Game Refinement Theory and its Application to Fighting Game and Action Game

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Abstract

Human cannot live without game in social life nowadays. We reached a level that video games have excitement about its potential, and now a lot of researchers and related workers are going for larger studies to actually make a game more entertaining and exciting. In addition a game as Ninth Art has its own special humanistic value. With such backgrounds game informatics has been established as a new research area in the old of information science and computer science. This thesis will focuses on the game refinement theory applications and its real world impact.

Game refinement idea is an unique theory that has been proposed based on the uncertainty of a games outcome. Game refinement measure was derived from the game information progress model and has been applied in the traditional board games and sports games. Video games started as simple blocks of light, but now they have heralded revolution of entertainment. The era of video games has arrived. Video games has accompanied the grown up of entire generation and plays an increasingly important role in the world of games. The challenge prevalent is the application of the theory in the domain of numerous video games, especially the popular electronic video games, such as fighting games and action games.

This research emphasizes on fighting games and action games and short abstractions and introductions are been made in the part related to fighting games. Meanwhile, distinguished fighting games are enumerated. This research picked up 10 games which are remarkable and have been well received among players. Data has been analyzed by game refinement theory shows incredible results. In some parts of action games, we have picked up the action game series which are well-known internationally, the series of God of War. Via collecting data, moreover, analysis and calculate data with game refinement theory. The third part of this research is about shooting games. Game classifying became more and more obscure today so many action games, even fighting games have contained factors of shooting. To facilitate researches from now on, this research also made some exploitation of programs about data analysis of one shooting game on antiquated FAMICOM.

In conclusion, the target of this research is to make contribution to apply the game refinement theory in these new areas and support the effectiveness of game refinement theory. Game refinement theory will make more remarkable contributions to game evaluating and game design in future.

Keyword: Game refinement theory, Fighting game, Action game, Game design, Mathematical model of game.

Chapter 1

Introduction

We, human-being cannot live without games. Two preeminent Greek philosophers once gave definitions for games. One of them, Plato, expressed that games are simulate activities generated from production and progression of ability of whole juvenility including animals and human-being. While the other, Aristotle explained games as one of relax and recreation activity after production without any destination. When it comes to modern society, definition which people give to games also has changed. Games are above material satisfaction in specifically limited time and space, following some special rules and pursue inspirit satisfaction as a way of social behavior activity [5].

The history of games can dated back to 5500 years ago. In the tomb of the famous juvenile pharaoh, Tutankhamun, archaeologists discovered SENET as one of the burial objects and it is the oldest chess game that had ever been discovered. For all of us know, the four most popular chess games are the game of go, chess, Chinese chess and Japanese chess. And about Chinese chess and Japanese chess, we can find something in common between them. For instance, the knight (horse) all move following shape of L. These four classic chess games all got a fabulous and long history. The game of go has a very significant status in the history of chess games. It is not only the oldest game we could ever been conscious of, but in the progression of long history, the game of go remains basically game rules which fundamentally havent changed a lot. The Chinese chess generated about 2300 B.C, propagated to Korea in the 2nd century and accessing trade routine, Chinese chess spread to Japan in around 700.

Until today, games cannot limited in chess games or card games [6]. Actually, the word game is a concept which is very wide, including movements of human-beings structure, movement of brain and modern electrical video games. All human activities including competition factors can be seen as game, even business activities, political combat and reality wars. According to the stats, process and form of games information, we can divide games into four tapes. Each game area has its corresponding math research model. In this dissertation, my research mainly emphases on electrical video games. Game informatics is a new research area of information science and computer science [2]. Players who love games of all around the world all have experience of playing video games with game consoles or host computers. And we can say that because of the procession of technology, integrate circuit are not exclusive any more. It popularize to every single family while

the progression of video games have a quick improvement. Till today, electrical video games have ordinarily became a byword of games [6]. Let me give you an example, one of your friend tells you that he is playing games, there is a high probability that the first reflection in our brain when we hear the word game is he is playing electrical video games. As this situation shows, electrical video games have an important influence on our life, even that it have an important influence on the definition of games. In consequent of this, we need to pay more attention to this whole new research branch. We picked up two genre of electronic video games in this dissertation, the first one of them is fighting game, while the other is action game. These two genre of games generated in early time and to electronic games, they have longer history.

In this research, most of methods and ideas are based on the game refinement theory, which is created by Professor Hiroyuki Iida. Game refinement theory is an especial theory that has be supported by a proposed based on the uncertainty of game outcome [1]. A game refinement measure was derived from the game information progress model and had been applied in the traditional board games. We can make sense that game refinement theory is a significant appraising standard and with this theory plays an important role in each different game area. We can use this theory to analysis different genre of games, without analysis chess games or card games only.

Basic on results given by doctors in Iida lab [2] [3], with the method using game refinement theory, remarkable achievements on analysis or apply for board game area have been made, also in sports game area even video game area. Nevertheless, speaking of video game, contrast to numerous results we have already made on fighting game or action game, we have not made such successes like them. Therefore, this research will put these two games types to major research object, using game refinement theory to analysis and debate, so that we are able to make some conclusion of these two popular hot game types, fighting game and action game, so that meanwhile we are able to make improvement of game refinement theory.

Otherwise, the third part of this research is about shooter game. Battle city is an eminent game on earlier FAMICOM [27]. Many of prevail action games on these days including shooting factors (for example, Uncharted series). We have to admit that as the progress and improvement of electric technology, boarder of electronic video games become to an obscure status. A lot of action games contain some shooting factor, while sometimes, just like we can make sense, fighting games are assorted to action games as well. In this additional research, by a program wrote via java, we can do some statistics such as the sum of hits by our tanks in each round of game and some other figures in a clear way, furthermore, we can use this mathematical mode of game refinement theory to analysis this game distinctly.

Chapter 2

Analysis of Fighting Games using Game Refinement Theory

2.1 Chapter Introduction

In this chapter we introduced classic Game Refinement Theory in initial part and some achievement reached by this theory. The classical game theory based on the idea of the existence of mixed strategy equilibria in two-person zero-sum games [3].

After that, a detailed abstract of game refinement theory circumstantiated by professor Iida will be given. the primary introduction related to Game Refinement model in board game [23]. And the reason we talk about this first is model in board game is the foundation of Game Refinement Theory. What we will introduce afterwards is Game Refinement Model. We are exert the model Continuous Movement Game in this research due to the mainly part of this research, fighting games and action games.

We are analyzing fighting game by exertion of game refinement theory and its applications to fighting game. We will enumerate a few fighting games that are global popular and have generalized the history of these fighting games. We have individuated 20 of these remarkable fighting games considered to be representational. We collected data via some impressive videos of famous games, then we analysis these data by Game Refinement Theory. Finally we are able to make some achievements and conclusions, whats more, we can do some discussions related to this research.

2.2 Classic Game Theory

The classical game theory based on the idea of the existence of mixed strategy equilibria in two-person zero-sum games. This has been popularized as a efficient tool in many fields, just like economics, political science, psychology, logic and biology. As far as concerned, game theory is a charming thing. So much games, like chess or card, and video games. What is more, here still be a wide area economic games, discussed by Myerson (1991) [12] and Kreps (1990) [11], and related political games, Ordeshook (1986) [13], Shubik (1982) [14] and Taylor (1995) [15]. The competition between two objects, contradict between staff

of management and physical labor, fighting to gain rights through legislation of council. And the judiciary power or wars, ceasefire agreed by government, peace, they had provided instances for games to improve. There are also psychological games played on personnel level, where the weapons are words, and the payoffs are good or bad feelings, Berne (1964) [16]. There are biological games, the competition between species where nature selection can be modeled as a game played between genes, Smith (1982) [14]. There is a connection between game theory and the mathematical areas of logic and computer science. One may view theoretical statistics as a two person game in which nature takes the role of one of the players, as discussed in Blackwell and Girshick (1954) [17] and Ferguson (1968) [18].

In general game progress, typically includes several players; one game played by only one player usually called as decision problem. The formal definition lays out the players, their preferences, their information, the strategic actions available to them, and how these factors influences the outcome. Games can be described formally at various levels of detail [19]. A cooperative game is a high degree description, specifying only what payoffs in each potential group, or union that can be obtained by members cooperation. The thing which is not being unequivocal is the process by unionization. For instance, players can be various distinct parties in senate. Each party has different degree of power, basic on number of seats they occupied in council. The game expresses which party can form a majority, but does not delineate, for example, the negotiation process through which an agreement to vote en bloc is achieved [19].

Cooperative game theory investigates coalition games in distinguished perspective related to amounts of power given by various players and achievements coalition should divide its proceeds. It is the most appropriate way applied to cases arouse in political science or international relationships, in which area that power is the most significant factor. For instance, Nash proposed a solution for division of gains from agreement in a bargaining problem which depends solely on the relative strengths of the two parties bargaining position [20]. The amount of power in one side has its determination by usually inefficient outcome when negotiations break down. Nashs model fits within the cooperative framework in that it does not delineate a specific timeline of offers and counteroffers, but rather focuses solely on the outcome of the bargaining process [21]. By the contrast, non-cooperative game theory is relative to analyze strategic selects. The paradigm of non-cooperative theory is the details of ordering and timing of players choices are crucial factors to decide the consequence of one game. On the other side, the non-cooperate model, of reducing would insert one special process in which it is prespecified to make an offer at one certain time. The item non-cooperate means that this game subgenre theory explicitly model shows process of the choice made by players based on their interest.

Cooperation can, and often does, arise in non-cooperative models of games, when players find it in their own most interests [19] [20].

Branches of game theory are different in their assumptions too. A central assumption in variety games theory is because of the rational of players. A rational player is who usually chooses an action which gives the consequence he would most like to see, give the results what he wants and what his opponent most like to be. The goal of game-theoretic

analysis in these branches, and moreover is to predict how the game will be played by rational players, or, relatedly, to give suggests on how to play the game best against opponents who are rational [22].

2.3 Game Refinement Theory

In former dissertation, we have introduced the concept of game theory. Nevertheless, game theory can only give an answer to the solution of winning games, which is a mathematical method put point on the players side. But in the game designers position, how to develop a totally new game theory became a problem. In order to solve this problem, Iida et al. [23] proposed game refinement theory in 2003.

Game theory and game refinement theory have always been a significant factor in the history of development of games played by computers and all general games. Speaking of these two theories, are there any differences between them and theories applying in society or social life may be two interesting part. Von Neumann, just like we all know, is one of the specialist who built up the whole background of modern game theory. His idea of minimax, one of the most effective chess playing algorithm the minimax game-tree search algorithm was born. From his theory, what we are able to get the best outcome in one game whatever the other players do. And we are also able to confirm the possibility of winning one game based on comprehension of prevail position. Whats more, the major point of game refinement is not the way of winning games and beating opponents but if the game is attractive to players and the entertainment of the game. This game refinement theory particularly try to figure out the players engagement, based on this value, games are sorted and analyzed to improve its own affinity.

Furthermore, game refinement theory could be applied for obtaining more comprehension in the development of game history [2]. So it gives us chance to see a more general and meaningful scene of evolution specific game variants. In the other hand, game refinement theory make us able to reevaluate one game on its entertainment part, in other words, it provides a whole new game evaluation method. By the way, game theory had provided us a mechanical way to evaluate games. In this perspective, game refinement theory can be applied to other domains too. Such as video games, commerce or education. These possibilities come from the core concept of game refinement theory that is measuring the engagement. In human production and daily life, this engagement always been used as one of the most significant standards of evaluating the effectiveness of those affairs. Game refinement theory is available to be applied into wider fields just as mentioned above.

Though game refinement theory distinct from game theory, these two theories both contributes to development and improvement of computer chess game. Furthermore, these theories will not use in game informatics field only. In the future it must be applied in wider fields, its unique glamour strong power and also liveliness provide them to play a more and more important role on the stage of modern life.

2.3.1 Game Refinement Model in Board Game

The dynamics of making decisions in ambiguous options has been proved and observed to be the major factor in estimating games degree of recreation and entertainment. Then Iida et al. [23] proposed the method of game refinement concept. The consequence of amazing games have always been an uncertainty until game been through. As a result, the movement within available options keeps on a constant status in the game. On the contrary, players can quickly these options reduce quickly in the space of decision. In this way, seesaw games are more possible to be refined. Then here we will review the rules of seesaw games first [24].

On the basic of seesaw games principals, Iida et al. [1] have proposed a logistic model for uncertainty of games. In players perspective, information of games result is an increasing function of time (the number of movements) t. Furthermore, we can see information of the games result as the amount of that already been solved uncertainty x(t). Game information progress stands for how certain is the result of game in a certain time or step. Let us see B and D as the average factor and the average number of depth in the game. If someone discovered the game information progress, for example after the game, the game progress $x(t)$ will be given as a linear function of time t with $0 \leq t \leq t_k$ and $0 \leq x(t) \leq x(t_k)$, as shown in Eq. (2.1).

$$x(t) = \frac{x(t_k)}{t_k}\ t \tag{2.1}$$

However, the game information progress given by Eq. (2.1) is unknown while in-game period. The presence of uncertainty during the game, often till the last moment of a game, considered to render game progress as exponential. Hence a real model of game information progress is given by Eq. (2.2).

$$x(t) = x(t_k)(\frac{t}{t_k})^n \tag{2.2}$$

Here n represents the constant parameter which is given based on the perspective of an observer of the game considered. while a shabby game would progress with a linear function, most situations do not. Therefore assuming a parameter n is significant based on the cognition of game progress prior to completion. If the information of the game is completely received (i.e., after the end of the game) and the value of n is 1, the game progress curve will emerge as a straight line. In almost games, however more evident in competitive games, the incomplete of detail information caused the value of n cannot be assumed conduce game progress is a steep curve until its completion, along with $x(t_k)$, t_k, $x(t)$ and t, just prior to game's end.

Then acceleration of game information progress is obtained by deriving Eq. (2.2) twice. Solving it at $t = t_k$, we have Eq. (2.3).

$$x''(t_k) = \frac{x(t_k)}{(t_k)^n}(t_k)^{n-2}\ n(n-1) = \frac{x(t_k)}{(t_k)^2}\ n(n-1) \tag{2.3}$$

It is assumed in the prevail model that game information progress in any type of game is encoded and transported in our brains. The physics of information in the brain is still uncharted, but it can be counterpart as the acceleration of information progress is subject to the forces and laws of physics. Too tiny game information acceleration may be a simple riddle to human to solve and for players to calculate, then it becomes unattractive. In contrast, too much game information acceleration surpasses the entertaining range will be frustration, and at some points beyond that could become overwhelming and incomprehensible.

Therefore, we expect that the larger the value $\frac{x(t_k)}{(t_k)^2}$ is, the more the game becomes exciting, due in part to the uncertainty of game outcome. Thus, we use its root square, $\frac{\sqrt{x(t_k)}}{t_k}$, as a game refinement measure for the game under consideration. We call it R value for short as shown in Eq. (2.4).

$$R = \frac{\sqrt{x(t_k)}}{t_k}\sqrt{n(n-1)} = C\frac{\sqrt{x(t_k)}}{t_k} \tag{2.4}$$

We show, in Table 2.1, measures of game refinement for various games. From the results, we conjecture the relation between the measure of game refinement and game sophistication, as stated– Sophisticated games have a common factor (i.e., same degree of informatical acceleration value, say 0.07-0.08) to feel engaged or excited regardless of different type of games.

Table 2.1: Measures of game refinement for various types of games

Game	$x(t_k)$	t_k	R
Chess	35	80	0.074
Shogi	80	115	0.078
Go	250	208	0.076

2.3.2 Game Refinement Model in Continuous Movement Game

For the later work [26], we expand the game refinement theory from traditional Board game to the sports game successfully. Similarly, we consider two parameter G and T what ex-press as the average number of successful shoots and the average number of shoots per game, then refinement value was strongly related with $\frac{G}{T^2}$.

Similarly, a abstract of the basic idea of game refinement theory from will be given[26]. The game progress is twofold. One is game speed or scoring rate, while another one is game information progress with focus on the game outcome. In sports games, for example, football or basketball, the scoring rate is calculated by two factors: (1) goal, i.e., total score and (2) time or steps to achieve the goal. Hence that the game speed is given by average number of successful shoots divided by average number of shoot attempts. For other score-limited sports games such as Volleyball and Tennis in which the goal (i.e., score to win) is set in advance, the average number of total points per game may correspond

to the steps to achieve the goal [25]. Game information progress presents the degree of certainty of a game's results in time or in steps. Let G and T be the average number of successful shots and the average number of shots per game, respectively.

Game information progress presents the degree of certainty of a game results in time or in steps. Let G and T be the average number of successful shots and the average number of shots per game, respectively. Having full information of the game progress, i.e. after its conclusion, game progress $x(t)$ will be given as a linear function of time t with $0 \leq t \leq T$ and $0 \leq x(t) \leq G$, as shown in Eq. (2.5).

$$x(t) = \frac{G}{T}\ t \tag{2.5}$$

However, the game information progress given by Eq. (2.5) is unknown during the in-game period. The presence of uncertainty during the game, often until the final moments of a game, reasonably renders game progress as exponential. Hence, a realistic model of game information progress is given by Eq. (2.6).

$$x(t) = G(\frac{t}{T})^n \tag{2.6}$$

Here n stands for a constant parameter which is given based on the perspective of an observer in the game considered. Then acceleration of game information progress is obtained by deriving Eq. (2.6) twice. Solving it at $t = T$, the equation becomes

$$x''(T) = \frac{Gn(n-1)}{T^n}t^{n-2} = \frac{G}{T^2}n(n-1)$$

It is assumed in the current model that game information progress in any type of game is encoded and transported in our brains. We do not yet know about the physics of information in the brain, but it is likely that the acceleration of information progress is related to the forces and laws of physics.

Hence, it is reasonably expected that the larger the value $\frac{G}{T^2}$ is, the more the game becomes exciting due to the uncertainty of game outcome. Thus, we use its root square, $\frac{\sqrt{G}}{T}$, as a game refinement measure for the game under consideration. We can call it R value for short.

Here we consider the gap between board games and sports games by deriving a formula to calculate the game information progress of board games. Let B and D be average branching factor (number of possible options) and game length (depth of whole game tree), respectively. One round in board games can be illustrated as decision tree. At each depth of the game tree, one will choose a move and the game will progress. Figure 2.1 illustrates one level of game tree. The distance d, which has been shown in Figure 2.1, can be found by using simple Pythagoras theorem, thus resulting in $d = \sqrt{\Delta l^2 + 1}$.

Assuming that the approximate value of horizontal difference between nodes is $\frac{B}{2}$, then we can make a substitution and get $d = \sqrt{(\frac{B}{2})^2 + 1}$. The game progress for one game is the total level of game tree times d. For the meantime, we do not consider Δt^2 because the value ($\Delta t^2 = 1$) is assumed to be much smaller compared to B. The game length

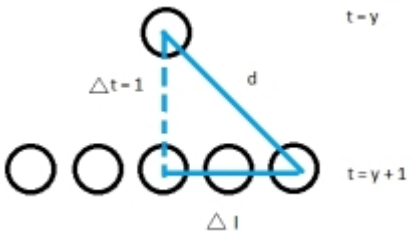

Figure 2.1: Illustration of one level of game tree

will be normalized by the average game length D, then the game progress $x(t)$ is given by $x(t) = \frac{t}{D} \cdot d = \frac{t}{D}\sqrt{(\frac{B}{2})^2} = \frac{Bt}{2D}$.

Then, in general we have, $x(t) = c\frac{B}{D}t$, where c is a different constant which depends on the game considered. However, we manage to explain how to obtain the game information progress value itself. The game progress in the domain of board games forms a linear graph with the maximum value $x(t)$ of B. Assuming $c = 1$, then we have a realistic game progress model for board games, which is given by

$$x(t) = B(\frac{t}{D})^n. \tag{2.7}$$

Eq. (2.7) shows that the game progress in board games corresponds to that of sports games as shown in Eq. (2.6).

To support the effectiveness of proposed game refinement measures, some data of games such as Chess and Go [23] from board games and two sports games [26] are compared. We show, in Table 2.2, a comparison of game refinement measures for various type of games. From Table 2.2, we see that sophisticated games have a common factor (i.e., same degree of acceleration value) to feel engagement or excitement regardless of different type of games.

Table 2.2: Measures of game refinement for various types of games

Game	$x(t_k)$	t_k	R
Basketball	36.38	82.01	0.073
Soccer	2.64	22	0.073
Badminton	46.336	79.344	0.086
Table tennis	54.863	96.465	0.077
DotA ver 6.80	68.6	106.2	0.078
StarCraft II Terran	1.64	16	0.081

2.4 Application in Fighting Game

According to the basic idea of game refinement theory, we have applied the model for different areas. In this section, we show further investigation in the domains of Fighting

Games such as Super Street Fighters 2, The king of fighters' 97, The king of fighters 2002, The king of fighters XIV, Dead or alive 5, TEKKEN 7 and so on. Fighting games as continues movement game, so the Game model is the same as the Game Refinement Model in Continuous Movement Game.

The first fighting game emerged in the 70s, the fighting games at that era are not like now, fighting game nowadays have wonderful gameplay, but the games at that time are just some simple movements which stimulating fighting, for instance, the boxing games are just stimulate boxing sports and something like this. In this part definition of game will be explained, in other words, what are fighting games. Then I intend to introduce the development history of fighting games in general. Moreover, we will apply Game Refinement Theory in the 10 games we have picked up. This research will analyze data we have obtained and then make some conclusion through the result.

2.4.1 History overview of Fighting Game

Fighting game as a very popular game is a video game genre Player controls an on-screen character and dedicate himself in close combat with a certain opponent who can be either an AI or controlled by another player [4]. The fight competitions usually consist of several rounds, hold in characteristic arena, each character owns distinct abilities but relatively available to select. Players have to possess skills such as blocking, counter-attacking, and chaining attacks together called "combos". Since the early 1990s, most fighting games began to permit players to manipulate designed attacks by performing specific input combinations. The fighting game genre is related to but distinct from beat 'em ups, which involve large numbers of enemies against the human player [4].

In fighting games, a combo (short for combination) is a term that designates a set of actions performed in sequence, usually with strict timing limitations, that yield a significant benefit or advantage. Combos are commonly used as an essential gameplay element, but can also serve as a high score or attack power modifier, or simply as a way to exhibit a flamboyant playing style. Dating back to the most ancient fighting game in Japanese arcade scene is called Segas 1976 Heavyweight Champ, which is a boxing game. Moreover, few karate games or kung-Fu games, for example, Karate Champ (1984) and Yie Ar Kung FU (1985), simulated realistic competitive martial arts [7]. Warrior in 1979 is another title of one of the first fighting games. It was basic on sword fighting duels and used a birds eye view which distinguished to Heavyweight Champ and later titles. Karate Champ in 1984 is well-known by its one-on-one fighting game genre and soon made a big achievement for this reason. In this game, a series of movements could be performed by using dual-joystick controls, whats more, like later fighting games, best-of three matches format had been used and it featured training bonus stages [4].

Being released in 1985, Konamis Yie Ar Kung Fu expanded improved Karate Champ by giving players chances to against a variety of competitors, giving players a whole new fighting experience created by them. Players can also perform different movements, up to 16, including projectile attacks [9]. Also in this year, Elites Frank Brunos boxing game had introduced a new concept, high and low guard, ducking, lateral dodging, and a meter built up by successful attacks, when successful attacks comes full a more powerful punch

Table 2.3: A brief history of Fighting Games

Fighting Game	Year	Platform	Feature
Heavyweight Champ	1976	ARCADE	The first video fighting game.
Karate Champ	1984	ARCADE	Establishing the one-on-one fighting game genre.
Yie Ar Kung Fu	1985	FC	Player could perform up to sixteen different moves.
Street Fighter	1987	ARCADE	Use the special moves and the game controls.
Fatal Fury	1991	NEOGEO	Placed more emphasis on storytelling.
Samurai Spirits	1993	NEOGEO	Famous for The warrior fought by weapons.
Street FighterII	1991	SFC	Execute multi-button special moves reliably.
Virtua Fighter	1993	SS	The first 3D fighting game.
The King of Fighters '94	1994	NEOGEO	Crossover characters from SNK's fighting game.
Mortal Kombat 3	1995	MD	Famous for its cruelty and bloody.
The King of Fighters '97	1997	NEOGEO	Famous for its fierce rhythm.
The King of Fighters '2002	2002	NEOGEO	The ninth game in The King of Fighters series.
Virtua Fighter 5	2006	PS3	The fifth game in The Virtua Fighter series. First game in PS3.
Dead or Alive 5	2012	PS3	The first DOA game to have multi-platform release.
The King of Fighters XIV	2016	PS4	The first KOF game rendered entirely in 3D.
TEKKEN 7	2017	PS4	The ninth game in the Tekken series.

will be able to be thrown.

Unfortunately, these games didnt win a universal praise because of the dominance of shooter games in Japanese arcades at that time, they even had just few in common on the reasons which fighting games have become to be understand today [7].

But both Karate Champ and Yie Ar Kung Fu had set an example for Capcoms Street Fighter in 1987 [8]. One of the charming point of this game was to use exceptive movements which could only be discovered by experiencing while controlling game and that elected kind of mysterious feeling attract players to go on, even more, this game exploring spirit come up with the games glamour appealing more people to this game. The Street

Fighter 2 in 1991 has been considered as a monument of fighting games history, a fighting games revolution. It had featured well-designed characters in innovated techniques. It also popularized combo mechanic, which enable skillful players combining several attacks together that eliminate opponents recover time if they timed them correctly [4].

When it comes to SF series, while many similar games inspired and impact developers and technology, are well known as 2D fighters. There is no available third dimension on-screen action to move on; characters can do some general movements, such as jump or crouch, move to right or left. But they are limited to shift into background or come to the foreground. There are always competitions accompanying the development of game commercial. Not soon, Sega created their remarkable fighting game, Virtua Fighter games in 1993. They kept most details of Street Fighter, like life gauge, stylized characters, special attacks, even 1-on-1 martial arts competition, nevertheless, the crucial part is they have developed 3D art instead of 2D art, designers used polygon rather than sprite-based illustrations. Players are not limited in moving right or left, jumping or crawling on the floor any longer, they are able to turn around in the battlefield. One more achievement is that players are not just knocking out his opponent, they can also hurling them out of the proscribed arena, which is known as ring out [10].

We can say that both SF2 and Virtua Fighter had an incredible influence on later games. SF2 impacts later games in its structures, Virtua Fighter has also impact the development of later games and inspire them in 3D view. Including 3D adaptions of existing 2D series that did not proceed well in the market. The most famous two game series of 3D games is called Tekken and Soul series and by Namco (Namco-Bandai). The Tekken series are more put their point on hand-to-hand combat, while the Soul series are more focus on characters fighting combined with weapon fighting. The first piece, Soul Blade, and sequels afterwards, from Soul Calibur 1 to Soul Calibur 4 are all in this way. In addition, both of these series contains basic factors of 3D fighters: the ability to use entire battlefield and move in available directions, and the ability to win by knocking other players out of the arena [7].

We show a brief history of Fighting Games in Table 2.3, we have enumerated some fighting games, from the worlds first fighting game born in 1976 to 2017, which are fascinating, marvelous and pushed development and revolution of fighting games in this table. We can make out the way fighting games had been through and the trend of development of fighting games in the rough from this table. We can say that from the earliest fighting game to fighting games now-a society when electrical industrial is developed-incredible changed have happened on fighting games.

2.4.2 Data Acquisition for Fighting Games

Data acquisition is one significant part of researching. 10 games were choosen in this research first to study. They are all remarkable games globally so there are always many competitions internationally being held, so it facilitates us to collect data, thats the reason they are selected as samples. We searched videos about these competitions in the internet (such as the "Fight club cup 2017 conference"), by watching these videos recording the data we need for studying. According to the game refinement model we have already

selected, we will record two data of them in one round while we are watching videos. The first data we are recording is the sum of hitting by characters in one round, and we see this data as T. The second data we are recording is the sum hits successfully by characters meanwhile we see this data as G. We adjust the speed of game recording videos in a slowly way to reduce the possibility to meet errors. We collected 20 groups of data in one fighting game, and the make an average of them. From now on, we are going to introduce these 10 incredible fighting games in general in passage next.

We collect the data from ten different famous fighting games. The 10 famous fighting games that we have taken are shown in Figure 2.2 to Figure 2.11:

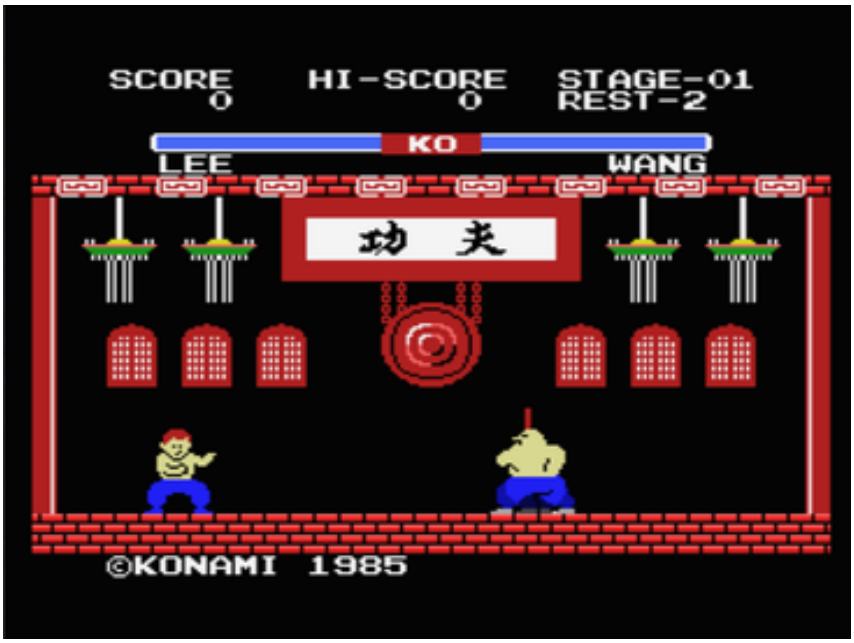

Figure 2.2: Yie Ar kung fu (Famicom) 1985

Yie Ar Kung-Fu was a game released in 1985. Although it was issued on Arcade at first, the most one familiar to players is the item replanted to Famicom [28]. As the illustrate above shows, this is the first scene in the first round of Yie Ar Kung-Fu, the character we are controlling will be faced to 5 different candidates. It brought innumerous shocks to players at that time as a fighting game in early time. The leading actor is able to follow 16 distinguished actions, such as stand up, crouch and jump, it can even follow attack command in these three situation above. Of course it cannot compare to fighting games today, but it is definitely still a standout game at that time.

Street fighter 2 is a fighting game which famous for ardent and competitive. It was released in 1991, differentiate with the former part released in 1987, this game is distinguished by its own glamour and unique technology and story even became a hot topic among society at that time [4]. This game enable characters in the game to do many different special movements, before the beginning of game, players are able to choose one favorite character from all the characters have been given. Each character has its own style of fighting, which is magnificent. This game also has combo system, we can input

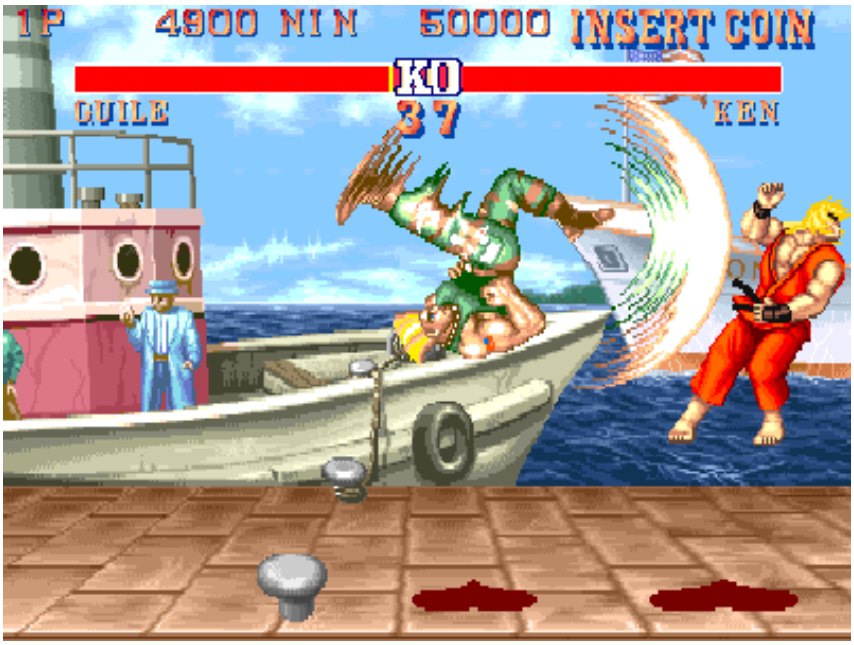

Figure 2.3: Street fighter II: The world warriors (Super Famicom) 1991

command to control characters and start flamboyant combo actions. Street fighter 2 had a directly influence on the development of Arcade, and brought an Arcades renaissance just because of the remarkable performance of Street Fighter 2. There are still fans who drench in this games even till today, and they are still insist on playing it. You can understand this phenomenon when Nintendo put the newest game machine on the saleswitch, which in it contains the newest version of Street Fighter 2. You can see the thriving influence of this game now.

Samurai Spirits is one of the fighting game plays killing by weapons released by company SNK in 1993 [4]. The most distinct part of this game is characters are fighting with weapons instead of physically fighting with bodies directly. Fighting game in earlier time were fighting just by punches and kicks. Samurai Spirits is seen to be the ancestor of 2D weapon fighting games, and it became one of the most representative game works of SNK. The western version of this series is also familiar to players, although it was more popular as a game of horrible translation by the staff of game inventors. This series games happened in 18th Japan, samurai means fighters in general just like cavalry in western countries. Definitely characters are not limited by samurai, some monsters in imagination or ancient stories and characters who are not Japanese are listed in it also.

Talking about Samurai Spirits, we cannot ignore Mortal Kombat anymore. This game is always compared with the former one, Street fighters 2. Being receiving positive remarks since its first presentation in 1992, the part appeals players most is its bloody vision effect and its real human-being appearance. And this game had been a good seller just because of these. The unique style of fighting was different from others too. It was not seen to be a popular game at first, but it raise a wave since it been released.

This game soon became a limited level game because of bloody scene, such as blast

Figure 2.4: Samurai Spirits (NEOGEO) 1993

Figure 2.5: Mortal Kombat 3(MD) 1995

heads and broken legs, which are normal scenes to see in this game. So the players are limited in adults too. Published newspapers and media used mainly part to report, so actually most people knew this game by media but not by playing this game himself. The third series released in 1995 is normally seen to be the peak of this series and the masterpiece.

The King of Fighters '97 was a fighting game invented by SNK too, it is also the fourth

Figure 2.6: The king of fighters' 97 (NEOGEO) 1997

work of The King of Fighters series. This game had been upon the stage in 1997 on the Arcade Neo Geo in Japan, and is the most popular one since before [6]. It have built the highest record of coin dropping in one week in Japan, what is not enough that it has an impressive impact in mainland of China and the hurl of this game is not evaded even right now. The penman was influenced by this The King of Fighters hurl too who saved money for lunch, eat less and use the money being saved to Arcade game center. The new characters appeared in this game were incredible popular so that they also have special acting in other series of this game. The manipulating of this game and the story of this game is extraordinarily marvelous and more standout than before, which made series of The King of Fighters97 the peak of fighting games.

The King of Fighters 2002 had been upon the stage on Arcade system on Neo Geo in Japan in 2002 initially. This work was well received by players, and it was flamboyant when characters do their attacks. But what is a pity is that the hided super combo was too complicated to hand in and players can hardly grasp the skills of fighting. The number of characters that performed was a historical number, created a new record of performing, which was 66. It was the game that contains the most characters performing. Nevertheless, because of the obvious difference between weak and strong in this game, the balance of game was burned into ashes. It will never reach the highness of The King of Fighters 97, but it is still a standout fighting game, many players still like this game even now.

Virtua Fighters 5 is the newest published work of its game series in SEGA game company, it is also the first fighting game on game machine Play Station 3. Virtua Fighters 5 from the year of 2006 is available on Arcade in Japan. This game also published version of ps3 and version of xbox360. The first work of this series emerged on the game machine called Saturn, published by SEGA Company too, and it was popularized as a fighting game. Fighting games were all 2Dvision before the appearance of this game, so we can

Figure 2.7: The king of fighters 2002 (NEOGEO) 2002

Figure 2.8: Virtua Fighter 5 (PlayStation 3) 2006

say that this game series had bring a revolution of games and also pushed the development of games.

Dead or Alive 5 is the fifth game of this series, been sold in 2012. There are something in common between Tekken and this game in controlling part, however, it is famous for the number female characters. Different from fighting games before, there are so many female characters, even more the male characters in this game. Even more, all female characters are sexy and seductive, wearing very less clothes and fighting dedicatedly. Many players who are not interested in fighting games purchased this one because of these charming

Figure 2.9: Dead or alive 5 (PlayStation 3) 2012

female characters. This became a interesting phenomenon and became the distinguish feature of this game. Many other players make fun of Dead or Alive for this reason.

Figure 2.10: The king of fighters XIV (PlayStation 4) 2016

The King of Fighters XIV was the newest fighting game of The King of Fighters invented by SNK Company. The PlayStation platform version began to sell in august, 2016. The King of Fighters series still have an incredible impact in China, so Chinese players also attention to this game. The characters scene of this game is 3D model, and it is remarkably gorgeous [4]. The hitting feeling of this game is remarkable too, even that it cannot across the peak, The King of Fighters 97. Meanwhile, as it used to be, this game tells a moving story, and added more new characters. Due to being popular in Chinese players, this work added some Chinese characters too.

Tekken7 was one fighting game invented and released by a game company called BANDAI NAMCO. It is the newest work of Tekken, and it is the first work run an

Figure 2.11: TEKKEN 7 (PlayStation 4) 2017

application of virtual engine. Since it being sold on the popular game machine ps4, it aroused a game surge among players. But actually, it invented and came out to market for the reason that BANDAI NAMCO was competing with Virtua Fighters. Since the Virtua Fighters series had no more new work to come out, Tekken now has a major influence in Japan and game races for Tekken are usually being held. Moreover, beginning to sell on 2017, technique of inventing games now became mature, Tekken has standout effect of scenes.

Table 2.4: Measures of Game Refinement for Fighting Games

Fighting Games name	G	T	R-value
Yie Ar Kung Fu (1985)	11.6	52.3	0.065
Street Fighter II: The World Warriors (1991)	14.1	52.8	0.071
Samurai Spirits (1993)	13.1	38.8	0.093
Mortal Kombat 3 (1995)	41.2	73.3	0.088
The King of Fighters '97 (1997)	21.3	48.9	0.094
The King of Fighters 2002 (2002)	23.5	46.1	0.105
Virtua Fighter 5 (2006)	21.1	41.3	0.111
Dead or Alive 5 (2012)	31.2	44.7	0.125
The King of Fighters XIV (2016)	49.2	63.1	0.111
Tekken 7 (2017)	26.3	40.1	0.128

The value of G and T in this 10 fighting games are enumerated as shows in Table 2.4, meanwhile R-value is listed too. The letter G represents the sum of hit successfully while the letter T represents the sum of been hit, by using the model of game refinement theory just like we have introduced we can get the value of R in each game by calculating.

We made a polygonal line according to times near and far, shows in Figure 2.12. Axis x represents years, meanwhile axis y represents the value of R. We are able to observe the develop trend and the changing tendency of R value generally. We can find out in a

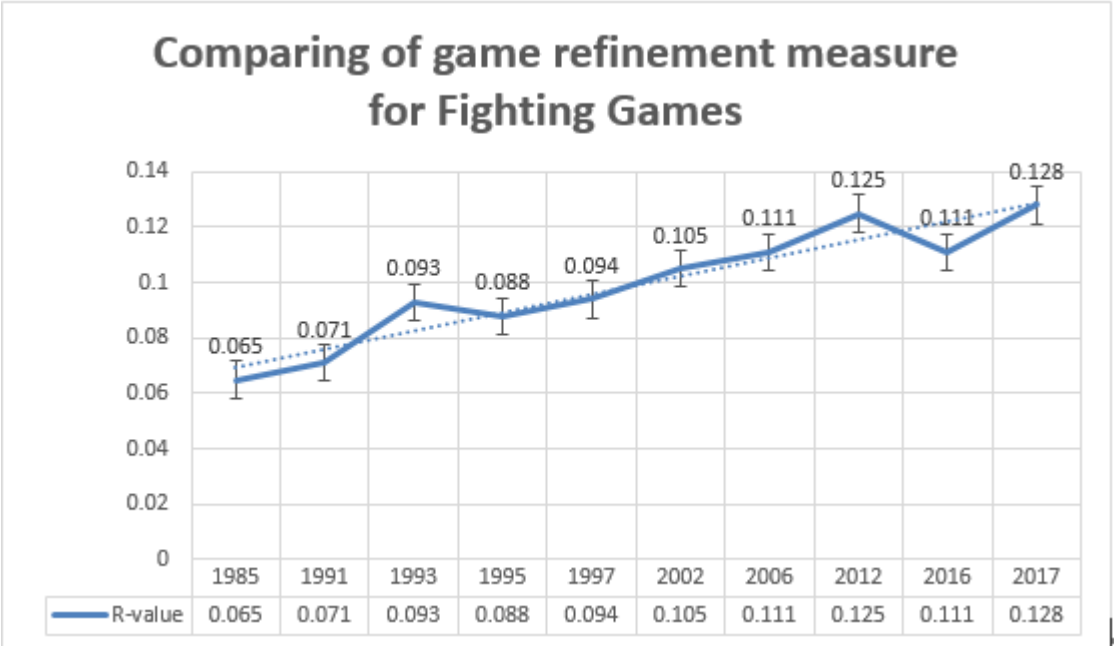

Figure 2.12: Comparing of game refinement measure of Fighting Games

directly way that in the earlier time R value of fighting games had always been in a low statement while R value of fighting games these years have grown higher and higher. We can tell in this illustrate that R value is increasing as time goes by, in other words, by years.

Players manipulate the protagonist to battle with opponent in the fighting games, some of attacks are valid, means hit opponent successfully and cause harm against enemy. On another perspective, every single attack attempt no matter completed or not, so in this condition, G represents the average number of successful attacks while T is average number of attack per game.

According to the players' real experience and emotion, Super Street Fighter series have the relatively slow game rhythm and perfect balance between every character, while characters attend some certain competition, psychological anticipation should be concerned; The King of Fighters series owns a more rapidly game rhythm and outstanding ornamental value, players have to concentrate on launching combos. So refinement values of these two games should be different. Game refinement value of Super Street Fighter 2 is similar to traditional board games and sports games just like football games, and The King of the Fighters has the extraordinary eminent high R-value shows that the game is recreation and thrilling. Perfect for displaying, improper for competition. The research result and experiment data coincides game experience and audiences' emotion.

2.5 Chapter Conclusion

We are able to find out easily by observing and analyzing the table above that from 1980s to 1990s, in earlier time fighting games, R value of ball games and board games are approaching to each other, about 0.06 to 0.08. We are able to aware that fighting games in the earlier time are similar to gym games, for fighting games in earlier time are boxing movement simply and karate games are simply karate movements and so on. Whats more, fighting games in earlier time have strong competitive sense, and this specialty makes fighting games similar to board game in the same time. Fighting games in the earlier time perform by the form of electrical video game, we even can confirm that earlier fighting games are gym games imitated by electrical video games. So it is not hard to make a comprehension that R value in earlier fighting games is approaching to R value in earlier board games.

When it comes to middle 90s till today, R value we have been counted is higher than before, generally fluctuated from 0.9 to 0.13. And why R value of fighting games nowadays is generally higher than fighting games in earlier time? That will be a meaningfully question to discuss. Analyzing R value according to Game Refinement Theory, the higher R value is, the faster speed the game has and the game will be more entertaining.

As dissertation demonstrated above, earlier fighting games are more like gyp games stimulated by electrical video games. Most games published in that time are made to be in this kind of statement. For instance, advertisements of electrical boxing games at that time are usually in this way: you can enjoy the pleasure of boxing game even when you are cozy at home, and feel the high tension of competition in reality. So you are able to understand when we arrive here that fighting games in earlier time have big differences from fighting games these days. Inventors of fighting games now put their attention more on the entertainment of games instead of stimulating gym competition game in reality only in earlier time. Let me give you an example so that could make you understand easier, Hadoken in Street Fighter series, and other many deadly blow in this game. But it can never be done by mortal in real world.

We also mentioned on above that Street Fighter 2 can be the monument of fighting games because it has changed the trend of fighting games [4]. Accompanied by development of electrical technique, the scene of video games become more and more clear and gorgeous, the speed of electronic processor became more and more quickly in the same time. And this also means that game inventors are able to create more flamboyant movements and deadly blow for characters in an easier way. Started with the born of Street Fighter 2, characters in the game are always able to do gorgeous combos, this is totally beautiful and makes players feel excited. Player who is controlling games may in high tension and experience of playing will be pushed into a new level. But the most significant point is, however, actions in the game and deadly blow can never be accomplished by human being in reality like we have mentioned.

Above all, the most significant distinguish between fighting games now and before is fighting games now put more attention on entertainment and recreation of game and high tension, or heart beat bring to players but not simply stimulating fighting movement in reality like fighting games in earlier time. Results we have got in this research are

significant and meaningful to reality social life too. Mainly fighting games in these days have a high speed of moving and processing with a strong entertainment. Fighting games like this are easily to be welcomed by players like we have already discussed. Game designers are available to use Game Refinement Theory to judge whether this game can be popular or not in the progression of game inventing. If a super low R value appeared, game inventors should really think it over if the game is worth to be published. After all, old-fashioned fighting games are not as popular as the time they have just born.

Chapter 3

Analysis of Action Games using Game Refinement Measurement

3.1 Chapter Introduction

The crucial part of this chapter is action game. Due to the identical game refinement theory model we are using for action games and fighting games, so we have introduced this model in former chapter [2]. This research based on researching of monument of action games, the one which is eminent and well-known around the whole world, God of War series. Both action games and fighting games have continuous movements, as they have similarities moreover it also contains shooting or defending factors just like fighting games. So we still take the model of Continuous Movement Game as the means of researching while we study action games through experiencing and demonstration.

We are going to demonstrate what action games exactly are and what elements action games contains in the initial part of this chapter. Secondly we are going to generalize the development history of action games in order to express the complete history of action games. The most special character that makes action games distinguished with others is that action games have definitely routines or flows, and action games nowadays usually have flows about over 10 hours. This is also the biggest difference between action games and fighting games [29]. So though we are using the same model while we are analyzing action games and fighting games, but when it comes to specific analyzing or researching through the idiographic anatomy, they are still not totally equal. Before that we will let you have a general impression of the God of War series. Here is an instruction elaborately so that you will have a fundamental impression about this game in a directly way. Firstly we are going to collect data respectively of the God of War series, what we will do next is to analyze these data and make a conclusion after that. Then we are able to make some achievements and conclusions through analyzing and finally do some discussions about this research.

3.2 Game Refinement Model in Action Game

We consider the progress of a fighting game. To find the game refinement measure, a remarkable game progress model is figured out by two factors: successful hit and attempt control. Players control the character to attack each other in the fighting games, some attack is valid, it means that hit opponent without defense, and make damage successfully. On the other hand, every single attack is an attempt no matter successful or not, so in this condition, H stands for the average number of successful hit, and A is the average number of attack per game. If one knows the game information progress, for example after the game, the game progress $x(t)$ will be given by Eq. 3.1.

$$x(t) = \frac{H}{A}\ t \tag{3.1}$$

A model of ACT information progress is given by Eq. 3.2.

$$x(t) = H(\frac{t}{A})^n \tag{3.2}$$

Here n stands for a constant parameter which is given based on the perspective of an observer in the game considered. Then acceleration of game information progress is obtained by deriving Eq. (3.2) twice. Solving it at $t = A$, the equation becomes

$$x''(T) = \frac{Hn(n-1)}{A^n}t^{n-2} = \frac{H}{A^2}n(n-1) \tag{3.3}$$

Hence we obtain the game refinement measure $GR = \frac{\sqrt{H}}{A}$.

3.3 Action Game

In this chapter, definition of action games and the history of action games development is the substential part. Actually it is not simple to definite what exactly action games are, and even fighting games we have discussed in last chapter can be seen as one branches of action games [5] [6]. Nevertheless, action games in the view of electrical video games players have no strictly boarder, in other words action games in their opinion are not containing fighting games sometimes, they become more simple, in many players perspective, only when you are controlling one game character passing chapters can it called an action game, such as Super Mario series, by instructing your character do a series of movements finally able to pass all chapters, you have to include flows of passing chapters then we call it an action game. But fighting games, however, are putting their attention on competition and are programmed by rounds, cannot be seen as action games. Indeed, even the top game expertise cannot answer this question flawlessly and give an exactly definition for the relation between action games and fighting games. The processing of games inventing technology allows electrical video games to have a vast capacity, so factors that one game contains can be incredible unlimited. Action games now may contain many different fighting games factors, or shooting, sometime also contains puzzle solving factors

[29]. This is what exactly makes action games definition becoming complicated. Content of this chapter is about exactly definition of action games and introduce the processing of action games to let you have an impression of what are action games. This is instrumental to researchers from now on and research in the future as far as I am concerned.

3.3.1 Definition of Action Game

So what are the action games? Actually, games take action as the mainly means of expression can be called action games. Action games include shooting games and fighting games [29]. So we can say that fighting games we studied in the second chapter can actually be classified into action games too. Multiplayer online battle arena or some real-time strategy games are considered to be sorted into action games also. Before the year of 2005, simply action games becoming more and more hard to see in the market [30]. We can hardly have glimpse of them when we purchasing soft games in shops. The reason is that actions can be expressed in many different forms.

As we all know, action games are generally represent one sort of electrical video games [6]. They emphasis on the ability for cooperation of players eyes and hands, so as the reaction of players. Mainly played by game console, assisted by computers, the story of action games can by simple or continuous, you are able to playing games if you have mature skills. But now story are using to push forward the main line of games, it adds high tension to games and completed the story of whole game. They have splendid stories, background music and optical effect in congruity, but easy to control. In several games, players are able to eliminate enemies by weapons or with bare hands, whats more some action games can battle with other players online in some situations if they would like to Players usually manipulate the protagonist or avatar while playing action games. The avatar must reach a level, collecting objects that are being asked, avoiding obstacles would being get injured, and battling with enemies by various attacks. At the end of a level or group of levels, the players always have to beat against a boss enemy character and that becomes the biggest challenge for them [10].

Action games are sorted into two types, one of them pays attention to beautiful, exaggerated movements while the other is more realistically. Some action games appeals players with the gorgeous combos and the manipulation of players, which is similar to fighting games we have been researched in last chapter [29]. Actions are just one of means of express sometimes. Action games still got one specialty is that characters the players are controlling can reach a high level from a low one and learn some skills through this experience. Players may met obstacles while becoming stronger or passing necessary stories and so on, player must use its brain and keep on ponder over while player is enjoying the game.

This is one special character that most action games are in common and make games more recreation. Player will have a feeling that action games contain so much action factors while playing action games. The action game includes many games factors while players accomplish challenges by physical means such as precise aim and quick response times. Action games contain other factors sometimes, just like competitions, puzzle-solving, or collecting objects, but they are not the keystone of this genre. Players may

also face strategy and exploration challenges, but these games aims on high reaction speed and cooperate of hands and eyes. Players usually have the pressure of time running out, or not enough time for complex strategic planning. In general, faster action games have more challenges. Action games may sometimes involve puzzle solving, but puzzles are quite simple because the players are under the pressure of time passing [30].

Realistically action games are restricted rated because of the violence factor they contain more or less and they looks so real. When the situation comes to unrealistically action games, for example the series of Mario, have nothing about violence, things are different. They are welcomed by every layer of players. So we can say that it is one-sided to connect action games to violence. As the development and processing of technology, action games made many improvements and completed itself during it. Electrical video games players may find out that action games contains fighting games factors sometimes, for instance in the end of the game when you are facing the boss character you have to beat him over. Moreover they may contain shooting factors sometimes, such as the remarkable series, Uncharted [6].

This famous action game series include a major proportion of shooting, and the shooting factor goes through the whole game series. Another example contains shooting factor is Assassins creed, even the series God of War that we are studying in this research contain the factor of shooting. This is receivable because shooting factor is contributing to the games tensional and makes them more interesting. In my opinion, the reason why do action games difficult to make an exactly definition is technology now enable players to experience multifarious actions while playing just one game. In earlier days, when technology is not so advanced like today and limited by the capacity of semiconductor which makes them more simply and monotones. However, no matter how many factors do one game contains, the most charming point of action games is that they have flows just like they were in early time [29]. The counterpart of action game is movie.

From beginning to the end, player have to experience it and enjoy it, and for both of them got an end. But as far as concerned action games are more fascinating than movies cause the selection player made, even every step player take can lead you to different endings, but as for movies, they have endings that have already been set.

3.3.2 History Overview of Action Game

The earlier history of action games started with the technology processing of video games. The initial of video games history was the introduction of a device called a Cathode-Ray Tube which invented by Thomas Goldsmith and Estle Mann in the year of 1947 [6]. This device using eight vacuum tubes to simulate a missile firing as a target and had knobs to adjust the curve and speed of the missile. Since then professional action computer games came to this world. The earliest computer games ran on university mainframe computers. The place, however, was the America. These simple games contains some simple subjects such as mouse in a maze or tic tac toe. These games prone to be forgotten by the people in that age, as the flowing of time.

In 1961, many students including Steve Russell came up a new idea with a game which became a byword of early games and was remarkable, the SpaceWar [9]. This game

controlled by two players in the same time fight against each other and in the game, they are controlling spacecraft. These spacecraft could fire missiles and they have to avoid the black hole in the middle of limiting surface so that they cannot be absorbed by it. This game was provided to the primitive internet and you are able to play it while using internet. Spacecraft was the first game that influences the whole world and probably we can call it the first action game in the world.

Although the history of electrical video games can be dated back to the year of 1947, according to the definition of electrical video games, earlier electrical video games are not able to classify into electrical video games definitely. The first reason is that they are not been sold in market and quantity product even not circulated around the world, it was just an sketch of electrical video game portrait by people working for electric and who had a hobby of it. Secondly there was not a saying of electrical video games at that time, people didnt treated them as totally games because of technology or games concept of people at that time.

When the video game industry began in the early 1970s, the success of Pong caused a big wave of games. The mainly early arcade video games were normal to see as sports games that attempted to simulate real sports, especially Pong clones and some other racing video games [6]. While some action games began to be popular in about the mid-1970s, with releases such as Gun Fight in 1975 and Sea Wolf in 1976 [31], the industry was still largely dominated by sports games, though the flood of Pong clones eventually led to the video game crash of 1977. About this issue, we have already discussed in last chapter that the earliest electrical video games were attempt to simulate real sports in real life and then being invented [31]. The ads at that time were designed like players are able to enjoy like doing the real sports outside or car racing, shootings at the home and they sells for it. But the most receivable reason was that technology at that age are not allowed much more game style.

The poor capacity of semiconductor, the lack functions of mainframes, invention of action games is limited in simulating sports in real life. Except the invention of literal games. And there was still a reason for the limited genre of games at that time is that video games was at bud moment at that time, there werent competed designing lines and staff professionally writing code for games were limited too. Even some programmers wrote content from start to very end by himself. This is out of imagination at these days which inventers were hundreds of people for just one famous game. We have a mature technology and industry of game is developed now. But why the earlier electrical video games were all related to sports games? This is a question not quite easy to answer. In the 70s which the industry of games had just started, maybe game inventers could not even imagine that electrical video games are able to processing and popular like nowadays. This is of course hard to imagine limited by technology at that time [30].

Nowadays, when people talk about games or mention games while communicating, the first reaction of game would like to be electrical video games, sports games, board games and so on. For many kind of sakes, it is not hard to comprehend that electrical video games in earlier days were designed to be sports games.

A crucial turning point for action games were in 1978, with the releasing of the shoot

'em up game Space Invaders [31], which marked to be the end of 1977 crash and the beginning of the golden age of arcade games [10]. Because of the successful of the Space Invaders mainstream, the whole game industry came to be dominated by action games, which have remained to be the most dominant genre in the arcades and on game consoles till nowadays [32]. Along with Space Invaders, Asteroids Deluxe from 1979 and Pac-Man from 1980 have also become iconic examples of the action genre. Robotron: 2084, released in arcades in 1982, also became a representative work in the shooter subgenre [6].

The ancestor of action games were shooting genre, isnt that a big surprise? There is a consensus based on games history that the Space Invader released in 1978 was the first work of action games [29]. It can be unacquainted if we mention the name of this game only, but to the players who have an experience of playing FAMICOM console, may acknowledge this game normally. Chinese players call it little bees due to the looking of its frames and the sound of it. Maybe we all have an experience of playing it but have no conscious about this little bees were the ancestor of action games or they will become a part of this research in the future.

In much the same way Space Invaders became the most representative masterpiece for the shooting video game genre at that time, Donkey Kong did the same for the platform game subgenre and released it in 1981. Paperboy, which released in 1984, using the idea of newspapers delivering and turn it into an action game, which rich the forms of the genre. The same year martial arts themed games emerged, with Karate Champ establishing the one-on-one fighting game subgenre [33], and Kung-Fu Master laying the foundations for the side-scrolling beat 'em up subgenre.

We can tell from the performing sequence of these games that till the time of 80s, the core part of action games avert to fighting genre. And as the processing of games, one-to-one fighting games have brewed an innovated genre, fighting games. So that some players are confused to classify fighting games and action games even until today. Some players considered that there are absolutely flows in action games while one-to one fighting games are more prone to the consequence, of wining or not, so it cannot be sorted into action games. But some others think that there will not be fighting games without the forerunner, action games. Moreover, fighting games are actually one form of action games. The disputer insisted until today and no one is able to make an exact definition for the boarder of action games and fighting games clearly.

But the most amuse thing is, people today normally considers the first fighting game in the world as one boxing game released in 1976 by SEGA Company [4]. And actually, expertizes consider the ancestor of action games to be Space Invaders which played on host computer in 1978[29]. Nevertheless, we have already seen fighting games as a part of action games and in this case why we are not see the first action game as this fighting game released by SEGA in 1976? This case will not turn to be solved ingeniously even years gone by. After all, electrical video games in the early time have huge differences with electrical video games today due to the environment of it and the elements or factors they contain.

Time now flows to the 90s. DOOM, released in 1994, was not the initial first-person shooter games, but it became a worldwide classic game for its innovated game style and

breaking the traditional form of rectangular rooms or flat floors. Third-person shooters became popular in recent years because of the refreshed ideas, such as lock-on targeting emerged in 1998's The Legend of Zelda: Ocarina of Time, the cover system introduced in 1999's WinBack, and over-the-shoulder aiming emerged in 2005's Resident Evil 4 [5].

There are several major subgenres and branches of action games. Nevertheless, there are still some action games without any clear classified, such as Frogger, as well as some other types of genres like Adventure or Strategy that have action factor in common [29].

- **Beat 'em ups:** Beat 'em ups are games that contains factor of fighting, while going through a side-scrolling stage of numerous adversaries, using martial arts or other close-range fighting skills. Fighting game: The character of fighting games is fighting between pairs of fighters, usually using martial arts movements and physical skills. Movements are limited to various attacks and defenses, and the game comes into an end when one of the fighter's blood item, which represents your life, fading to transparent. The fighting depends on special movements and continuous combos. There are both 2D and 3D fighting games you can purchase, but now 3D fighting games have taken place of 2D planes and occasionally include side-stepping. They are distinguished from sports games such as boxing and wrestling games which attempt to stimulate movements and techniques more realistically.

- **Maze game:** Maze games such as Pac-Man involve navigating a maze to avoid or chase adversaries.

- **Platform game:** Platform games like jumping in game surface in different heights or altitudes, players have to battle against enemies in the meanwhile avoid obstacles. Physics of characters are often unrealistic, and game levels are often vertically exaggerated. They exist in both 2D and 3D forms.

- **Rhythm action game:** Rhythm action games test the sense of rhythm for everyone, and you will obtain points if pressing buttons or blocks of lights in game accurately with the dropping of musical beats. This is a relatively fresh subgenre of action game. Rhythm games are sometimes sorted into the genre of music game.

- **Shooter game:** Shooter games need players to take action in a distance by a ranged weapon, challenging them of aiming with accuracy. Shooting is often seen as a byword of violence, however, non-violent shooters exist as well, such as Splatoon. This subgenre includes first-person shooters and third-person shooters, as well as a plethora of other shoot 'em up games taking place from a top-down or side-view perspective.

- **Survival game:** Survival games start with limited surviving items, in a remote, isolated environment, players have to collect items, such as craft tools, weapons, or shelter, in order to survive themselves or alive in possibly. Many backgrounds are setting automatically by program in random environments, and are open-ended without setting goals. They may overlap with the survival horror genre, in which the

player must survive in a completed terrify background, such as a zombie apocalypse. One specific branches of survival game is called battle royale.

The standard of action games was determined because of the presence of these eminent games and they even have an influence on human daily life. Till 21 century, Sony Company released the stunning series, God of War, and this series makes action games more exceptional than before. The series God of War is known to be the first of three notable action games, and it is celebrated around whole world. This game distinguished itself by excellent handle and epically story, changed viewpoints of action games among the players in the whole world. Stories are not the consist of action games in earlier action games before that, but the handle feelings which are significant—that was a concept of action games at that time. But after passing the completely series God of War, many players expresses that elaborate stories could exactly make the game more entertaining.

This mode brings an experience like you are watching movies, and it accessed the experience of watching movies while you are playing [35]. Of course, it is necessary for a game to have comfortable feels for handling and hitting effects, and the emerging of God of War series has inspired game inventers for designing games. Two years later, in 2007, the series of Uncharted released another eminent game. From the crude image of game to numerous splendid action games now, it shows a routine of technology processing. In this chapter, analysis and research will be proceed based on the God of War series, which have its influence among the world.

3.4 Application in Action Game

Due to the character of basic game refinement theory, we have applied the model for various situations. In this part, introductions for some other investigations for Action games will be given. Action games are numerous today, and they are famous for pretty long flows. That means that you have to spend more time to pass an action game. Different from the settings for fighting games, like action games are flowed by round, which one round is usually spend a few minutes. But for action games, when come to fight against the boss, you have to maintain playing 10 minutes up to half an hour [6]. Due to this specialty of action games, we dont have adequate time to study in many different action games. So we choose the God of War, this remarkable action game series to be the main object of researching after analyzing and researching. And the crucial part of this research is the fighting against the boss.

Discussion related to action game and the genres of them was been through in last chapter. But here is something I have to add that many players see games similar to the God of War series, no matter story are similar or handle is similar, as Action Adventure Game [30]. So you will have a glimpse to the mess classify of electrical video games by this situation more or less. Because of the processing technology of game inventing, one game usually contains a lot of factors, meanwhile game classifying seems to be a vacuum state when the electrical video games industry have just boomed. This is one of the reasons that caused the mess of game classifying in my opinion.

Action game as continuous movement game, so the game model is the same as the Game Refinement Model in Continuous Movement Game. In the same situation with fighting games, the earliest action game in our concept emerged in the 70s. And they were actually, lack of designing and innovation. After completing and processing for many years, action games now reach a high standard and become more eminent day by day. When we picked up the series God of War as the object for researching, many situation we have taken into considered, one of these situation is the huge differences between action games before and action games now [31].

In this chapter, abstracts about the series of the God of War will be recounted elaborately in the first step and then focus on applying Game Refinement Theory for this series of games. First of all, we are going to collect data via watching videos, and data will be analyzed to make a conclusion.

3.4.1 The God of War series

The God of War, which released by Sony Entertainment Company, is the first action console electrical video game they have invented. And it was applied to PS2 platform game in northern America in the march of 2005. The whole series have an ancient Greek mythology background, which is flamboyant and magnificence, moreover they are indeed related to ancient Greek mythology by time and story.

The story of game is epically, Kratos, who became the god of war from mortal, he plotted a plan of holocaust, the object of this calamity includes all other immortals [35]. Besides HD version, replica version and collection version, this series have already released 7 productions in sum. One of them which released in 2007, named God of War: Betrayal, was a version invented specially for mobile phone installment. This game distinguished from all other games of God of War series, and it has limited audience, even the game itself was alternative peculiar, so it is hard to find some information related to this game now. So we are not going to study it in this research due to this kind of situation.

The magnificence story has always been a topic between players. It was indeed amusing and in my opinion, the story is the framework of this game and supported the game from beginning to the very end. The games based on Greek myth, after re-writing and adjusting, a splendid epically story has accomplished and come into players eyes. The protagonist, Kratos, was setting as a mortal man who born as the son of the king of god, Zeus and a mortal woman. At the initial part of this game, Kratos was the general of Sparta troops, once there broke out a war with barbarian. Kratos sold his own soul to the god of war, Ares, in order to triumph over the army which led by barbarians.

The price of triumph was high, since then he became manipulated by Aress mind arbitrarily and lost all his own conscience. Ares abandoned and betrayed Kratos in order to achieve his own destination in a continuous series of strategies, while Kratos awaked, overwhelmed numerous trainings, and finally defeated Ares becoming new god of war. But he didnt able to get rid of the destiny to be manipulated and fooled by other immortals, the raged Kratos opened the box of Pandora and gained refresh power. In the end of this game, Kratos killed all immortals successfully including the most powered one, Zeus. He

made the choice to leave this power to human, and commit a suicide to unleash this kind of power.

This is the mainly story of the series, the God of War. The other four works are performed as the related games, based on the experiences of Kratos when he killing various immortals. Story was so magnificent and splendid, it also spreads an thought of never be surrendered, long live freedom and an inspiration of revolting and fighting for freedom. This makes the God of War series receiving complimentary among the world and became a legendary of action games. The maneuverability of this series was exceptional too. The hitting feeling was strong which makes players feel like positioned in real situation and caused a sense of tension [35].

God of War series are third-person view single player action-adventure video games with even splitting and whipping factors, remarked from a fixed camera perspective. Players control the character Kratos in combo-based combat, platform, and puzzle solving game factor, and battles foes who first built up against Greek myth, including undead soldiers, harpies, minotaurs, Medusa and Gorgons, cyclopes, wraiths, Sirens, satyrs, centaurs, cerberuses, and so on. player are asked to climb walls or ladders, under the request of platform factor, jump across chasms, swing on ropes, even maintains the balance among beams to proceed through game sections.

Some of the puzzles are easy to solve, such as pushing boxes so that the players can use it as one jumping-off point to pass through an alley which could not be accomplished with normal jumping, but others are complicated, like you must find several items in certain different areas in the game to unlock gates. So even though the God of War series are action games, factors do this game contain are abundant. Moreover, there is puzzle solving factor and many puzzle solving games inlaid what makes this game kind of like a puzzle game [33]. We have already enumerated all game have been released of the God of War series by time in Table 3.1, including replica version and special edition version, we will have a clear comprehension via observing this table.

Table 3.1: History of God of War

Version	Year	Platform	Feature
God of War	2005	PS2	The first game in the series.
God of War II	2007	PS2	The second game in the series.
God of War: Betrayal	2007	M-Phone	A video game for mobile phones.
God of War: Chains of Olympus	2008	PSP	The 1st game for the PSP.
God of War Collection	2009	PS3	A reissue of first and second games.
God of War III	2010	PS3	The best game in the series.
God of War: Ghost of Sparta	2010	PSP	The second game for PSP.
God of War: Origins Collection	2011	PS3	A 2011 reissue of two PSP game.
God of War: Saga	2012	PS3	Reissue of five games in the series.
God of War: Ascension	2013	PS3	The last game for this series.
God of War Collection	2014	PSVA	A reissue of first and second games.
God of War III: Remastered	2015	PS4	A 2015 reissue of God of War III.

What else is that the newest piece of God of War series will be released in the March of 2018, on the platform of PS4. And this game set its background in myth too—northern Europe myth, which is more attractive. Our protagonist, however, didnt pass away, he continues his fighting in the world view of northern Europe. Players around the whole world are looking forward to this game, and I made an appointment of purchasing this game far earlier in the internet store.

3.4.2 Data Acquisition for God of War series

Data collecting is a crucial consistent of this research. In this thesis, related data of battles with the boss will be collected, for 6 games in the God of War series. As one renowned series, there are a lot of commentaries on the internet, and there are many videos made for series God of War specially which have completely flows. These videos facilitate us to collect data.

This research picked up one preeminent announcers commentary video to which passed all chapters to collect data. Necessary data will be recorded access watching this video. In the meanwhile, the penman have already passed all of these chapters in these 6 games to ensure the efficiency. According to the game refinement theory we have been choose, we will record two data in one round while watching this video. We have already mentioned in former chapter that the boss battle in God of War series and fighting games can be seen as the identical situation. For this reason, the model is identical with former chapter too in this research.

According to the model we are using to record data, the first data we are writing down is the sum of attack instructions completed by Kratos and the boss in game. We denote this data as A. the second data we record is the sum of successfully attack adversary, in other words, the efficient instructions output by players and we denoted it as H. we will adjust the speed of game video to make it being played slowly to reduce possibility of missing or errors.

Excluding replica version and re-edition version, there are 7 work in sum for the God of War series. Except the one which hardly to find any information released on mobile phone platform, there are 6 works in total. In this research we will analyze these 6 productions. Elements included in the series God of War were so many and distinguished that, for example, action, puzzle-solving, battles with soldiers in most situations, numerous factors contain in this game and it is seems to be not realistic to study in all factors [35].

So in this research we choose the part, battle with boss. The reason is that in one action game, the battle with boss can be crucial to the story and may influence the direction of story, even decides the story ending. So we can say that the function of boss battle is to push the story proceeding. The series God of War, as the object we are going to study in this research, to facilitate following study and make this thesis clearly, we will introduce these 6 games in the first part. We are going to order the 6 games by time of releasing and put the first one as the earliest. From Table 3.1 to Table 3.7, scenes on certain console have been showed and introduce these games.

The first work of series God of War was released on platform PS2 in 2005, we have to say that no matter scenes, music effort, or handle feelings are both fabulous and exclusive.

Figure 3.1: God of War (PS2) 2005

Furthermore, the story of this game was marvelous in the meanwhile. The games based on Greek myth, after re-writing and adjusting, a splendid epically story has accomplished and come into players eyes. The protagonist, Kratos, was setting as a mortal man who born as the son of the king of god, Zeus and a mortal woman. At the initial part of this game, Kratos was the general of Sparta troops, once there broke out a war with barbarian. Kratos sold his own soul to the god of war, Ares, in order to triumph over the army which led by barbarians. He fall into traps set by Ares. While after lost most intimate friends and relatives, Kratos awaked, overwhelmed numerous trainings, and finally defeated Ares, replanted his status and become the new god of war.

Table 3.2: Measures of Game Refinement for God of War

Boss name	H	A	$R-value$
Hydra(part1)	76	87	0.100
Hydra(part2)	121	137	0.080
Hydra(part3)	162	205	0.062
Medusa	59	72	0.107
Pandoras Guardian(part1)	164	205	0.062
Pandoras Guardian(part2)	83	108	0.084
Ares(part1)	74	98	0.088
Ares(part2)	144	197	0.061
Ares(part3)	54	83	0.089

This game caused a new wave of Greek myth and this game is renowned for its special story. The flow of this game is about 10 hours, players control 4 weapons, there are also combos corresponding to each weapon. And this became a mark and ace card of the series God of War. However, by the standard nowadays, game scenes might be simple and crude, many designs boss battle are not logical and these are points waited to proceed. Although contains so many flawless, the glamour of this game is still not being covered.

Figure 3.2: God of War II (PS2) 2007

God of War II was invented by Studios Santa Monica, SCE Company as an action Adventure game. It has been released on platform PlayStation2 professionally in the first, as the sequel of the God of War. This story mainly tells the story after our protagonist Kratos, became the refresh God of war. It is popular with the topic that this game used all functions of console PS2 at that time. This is an action adventure game that carrying with the hack and slash system. Players control character Kratos to do some fighting combos, and it built platform and contains puzzle-solving factor.

The enemies in the game are still inspired in ancient Greek myths. Kratos who had become to new God of war, found out that he had been treated and fooled by all other immortals, after he lost his friends and relatives, he began to carry all agony and planned to revenge. In the final of this story, Athena appeared in the battle and stopped one stabbing to Zeus, Zeus got a chance to flee. This became the story foundation of the third piece. This game is seen to be one of the best PS2 games and action games ever, and was laudable so that it received widely positive remarks. The positive remark on Game Rankings was 92.68% [33]. One blemish in this perfect is that the setting for battles, which are facing the boss were prone to be more formidable, so necessary skills are inevitable to pass all chapters.

God of War: Chains of Olympus was the original piece of work of God of War series, which are well-sold on platform PS2. It was invented by Ready at Dawn studio, released in 2008. This game exerted all PSPs 3D handle functions, and displayed game scenes and delicate characters could compare to PS2 version [35]. This is the first work of this series released on console. Chains of Olympics inherited identical story settings and game genre, players will play the role of the fighter Kratos in this game too. Facing with whole new trenches, enemies and training tours of Olympic immortals, and experience story different from the first original story. The game inherited characters in PS2 series, flash-backed film run mode game scene which is popular in players and vehemence fighting system, added new rounds, monsters, machineries and movements. Even the story based on ancient Greek myth was whole new too. This work mainly talk about story between

Table 3.3: Measures of Game Refinement for God of War II

Boss name	H	A	$R-value$
Colossus of Rhodes(part1)	33	52	0.110
Colossus of Rhodes(part2)	89	121	0.078
Colossus of Rhodes(part3)	108	137	0.076
Theseus(part1)	66	110	0.074
Theseus(part2)	82	112	0.081
Barbarian King(Alrik)(part1)	40	75	0.084
Barbarian King(Alrik)(part2)	149	185	0.066
Euryale(part1)	70	95	0.088
Euryale(part2)	93	129	0.075
Perseus(part1)	91	140	0.068
Perseus(part2)	73	136	0.063
Sparta Soldier	89	109	0.087
Kraken	104	155	0.066
Sisters of Fate(part1)	160	210	0.060
Sisters of Fate(part2)	41	60	0.106
Sisters of Fate(part3)	156	198	0.063
Clotho	106	138	0.075
Zeus(part1)	43	69	0.095
Zeus(part2)	124	183	0.061

Figure 3.3: God of War: Chains of Olympus (PSP) 2008

the first piece and the second piece, searching for the lost God of Sun, Apollo. It was during penman's college life when the game was released then the God of War limited edition PSP professional for this game was purchased, but it is a pity that it was lost while lending to others.

God of War III was invented released in March 16th, 2010 by SEGA as an action

Table 3.4: Measures of Game Refinement for God of War: Chains of Olympus

Boss name	H	A	$R-value$
Persian King	61	95	0.082
Basilisk	62	89	0.088
Charon(part1)	136	174	0.067
Charon(part2)	25	40	0.125
Persephone(part1)	79	108	0.082
Persephone(part2)	104	140	0.073

Figure 3.4: God of War III (PS3) 2010

adventure game. It is also the first game loaded on PS3 console. As the sequel of the God of War2, this game based on ancient Greek myth too, and mainly tells a revenge story. The background was set in ancient Greek, players control the protagonist, the God of War, Kratos, plotted a revenge to the one who betrayed him, his father Zeus. Kratos set a fire on Olympics Mountain and the war began. He climbed onto Olympics, by the lead and instructions of Athenas spirit, Kratos enable to find the Pandoras Box with monster, Holy Spirit, and titanic giant. He opened the Pandoras Box in the end, defeated the leader of immortals, Zeus, put govern of Olympics immortals to an end.

The sale of this game is nearly 5,200,000 up to June, 2012, and is still increasing [29]. It also keeps on releasing HD replica version every year since it been release. You can infer how successful and remarkable in this game. Nearly all players who own a PS3 console have an experience of playing this game, many merchants who intend to show off the perfect function of PS3 console choose this game. It is the final instalment of God of War trilogy, Kratos defeated other immortals and decided to suicide to keep the power of hope for mortal world. The most major reason purchasing PS3 was this game and just because of this game, penman became the only student who has a PS3 console in my class during college time. Astonished looks of my classmate were still in penman's recollection when they saw the marvelous scenes while penman played this game.

Table 3.5: Measures of Game Refinement for God of War III

Boss name	H	A	$R-value$
Poseidon(part1)	92	114	0.084
Poseidon(part2)	54	68	0.108
Poseidon(part3)	83	101	0.090
Hades(part1)	124	155	0.072
Hades(part2)	38	57	0.108
Helios(part1)	66	90	0.090
Helios(part2)	52	68	0.106
Hermes	69	95	0.087
Hercules(part1)	124	157	0.071
Hercules(part2)	93	115	0.084
Cronos	70	96	0.087
Zeus(part1)	105	152	0.067
Zeus(part2)	38	71	0.087
Zeus(part3)	102	143	0.071
Zeus(part4)	31	43	0.129

Figure 3.5: God of War: Ghost of Sparta (PSP) 2010

God of War: Ghost of Sparta was an action game released by Sony company in November 2cd, 2010. Players need to control Kratos, who attained the power of god of war and adventure in the game. This is the second game on PSP of the popular series, God of War. This game inherited original pieces background and game genre, set as the story before the second game of this series. It tells the story of Sparta fighters attaining God of Wars power. The scene of this game, system and containing are enhanced largely. It was invented by Ready at Dawn studio again which released former game and assisted by Santa Monica Studio [35].

Players are able to meet and battle with mermaid soldiers and enormous sea monsters while controlling Kratos crossing Atlantis, you will go deep into jokul to fight against

Table 3.6: Measures of Game Refinement for God of War: Ghost of Sparta

Boss name	H	A	$R-value$
Scylla	40	56	0.112
Callisto	100	136	0.074
Erinys(part1)	72	111	0.076
Erinys(part2)	40	62	0.102
Piraeus Lion	128	172	0.066
Deimos	102	135	0.075
Thanatos(part1)	143	189	0.063
Thanatos(part2)	45	60	0.112

stone giants and complete such adventures. To end the persecutee of nightmares and curse, he had to face his dark memories. The shatters of memories urged him to find his brother, who had been lost for years, Deimos. The adventure course of Sparta spirit will show you many lost scene in the God of War world. It will tell you the story of Kratoss tattoos, scars and original family to complete to story of virtual God of War world. It used all functions of PSP console and worked concerted, made it a masterpiece in the end era of PSP.

Figure 3.6: God of War: Ascension (PS3) 2013

God of War: Ascension is an action game released to market by SCE Company in March 15th, 2013. It is the former story of God of War series, and the nearest work of God of War series up to now. The same with other two games on PSP been released as former story of God of War. And in the timeline, it is the earliest story of God of War, mainly tells the story about Kratos human life before he became the god of war. Time set in six months later after he had been fooled and treated and killed his own wife and children. Kratos, who sold his soul, went through many adventures and troubles to break the treatment he signed with former God of war, Ares.

This game completed whole story of this game and the series has accomplished after it

being published. It adds glamour to this game series. We have to say that although this game is a remarkable one too, it cannot reach the altitude of the third work of God of War series. For the reason of inventing time and releasing time, there are some aspects better than the God of War3. For instance, the optimized game scenes, redesigned movements and so on. Moreover, the puzzle-solving factor made a big progress compares to the former work. Sometimes you have to spend plenty of time to solve one puzzle. The innovation of this game is created multi-player online mode, which adds entertainment to this game [29].

Table 3.7: Measures of Game Refinement for God of War: Ascension

Boss name	H	A	$R-value$
Aegaeon(part1)	91	119	0.080
Aegaeon(part2)	116	153	0.070
Aegaeon(part3)	83	125	0.073
Manticore	92	130	0.074
Pollux and Castor(part1)	40	73	0.087
Pollux and Castor(part2)	64	98	0.082
Pollux and Castor(part3)	91	146	0.065
The Furies(part1)	81	119	0.076
The Furies(part2)	104	152	0.067
Alecto(part1)	143	188	0.064
Alecto(part2)	110	153	0.069

We have recorded all value H and A of the 6 game in God of War series by collecting data. Meanwhile according to the Game Refinement Theory, we got R-value by calculating. We have enumerated all data elaborately in Table 3.2 to Table 3.7, and each table corresponding one game in The God of War series. Whats more, we have designed tables by times early and late. Letter H represents the sum of successfully attacks, while letter A represents all attacks, including successes and failed.

Player controls Kratos in this fighting game to attack boss and some of the attacks are efficiently while others are not. That means that boss will be attack by players while without any defends and will cause injury successfully. In the other hand, every single attack is a try and no matter success or not, in this situation we record out T value. By observing tables, we can find that the God of War series are distinct with simple fighting games. Fighting games decide winner and loser in one round like board games.

Nevertheless, in the God of War series, you have to go through 2 or 3 parts to defeat a boss, and always accompanied with the transform of boss. With the transformation the way of attacking, interlude cinematic and game scenes all changed in the meanwhile. This will fresh the game and adds amusement to the game. Interlude cinematic are played during this time and that allows players to adjust emotion and relax during the nervous tensional boss battle, the concentrate to following fighting. It can push story goes in other way and complete game experience.

We have already mentioned in former passage that action games now will bring an experience like watching movies [29] [31]. What is an eminent movie? That depends on

attractive story, which could lead you concentrate on this movie, including the using of story board, and it decides whether it is an eminent movie or not. The invention of action game is the same. Like we emphasis in former passage, story is the crucial part for one action game. For example, Uncharted series. Some handle and entertainment are not top actually, but the perfect story made it a legend. The God of War series are remarkable for stories.

Based on ancient Greek myth, it is a magnificent view of history, moreover the marvelous games scenes, really shocked and surprised players. Now we turn back to the issue we just talk about. Why boss battles in the series God of War are divided into few parts? By observing this table, comprehension of all battle scenes in the games in God of War series are divided into 2 or 3 parts will be clear. The first reason is that the story goes need it to be, another reason is the issue of time. As a game which its flow is above 10 hours, it is obviously that battle games limited in few minutes are not sufficient if it designed like fighting games which battle scenes just continue few minutes. Players will be lack of satisfaction and short fighting scenes are disadvantage to push the story go on.

So the fighting scenes with boss in action games cannot be designed too short and limited. But in such a long time, it will bring physically burden and stress to players if there are not parts to divide the whole fighting scene for players to continue what makes efficient of game to a converse way. Dividing the fight with boss will abundant the fight and players are able to see all forms of boss, various movements and scenes. This is a key to remark whether a game is an eminent one or not.

3.5 Chapter Conclusion

By observing and analyzing all data table in completed game series, cognition of nearly in all battles with boss while being calculated according to game refinement theory, R-value in distinct boss battles are different too, even we can say there are huge differences between them is clarified. The first game of God of War series, for many reasons, has less number of boss battles during complete flow, which it was just four. In the similar way, by observing Table 3.4, we are able to find out that 4 is the totally number of boss in God of War: Chains of Olympus. As for a game released on PSP console, flows are absolutely shorter when compares to game released on mainframe.

Players are easy to comprehend this. So the biggest flawless of the first game is that the number of bosses are too limited, and it is always been made fun of just because of this condition. We have already mentioned in former passage that all boss battles can be divided into few parts in God of War series, except some boss battle which have no influence on the complete story, normally are divided into 2 parts or 3. The significant one is the battle with final boss, Zeus, which had been divided into 4 parts. This is not hard to understand because the whole series are aim to defeat the ruler of immortals, Zeus, and it is the target of our protagonist. So game designers are definitely to consume some time and use their genies to let players available for a best experience. Game inventers to divide the battle with boss into few parts to abundant that and players are able to see all transformations of boss. And it mainly became the standard mode of classic games right

now and it also became the crucial factor to remark one game is an eminent one or not.

Now we are observing the boss battle in the first work of the God of War series according to Table 3.2. The second boss is Medusa, a notorious female monster in Greek myth. Due to this battle is just designed for regaining power of our protagonist, Kratos, and had no impact on the main story line of whole tale. So there is just one part of this battle. We can see that the R-value of this boss battle is 0.107, the highest value among whole game. It can be recognized clearly that this boss battle was extremely simple while fighting with Medusa which spent limited time to defeat her.

But while fighting with the final boss, former God of War, Ares, things had gotten harder. The part 2 which fighting with him was far tougher to pass through compares to other battles in the game, and it took me much time to pass it. We can recognize in this Table that R-value in this part is 0.061, the smallest of whole game. So we collect data and analyze them by the Game Refinement Theory can make sense and could explain the entertainment of game. When R-value is small, this fighting part is usually hard to triumph and challengeable while R-value is big, this fighting part can be kind of easier to pass. For the reason whole game was passed while collecting data. As a player not professional, R-value we concluded and the experience while playing the game, are quiet synchronized..

Now we are going to discuss the second work of the God of War series according to the following Table 3.3. What we would like to know is that the boss number of God of War II is the largest among the whole series, 10 in total. And something amuse is that in the second half part of this game, you will fight with Sparta soldiers and it is designed as fighting game completely. 2D game scenes are similar to the Street Fighter series.

And this also explained fighting games now contain so much factors so that they caused the mess of game classifying phenomenon these days. Compares with other games, data are lower in this one. The data of final battle with Zeus is 0.061, analogues with board games. There are just two data which are above 0.1, but this is a poor proportion of the whole game. It also explains why the second work of God of War becomes a more difficult one of them. This game considered to be challengeable and competitive while playing it and it is hard to pass all chapters. The consequence is the same if you see the research on internet that this game is definitely the hardest one in the whole series.

God of War III, The third work of the God of War series is a flamboyant piece of work. PS3 supports HD mode and make this game enhanced much about game experience. Moreover, the boss is always a powerful immortal of Greek myth by the necessary of story what makes players exited. R-value in this game is not so large in this work, which means that this game doesnt have a high coefficient of difficulty. The specialty of this game is that the last part of boss battle is not so difficult to pass and along with many interlude cinematic and flamboyant movements, brings a relaxed feeling to players. We are able to make this conclusion according to the data in Table 3.4.

Each boss battle are easier than the one in last game, this provides a relaxing time for players and they are able to concentrate on the final gorgeous combos. The biggest character of God of War series is in the last part when you are facing boss, there will be corresponding board marks in the screen. Players control the protagonist basic on marks

on the screen and press the corresponding board, adjust the rhythm of playing, then gorgeous final combo is able to be complete perfectly. The God of War series is renowned by its sanguinary scenes too, and the most sanguinary one is the part in the end. So inventers deliberately lower the coefficient of difficulty allowing players to experience this feeling thoroughly. Accompanied with functions of mainframe, we are able to experience this action movie-like feeling completely. This part is a major improvement compares to the second work.

Except these 3 main line work, the others are related games of this series. They are not so influential as main line games but still eminent works. God of War: Chains of Olympus is the first work released on PSP console, it is still waited to be improved compares to the second work, God of War: Ghost of Sparta. Due to the invention time, God of War: Ghost of Sparta inherited advantages of the third piece. Each last part of boss battle is in the same situation with the third work via data in Table 3.6. R-value are higher than the former part so this work brings brilliant experience to players what makes itself a remarkable game in the final time of PSP.

God of War: Ascension is the latest work of the God of War series. According to data in Table 3.7, this game didnt inherit the mode which the third work of this series has, players commentaries are this game is harder to pass and other remarks like this while the flow is short in the meantime. So it is not that popular and welcomed like other games in this series. It is obviously to find out that this game is harder to handle by the data in Table 3.7.

R-value is normally to be lower, none of them is above 0.09. The officially interpretation is that inventing company are challenging to make some variety in games. The issue of difficulty has been introduced before they have circulated in the market, this game would like to be more difficult to pass all chapter. What else, this game includes multiplayer online mode and this was the first multiplayer challenge in this series. But it is a pity that this game is not as popular as other games in this series so there is not a replica version for it.

We have already analyzed and discussed all games in the God of War series. We can conclude that the Game Refinement Theory can be applied for almost classic action games analysis. Data we collected can explain this and make sense too. The Game Refinement Theory corresponds to status of every single game. The math model of Game Refinement Theory is a useful tool to study action games and can achieve some results of them. The target and the innovated point of this research is to apply Game Refinement Theory for action games to action games which have never been experimented before.

The Game Refinement Theory applied to board game, sports game and real time game on internet made some achievements, nevertheless, the action game area is still vacuum and blank, no one have ever study in it or games related to it. By this way, this research compensates this kind of vacuum and is significant, contributed to the processing of Game Refinement Theory. Due to the long flow of action games, research on it would spend more time. Research till now has analyze the God of War series as the unique case, so we will study on other eminent games in the near future.

Chapter 4

Analysis of Shooter Game using Game Refinement Theory

4.1 Chapter Introduction

Research on shooter game will be the mainly part of this chapter. Emerged in the primitive era of electrical video games with fighting games and action games, nevertheless, games contain shooter factor only exist in the nonage of it [6]. Now they are seen as a branch of action games, contained by all prevail classical action games. (for instance, the God of War series and the Uncharted series). Otherwise, fighting game area is exploited to implicate a factor of shooter too. In this case, this chapter is seen to be a prolongation of the action games chapter, a continuation of research. Bullets launching often owns a high velocity that makes it untoward to calculate by unaided eyes in the meanwhile fallibly in collecting data or causing error. There was a colleague in this lab attempt to research on it then he had to abnegate on account of this obstacle. The target of this research is to surmount obstacles preveniently turn collection in rapidly velocity efficiently of shooting sum in reality.

Calculating by unaided eyes prone to be in adaptable and consuming plenty of time, the most efficient way comes to be programming. Applying a JAVA shooter game added valid calculating code, system will calculate effective data automatically during manipulating time. They can be apply to Game Refinement Theory without tortuous. This chapter concentrates on the reality of calculating programming. Math model are provided in this chapter, recommending processing of shooter game and selected game of this research. Data created automatically via program will apply for analysis and applications with Game Refinement Theory then results will been discussed and concluded. Code of calculating bombing numbers will be assumed in the appendix.

4.2 Shooter Game

In this chapter we are beginning with shooter games definition and classify, subjoined some history of it. Shorted as STG, shooter game is one genre of games and a subgenre of

action games. Possessing action games characters and realized by acting, purely shooter games are not exist. Whatever implements are being used, games processing shooting movement can be called as shooter games. To distinguish with general action games, games emphasis on accomplishing by shooting only can be intituled as shooter games. As an outstretched part of action game research, essential point of definition and classifying will be clarified to complete action game researching.

4.2.1 Definition of Shooter Game

As a subgenre of action games, shooter games inclined to attack with virtual weapons or real. Contained violence element is a controversial peculiarity of them but meanwhile, cartoon shooter games are eliminated violence element absolutely like Angry Bird, unilateralism is explicated to connect violence and shooter games [36]. Shooter games was enumerated as one genre shorted as STG. With the increasingly part of action factor in shooting games, to facilitate classifying, shooter games are sorted as a subgenre of action games once again. Nonetheless, still games emphasis on accomplishing by shooting are calling shooter games.

They are prone to be distinguished by view and are sorted by various views. Initial shooter games were not 3D version and they were with shabby scenes. Prevail first shooter view and third shooter view is not foundation status of shooter games. They are generally designed as 2D view, sorted elaborately as Platform Game and Side-scrolling Game. The most renowned one of platform shooter game is Contra on FAMICOM, nearly all youngsters have an experience of controlling. Enemies in Side-scrolling Game often appear above surface or on the right, players are asked to manipulate game characters or spacecrafts. It was ordinary status of initial shooter games. With the game technology improving, shooter games prevalent are sorted as first person shooting game and third person shooting game. All shooter games can be comprised in this way and here is action games classify [36].

- **First Person Shooting**
  First Person Shooting, shorted for FPS, designed in players view, the most remarkable one called Call of Duty, released one refreshed piece annual then well-sold. Players are in first person view, like you are positioned in games environment instead of manipulating virtual characters in screen. It brings viewing impact enhanced initiative and realistic perceive status in the meanwhile. Initial first person shooter games provoking tension via screen beam and rapid controlling rhythm. Accompanied by improvement of hardware and compounding of game genres, abundant stories, delicate scenes also creative sound effect are able to be provided.

  One thing is notable that sense of realistic stimulated first person game boom. To enhance this feeling of realistic, challenges to recur real world appearance begin to bud. Pursue for extraordinary scenes led by first person games started in 2007. Meanwhile, the popularity of first person games catalyzed the development of game engine and pushed it to be topics between players. This phenomenon has never emerged in other game genres.

- **Third Person Shooting**
  Third Person Shooting, shorted for TPS, is a subgenre of shooter games too, distinguished itself characters are seeable on the screen instead of displaying characters view only. So they emphasis on movements while first person shooter games emphasis on realistic feelings. The masterpiece of third person shooter games is biohazard series, players are able to observe every movement the character made while playing.

  Players are able to see the protagonist like a beholder, facilitates situations getting hurt and surroundings, bullet lines and so on. Feeling of realistic erodes for this reason. Kind of shooter games now are designed to enable players shift from first person and third person, this transfer enable players to experience both of realistic and moving.

- **Light gun shooter**
  Using outside equipment replacing game controller or imputing by mouse and board. Apply for domestic console or arcade.

- **Shooting gallery**
  Imitating shooting gallery. Can be seen as a subgenre of imitating games but not solemn or strictly, theme on shooting gallery only. Object can be enemy soldiers or toys, cartoon characters.

- **Tactical shooters**
  It is called Simulation shooter game also, shorted for SSG. Players are facing enemies in the meanwhile conduct teams or troops on battlefield, in high standard of simulating reality, low standard of entertaining. Otherwise they are notable for tactical, it is also a subgenre of simulating games. Content above introduced main subgenres of shooter games. As a genre existed since early electrical video games generated, sorted into action games completely now. Action games contain shooter games factor more or less and it is inevitable to research on shooter games while research action games.

4.2.2 History overview of Shooter Game

Here is an elaborately instruction of shooter game processing history. It can be dated back to 1962 as one of the primitive electrical video genres. Invented by Steve Russell and his classmates in Massachusetts Institude of Techonology in 1962, Space War provided players to attack enemies spaceships by weapons while avoiding striking planets. It was completed on PDP-1, presented scenes via advanced anodic radial tube. This was the initial entertainment couple shooter game, 4 years late than first electrical video game in the world, Tennis for Two, and appeared on computer program [36]. It is the ancestor of shooter games, displayed in Figure 4-1, the real circulation status are showing.

Though designed by simple points and lines, it is especial and memorable. Players need to manipulate spaceships circulating by professional machines, destroy and burn opponent down by missile and beam, in the meantime avoiding crush to planets. Gravitation,

Figure 4.1: Space War on PDP-1(1962)

accelerate, inertia and other physics characters are stimulated to integrity, accelerated moving space are randomly appeared. It contains voluminous factors that later shooter games include.

About 10 years after Space War come into the world, electrical video games came out of laboratory and became a popular entertainment. The first arcade boom happened in the 70s America and the primarily work was also shooter game, Space Invaders in 1978 [29]. Space Invaders is one of the ancestors of shooter games, even electrical video games and can be scripted into games history. We mentioned in last chapter is it also the proverbial ancestor of action game. The illustration of Invaders became one of the symbols in pixel era. Invented by Taito Company and ameliorated from designers work Space Monsters, adds crucial shooting instructions, this game allowed players attack computers in long distance. Distinguished with prevail games proceeded by avoiding or crushing, shooter games born as a refresh game genre.

Numerous mimic works emerged since Space Invaders attained success. Counterparts are almost plagiarized works, for instance, Galaxian released by Namco one year later, delicate adjusted details of Space Invaders then put into market as innovated work. Otherwise, widely attendant of companies and sellers matured and blossomed shooter games in short term then stimulated innovation of game entire game area. Invented by remarkable game designer Eugene Jarvis in 1980, Defender was released as another shooter game. It was innovated not only in horizontal version instead of traditional vertical version, but also made progression in breaking through regular windows realizing scroll background work. Games scenes transferring accompanied with players moving and stretching new layout, obviously built a foundation for all games after.

In the whole late 70s and 80s first, the golden age of American arcade market, shooter games occupied a ruled status. They are born for arcades. Atari collapse evidence hap-

pened in 1983 frozen American arcade market into midwinter and aroused an arcade recession. Fortunately, Nintendo and its FAMICOM console arise in the other shore of pacific leading shooter games to another firmament [31].

The second year after FC born, the first game released by Namco on it was arcade version Galaxian. It aroused heavier bizzard in China than in Japan. As a Chinese, penman knows it profoundly for most Chinese in this age reflect it in brain immediately when catching sight of it even forget its name. We displayed game scenes of Galaxian in Figure 4-2. In the end of this year on 8th November, Xevious released in 1982 was replanted into FC console too, which also invented by Namco. It brought abundant profits to Namco as a vertical scroll shooter game, soled 1500000 in few months finally became the best seller shooter game in the history of FC. When the new Namco office building completed in the next year, professionals considered it is benefit in the successful of games last year call it iron paddles building in jest.

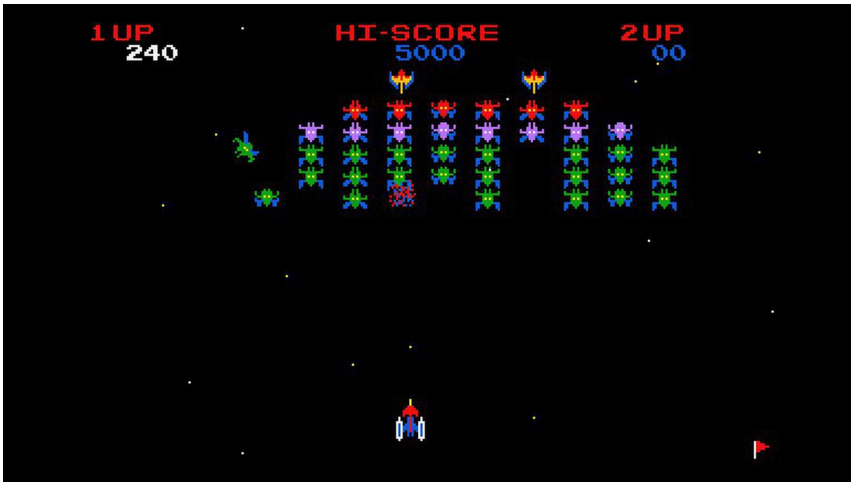

Figure 4.2: Screenshot of Galaxian (1984)

The successful of FC made inventers to consider replant works into console in the meanwhile of inventing arcade shooter games. From initial FC to SFC, MD or PC-E, or other platforms, they assisted each other. In the whole early 80s to first 90s, earlier mainly game publishers released shooter games more or less, a large amount of them became masterpiece of its own company. For example 1942 series released by Capcom, Star Soldier series released by Hudson [6]. The most remarkable one can be Gradius released by Konami and its additional work Salamander series, they are eminent works and outstand horizontal shooter games in top from scenes, background music or chapters and system. In the same time, shooter games proceeded rapidly in arcade market too. Excluding Gradius, splendid shooter games are still numerous. Darius, R-TYPE, also THUNDER FORCE series are releasing refresh works continuously and replanted to many platforms. Passing to 90s, Companies emphasis on arcade raised. Video System company released Areo FightersSEIBU released RAIDEN. Street fighter2 released by Capcom in 1991 catalyzed fighting games rising like waves Space invaders aroused at that time [7]. Rubbed space of shooter games, Street Fighters was such a success that many players turned to fighting

army. Accompanied by inevitable 3D era coming, 2D shooter games fading more rapidly. Shooter games on arcade descend swiftly, fighting games soon occupied its station. On the contrary, SS mainframe are not matched to PLAYSTSTION in functions in family console so it collected plenty remarkable works.

FPS are the dominating way of shooter games nowadays. Traditional 2D shooter games fading are inevitable reality, once insist on operating solely was broke due to financial deficit. Released farewell work Dodonpachi Dai-OuJou on Xbox360 platform, transformed to invent social games and mobile games [36]. Fading of Japanese arcade market, rising of 3D games, transferring of players types and so on, there are bunches of reasons to explain shooter games fading. Compares to other games confronted the same issue, leaking of transforming measures is the most lethal one. As one of the ancient game genres, shooter games have adequate simple steps to make it easy to be invented otherwise complete in a limited time. Works in the early 80s have already included most factors afterwards, the enhanced partial can be facial scenes, music or difficulty level to pass game. When weary of shooter game concept itself, ancient shooter games inevitable to fade in the condition of improving impossibility. What to comfort is though ancient shooter games are not exist anymore, they are still flourish by other means today in the form of FPS, and became a basilic part in action games. Formal Call of Duty series are hot sold by the time of this dissertation accomplished. One refresh work will be released annual and popularized. This explains shooter games are not vanished, they are exist in other forms.

4.3 Application in Shooter Game

This chapter research on concrete applications of shooter games. According to the fundamental idea of game refinement theory, we have applied the model for distinct areas and situations. Prolonged research will be exhibit in later chapter for shooter games. As a subgenre of action games it is inevitable to be researched. The high velocity of launching makes it tougher to collect related data, even there is no guarantee of error-free. Basis on this situation, this research select a JAVA programmed shooter game invented by Battle City according to FAMICOM platform. Program will calculate data necessary automatically while running this game in condition that adds corresponding code in it which enable data collecting to reality. Secondly data will be analyzed and concluded.

4.3.1 Battle City on the JAVA platform

Battle City, invented by Namco Company, released in 1985 as a platform shooter game [6]. The theme of Battle City is guarding base. It is contains built-in round editor, rarely to see on FC platform, players could create unique round if they like and intensify base or tanks by attaining implements. Entertaining game actually, players need to attack opponent tanks while guard his own from being destroyed. This setting makes game more thrilling and breathtaking, practice scenes are showed in Figure 4.3.

$13 * 13$ maps consists 35 rounds of Battle City, terrain included block balls, ocean, nickelclad and floor. There were not excess factors in it, however, players need to be the

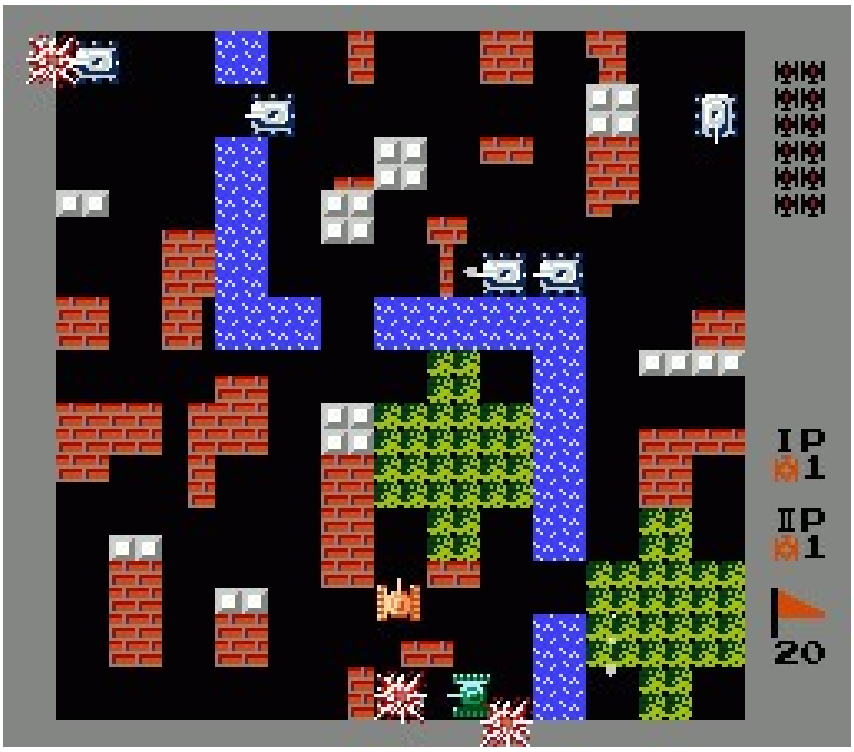

Figure 4.3: Screenshot of Battle City (1985)

instructor of the last tank troop preventing tank base being destroyed to fight. Treasures contains distinct functions are available to be attained, enemies include armored car, light tank, heavy tank and antitank gun. Possibility exists in offset opponents fire and own fire or fired by own. It was no significant among Japanese players but situation transferred when it comes to China. Battle City can be a byword of FC games without exaggerating. Once has an experience of playing FAMICOM all has been through this game. The popularity can be expressed in this way. This splendid game was chosen to be researching object in order to study action games. An intimate of penman did research for this game when he progressing his dissertation. Now obtained his permission, we take advantage of Battle City programmed by JAVA and show its practice scene as Figure 4.4.

Though not re-appeared exactly with FC version, all elements and game character were realized. JAVA version brings approximately experience with FAMICOM by real running, so it can be seen as a JAVA version. Players are commended to attack enemies tank while guard his own too. One thing makes this game not so flawless is that it has only one round while the original version has 35. It can be run and played on computers just as a normal game, calculating code are necessary when precision data needed to collect data automatically. Code we added will be given in dissertation appendix. Then another thing needed to explain is FC, SFC and other platform games were allowed to explicit data by some equipment for researching or entertaining due to the ancient time line and it is legal. So Battle City in this research on realized on JAVA platform can be applied.

Figure 4.4: Screenshot of Battle City on the JAVA platform

4.3.2 Data Acquisition for Shooter Game

Here in this part is about data collecting. According to Game Refinement Theory, we need to collect two data sorts, one of them is sum of bombs launched by our own noted as S, while the other is hit target successful noted as H. Corresponding code was applied to JAVA platform so recording is not necessary while playing to collect data. System will display information directly when the game is over. As Figure 4.5 shows, sum of hitting successfully is a certain value due to only one round was applied. Now we circulate it for 10 times then data required will be displayed in system by the time games over.

We have enumerated S and H in 10 rounds and also corresponding R-value in Table 4.1. H presents the sum of hitting successfully while S represents the sum of launching. Via math model of Game Refinement Theory we can calculate corresponding $R - value$ in each round.

Polygonal line picture was made basic on data we attained as Figure 4.6 shows, axle x represents each round while axle y represents R-value. The fluctuated R-value is available to be observed and been seen directly. The 10 rounds were exactly the same round so R-value didnt fluctuate apparently, distributing from 0.06 to 0.07 stably. It can be analogue to board game and sports game and R-value was approximate to fighting games on earlier FC platform. This chapter emphasis on realizing data collecting, so there were defects while practice applying and we will dedicate ourselves in completing research about shooter games. The biggest R-value was 0.071 while the smallest was 0.063. R-value in Battle City prone to fluctuate from 0.065 to 0.071 after analyzing which approximate to earlier fighting games. It is amuse that shooter games and fighting games belong to action game category in some aspects.

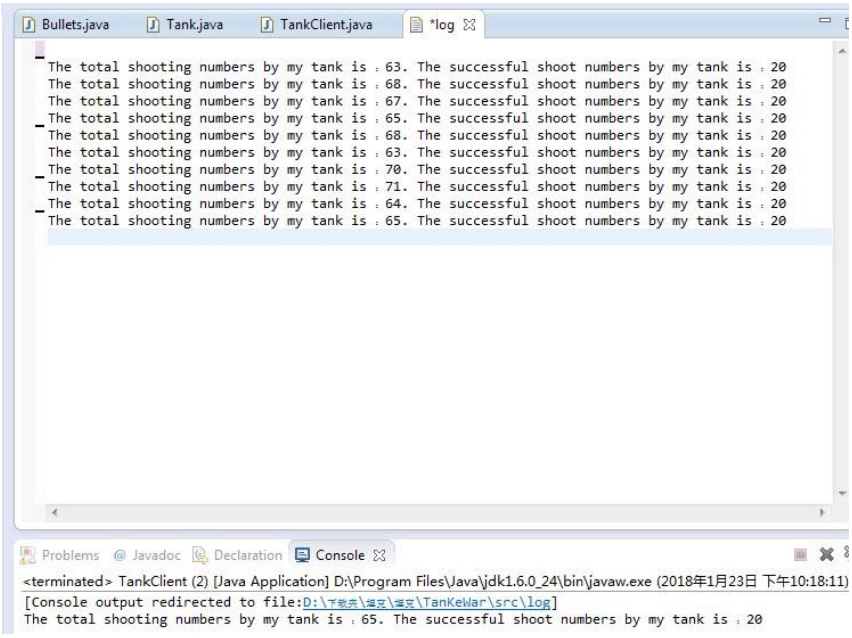

Figure 4.5: Automatic statistics collection for Battle City

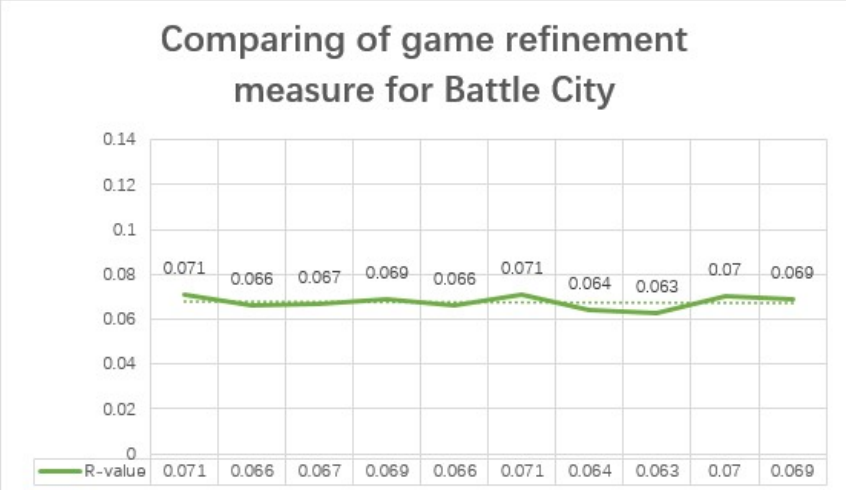

Figure 4.6: Comparing of game refinement measure of Battle City

4.4 Chapter Conclusion

As a stretch and prolonged part of action game research, collecting and calculating data were realized by programming. Factors contained in shooter game, for instance, bullets, bombs, have high velocity and hardly to be catch by naked eyes and other characters straitened researching. So efficient program are necessary while analyzing this game genre to proceed data collecting automatically. Based on original Battle City version, recur in Java platform, we picked up this shooter game to research. Via data we obtained general region of R-value is available, from 0.06 to 0.07 roughly. This interval was approximate

Table 4.1: Measures of Game Refinement for Battle City

H	S	$R-value$
20	63	0.071
20	68	0.066
20	67	0.067
20	65	0.069
20	68	0.066
20	63	0.071
20	70	0.064
20	71	0.063
20	64	0.070
20	65	0.069

to earlier fighting games and action games. Meanwhile, as one subgenre of action games, R-value in this interval is regular and easy to comprehend. This demonstrates and evident the validity of Game Refinement Theory.

$R-value$ was approximated between earlier shooter games and earlier fighting games, while based on the second chapter related to fighting games, we made a conclusion fighting games are cline to entertainment and emphasis on it as time passing, compares with earlier fighting games displayed a higher value and shows a tendency to be increasingly higher in the future. So why not hypothesis bravely that shooter games are similar to fighting games, giving an increasingly higher R-value while proceeding and completing itself? This is a amuse issue so in this chapter emphasis on realizing data calculating automatically by program so the shooter games we analyzed was not abundant. More shooter games will be applied for data collecting from now on then apply Game Refinement Theory math model to analyze in order to make a conclusion.

Chapter 5

Conclusion

5.1 Fighting Game

In Chapter 2, We are able to find out easily by observing and analyzing the table above that from 1980s to 1990s, in earlier time fighting games, R value of ball games and board games are approaching to each other, about 0.06 to 0.08. We are able to aware that fighting games in the earlier time are similar to gym games, for fighting games in earlier time are boxing movement simply and karate games are simply karate movements and so on. What's more, fighting games in earlier time have strong competitive sense, and this specialty makes fighting games similar to board game in the same time. Fighting games in the earlier time perform by the form of electrical video game, we even can confirm that earlier fighting games are gym games imitated by electrical video games. So it is not hard to make a comprehension that R value in earlier fighting games is approaching to R value in earlier board games.

When it comes to middle 90s till today, R value we have been counted is higher than before, generally fluctuated from 0.9 to 0.13. And why R value of fighting games nowadays is generally higher than fighting games in earlier time? That will be a meaningfully question to discuss. Analyzing R value according to Game Refinement Theory, the higher R value is, the faster speed the game has and the game will be more entertaining. What I have already written in my dissertation above is that earlier fighting games are more like gyp games stimulated by electrical video games. Most games published in that time are made to be in this kind of statement. For instance, advertisements of electrical boxing games at that time are usually in this way: you can enjoy the pleasure of boxing game even when you are cozy at home, and feel the high tension of competition in reality. So you are able to understand when we arrive here that fighting games in earlier time have big differences from fighting games these days. Inventors of fighting games now put their attention more on the entertainment of games instead of stimulating gym competition game in reality only in earlier time. Let me give you an example so that could make you understand easier, Hadoken in Street Fighter series, and other many deadly blow in this game. But it can never be done by mortal in real world.

We also mentioned on above that Street Fighter 2 can be the monument of fighting

games because it has changed the trend of fighting games [4]. Accompanied by development of electrical technique, the scene of video games become more and more clear and gorgeous, the speed of electronic processor became more and more quickly in the same time. And this also means that game inventors are able to create more flamboyant movements and deadly blow for characters in an easier way. Started with the born of Street Fighter 2, characters in the game are always able to do gorgeous combos, this is totally beautiful and makes players feel excited. Player who is controlling games may in high tension and experience of playing will be pushed into a new level. But the most significant point is, however, actions in the game and deadly blow can never be accomplished by human being in reality like we have mentioned.

Above all, the most significant distinguish between fighting games now and before is fighting games now put more attention on entertainment and recreation of game and high tension, or heart beat bring to players but not simply stimulating fighting movement in reality like fighting games in earlier time. Results we have got in this research are significant and meaningful to reality social life too. Mainly fighting games in these days have a high speed of moving and processing with a strong entertainment. Fighting games like this are easily to be welcomed by players like we have already discussed. Game designers are available to use Game Refinement Theory to judge whether this game can be popular or not in the progression of game inventing. If you got a super low R value, game inventors should really think it over if the game is worth to be published. After all, old-fashioned fighting games are not as popular as the time they have just born.

5.2 Action Game

In Chapter 3, we analyzed and discussed all games in the God of War series. We can conclude that the Game Refinement Theory can be applied for almost classic action games analysis. Data we collected can explain this and make sense too. The Game Refinement Theory corresponds to status of every single game. The math model of Game Refinement Theory is a useful tool to study action games and can achieve some results of them. The target and the innovated point of this research is to apply Game Refinement Theory for action games to action games which have never been experimented before. The Game Refinement Theory applied to board game, sports game and real time game on internet made some achievements, nevertheless, the action game area is still vacuum and blank, no one have ever study in it or games related to it. By this way, this research compensates this kind of vacuum and is significant, contributed to the processing of Game Refinement Theory. Due to the long flow of action games, research on it would spend more time. Research till now has analyze the God of War series as the unique case, so we will study on other eminent games in the near future.

5.3 Shooter Game

In Chapter 4, as a stretch and prolonged part of action game research, collecting and calculating data were realized by programming. Factors contained in shooter game, for instance, bullets, bombs, have high velocity and hardly to be catch by naked eyes and other characters straitened researching. So efficient program are necessary while analyzing this game genre to proceed data collecting automatically. Based on original Battle City version, recur in Java platform, we picked up this shooter game to research. Via data we obtained general region of R-value is available, from 0.06 to 0.07 roughly. This interval was approximate to earlier fighting games and action games. Meanwhile, as one subgenre of action games, R-value in this interval is regular and easy to comprehend. This demonstrates and evident the validity of Game Refinement Theory. $R - value$ was approximated between earlier shooter games and earlier fighting games, while based on the second chapter related to fighting games, we made a conclusion fighting games are cline to entertainment and emphasis on it as time passing, compares with earlier fighting games displayed a higher value and shows a tendency to be increasingly higher in the future. So why not hypothesis bravely that shooter games are similar to fighting games, giving an increasingly higher R-value while proceeding and completing itself? This is a amuse issue so in this chapter emphasis on realizing data calculating automatically by program so the shooter games we analyzed was not abundant. More shooter games will be applied for data collecting from now on then apply Game Refinement Theory math model to analyze in order to make a conclusion.

Chapter 6

Conclusion and future work

6.1 Conclusion

Research can be divided to two parts generally in this thesis, the fighting games part accompanied action games part. Demonstration has been made in former passage since shooter games are considered to be a subgenre of action games, chapter related to shooter games was seen as a prolonged chapter of action game research. Conclusion been made in fighting games part was that R-value in earlier fighting games was limited while proceeded in fighting games prevalent. R-value in fighting games are generally increasing by years annually. R-value was approximate between ball games or board games and fighting games from 1980s to first 1990s, at about 0.06 to 0.08. Moreover, what have been clarified that earlier fighting games are similar to sports games, for instance earlier fighting games were simply simulate boxing movement, or karate, and so on. They were emphasis on competitive which analogue to board games. We can say that earlier fighting games were actually sports games stimulated by electrical video games hence R-value between earlier fighting games and sports games, board games were extremely approximate.

From middle and late 1990s to nowadays, R-value we calculated was higher, generally from 0.9 to 0.13. According to Game Refinement Theory, the higher R-value is, the high velocity is the game and makes it more entertaining and amusing. Fighting game nowadays are more prone to its entertainment and recreation, game concept based on simulate sports competition in reality was abandoned. Numerous fighting games after Street Fighter2, characters are able to do flamboyant combos in an unleashed and magnificent way which adds tension and physical excitement to players while controlling games. Combos or continuous movements splendid like that are impossible for humanity in reality. So fighting games nowadays are radically distinguished with earlier fighting games for fighting games now are cline to entertainment and thrilling feelings bring to players while earlier fighting games are prone to fighting or movement simulated to reality. Combos became an increasingly magnificent factor and a crucial element of fighting games prevalent or not. The result of this research contributes to real social society and is meaningful. Prevail fighting games contains high speed, strong entertainment and they are welcomed by players. Game designers are able to judge whether the game will be welcomed or not

via Game Refinement Theory while they inventing games.

In the part which researched and discussed action games, we made eminent achievement too. In each game of the God of War series, R-value in boss battle been calculated according to Game Refinement Theory were distinctive. After analyzing R-value in boss battle of the God of War series, some amusing conclusions were made. Bosses were limited in the first work of God of war series and R-value was in a low status eventually which make it hard to pass all chapters. R-value in the second work of God of War series were not so high made the second work an impracticable one of the God of War series. The third work and the last work of the God of War series have a relative high R-value so the most tension feelings and unleash of emotion were brought. Conclusions been made according to Game Refinement Theory and emotions or feelings brought to players were generally in common so we can determine the efficient application to prevail action games analysis of Game Refinement Theory and also provides support to action games flows design. The Game Refinement Theory was a useful tool and contributes to action game research. The crucial target of this research is to make some efforts to apply Game Refinement Theory to action games. Game Refinement Theory has already contributed to board games, sports games, and also some Real Time Games on internet and was efficiently applied and research on them, nevertheless, research on action games was a vacuum and no one has been research on it. The result of this research can compensate this vacuum and significant to the development of Game Refinement Theory.

As a prolonged and stretched part of action games research, we realized data collecting of an earlier shooter game by program. Factors contained by shooter games, such as bullets and bombs launching have characters that in high velocity and hardly caught by naked eyes or been calculated, so it is inevitable and necessary to calculate data automatically by programming. The crucial part of this chapter is to realize calculate shooter games data automatically via program. This research transferred shooter games data collecting to reality and contributes to the development and proceeding of Game Refinement Theory. We have attained region of R-value of shooter games in this research, about 0.06 to 0.07. This interval was approximate to earlier fighting games and action games. As a subgenre of action games, shooter games demonstrates the efficient of R-value indirectly, in other perspective, it also demonstrates the efficient of Game Refinement Theory. We can believe that Game Refinement Theory will contribute to wilder area and numerous fields in the near future.

6.2 Future work

We will analyze and study on more fighting games and action games in approaching future to complete and improve this research. Combos factor in fighting games is an inevitable part for them and the key or crucial element to judge whether a fighting game is entertaining or not. We will use fighting games AI to analyze the importance of combos to a fighting game and moreover, to test and verify relationships between earlier fighting games and fighting games nowadays then predict the routine and direction of fighting games development by applying Game Refinement Theory. In the other hand, action

games all own long flows need to spend plenty of time to collect data for. So research now basic on the God of War series simply, other remarkable games will be researched next in the future.

There are not adequate achievements been made right now to complete action game research so more distinct games will be studied on by collecting data and analyzing, furthermore, applying to complete related research. Results obtained by Game Refinement Theory will be analyzed by it. The completion of Game Refinement Theory contributes to action game designing and provides supporting efforts.

We can tell from the result and achievement of this research that earlier shooter games have an approximate R-value with earlier fighting games. We made a conclusion in this thesis that fighting games are prone to entertainment and recreation by passing time and shows an increasingly higher tendency compares to earlier fighting games. Shall we hypothesis boldly that shooter games are similar to fighting games, as the development of shooter games, R-value of it will increase by time. This is an amuse topic and issue. Due to the crucial part of this thesis is to realize calculating data of shooter games automatically and the sum of shooting was not adequate, so in research from now on more shooter games data will be collected then analyzed by corresponding model of Game Refinement Theory to make a completed conclusion. Then contribute to the development and improvement of Game Refinement Theory.

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Appendix

Add two attributes to Tank.java, recording respectively as sum of launched by our part and sum of hitting successfully, initialize to 0.

```
public static int bombTotal = 0;
public static int bombEffective = 0;
```

Add statistics（） method to Tank.java category responsible for printing bombs launched by our part then quit the game.

```
public static void statistics()
{
    System.out.println("The total shooting numbers by my tank is :
    "+Tank.bombTotal+". The successful shoot numbers by my tank is :
    "+Tank.bombEffective);
    Tank.bombTotal = 0;
    Tank.bombEffective = 0;
    System.exit(0);
}
```

Add sum of hitting successfully to hitTanks method in Bullets category.

```
public boolean hitTanks(List<Tank> tanks) {// when bullet hits tanks
    for (int i = 0; i < tanks.size(); i++) {
        if (hitTank(tanks.get(i))) { // apply hitTank for each tank
```

```
                Tank.bombEffective ++;
                return true;
            }
        }
        return false;
    }
```

Add sum of launched by our part to keyPressed method in Tank.java category.

```
public void keyPressed(KeyEvent e) {  // receive board incident
        int key = e.getKeyCode();
        switch (key) {
        case KeyEvent.VK_R:  // press R to restart game
            Tank.bombTotal = 0;
            Tank.bombEffective = 0;
            tc.tanks.clear();  // clear
            tc.bullets.clear();
            tc.trees.clear();
            tc.otherWall.clear();
            tc.homeWall.clear();
            tc.metalWall.clear();
            tc.homeTank.setLive(false);
            if (tc.tanks.size() == 0) {   // appear tanks when area gets
vacuum
                for (int i = 0; i < 20; i++) {
                    if (i < 9)                          // set tanks' appear
position
                        tc.tanks.add(new Tank(150 + 70 * i, 40, false,
                                Direction.R, tc));
                    else if (i < 15)
                        tc.tanks.add(new Tank(700, 140 + 50 * (i -6), false,
                                Direction.D, tc));
                    else
                        tc.tanks.add(new Tank(10,  50 * (i - 12), false,
                                Direction.L, tc));
                }
            }

            tc.homeTank = new Tank(300, 560, true, Direction.STOP, tc);//
```

```
set position our part appears

            if (!tc.home.isLive())  // reset life for home
                tc.home.setLive(true);
            new TankClient(); // ecreate surface
            break;
        case KeyEvent.VK_RIGHT: // monitor right board
            bR = true;
            break;

        case KeyEvent.VK_LEFT:// monitor left board
            bL = true;
            break;

        case KeyEvent.VK_UP:  // monitor up board
            bU = true;
            break;

        case KeyEvent.VK_DOWN:// monitor down board
            bD = true;
            break;
        case KeyEvent.VK_F:
            bombTotal ++;
            break;
        }
        decideDirection();// use function to ensure moving direction
        }
```

Use statistics（） method when vanish opposite tanks.

```
        if (tanks.size() == 0 && home.isLive() && homeTank.isLive()) {
            Font f = g.getFont();
            g.setFont(new Font("TimesRoman", Font.BOLD, 60)); // judge
            whether defeated or not
            this.otherWall.clear();
            g.drawString("you win! ", 310, 300);
            g.setFont(f);
            // you win
            Tank.statistics();
            }
```

Use statistics（） method when vanished by opposite tanks

```
    public boolean hitTank(Tank t) { // when bullets hit opposite tanks

        if (this.live && this.getRect().intersects(t.getRect()) &&
        t.isLive()&& this.good != t.isGood()) {
            BombTank e = new BombTank(t.getX(), t.getY(), tc);
            tc.bombTanks.add(e);
            if (t.isGood())
            {
                t.setLife(t.getLife() - 50); // 50 life reduced when hit
by one certain bullet, die when 4 received, 200 life value in total
                if (t.getLife() <= 0)
                {
                    t.setLive(false); // set life to perished status when
life is 0
                    Tank.statistics();// print sum of bombs launched and
hit opposite successfully when tanks on own part vanished
                }
            }
            else
            {
                t.setLive(false);
            }

            this.live = false;

            return true; // true fire successfully, return
        }
        return false; // failed return
        }
```

Use statistics（） method when own home destroyed.

```
    public void gameOver(Graphics g) {
        tc.tanks.clear();// clear surface
        tc.metalWall.clear();
        tc.otherWall.clear();
        tc.bombTanks.clear();
```

```
tc.theRiver.clear();
tc.trees.clear();
tc.bullets.clear();
tc.homeTank.setLive(false);
Color c = g.getColor(); // set parameter
g.setColor(Color.green);
Font f = g.getFont();
g.setFont(new Font(" ", Font.PLAIN, 40));
g.drawString("you lose!", 220, 250);
g.drawString("  game over! ", 220, 300);
g.setFont(f);
g.setColor(c);
// home destroyed result in game failure
Tank.statistics();
}
```