The Application of Circular Collision Detection and Target Tracking to Improve the Collision Accuracy in 2D Games

Jungyoon Kim[1], Jiyong Ge[2], Zhixiao Wang[2] and Wonhyung Lee[2,*]

[1]Graduate School of Game, Gachon University, 1342 Seongnam Daero, Sujeong-Gu, Seongnam-Si, Gyeonggi-Do, South Korea.
[2]Graduate School of Advanced Imaging Science, Multimedia and Film, Chung-Ang University, 84 Heukseok-ro, Heukseok-dong, Dongjak-gu, Seoul, South Korea.
*Corresponding author

Abstract—**Interaction design, as the language between game and player, plays an important role in the whole game design. This paper introduces a 2D flying shooting game which is a combination of Arduino integrated circuit equipment and Processing programming software, and players can control the game by the PS2 joystick or computer keyboard. The application of circular collision detection technology and target tracking algorithm greatly improves the collision accuracy.**

Keywords—collision accuracy; circular collision detection; target tracking

I. INTRODUCTION

At present, playing video games is a popular way for people to reduce the pressure of their lives. And there are two categories of game products in current market: software game and hardware game. However, game development in the future must be a combination of hardware and software. The interactivity of modern game design will determine the fate of the game.

In addition, how to detect collision is a technical problem that most competitive games need solving. To solve the problem, a variety of algorithms and techniques have been developed to improve the accuracy and efficiency of collision detection in related research fields.

This paper presents a 2D shooting game based on hardware and software development platform. Two techniques are employed in the game: circular collision detection and target tracking. Compared with the rectangular collision detection and pixel collision detection method, circular collision detection is easy to find a balance between speed and accuracy. The target tracking algorithm gives boss monster sprites the function of tracking the master sprite in the game.

II. RELATED WORKS

Shooting game is a very popular game type and is also a kind of action game [1]. There are many ways to realize shooting game, such as FPS shooting game based on Unity3D, 2D shooting game based on iOS, flight shooting game based on Android. Moreover, there are many popular development languages in game development, including C/C++ language, C# language, Java language, assembler language and so on [2].

In this paper, the proposed shooting game uses software platform and hardware platform for serial communication. The hardware platform is composed of Arduino UNO integrated circuit board and PS2 joystick module, and the software platform mainly uses the Processing (programming language) which is based on the Java programming language.

III. THE RESEARCH RELATED TO ARDUINO PROGRAMMING

Arduino is an open source electronic prototype platform with resource expansion and artistic experience. It mainly includes Arduino board and Arduino IDE software programming platform [3]. The Arduino platform, developed by a European development team in the winter of 2005, has the features of simplicity, rapid development. In addition, it can drive motors, LEDs, sensors and other components. Therefore, the Arduino microcontroller is often used as an open source programmable tool to create interactive work [4]. As shown in Fig. 1, The Monet painting in the canvas accepts the photosensitive resistance of the Arduino controller, and the stronger the light is detected, the brighter the oil painting will be. On the contrary, the darker it becomes. This is a classic example of Arduino programming.
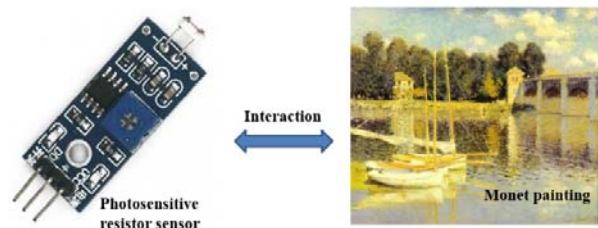

FIGURE I. THE TRANSFORMATION OF LIGHT IN MONET'S OIL PAINTING

Arduino is often used as a microcontroller in game development. This game uses Arduino board and PS2 joystick module to make a game microcontroller as Fig. 2.
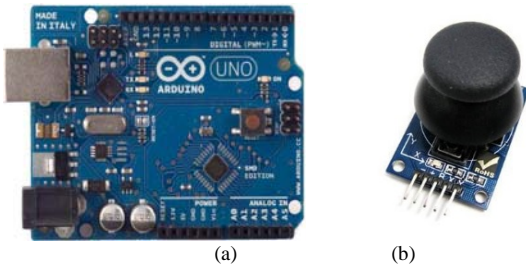
FIGURE II. (A) ARDUINO CIRCUIT BOARD (B) PS2 JOYSTICK MODULE

The Arduino hardware module connects to the computer through the USB data line, and it can realize and communicate with the Arduino IDE software platform. In the game, players can choose to use joystick or keyboard to control the direction of movement of the master sprite. The master sprite represents the role of the player in this game.

IV. APPLYING PROCESSING IN GAME DESIGN

Processing is an interactive graphical programming language used in the electronic art, media art and visual interaction design [5]. Compared with some other high-level languages, Processing is more specialized and easier to use. At present, although Processing has not been widely used in large-scale game development, with superior image processing and modeling capabilities, it can create exquisite game characters and improve the comfort of the game screen. This makes it have great potential in the field of game development.
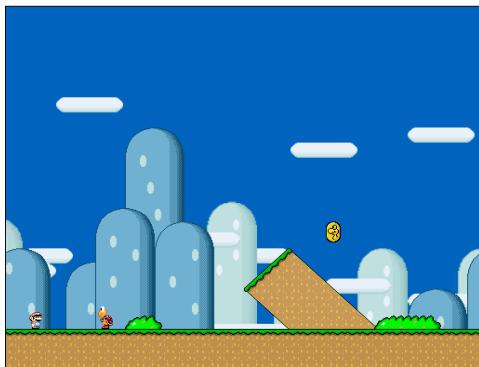

FIGURE III. MARIO GAME

It can design many interactive games through using Processing. As follows, Fig. 3 is a Mario game. The flight shooting game designed in this paper uses Processing to load the master sprite and a variety of different monster sprite models, design the corresponding game scene, add the appropriate background sound, and simulate the impact explosion effect.

Arduino programming and Processing programming can be well applied into video games. The following content will analyze how to improve the game interaction through the platform of Arduino and Processing.

V. OBJECT COLLISION AND DETECTION METHOD

Collision detection is a question that needs to be solved in many fields, including robot motion, animation simulation, computational geometry, virtual reality games [6]. Collision detection typically refers to the computational problem of detecting the intersection of two or more objects [7]. The traditional collision detection algorithm, which is the most basic collision detection algorithm, needs to traverse all the basic set elements. Therefore, the disadvantage is the low-efficiency of the operation.

The effect of video game must conform to the physical laws of the world. Therefore, collision detection is an unavoidable problem in game creation. This paper focuses on the collision detection problem in 2D games. There are many kinds of collision detection methods in the 2D games, such as rectangular detection, circular detection, pixel detection and so on.

The collision detection of general rules can be processed into rectangular collision. The principle is to determine whether the two rectangular regions overlap [8]. And the diagrammatic sketch is illustrated in Fig. 4. If the side rectangle intersects with the center, it will be considered as a collision.
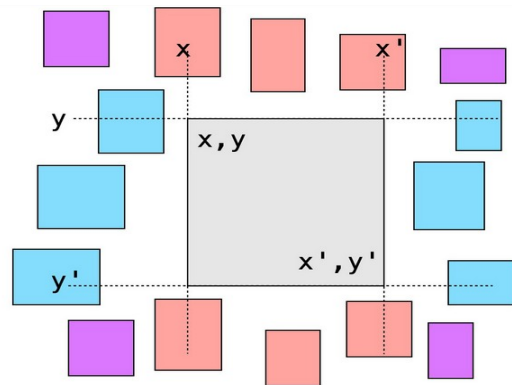

FIGURE IV. RECTANGULAR COLLISION DETECTION

Rectangular collision detection algorithm is a rough collision detection method, which is not suitable for collision detection among irregular objects. Compared with rectangular collision detection, choosing circular collision detection is much better. Its detection principle is to determine whether the distance between two circle's centers is greater than the sum of two different radii [9], as shown in Fig. 5.
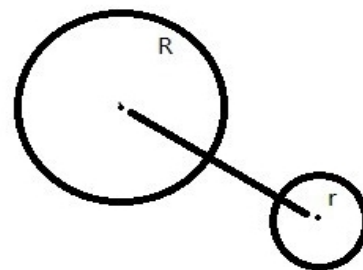

FIGURE V. CIRCULAR COLLISION DETECTION

Pixel detection is one of the most accurate detection methods. The test method is to check and compare each pixel of the two graphs. Although the precision of pixel collision detection is high, the operation efficiency is very low. As the range and type of each algorithm are different, it is necessary to choose the appropriate collision detection algorithm. After testing and analysis, the circular collision detection is the most suitable algorithm for 2D games.

VI. THE APPLICATION OF CIRCULAR COLLISION DETECTION AND TARGET TRACKING IN GAME DESIGN

Compared with other algorithms, the circular collision detection algorithm is simple to calculate. In addition, it not only ensures the detection accuracy, but also improves the detection speed. The result is shown in Fig. 6.
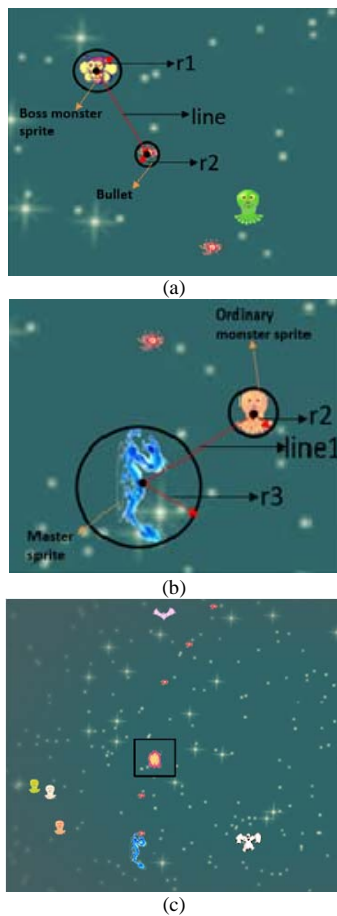

(a)

(b)

(c)

FIGURE VI. CIRCULAR COLLISION DETECTION: (A) MONSTER SPRITE AND BULLET (B) MONSTER SPRITE AND MASTER SPRITE (C) COLLISION EXPLOSION

From the Fig. 6 (a), an explosion can't be seen when the sum of radius r1 and radius r2 is less than the line which is the distance between monster sprite and bullet. Otherwise, the players can see that. Fig. 6(b) is similar with Fig. 6(a). Fig. 6(c) is the explosion effect during the collision.

Moreover, the target tracking algorithm is also used in this game. When the boss monster sprite appears, it will judge the coordinate of the master sprite firstly, and then move close to it until boss monster sprite was destroyed or collision happened. The tracking demo has been shown in Fig.7.
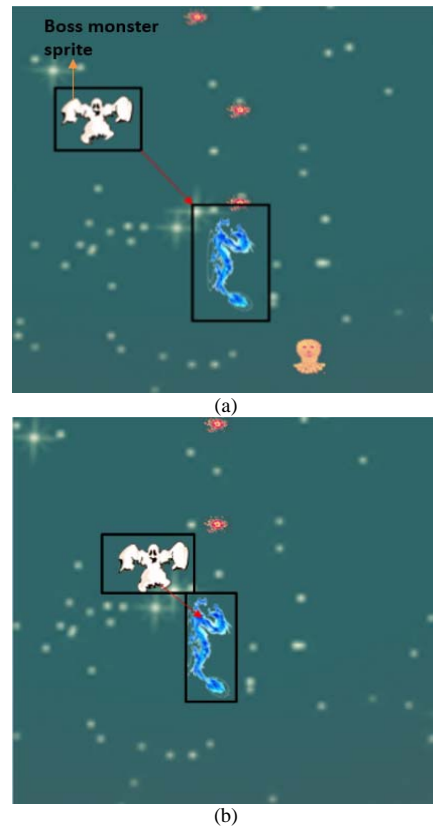

(a)

(b)

FIGURE VII. TARGET TRACKING

Moving object detection and tracking is a process that combines the image pattern recognition and image tracking method to detect the target in the image sequence, and it is a hot topic in the field of computer vision. It mainly involves digital image processing, statistics, cognitive science, computer science and many other fields [10]. Therefore, it has a strong theoretical and practical value. This technology is fully applied to the game design in this paper.

VII. SUMMARY

This paper proposes a method to realize 2D flying shooting game based on the Arduino hardware platform and Processing software platform. Through the serial port, the game fully integrates the electronic technology, SCM technology and graphics programming technology.

Meanwhile, the application of circular collision detection and object tracking algorithm enriches the game plot and enhances the collision accuracy. Furthermore, the game player can interact with the game to enjoy the fun and ease the pressure.

REFERENCES

[1] Information on https://en.wikipedia.org/wiki/Shooter_game/

[2] Information on https://en.wikipedia.org/wiki/Game_programming

[3] Yusuf Abdullahi Badamasi, The working principle of an Arduino, IEEE, 11th International Conference on Electronics, Computer and Computation, 2014.

[4] A. M. Gibb, NEW MEDIA ART, DESIGN, AND THE ARDUINO MICROCONTROLLER: A MALLEABLE TOOL, Master's thesis, Pratt Institute, Feb.2010, pp. 1-6.

[5] Information on https://en.wikipedia.org/wiki/Processing (programming language)/

[6] R. Boulic, A. Luciani, Collision detection algorithm, a handbook of terms, Enactive Systems Books, 2007, pp. 44-45.

[7] Information on https://en.wikipedia.org/wiki/Collision_detection/

[8] Information on http://compsci.ca/v3/viewtopic.php?t=13661

[9] Kaiqiang Guo, Jiewu Xia, An Improved Algorithm of Collision Detection in 2D Grapple Games, Third International Symposium on Intelligent Information Technology and Security Informatics, 2010, pp. 328-331.

[10] Xiao-Feng Tong, Han-Qing Lu, Qing-Shan Liu, An effective and fast soccer ball detection and tracking method, Proceedings of the 17th International Conference on Pattern Recognition, 2004. ICPR 2004.