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Movement Expression in the Stop-motion Animation

Woo Song Bang[1], Soon-Gohn Kim[2]
[1]Department of Cartoon and Game Animation, Yewon Arts University
e-mail : bluefish_66@hanmail.net
[2]Department of Computer Multimedia Science, Joongbu University
e-mail : sgkim@joongbu.ac.kr

Abstract This paper describes the movement expression for animation using stop-motion method. The expression of movement in animation is the most important factor to form the work. The movement of expression and the relationship of Timing are the basic factors in understand visual arts, animation. At this time, the meaning of timing are the amounts of time spent moving the object and character. In this Paper, we show the basic principles of Timing in Stop-motion animation through experimentation, identifying how Timing change with camera angles and comparing them to the present ideal Timing method.

Keyword: Timing, Stop-motion Animation, Principle, Spacing

1. Introduction

Animation is referred to as the connection of images of consecutive movement as the expression technique of object's movement which is made by a human beings optical illusion. When the human eye see's an object, their cornea remembers an afterimage of the object for 1/16 second. The minimum time unit our eyes can read is 1/16 second.

On the other hand, if our eyes see sixteen images at one still moment, they can recognize the movement of images at rest due to remember the afterimage of previous image seen. Animation is manufactured by the Frame by Frame method based on these principles. But the Stop-motion is an animation that moves a character manufactured by dolls or clay step by step and is made into a film by the Frame by Frame method. The Timing of Stop-motion animation implies the control of speed of each character's movement with direction. It means spending time on each scene and total time including all movement. The Timing of all animation including the Stop-motion is one of the most important factors to compose the scenes.

Our purpose in this study is to show the ideal Timing method should be recognized in accordance with changing the camera and its angles and comparison and is done through our experimentations.

2. Ideal Processing Method

The Timing comcept are the amounts of time spent on the object moving. If there is speech or music, the Timing is already determined. In this case, the Timing is determined by the soundtrack. When the speech or Timing is determined, usually a Stopwatch or Metronome is used. When the time is measured by the Stopwatch, the average length is accepted after the action is rehearsed four or five times. The Timing in the animation tends to be faster than actual spending time so the choice of a shorter action is good selection.,

3. Spacing and Timing

When we make the movements in the animation, we should pay attention to the Spacing and Timing. If we dot on the paper irregularly with a pen and move the paper at the same time, a line composed of serial dots with different space will be made on the paper.

At this time, the beating of a pen becomes the Timing and moving the paper is the Spacing. The Timing implies the amount of time spent when an object moves. The Spacing means the amount of physical space that a object or a character moves. When the increase and decrease of Spacing is regular, the movements of object in animation can be maintained evenly. Maintaining the Spacing evenly implies that the movements of objects are expressed very well and this stands for the expression of acceleration and deceleration that take place when it moves.

For example, when we observe the movements of a car, we can see that the car moves slowly at the start and then faster and faster with time and it reaches a maximum speed. After that, the speed decreases and finally it stops. At this time, we can say that the accelerate stage is Ease-in or Slow-in and decelerate step is Ease-out or Slow-out

We also can see these phenomena in machinery and the using of Ease-in and Ease-out is an essential condition in the animation work. If there isn't the Ease-in and Ease-out technique, the movement of all objects may be seen as the movements of a lifeless robot. The Ease-in technique is used when the movement of all objects starts softly and it should not be used when the powerful movement is started. On the contrary, the Ease-out is used when the movement is reduced softly and it should not be used when the bound or the powerful movement as like the Ease-in is reduced.

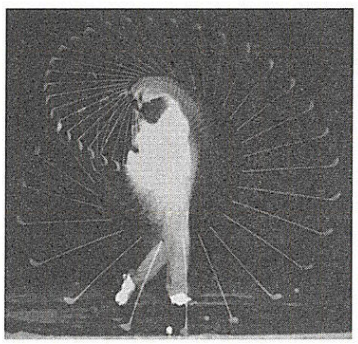

Fig. 1. Note the ease outs on the swing

4. Basic Unit of Timing

4.1 Newton's Law of Gravitation and Law of Motion

In order to make the most natural Timing, we should analyze and understand the law of motion for the movements that the character or object has in any circumstance. We can see the basic laws in Newton's Law of Gravitation and Law of Motion.

Newton's First Law

All objects try to keep their original status until outer force is added to them. The more inertia increases, the less the object moves and all objects maintain their original state until the force is added to them from the outside. Therefore the standstill objects try to sustain their states permanently and the moving objects try to run their rectilineal motion with same speed permanently. The speed and direction do not change till the obstacles appear. For example, when the running bus stops suddenly, the passengers in the bus fall down forward and we can see that the bus goes forward (frictional force).

If we pull the paper just under the cup suddenly and quickly then the thin paper falls off, but the cup maintain its original state. The nature which tries to keep its state is the Newton's First Law.

Newton's Second Law

When the force is added to object, the acceleration of it is proportional to the force and is inverse proportion to the mass of object.

F(force) = M(mass) A(acceleration), A=F/A
W(weight) = M(mass)G(acceleration of gravity)

Table 1. Unit of Newton's Second Law

	Force	Mass	Acceleration	Megadyne
SI	newton(N)	kilogram(kg)	m/s^2	$1N=1kg{\cdot}m/s^2$
CGS	dyne	gram(g)	cm/s^2	$1dyne=1g{\cdot}cm/s^2$
UK	pound(lb)	slug	ft/s^2	$1lb=1slug{\cdot}ft/s^2$
$1N=1kg{\cdot}m/s2=(1000g){\cdot}(100cm)/s^2=10^5g{\cdot}cm/s^2=10^5dyme$				

The mass is the indication of inertia expressed as number and the weight implies the force which the earth pulls the object. When any object moves without the acceleration, the force does not exist. If the force is not affected the acceleration disappears. At this time, the direction added to the force and the direction of acceleration are always the same and the fixed speed movement without the acceleration is motion without force added. This is the Newton's Second Law.

The supporting theory for the Newton's Law is Galileo Galilei's. He, an astronomer, insisted that the moving object on the surface without frictional force runs its rectilineal motion with same speed permanently until other forces other than gravity are operated.

Newton's Third Law

If an object adds the force to B object (action), B also adds the same amount of force to A (reaction). Therefore if the force is added, the same amount of force is operated to opposite direction.

For example, if a rocket jets out fuel gases, it goes the opposite direction of the spouting fuel gas. When a gun is fired, we can see it is pushed backward due to its reaction. As like the formation of Universal Gravitation between the earth and the moon, or the action which a human being walks on the earth, all movements small or big have action and reaction. At this time, the amounts of the force are the same and the direction is operated inversely. The point of action is in the opposite object.

The action and reaction cannot hold the balance in each object because they have an influence on the objects and therefore the equilibrium is not kept. The equilibrium can cancel each other out and be maintained because it is composed of forces operated to the only one object

Finally, the action and reaction occur with there is contact of two objects directly or they are also realized in the distance (Universal Gravitation, electric intensity, and magnetic force). This is the Newton's Third Law, Action and Reaction.

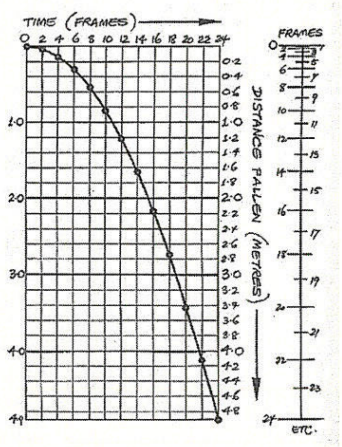

Fig. 2. The Trace of Falling Ball Influenced by Gravitation, the Action and Reaction

4.2 Inside Law of Motion of Character

The Newton's First Law says that the object does not move till any force is added to it. As like this, the movement, as is, in the animation has only the secondary meaning. The important thing is how the hidden causes of character's movements are expressed.

In the case of lifeless thing, the cause is usually force or gravity which occurrs by the natural phenomenon such as wind and, in the case of living thing, it occurs from the outside force or contraction of muscles. The most important thing is to express the will, feeling and intuition of moving character's or animals' inside.

For instance, when we try to move any character from A to B, we should consider the following force can be moved. First, the gravity pulls the character toward the surface of the land. Second, the character's structure composed of any muscle tissues moves. Third, it moves in accordance with the psychological cause of character which is a motive for the movement. For example, it dodges a blow, it receives a guest hospitably, or it threatens any person with

a dangerous weapon.

These are the inside laws of motion and factors making the expression of the Timing apparent.

5. Experimentation

In this study, we made an experiment with the Timing of movement based only on Newton's Law of Gravitation and Law of Motion ignoring the character's inside law of motion. We realized animation that uses the Max in order to find the most ideal method is best and applied it to the Stop-motion and quoted the results.

5.1 Timing of the motion

We can divide the movements of objects easily to the simple motion and complex motion. If the movement of an iron ball is regarded as the simple motion, on the contrary, the movement of humans or animals are classified as the complex motion because it consists of numerous joints and the wide and timing of movement of each part are different and complex.

The results are analyzed separately by their timing. Under the law of action and reaction, the fourteen intermediate actions are needed when the timing of an iron ball's movement is stopped slowly by the fractional force after the standstill ball moves because of the added force (results of experiment).

On the contrary, we should give the timing to the numerous joints in body which are ready to run and should maintain the balance of main movement. It is not the simple motion or complex motion for the movement, referred to above, but the more so the timing for the movement with the ease-in and ease-out in which the audience expects the next action.

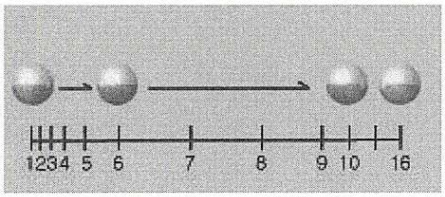

Fig. 3. Timing in the simple motion

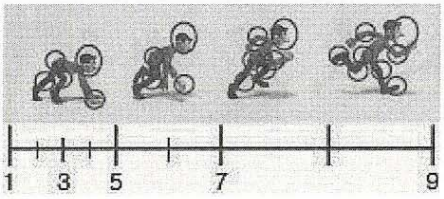

Fig. 4. Timing in the complex motion

5.2 Timing by the distance and angle

Based on experimental result, although the object moves with the same speed, the feeling of speed, the timing, is different by the position of the camera. If the speed is especially fast, it is proportional, and it shows that the range of proportion increases for the ease-in and ease-out.

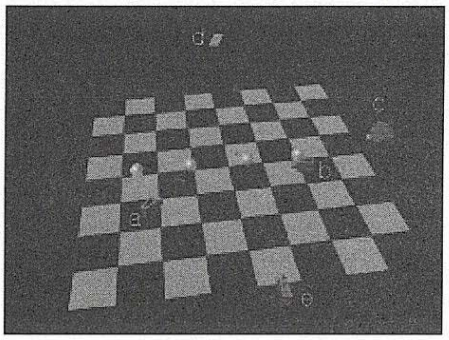

Fig. 5. Position of camera for experiment and movement course of object

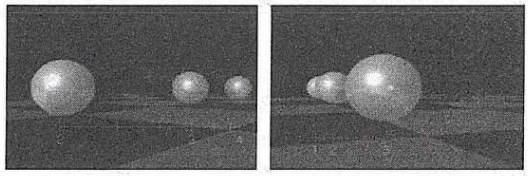

Fig. 6, 7. Timing on the angle of a and b in Fig 4

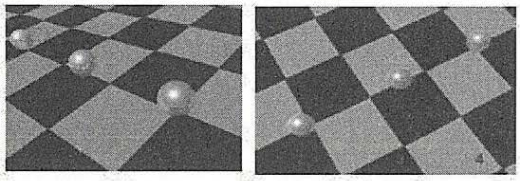

Fig 8, 9. Timing on the angle of c and d in Figure 4

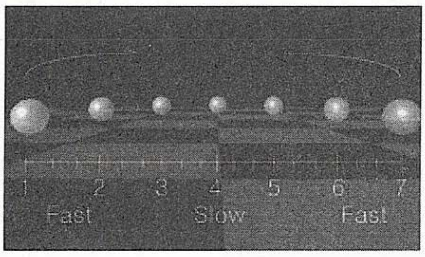

Fig. 10. Timing changed by the angle

In the results of experiment, we can snow that the timing of a moving iron ball presented in the above pictures differs significantly from the distance and angle technique.

5.3 Timing by the natural law

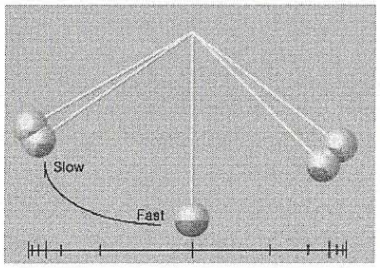

Fig. 11. Timing by the natural law

During animation work, we can rarely say that there is onlu one answer because the factors determining the timing are various. If we ignore the natural phenomenon, the movement of human body and the movement of animal because of existence of each specific law, as like the results of experiment, the expression of timing by the distance and angle of camera are different. Therefore, we require the understanding of the law of motion in order to create well-directed animation.

6. Conclusion

The joining of proper timing for each numerous action is not easy during the actual animation work. On the other hand, we should understand the timing in time section between actions connected in actual work and this time section is obtained generally by training.

Also we should observe carefully each specific law such as the natural phenomenon including the Newton's Law of Gravitation and Law of Motion, the movements of human body, and the movements of animals. We should apply them because it is important that we should have our timing with the application for the phenomena such as speed, mass, and illusion (including the timing by the distance and angle of camera).

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Authors

Woo Song Bang

Received B.F.A. degree in the field of Sculpture from Chosun University in February 1996 and M.F.A degree in the field of fine art from The City College of New York University in February 2000 and been Ph.D. in the field of Information Science from Joongbu University since 2004.

In 2004 He joined the faculty of Yewon Arts University where he is currently a professor in Department of Cartoon and Game Animation. His research interests include Computer Animation, Multimedia Authoring, Multimedia Programming. He is a Member KCGS, DCS

Soon-Gohn Kim

Received a B.S. degree in Mineral Resorce Engineering from Cheonbuk National University 1979, and M.S. degree in Computer Education Science from Dongkuk University 1987 and Ph D. degree in Computer Engineering from Cheonbuk Natioal University 1999.

In 1995 he joined the faculty of Joongbu University where he is currently a professor in Department of Computer Multimedia Science. His research interests include Cryptography Protocol, Multimedia Communication systems, Distance learning, Multimedia Authoring, Multimedia Programming, Computer Networking, Information Security. He is a Member of KICS, KIMICS, KIPS, KMS, KCGS, KISS and DCS.