4th International Conference on Advances in Mechanical Engineering
ICAME 2015, 26-27 August 2015, Patra Jasa Bali, Indonesia

Representing Human Movement and Behaviour in Virtual Environment Using Gaming Software

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Keywords: Human movement, Virtual environment, Gaming software, DarkBASIC, AUNT-SUE

Abstract. Gaming software, DarkBASIC Professional (DBPro) is widely used for the games application. In this research, the software is applied as a tool to simulate human movement and behaviour in crowded areas within virtual environment. Emphasize is to accommodate the largest possible range of humans with diverse abilities as part of AUNT-SUE (Accessibility and Users Needs in Transport – Sustainable Urban Environment) project. In this paper, the method applied to represent humans in virtual environment using DBPro will be discussed.

Introduction

DarkBASIC Professional (DBPro) is gaming software that was developed based on the BASIC computing language. The language has been enhanced specifically to aid the creation of games programs [1] and contains none of the complexity of other commonly used computer languages for commercial games such as Microsoft Visual and C++ [2]. The language has many unique commands for displaying graphics, controlling images and creating 2D and 3D images. Programs can be developed for low development costs [3] while all games created using the language are license and royalty free.

Figure 1: Example of virtual environment [4]

DBPro software is widely used for the games application. However, as it is able to simulate a graphical scene in 2D and 3D design, the software is also used in other applications. For example, [4] applied DBPro for criminology research as shown in Figure 1. The research was developed under Crime Prevention Through Environmental Design (CPTED), a multidisciplinary research that determined criminal behaviour using environmental design. The objective was to reduce the occurrence and fear of crime whilst improving quality of life.

DBPro was also used by [3] to develop a survey tool that collect the travelling behaviour data and monitor behaviour adaptation. The developed tool was based on the virtual reality role-playing game known as Travel Activity Constraint Adaptation Simulation (TACA SIM). The objective was to investigate the adaptability of human travelling behaviour under the simulated scenario of rapid fuel price increases.

In this research, DBPro is used to develop a simulation tool of individual human movement and behaviour in crowded areas. As its origin from AUNT-SUE (Accessibility and Users Needs in Transport – Sustainable Urban Environment) project this research has an emphasis on gaining knowledge of some of the human movement and behaviour characteristics in the real world that can be modelled in the virtual environment. In this paper, the method and process involved to represent the humans (software design and modellng) in virtual environment will be discussed. Selected case study from the simulation is also presented.

Software Design and Modelling

The software design and modelling for this research is based on the understanding of human movement and behaviour in crowded areas taken from the real world video observation analysis in [5]. The method in [5] is enhanced and applied as the software design model as shown in Figure 2. The software design starts with the focus subject which is the individual human entity in crowd. In this research two types of entities were selected including the adult and older people. Each entities consist of several parameters that differentiate the entities characteristics.

Figure 2: Software design model

The parameters of entities in virtual environment is actually the factors affecting human movement and behaviour observed from the real world. Six parameters were defined and details discussion is conducted in the next session. After the parameters for each entities are established, different types of movement are designed including the free, same and opposite direction. The movement of the entities in the virtual environment is analysed and compared with the movement in the real world in order to understand the similarities and differences. The advantages and limitations of the software are considered during the design process. Based on the sofware analysis, selected case studies are designed to validate the software. In this research, the selected case studies include the multi-mode transportation system, bottleneck and non-bottleneck layout of a building.

Design of Parameters

The factors affecting human movement and behaviour in the real world are considered as the parameters for each entity in the virtual environment. The parameters play important roles in developing different types of simulation that utilise different movement scenarios in the real world. However, some modification has been made in order to represent the parameters in the virtual environment. Table 1 describe the representation of the parameters from the real world in the virtual environment which contain the command or programming source code applied for each entity.

The personal objectives refers to selected movement from this research such as free, same and opposite directions. Two commands were used to represent the movement; *Position Object* and *AI Entity Go to Position*. The visual perception refers to the view arc and view range that applied for the virtual entities. In DBPro the value of the view arc is in the range of 1 to 360 degrees. Figure 3 shows an overview of visual perception in DBPro. The speed of movement refers to the movement speed of the entitiy in DarkBASIC units per second. Different entity was designed with different

speed of movement based and detail discussion is conducted in the next section. Personal space as shown in Figure 3 refers to the space available around the entities.

Table 1: Individual parameters in virtual environment [6]

No.	Parameters	Representation in Virtual Environment (*Coding*)
1.	Personal Objectives	*Position Object* *AI Entity Go to Position*
2.	Visual Perception	*AI Set Entity View Arc* *AI Set Entity View Range*
3.	Speed of Movement	*AI Set Entity Speed*
4.	Personal Space	*AI Set Radius*
5.	Crowd Density	Based on number of humans over floor size
6.	Avoidance Angle or Distance	Based on DarkAI from the software

Crowd density refers to the total number of entities within the floor area. In this research, the floor area is designed recognizing that the maximum number of entities in order to ensure viable simulation is limited to 90. The size of floor area was designed to be 600 unit pixels × 600 unit pixels (30 m × 30 m). Lastly, the avoidance angle or distance refers to the situation where the entities in virtual entities avoid each other during the movement. The avoidance angle or distance used the uncontrollable command from the software that based on the artificial intelligent. However, the command is also affected by the Personal Space and Visual Perception parameters.

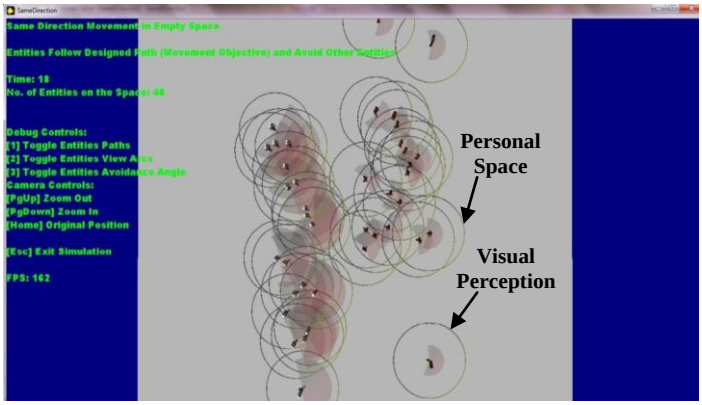

Figure 3: Personal Space and Visual Perception parameter in virtual environment [6]

Design of Entities

Two subjects, an adult and an older people are selected as the entities for virtual environment simulation. Both entities are designed with the three dimensional (3D) design based on the work of [7] to provide more realism for the simulation. Table 2 shows the entity source codes for the simulation. Based on [7], 1 unit pixel (DarkBASIC unit) is equal to 5 cm in the real world. Therefore, within the source code the speed of movement for adult entity is set to be 24 unit pixels of 1.2 m/s. The view arc is set between 160 to 210 degrees with the view range of 40 unit pixels or 2 meters. The adult entity is also design with blue colour based on DarkBASIC RGB (Red, Green and Blue) colour spectrum.

On the other hand, the older entity as shown in Figure 4 is set to have 16 unit pixels per second or 0.8 m/s speed of movement. The view arc is set between 140 to 190 degrees with the view range

of 20 unit pixels or 1 meter. Lastly, the older entity is designed with red colour based on the DarkBASIC RGB colour spectrum. The selection of the speed, view arc and range was based on the work of [8], [9] and assumption of the author.

Table 2: Adult and Older entity source codes in virtual environment [6]

Adult Entity	Older Entity
AI Set Entity Speed I, ***24***	*AI Set Entity Speed I,* ***16***
AI Set Entity View Arc I, ***160, 210***	*AI Set Entity View Arc I,* ***140, 190***
AI Set Entity View Range I, ***40***	*AI Set Entity View Range I,* ***20***
*Color Object I, RGB (****0, 0, 255****)*	*Color Object I, RGB (****255, 0, 0****)*

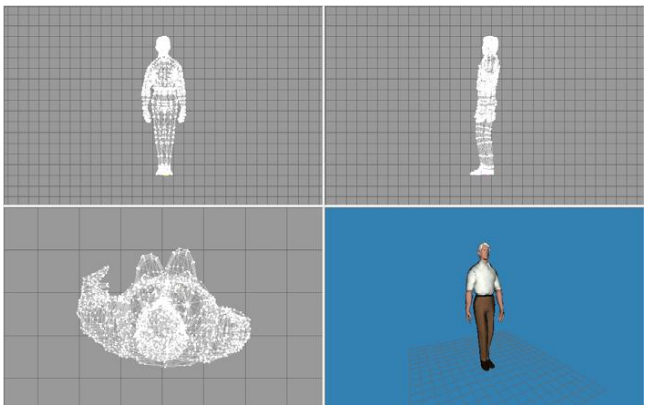

Figure 4: Older entity in 3D design (Wai Loon 2011)

Example of Case Studies and Discussions

Figure 5 shows an example of multi-mode transportation system case study conducted for this research. The figure in left show the real world situation at the Stesen Sentral Kuala Lumpur where humans with different activities can be observed. Different factors may affect the human movement and behaviour. Based on the understanding of human movement and behaviour conducted in [5], the simulation is conducted to understand the affect of layout design and obstacles to humans as shown in Figure 5 (right).

The simulation layout consist of ticket machine, stall, big screen etc. similar to the real world. The human entities were designed moving in opposite direction from two different start points. Several simulation were conducted in order to validate the software including the different crowd density movement, changes in visual perception and personal space, ratio of adult and older people within the crowd etc.

Figure 5: The Stesen Sentral (left) and the simulation in virtual environment (right)

The main objective of lower level validation was to confirm that the modelling of the individual movements and behaviours in the virtual environment have some kind of agreement with the real world. The software validation provides information on the advantages and limitations of the simulation copared to the real world. It includes an understanding of the similarities and differences of the virtual entity movement based on the selection of different parameters compared to humans the in real world.

Conclusions and Future Works

This paper shows the application of gaming software, DarkBASIC Professional as a tool to simulate human movement and behaviour in the virtual environment. The virtual humans were developed based on the understanding of human movement and behaviour from the real world observation analysis. The factors affecting human movement and behaviour in the real world were used as the parameters for two types of virtual entities; the adult and older people. This research shows that the gaming software is capable to simulate the human movement and behaviour in crowded areas. As for the future works, real world experiment is expected to be conducted to evaluate the effectiveness of the simulation.

Acknowledgement

The authors would like to Universiti Malaysia Sarawak (UNIMAS) and Loughborough University for providing good facilities for this research.

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