# Spatial Information of Game for Body Interface Using Webcam

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***Abstract***: In this paper, we propose an efficient game spatial division and analysis algorithm that gives special information for collision avoidance of game objects and natural interface. We divide into 9 parts of game space and part 4, 5, 6 are divided into 2 more detail parts for check the enemy position and movement information of gamer. And we calculate optimal path for collide avoidance of the enemy. To evaluate the method, we implemented a motion based game that consists of a webcam, a player, an enemy, and we obtained some valid results of our method for the collision avoidance and interesting interactions. The results demonstrated that the proposed approach is robust. If movement information is in front of enemy, then the enemy waits or turns back and finds the place and runs to avoid attack. This algorithm can be used basic development of effective body interface and level control for motion based game.

***Keywords***: game spatial division, collision avoidance, optimal path, motion based game

## I. INTRODUCTION

Game is highly-concentrated on culture & informati on technology in the digital entertainment industry and is to lead the 21st century in the field of cult ural contents industry. Currently, the game industry is undergoing rapid growth, helped by the ever-dev eloping computer and internet technology. The gam e industry is showing infinite potentials as the new growth engine for the economy and employment ge nerator because of the internet-driven individualized cultural atmosphere and computer-focused entertain ment trend. In particular, motion-based games and t echnology-integrated games, which use various gam e technologies and computer vision techniques, are emerging as the new trend[1-7]. Motion-based game is the kind of game in which the gamer gets engro ssed in the game with maximized sense of reality t hrough interaction and it has been designed to trac k the changes in the gamer's responses. It is not li ke other games in which only eyes and hands are used to do the game. In the motion-based game, o n the other hand, the user fully expresses the gestu res of the characters in the game with his or her o wn body[2-7]. Most of the games developed for P C use are designed to use only limited array of ha rdware, such as keyboard, mouse and joystick, whi ch puts limits on the space used and also lessens t he sense of reality. Developing motion-based games, is not simple since it requires hardware developme nt as well as software, unlike in the case of conve ntional PC games. Motion-based games consist of a rcade-motion games in a big game room, consol-m otion game using game-controller with motion featu res and PC motion-based games[3]. PC motion-bas ed games lag behind consol or arcade games in ga me reality or other effects because of less-develope d game graphics or feedback systems. But the adva ntages of PC motion-based games are wide availabi lity and relatively cheap game production cost[1-4]. Therefore, this paper seeks to suggest effective coll ision avoidance in an effort to develop sensory fun ctional game for entertaining exercise. To realize th e algorithm, virtual space division method is used t o suggest and verify the collision avoidance metho dology. For this purpose, the sensory functional ga me(first-person action game) which is composed of web camera, gamer and enemy character, has been made and proposed algorithm undergoes the verifica tion process through experiments.

## II. Motion-based Game

Fig. 1. is the diagram of the motion based serious game (first-person action game) in which the gamer can gain scores as well as getting the benefit of working out,

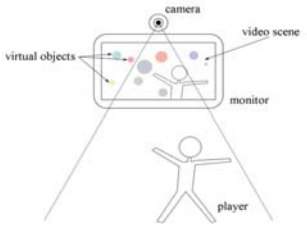



Fig. 1. Configuration of motion based game

by attacking the virtual object appearing on the monitor according to the game scenario. The enemy character, which is the virtual object is VH:Virtual Horse[8]. The game space has been designed to make the visual zone wide enough and to bring the workout effect for the gamer through the use of hands, arms, head, torso and so on. The movement information has been used as the attacking data so the collision led to scoring, through which the levels of difficulty and actions could be controlled.

### 1. Game collision event

In this paper, the most commonly used "quadrangle collision" has been used to detect the collision.

### 1.1 Quadrangle collision

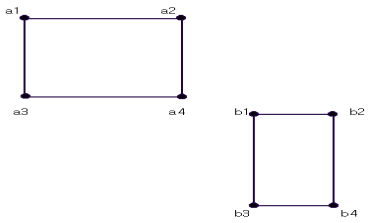



Fig. 2. Collision detection using quadrangle

Quadrangle has four feature points(Fig.2) and each has x and y coordinates. So the values of each coordinate can be used to identify the collision of quadrangles. For example, if we say the a4 coordinate is (x4,y4) and b1 coordinate is (x1',y1') the collision has not happened if the condition satisfies either (x1'>x4 || y1'> y4) or (x1>x4' || y1 > y4') when the a1 coordinate is (x1,y1) and the b4 coordinate is (x4',y4').

## III . COLLISION AVOIDANCE

Color and action information enables the cognition of the necessary parts in the game space. But in games in which real-time interface is required, calculation for cognition can lower the speed of frame rate and therefore hamper the real-time interaction. To increase the movements of the gamer and to be able to use the movements information of shoulder and torso(as well as skin areas on the hands and the face) for attack data, this paper extracts the information for actions by using the visual information frame by frame and tries to analyze the action information and game space to realize the collision avoidance by sensing the action information and by controlling the movements of the virtual object.

### 1. Proposed algorithm

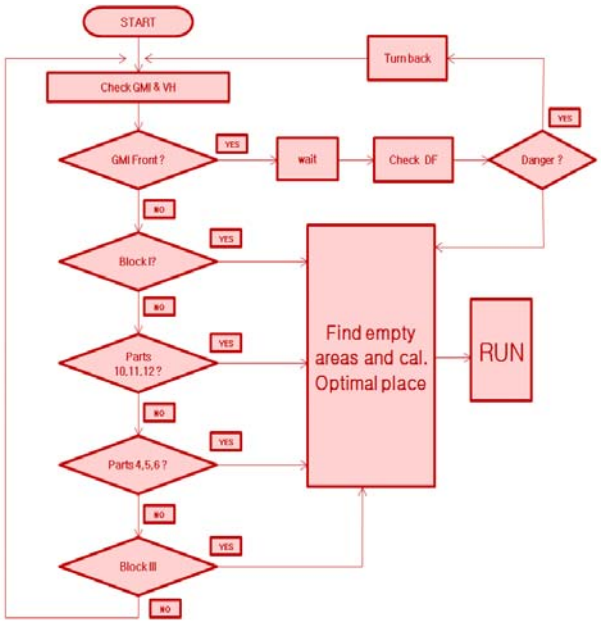



Fig. 3. Flowchart of the proposed algorithm

First of all, the space information for the game has been segmented from area 1 to area 12. Information for each area has been acquired after dissecting the areas, into 1-3(Block I), 4-7(Block II including 10, 11,12), and 7-9(Block III). After the analysis of the gamer's movement information in each area, it is compared with the current positional information of the enemy for the calculation of the optimal position course in the four directions where the enemy character could move. Block I is the uppermost area which only the

hands of the gamer can touch and therefore highly secure. In Block II, we can get information on hands, arms and the head. Block III gives the information on body, hands and arms. So we have to consider it when generating the path for collision avoidance. For example, in Block I, area 1 has the longest gamer's movement path than area 1 or area 3 and it is relatively advantageous if the movement goes to area 1 when the gamer's movements are in 5,6,8,9 in the area 4. When VH is in area 1 and the movement information is in area 3,5,6, and 8, VH does the standing leaps to calculate the optimal path. If the area 3 or the area 5 is empty, the next movement is calculated after movement to the area 3 and 5. In this way, area information is identified and analyzed to realize the effective collision avoidance. (Refer to Fig. 3.) Fig. 3 shows the finding optimal path algorithm for collision avoidance of VH.

**2. Division of the game space**

(a) spatial division (b) position of hand

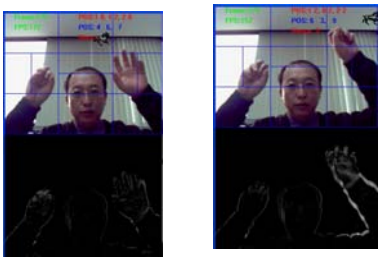
Fig. 4. Game spatial division

The area 4, 5, and 6(Block II) have the most hand movements and especially the area 5 has the most head movement information. Areas 4, 5, 6 are divided into 2 more detail areas 10, 11, 12 for check the enemy position and movement information of gamer. Area 7, 8 and 9(Block III) can have torso and hand movements at the same time. Area 1, 2 and 3(Block I) are where only hands can go and could be classified as the area of less movement information.

## V. Experiment

Various game situations between the enemy character(VH, horse) and the gamer have been experimented by using the proposed algorithm. The upper visual of the gamer visual in the experiment is color and the lower visual is gray and the resulting visual has been applied the threshold value in the case of specific movement. Since the time gap from frame to frame is different from game to game, the division has been applied such as t1 frame, t2 frame and etc

**1. Experiment 1**

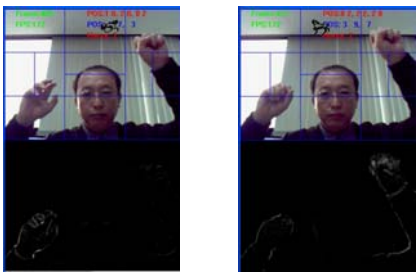


(a)t1 framae image (b)t2 frame image

Fig. 5. Image of Experiment I

VH is moving in the area 2 and the movement information is in area 10, 12, and 7. But the movement information in the next frame suddenly changes to area 3.(Fig. 5.(a)) VH waits in its position to identify the movement information because its current movement and the gamer's hand movement are in the same area. In the next frame VH identifies the movement information in which the gamer's left hand moves to area 3 and accelerates to move to area 3.(Fig. 5.(b)) In Experiment 1, VH effectively avoids collision with the gamer's hand by using the proposed algorithm When the movement information exists in the front part of the same direction, VH can do the standing jumps in its position while keeping getting the movement information, thus realizing more pleasurable and effective collision avoidance.

**2. Experiment II**



(a)t1 frame image (b)t2 frame image

Fig. 6. Image of Experiment II

VH is moving in the area 2 and the movement information is in area 10, 12, 7 and 9(Fig. 6.(a)). But the movement information changes getting upwards to area 3 in the next frame(Fig. 6.(b)). VH waits in its

position to identify the movement information like experiment I because its current movement and the gamer's hand movement is getting dangerous. In the next frame VH identifies the movement information in which the gamer's left hand moves to area 3 and turns back to area 1. In Experiment II, VH has no room to avoid collision with the gamer's hand and turns back to safe area 1 by using the proposed algorithm. When the movement information exists continuously in the front part of the same direction, VH can do the standing jumps or turning back in its position, thus realizing effective collision avoidance and natural interaction.

## VI. CONCLUSION

Motion-based games are different from conventiona l games in that the gamer can enjoy the game with whole body instead of with mere hands and eyes and they are getting established as the new trend in the field.

To produce the motion based serious game, the paper divides and analyzes the movement are of the gamer, extracts the movement information through visual information of each frame and suggests the algorithm which can control the effective movement paths for the virtual object which is the enemy character. For verification, the motion based serious game(first-person action game) has been made and experiments have been done by changing the movement information which includes the current position of the VH and the gamer position. The experiments have verified the validity of the proposed algorithm. Especially, when the movement information and the movement information of the VH are in the same direction, the VH can do the standing jumps while keeping getting the movement information to find the next path or turning back, realizing interesting interactions with the gamer. In addition, through rapid raising and horizontal acceleration of the VH, the gamer has been induced to move more. The proposed algorithm could be used as the basic materials for producing the motion base serious games using webcam.

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