

Human Movement Representation in Virtual Environment Using Gaming Software

SHAHROL Mohamaddan^{1,a}, SYED TARMIZI Syed Shazali^{1,b}, ANA SAKURA Zainal Abidin^{1,c} and KEITH Case^{2,d}

¹Department of Mechanical and Manufacturing, Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS), 94300 Kota Samarahan, Sarawak, Malaysia

²Mechanical and Manufacturing Engineering, Loughborough University, Leicestershire, LE11 3TU, United Kingdom

^amshahrol@feng.unimas.my, ^bstarmizi@feng.unimas.my, ^czaasakura@feng.unimas.my
^dK.Case@lboro.ac.uk

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 was applied as a tool to simulate human movement and behaviour 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. Two subjects (adult and older people) were selected as the virtual entities. The virtual entities were modelled based on humans movement and behaviour in the real world. Low level validation and example of case study was presented in this paper.

Introduction

DarkBASIC Professional (DBPro) is a 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, the software is also used in other applications as it is able to simulate a graphical scene in 2D and 3D design. 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, the methods applied to represent humans as the object within DBPro will be discussed. 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 or ‘translated’ into the virtual environment.

Methods

Human Movement Motion Detection

The motion detection system using periodic background estimation subtraction method was conducted to measure the human speed of movement [5]. The speed of movement is important input or parameter in developing the virtual humans. Two subjects, an adult and older people was selected for this research. Blobs as shown in Figure 2 were created for each motion objects taken from video camera using MATLAB software. The images were converted into binary by autothreshold and enhanced using dilation and erosion. Lastly, the images were luminance normalize before background subtraction to acquire the speed of movement. Based on the analysis, an adult human walking at 1.2m/s while the older people at 0.8m/s.

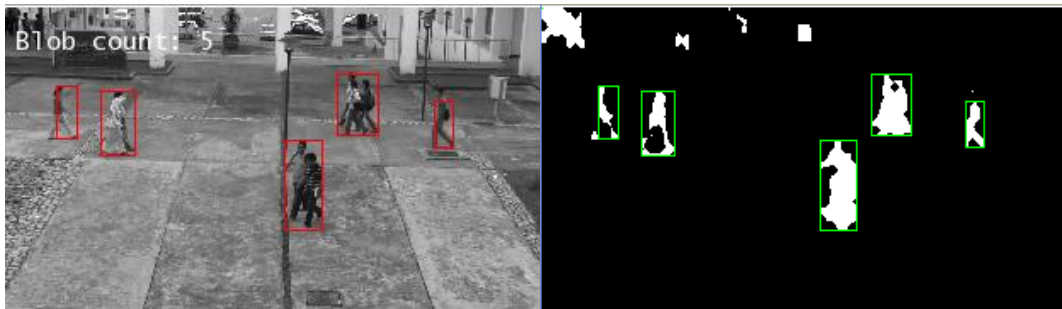


Figure 2: Blobs for output and binary images [6]

Video Observation and Behaviour Rules

Besides human speed of movement, there is a need to understand the human movement and behaviour in the real world. The movement and behaviour is another important parameters that need to be considered before represent the humans into the virtual environment. Observational study was conducted in [7] where an exit door at multi-mode transportation area was selected as the observation area. Video camera was used to record the movement and conceptual behaviour was developed to detail up the human movement and behaviour. The step involve is shown in Figure 3.



Figure 3: Video observational analysis

Based on the study conducted in [7] and [8], it is concluded that six factors affecting humans movement and behaviour including the personal objectives, visual perception, speed of movement, personal space, crowd density and avoidance angle or distance. The six factors were then applied in the DBPro coding to design and model the software.

DBPro Coding: Software Design and Modelling

Since human movement in the real world is considered complex and unpredictable, there is a need to simplify or modify the movement. 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. The parameters were coded accordingly as shown in Table 1.

Table 1: Individual parameters in virtual environment [8]

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

The personal objectives refers to selected movement for 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 4 shows an overview of visual perception in DBPro. The speed of movement refers to the movement speed of the entity in DarkBASIC units per second. Different entity was designed with different speed of movement. Personal space as shown in Figure 4 refers to the space available around the entities.

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 \times 600 unit pixels (30 m \times 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.

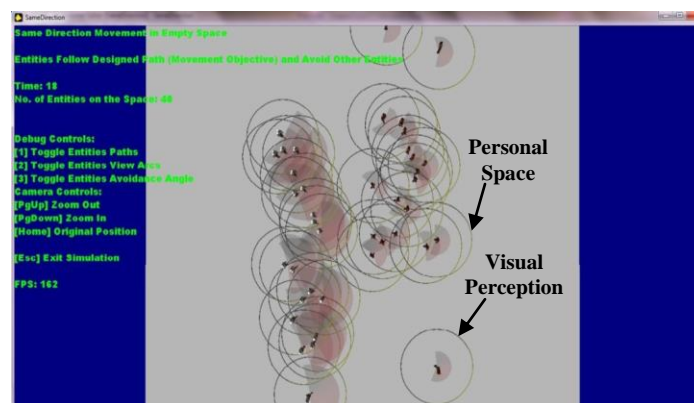


Figure 4: Personal Space and Visual Perception parameter in virtual environment [8]

DBPro Coding: Virtual Entities Design

Two subjects, an adult and 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 [6] to provide more realism for the simulation. Table 2 shows the entity source codes for the simulation. Based on [6], 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 or 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 5 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 [5], [9], [10] and assumption of the author.

Table 2: Adult and Older entity source codes in virtual environment [8]

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

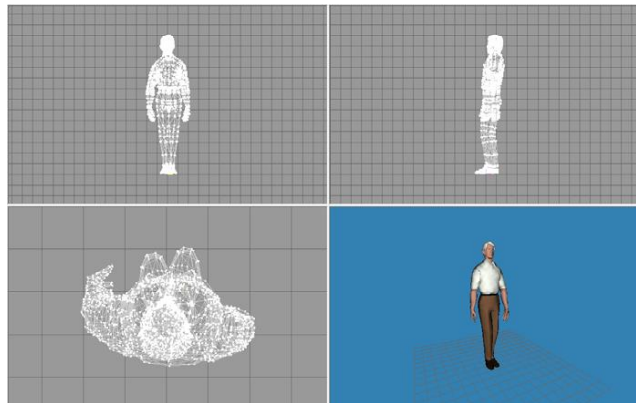


Figure 5: Older entity in 3D design [6]

Simulation Results and Discussions

Based on the proposed method, the human movement simulation was conducted in Figure 6 and 7. Figure 6 shows the lower level validation where the objective 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 compared 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 the humans in real world. For example, in Figure 6 (right) it is show that human move with different movement due to different crowd density. The first virtual human in the crowd moving in average of 1.05m/s to arrive at the end point while the last virtual human (30th) moving in around 0.5m/s.

Figure 7 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. Based on lower level validation, the simulation is conducted to understand the affect of layout design and obstacles to humans as shown in Figure 7 (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. Detail discussion on the affect of different layout to humans etc. is not discussed in this paper since the focus only on how to apply the gaming software to represent human movement in virtual environment.

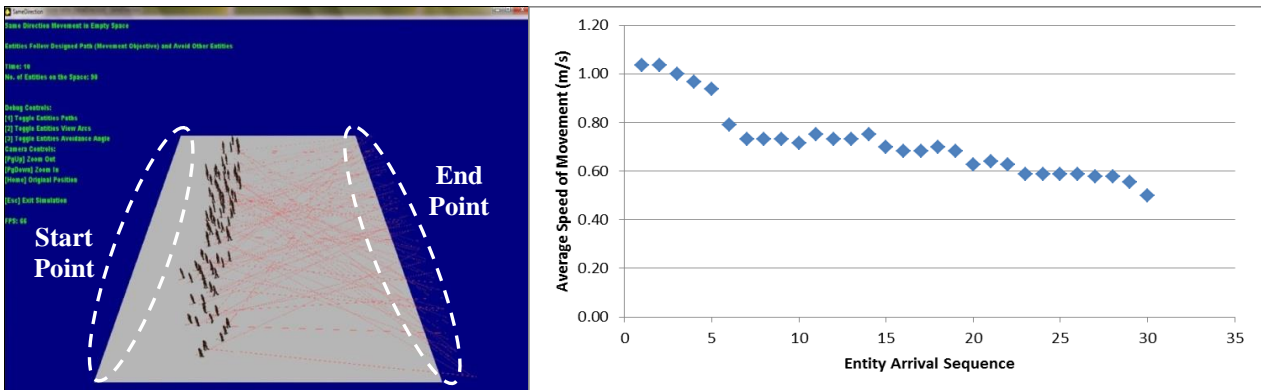


Figure 6: Lower level validation – Simulation (left) and Movement result (right)



Figure 7: The Stesen Sentral (left) and the simulation in virtual environment (right)

Conclusions

This paper discussed the method applied to represent human movement in the real world into the virtual environment using gaming software, DBPro. Motion detection method was applied to acquire the human speed of movement in the real world. Besides, video observation and behaviour rules were developed to understand human movement and behaviour in the real world. The important part of this paper is on how to model the movement and behaviour in the real world using DBPro coding. Since DBPro is a gaming software, the coding need to be developed carefully in order to reflect the research objective. Lower level validation need to be conducted in order to analyse the software. Different types of case studies can be performed using the software and multi-mode transportation system is one of the example from the real world situation at Stesen Sentral, Kuala Lumpur.

References

- [1] A. Stewart, Hands On DarkBASIC Pro – Volume 1, 8th edition, Digital Skills, UK, 2009.
- [2] S.T. Syed Shazali, Human Behavior Modelling through Human Intelligent Software, Doctoral Thesis, UK, 2010.
- [3] M. Watcharasukarn, S. Krumdieck, R. Green and A. Dantas, Researching Travel Behavior and Adaptability: Using a Virtual Reality Role-Playing Game, Simulation & Gaming, Vol. 42, No. 1, 100-117 (2011).

- [4] A. Park and T. Calvert, A Social Agent Pedestrian Model, Computer Animation and Virtual World, Vol. 19, No. 3-4, 331-340 (2008)
- [5] S.T. Syed Shazali, W.L. Cheong, S. Mohamaddan, A.M.N. Abg Kamaruddin, A. Yassin and K. Case, International Conference on Information Technology in Asia, 1-4 (2011)
- [6] W.L. Cheong, Motion Detection and Simulation Study On Human Walking Behaviour, Master Thesis, UNIMAS, 2011
- [7] S. Mohamaddan and K. Case, Towards Understanding of Human Behaviour in Crowded Spaces Using Video Observation Analysis, International Conference on Manufacturing Research (2012)
- [8] S. Mohamaddan, Human Movement and Behaviour Simulation Using Gaming Software, Doctoral Thesis, UK, 2013
- [9] Information on <http://www.artinarch.com/vp05.html>
- [10] K. Teknomo, Microscopic Pedestrian Flow Characteristics: Development of An Image Processing Data Collection and Simulation Model, Doctoral Thesis, Tohoku University, 2002