Gesture-based Interactive Shooting Game Using Kalman Filter

Ye-Jin LEE[1], Hong-Jun Ju[1], Hyun-Mi O3[2] , Tae-Yong Kim*, [1]

[1] *Graduate School of Advanced Science and Multimedia Chung-Ang University / Seoul, Korea*
[2] *Undergraduate school of Integrative Engineering Chung-Ang University / Seoul, Korea*
*Corresponding Author (author@affilation.com)

Abstract: In this study, we developed a user movement-based shooting game that can be operated easily using a simple object instead of a complicated game controller. This new system of shooting game is suggested to show higher user involvement with lower pressure on body posture. We first detect object from the real-time input video to set an object as the controller. Then the object with designated color values is converted into HSV color space for masking. This is to exclude cases with similar color detection from the background. Then, morphological operations are performed on the processed image to correct noise due to external interferences. Afterwards, the detected object is fabricated as the user's controller in gaming screen. The Kalman filter was used to keep track of this object or controller. Using the user`s real-time movement as the main operating tool of the game, the suggested game shows an increase in user engagement.

1. Introduction

Many years of research and study on the relationship of interactivity and enjoyment of video game players has shown that an increase in user involvement results in greater user enjoyment. Most existing first person shooter (FPS) games, which employ controllers such as mice, keyboards, or joysticks, restrict user involvement; therefore, this type of games can give only a limited amount of game enjoyment or satisfaction to the players. Moreover, the users have to sit up in a fixed posture for a long period time to play these games, which can cause serious gaming injuries like sore shoulders, sore thumbs, and even back pains [1].

Recent researches replaced existing non-deformable controllers with players' gestures or other sensory information for user interaction in video games to increase user involvement. The results of the researches show that gesture-based games do not disturb the player`s engagement, but rather increase player`s engagement during the game [2]. In addition, the information obtained from multiple sensory sources can be used to add a sense of reality while players execute their duty. This further increases the users' motivation and engagement [3].

In this study, we propose a game system to increase user immersion in FPS games using real-time player movement for shooting control. We first improve the aforementioned limited gaming environment by replacing rigid and multifunctional controllers with more intuitive and simple

objects. We then detect and track the object from input images using the object's color information. We used the Kalman filter for rotational and blocking problems that occur while tracking the moving objects in real-time.

2. Object Detection and Tracking System

The flow chart of the proposed method for object detection and tracking is displayed in Fig. 1.
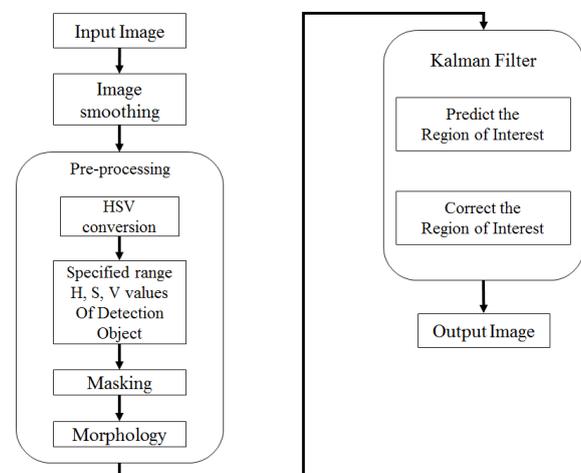
Fig 1. Flow chart of the proposed method

First, the image-smoothing process is performed to remove possible noise from the input image. After this, pre-processing is performed to detect the object that is

used instead of the controller. In order to detect the object, basic color information is used as the feature. However, in case of the red-green-blue (RGB) color space, a similar color detected in the background of input image significantly lowers the precision rate of object detection. Hence, we use hue, saturation, and value (HSV) color space for color object masking because it reflects the human perception of color better [4]. Using HSV, the range of hue, saturation, and value of the object to be detected are set as features. Then all the other parts except those with colors in predefined ranges are filtered through a mask to increase the accuracy of detection. Specifically, the parts for the masked image with internal shadow or external interference undergo revision by morphological operations [5]. After these four steps of pre-processing, the Kalman filter is used to track the detected object [6]. The resulting output image after the Kalman filtering process is then displayed in the game screen as an object that the player can control.

The fundamental purpose of Kalman filter is to enhance the imprecise values that contain some errors through filtering operations. One of the advantages of using the Kalman filter is that it is possible to predict the next location of object being tracked by analyzing the location information in the previous frames. This is possible because the location of the object in the current frame is determined by the previous frame. Therefore, problems of failure in tracking due to occlusion or rapidness of the object can be mitigated by using the Kalman filter. Nevertheless, if the object being tracked is occluded by another for a long period, or if a sudden reorientation occurs during tracking, it may result in serious deviation from the expected path.

3. Gesture Interaction based FPS Game

A stage in the shooting game is cleared when the player or the shooter attacks and exterminates the opponents. This characteristic of a shooting game requires player's agility and instantaneous decision. Nonetheless, the simple controls of shooting games attract not only young adolescents but also middle-aged and elderly people to the game.
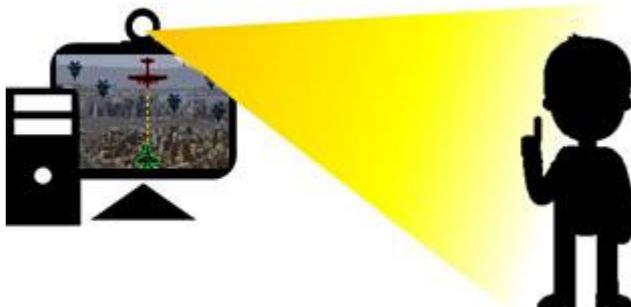
Fig 2. Operating the game

The gesture interaction based shooting game is designed using the method proposed in section 2.

The experiment progresses through a fixed camera located indoors. Frames per second of experiment is 24fps. The experimental result is shown in Figure 3.
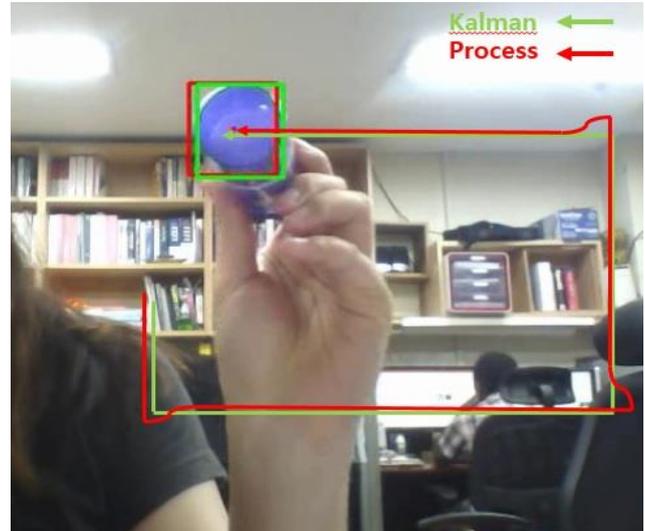
Fig 3. Experimental result

As explained previously, the object is detected if an object with predefined ranges of HSV values appears on the screen. When masking is done in HSV, the detected object is revised by using morphological image processing. Then, a revised version of the detected object is used as the player's controller in game display. The image of the controller in game display is shown in **Figure 4.**

Fig 4. Image of controller in Game display

The Kalman filter is used to track the detected object. The object being tracked on the game screen simply follows the direction of the object in the user's hand. In other words, if the user moves the object to the right, the controller on the screen moves to the right as well. While the user is actively moving the controller, various weapons that can be used to attack opponents are poured out on the game screen. The background image of the game is set to an aerial view of downtown. In the game, players are

assigned a mission to save the city and preserve peace by battling invaders. During the battle, users will face two types of invaders: general opponents or the leader of the invading army. This leader of opponents can cause serious damages to the user. In each stage, the invaders will continuously appear for some time in the game. Higher stages are designed to present greater number of opponents to defeat at higher speed. As the user is attacked by the opponents, the background color of the game will gradually change. In addition to this, the speed of the user's controller will decrease by a certain amount every time the user is attacked.

4. Conclusion

In this study, we developed a new FPS game based on gesture interaction to increase user involvement and satisfaction from past FPS games. An object with predefined ranges of HSV is used as a controller, and the object needs to be recognized at a certain distance away from the sensor. Using a simple object as the controller of the shooting game, the suggested game shows increase in user engagement. Moreover, this user movement based game can significantly decrease the discomfort caused by fixed gaming postures.

Acknowledgement

References

[1] Lui, Donald PY, Grace PY Szeto, and Alice YM Jones, "The pattern of electronic game use and related bodily discomfort in Hong Kong primary school children," *Computers & Education,* 57.2 pp. 1665-1674, September 2011.

[2] Lindley, S. E., Le Couteur, J., & Berthouze, N. L. "Stirring up experience through movement in game play: effects on engagement and social behavior," *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2008, pp.511-514.

[3] Keith V, Nesbitt and I. Hoskens. "Multi-sensory game interface improves player satisfaction but not performance." *Proceedings of the ninth conference on Australasian user interface-Volume 76*. Australian Computer Society, Inc., 2008, pp.13-18.

[4] Gao, H. B., & Wan, Q. Y. "Blue white license plate location method based on openCV." *Information, Computer and Application Engineering: Proceedings of the International Conference on Information Technology and Computer Application Engineering (ITCAE 2014), Hong Kong, China, 10-11 December 2014*. CRC Press, 2015.pp.396-397.

[5] R. C. Gonzalez and R. E. Woods, "Digital image processing." *Nueva Jersey* (2008), pp.652-661.

[6] Kalman, R.E. "A new approach to linear filtering and prediction problems." *Journal of basic Engineering* 82.1 (1960): pp.35-45.

Biographies

YeJin Lee is an M.S. student at Chung-Ang University Graduate School of Advanced Imaging Science and Multimedia. She received B.S. degree from Kimpo University in 2015; she is a Game Technology and Application (GTA) Lab student; interested in Pedestrian Detection and Tracking

HongJun Ju is an M.S. student at Chung-Ang University Graduate School of Advanced Imaging Science and Multimedia. He is a Game Technology and Application (GTA) Lab student. In 2014, he received a B.S. degree from Seoul Hoseo Occupational Training College; he is interested in face recognition.

HyunMi Oh is an undergraduate student at the school of Integrative Engineering Chung-Ang University.

Taeyong Kim is a Professor at GSAIM Chung-Ang University in Seoul, Korea since 2003. He runs the GTA Lab. From 1988-1999, he was an engineer at Korea Telecom. He received a Ph.D. from Pohang University of Science & Technology and is interested in digital imaging and game