Therefore based on the limitation mentioned above there is a need to design an application that can tackle the barrier that is been observed and do research more on a better way to improve the interactivity using kinect Xbox. The solution to the problem is to develop an application which will give the user to interact with the environment using their own body movement.

Besides that, the lack of proper and suitable Human interaction integrated with virtual environment for 3D walkthrough is also another problem that was observed. Normally interaction with the walkthrough environment is always using the mouse to click and the keyboard perhaps. This Human integration only works with the kinect Xbox as it detects our motion and interacts simultaneously with the environment without the need to use the external devices such as keyboard or mouse.

1.3 Methods (solutions)

Kinect SDK software platform is designed to deliver a personalized and customizable user experience on 3D walkthrough. Compared to many existing platforms,

kinect Xbox is truly open to continued innovation and new experiences. The Kinect SDK provides the tools and APIs necessary to provide interaction using our motions.

The recent kinect SDK has the latest advances in audio processing, which include a four-element microphone array with sophisticated acoustic noise and echo cancellation for crystal clear audio. Moreover, the depth data, which provides the distance of an object from the Kinect camera, as well as the raw audio and image data, which together open up opportunities for creating richer natural user, interface experiences. It is also highly performant and robust skeletal tracking capabilities for determining the body positions of one or two persons moving within the Kinect field of view. For one, the SDK promises to have compiled version of all necessary tools in exploiting the Kinect's technology. Also, the SDK will feature a more stable and user-friendly directory/interface that will make it easier for developers to identify the tools needed for their research. (KinectHacks, 2012)

2. Literature Review
2.1. Virtual Reality

Virtual Reality (VR) can be defined to be a computer generated environment that can utilize visual, auditory (touch and force) channels for communication between a user and a computer. Interactive walkthrough virtual environments have gained more attention in commercial as well as academic applications recently. (Ghada M.Fathy ,2011). Through this system the user gets the experience of being surrounded or immersed in a virtual environment. An algorithm has been implemented to create an indoor virtual walkthrough environment with non-fixed viewing point. Though there is still room for improvements, our method can provide a realistic environment on the web for ordinary users with minimal sacrifice in image quality and execution speed. (Tze-kin LAO, 2000)The desirable overall target system is one where all those involved from clients to designers would have a good understanding of the model object at any time, and without trouble. (Randa T. Abu Snaineh, 2011). We have developed an Augmented Reality (AR) application that allows the audience to interact and talk with a virtual character through a large screen called augmented mirror. (Eduardo Souza Santos, 2011).To achieve the illusion of the integration between the real and synthetic objects, the generated objects must remain aligned with the 3D position and orientation of the real objects. (Luigi Gallo, 2011).

The benefits of using wide-area tracking equipment in which users can explore a virtual environment in a natural manner come from recent advances in wide area position and orientation tracking technology that now enable us to track a user's movement through spaces that are larger than the 1.5-3 meter diameter

spaces normally tracked by electromagnetic tracking devices (Figure 2). A distributed virtual reality system allows remote users to share and to view a common virtual environment via connected networks. (Addison Chan, 2001).

In order to improve the rendering efficiency, these new resampled points are clustered by their 3D coordinates and normal vectors. At the same time, the sampling rate comparison algorithm. (Yanci Zhang, 2002).

Fig 2: electromagnetic tracking devices

Teller took the concept further and found an analytic solution to the portal-to portal visibility problem based on linear programming techniques. (Pedro Pries, 2001). The performance of our algorithm is affected by some implementation factors such as network bandwidth, walkthrough speed and the size of the viewcell. (Zhi Zheng, 2003). The creation of modelling and rendering systems capable to provide photorealistic & interactive walkthroughs of complex, real-world environments. (Nikos Komodakis, 2002). The frame rate is now limited by the speed of polygon culling techniques and software lighting. Further eliminating polygons seems to have no more effect on improving the frame rate.

Increased performance is achieved at the expense of some image quality. In general, a greater number of textures, together with properly configured portal parameters and the use of morphing, will improve the image quality. It presents a new reconstruction technique that suits for environment walkthroughs. Approach is effective when applied to real imagery. (Steven M. Seitz, 1998). We have introduced textured virtual walls which enable us to take advantage of the combination of two paradigms: texture-based simplification and cell-to-cell visibility. First results show significant frame rate speedups with little or no loss in image quality.

We have presented a system for interactive rendering of architectural walkthroughs that uses image-based techniques to increase performance while maintaining high quality and smooth motion. Conceptually, the simplest approach to combining such models into a virtual world would be to convert all data into a single walkthrough model format and to use one set of tools to navigate it. It is preferable to use these models as they were designed, with their abstractions and machinery in place. (Richard Bukowski, 2001). To acquire higher resolution images and nearly full

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panorama projections, a multiple camera configuration is an alternative. Similar to a light-field camera, the current authors are developing a multisensory camera for capturing all directional rays from one position at the same time. (Dong Hoon Lee, 2003). The basic idea underlying our approach is that the shape of a 3D object can be captured by a curvature map of its surface. (J̈urgen Assfalg, 2003). We have proposed a new method of interactive walk-through which takes the omnidirectional images at discrete positions and enables us to look around at arbitrary viewpoints. (Kaname Tomite, 2002).

We accelerate architectural walkthroughs by replacing 3D geometry seen through doors and windows with images. (Daniel G. Aliaga, 1998). Benefits for visualizing of construction projects during design and actual construction. Virtual walkthroughs can allow participants to perform design/construction review tasks collaboratively, while locally present, or remotely connected. A hands-free navigation system to be integrated into virtual environments. "Joyfoot" consists of some acceleration sensors attached to the human leg for detecting motion (Figure 3). The sensors are connected with some rubber bands directly below the knee. (Salvador Barrera, 2004).

Fig 3: Joyfoot

The 3D visibility complex is another way of describing and studying the visibility of 3D space by a dual space of 3D lines in which all the visibility events and their adjacencies are described (Daniel Cohen-Or, 2003). We proposed an efficient approach for rendering of high quality walkthrough animation sequences. Our contribution is in developing a fully automatic, perception-based guidance of in-between frame computation which minimizes the number of pixels computed using costly ray tracing and seamlessly replaces them by pixels derived using inexpensive IBR techniques (Karol Myszkowski, 2000). Most 3D cell-visibility computation techniques are simply impractical for large models. We exploit the significant hardware rendering speeds available on the graphics cards using an effective, yet practical algorithm. The performance of the rendering algorithm is directly dependent on the size of the vLODs and this size can be reduced significantly by performing more

aggressive occlusion culling and increasing the occluder set. (Jatin Chhugani, 2005).

2.2. REAL TIME

For the interaction we designed two use cases: One is a "tour guide" mode, in which a pre-defined camera path leads through the virtual scene. The other one is a "free walk" mode, where the user can change the viewing position by using touch gestures, and adjust the viewing orientation by changing the relative position of his face to the front-facing camera. (Ming Li, 2011). The vision system includes four modules: Initialization, Feature Detection, Feature Tracking and 3D Point and Reconstruction. (Sheng Yong Chen, 2011). An improved motion tracking algorithm is utilized to achieve real-time tracking and self-correction. (Hua Xiong, 2011). There is a trade-off between realism and real-time and also between visual quality and rendering performance. Increasing realism will slower the processing speed. (M.S.Sunar, 2006).

A Kindest device was used as a hardware setup for simultaneous real-time acquisition of colour images and correspondent range data. (Alexey Abramov, 2011). Real-time human-like avatar behaviour in virtual environments improves the realism of virtual reality (VR) worlds. Avatars that can do rich human-like activities and movements in real-time make virtual environments more interesting. (Enhua Wu, 2002). Real-time rendering is achieved by using the latest hardware functionality. (D. Porquet, 2004). In this context we have developed an Augmented Reality (AR) application that allows the audience to interact and talk with a virtual character through a large screen called augmented mirror. The avatar movements are controlled by an actor in real-time using a Motion Capture (MoCap) system. MoCap devices are also used to control the interaction between the user and the virtual objects. (Lucía Vera, 2011).We have presented a novel algorithm for continuous collision detection between a moving avatar and the virtual environment. Given discrete positions of the avatar, it uses an arbitrary in-between motion to compute an interpolated path between the instances. (Stephane Redon, 2004).

A frameless rendering algorithm is incorporated to ensure smooth motion regardless of rendering performance. DVS is an object-oriented design that implements the basic functionality needed for real-time distributed rendering. (Jeffrey Mahovsky, 2003).

2.3. MOTION DETECTION

The method we propose in this paper mainly allows the users for controlling the applications without using keyboards and mouse devices. The users can view pictures, read e-books, and do presentations via the proposed unified Two-Handed Gesture Interaction

method. (Jiaqing Lin, 2011). Donikian et al. proposed a modelling system which is able to produce a multi-level data-base of virtual urban environments devoted to driving simulations.Ali et al. used a multi-agent geo-simulation approach to simulate customers' behaviours in shopping malls.(Bernard Moulin,2010). According to Calle et al. [2], HCI research has been targeting users who are not used to interacting with computers. According to Moeslund et al. [14], functional taxonomy for human body motion has four major parts processes. The processes are initialization, tracking, pose estimation and recognition. (Mohd Kufaisal, 2011). Within virtual worlds, a user can move through the environment altering their view of the world and the components they can interact with. (Norman Murray, 2011).

Many fingertips detection methods are based on hand Segmentation techniques because it decreases pixel area which is going to process by the algorithm by selecting only areas of interest. (Kunal Singal, 2011). Instead of using a model which can be created by Kinect it is better to fit a predefined 3D model of human to the size of the user's body. With the increasing technological capabilities, the field of 3D avatar usage will be unlimited. (Kairat Aitpayev, 2005). Voronoi diagram is a geometrical structure and one of the most important research topics in discrete computing geometry. Viewer can control its avatar to move or rotate in the 3D scene with keyboard or mouse. (Lu Wang, 2006).

The performance with these methods can also be very much impaired if the 3D face includes elements like hair, ears, and neck. Region-based approaches promise much higher effectiveness in that, at least in principle; they can apply different processing to distinct face regions and therefore filter out those regions that are mostly affected by expression changes or spurious elements. Nevertheless, they are also sensitive to face alignment and useful face regions are hard to detect automatically. Their performance depends on local features and differences in resolution (Stefano Berretti, 2010).

2.4. USER INTERFACE & PLATFORM

The SDK includes Windows 7 compatible PC drivers for Kinect device. It provides Kinect capabilities to developers to build applications with C++, C#, or Visual Basic by using Microsoft Visual Studio 2010. The subjective user feedback for the user interface with planning is positive in general. Some of the users may find the viewpoint hard to control in the beginning (Especially for those who like to play games with keyboards) but all of them can get used to the control very soon. (Tsai-Yen Li). For instance, subjects tend to underestimate egocentric distances visual speeds and travelled distances during walking in IVEs. The limited field-of-view (FoV) and various side-effects of

uncomfortable VR equipment may have an impact on this perception phenomenon (Gerd Bruder, 2009).

Such an interface allows users, by using both kinetographic and metaphoric hand and arm gestures, to execute basic tasks such as image selection, zooming, translating, rotating and pointing, and complex tasks such as the manual selection and extraction of a region-of-interest (ROI) (Luigi Gallo). It is expected that this will allow the estimation of the motion field direction to reach the levels of existing techniques making use of several views, while further increasing the accuracy of the magnitude estimate (Simon Hadfield Richard, 2011). Vanishing points method improved the accuracy of the obtained data, and was applicable to the video sequence by increasing the number of frames of images used to detect the lines (Ichiro Yuyama, 2007). Navigation is an important aspect of interaction with a Virtual Environment (VE). Users of VEs need to understand the space that surrounds them and find their way around (Luca Chittaro, 2005).

As part of remembering a person and trying to recognize a new skeleton, the system captures a series of frames to procure more of the possible variations, usually when the conditions are suitable or, better still, optimal, for recognition. (Tommer Leyvand, 2011). The Kinect sensor captures depth and colour images simultaneously at a frame rate of up to 30 fps. The Kinect sensor consists of an infrared laser emitter, an infrared camera and an RGB camera (Kourosh Khoshelham, 2012).To scan a full human shape, Kinect should be put around 3 meters away from the body, and the resolution is very low. Kinect is compact, low-price, and as easy to use as a video camera, which can be acquired by general users (Jing Tong, 2012).

3. RESEARCH METHODOLOGY

3.1. OBJECTIVES OF THE RESEARCH

The purpose of the project is to improve and enhance communication between the user and the 3D virtual walkthrough using kinect Xbox to detect the motion of the user's body and used as navigation. The following are the objectives of the research:

a. To study suitable methods (techniques) for interaction in virtual 3D walkthrough.
b. To design and develop the motion based real time virtual 3D walkthrough
c. To test and evaluate the MoDet Walk using simple-usability testing.

3.2. DEVELOPMENT METHODOLOGY

Many researches are done to use different forms of methods to provide interactivity with the 3D virtual

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walkthrough application. This project development methodology is based on Motion Detection Real time application that supports the motion sensing. However, Software Development Life Cycle method will be implemented on the development of this application. Figure 4 shows the Software Development Life Cycle method which comprises of 5 different stages namely requirement specification, analysis, system architecture and design, implementation, system integration and testing and lastly maintenance.
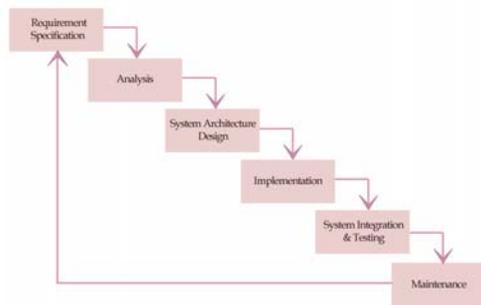

Fig 4: Software Development Life Cycle Methodology

3.3. PROPOSED TECHNIQUES

The SDK provides a sophisticated software library and tools to help developers use the rich form of Kinect-based natural input, which senses and reacts to real-world events. The Kinect and the software library interact with your application, as shown below (Figure 5).
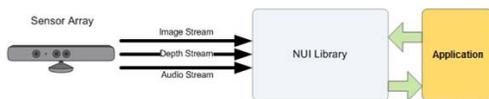

Fig 5: Design model

The components of the SDK include (Figure 6):
a. Kinect hardware - The hardware components, including the Kinect and the USB hub through which the sensor is connected to the computer.
b. Kinect drivers - The Windows drivers for the Kinect, which are installed as part of the SDK setup process as described in this document. The Kinect drivers support:
   • The Kinect microphone array as a kernel-mode audio device that you can access through the standard audio APIs in Windows.
   • Audio and video streaming controls for streaming audio and video (color, depth and skeleton).
   • Device enumeration functions that enable an application to use more than one Kinect.
c. Audio and Video Components
   • Kinect Natural User Interface for Skeleton Tracking, Audio, Color and Depth Imaging

d. DirectX Media Object (DMO) for microphone array beam-forming and audio source localization.
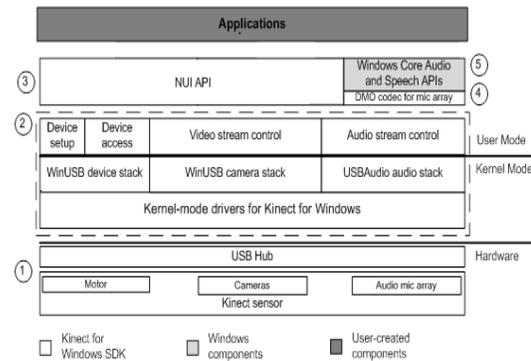e. Windows 7 standard APIs - The audio, speech, and media APIs in Windows 7, as described in the Windows 7 SDK and the

Fig 6: SDK Architecture (Kinect for windows Architecture, 2012)

4. RESEARCH SCOPE

The scope of the research covers the design and development of MoDet-Walk based on the Kinect SDK domain of libraries. The study involves the Walkthrough of LImkokwing University of Creative Technology and Kinect Xbox. The system will be developed using the vision based tracking techniques and user interface augmented reality techniques such as the Tangible User Interface (TUI) using mouse and keyboard and the Natural user Interface (NUI) using own fingers. Thus this development concerns how the movements are detected through the Kinect Xbox and communicate with the environment of the Virtual Walkthrough video.

5. PROTOTYPE

The avatar is created like the human body shape. Now, with Avatar Kinect, you can control your avatar's facial expression, head, and arm movements. As you talk, frown, smile, or scowl, your voice and facial expressions are enacted by your avatar, bringing your avatar to life. Figure 7, Figure 8 and Figure 9 shows the avatar created using the detection of the real body in reality.

Fig 7: avatar created using the detection of the real body in reality

Fig 8: avatar created using the detection of the real body in reality

Fig 9: avatar created using the detection of the real body in reality

These are the prototype that shows how kinects works with the 3D walkthrough environment. When the motion of the human body is detected the human can navigate themselves into the 3D walkthrough environment using their body movement. For example in the figure 8.0, the motion of the human body is integrated with the 3D virtual walkthrough which enables the avatar to walk inside the walkthrough.

Fig 8: motion of the human body is integrated with the 3D virtual

Whereby figure 9 shows that the hand movement of right and left are using the hand gestures. So, by using the motion sense in kinect when the use moves his right-hand so the avatar turns right. This kinect xbox is particularly controlled by our motion itself.Besi

Fig 9: hand movement

6. Discussion and Future work

In future we can also work on adding a feature that will allow finger gestures to be translated to feel the virtual walkthrough environment by touching the surrounding. And depth image data for the input while in the tracking. The latest technology about Kinect has been mention in this paper. Use of Kinect not only narrow on Xbox 360 console only but can be used at our own computer. Nowadays, natural interactions becoming more interesting area and have a bright future to bring our world to the biggest steps in an interaction with virtual environment. Improvement in human body motion needs to be done from time to time because it can be apply in other area of knowledge. Potential application from this research will come out with the alternatives motion capture. This motion capture will pledge to be a low-cost motion capture and can be used in many ways such as surveillance and 3D animation.

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7. CONCLUSION

This paper aims to provide an application that uses gestures to interact with virtual objects in an Augmented Reality application. The usage of kinect Xbox technology is gradually growing and is dynamically changing a lot of things happening around the world. Moreover this MoDet-Walk is an effective and more efficient way for people to learn. It allows the users to attempt to use human movement to navigate in the 3D virtual walkthrough. There are also several other interesting extensions, such as adding extra functionality to how the system controls. We are currently working on further improvements by integrating enriched movement representations using kinect Xbox aimed at assisting the interactions with the virtual walkthrough. We should conduct an experiment for quantitatively evaluating the effectiveness of the proposed method and the prototype application. We also would like to continuously improve the operational environment as a truly natural interaction environment in the future. Providing a way for using the gesture-based interactions to manage operations in a virtual walkthrough environment is a promising approach.

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