International Journal of Multimedia and Ubiquitous Engineering
Vol. 1, No. 2, June, 2006

A Study on the Essential Elements for Animation using Stop-Motion

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Abstract In this paper we propose the basic theory such as anticipation, action, reaction, overlap, tempo, and passing position which are essential elements in order to make a beautiful animation One of the most important things in making an animation using stop-motion is setting the timing and spacing. Also during a squash or stretch movement or a shape change, the mass of the object should stay constant. In other words, the shape is changing, although its mass and volume remains the same. In animation, just like in real life, everything should be moving in arcs. As the basics of these theories, creating harmonious lines is good way to make animation.

Keyword: Stop-motion, anticipation, action, reaction, overlap

1. Introduction

Animation is normally defined as the creation of an illusion of movement by assembling a sequence of still images. Before going on to describe the techniques of animation, it is important to emphasize that the quality of the sequence is more important than the quality of the image. It is possible to make bad film with beautiful drawings or models-the art of animate film is in action.

All film is essential an optical illusion, a trick of the eye, known as persistence of vision. The human eye retains an image which can be substituted by another, slightly different image, then movement appears to occur. What people are really seeing when they look at a cinema screen is not a moving picture but a series of still pictures shown in such rapid succession (at 24 frames every second) that people's eyes are deceived. Utilizing persistence of vision, stop-motion animation using puppet is made using frame by frame.

2. Definition of Stop-Motion

Stop-motion animation, also called 3 dimensional animation or puppet animation, uses 3 dimensional elements, both sets and characters. The name stop-motion comes from the action being interrupted frame after frame, with the animator making changes on the puppets in between frames. When creating movement with puppets, animator should figure out how to make smooth joint movements to mimic the way human beings move.

Some of examples the films using stop-motion are the animation of King Kong, the films of Ray Harryhausen (The seventh voyage of Sinbad, Jason and the Argonauts), or the animation of the original Starwars films. When the characters are made of clay, the process is called claymation. The name claymation is a registered trademark by Will Vinton Studios. The best known claymation is found in the adventures of Gumby, the commercials of Will Vinton Studios and the films of Aardman animation, featuring Wallace and Gromit.

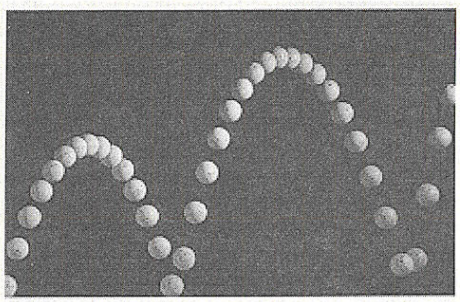
3. The Study of Masic of Motion

3.1 Increment

While shooting with film, we see a lot of sequential still images of frames. The illusion of movement is created by photographing a series of images in a succession of frames. Each frame is an alteration of the previous one. Generally the animator works at 24 frames per second, (FPS) and when shooting with video, 30 frames per second in NTSC format. (PAL is 25 frames per second). Shooting 24, (25 or 30) frames a second-shooting on 1s, animating on ones or single framing makes the animation very smooth and pleasing to the eye, but it is also time consuming. In order to speed up the process of making animation and make it cost effective, it is quite common to shoot on twos which means animating on twos, or double framing instead of shooting 24 (or 30) movements per second, shooting or animating each frame twice, 12 (or 15) moves per second. Double framing as a rule does not look quite as smooth as single framing, but it is still quite acceptable and widely used. Most animation studios, such as Disney and Warner brothers use it to speed up the production time. Some animators create film shooting on 3s, or triple framing. This is even less smooth than on 2s and the movement does not appear natural. In the 1950's, in order to make animation for television, Hannah Barberra studios designed some animated television series with simple animation shot on 4s. There was only 6 drawings per second, the animation was crude, but the stories were funny, the look and overall production values were high, the characters were well developed and the sets were well drawn. However, although there are different framing techniques in making animation, the greatest concern lies in the movement. Every movement should be a harmonious line, a fluid arc as in nature.

Spacing and Timing: One of the most important things in making the animation is working out spacing and timing. For example, use a pen to beat an even rhythm on a sheet of paper while the paper is being pulled at different speeds to illustrate spot. The pencil beats are the timing and the moving paper is the spacing. Timing is the amount of frames it takes for the object to move through a scene.

Spacing is the amount of space it takes for the object to move through a scene. When increments are evenly spaced, the speed of the animation or the object in movement will be constant. Maintaining the spacing effectively is expresses itself in the movement which demonstrates acceleration and deceleration in animation. For example, with a car, a bicycle or a human being, any movement starts slowly, accelerates, peaks, slows down and stops. The processing of speeding up is acceleration and the processing of slowing down is deceleration. Acceleration is called an ease-in or slow-in and a deceleration is called an ease-out or slow-out. Even machines have ease-ins and ease-outs. Using ease-ins and ease-outs is mandatory in animation. Without them, the animation will seem robotic or machine-like. By using the ease-ins and ease-outs, the animation will feel natural and alive.



Bouncing Golf Ball, 1940. °

Fig. 1. Ease-in and Ease-out

3.2 Displacement of Mass

Squash and Stretch: Squash and stretch are compression and distention. The important thing to remember is that during a squash and a stretch, the mass of the object stays constant even though the shape is changed. Squash happens when a force on one object or character cause it to come in contact with another object. Squash is an appearance of flattening by friction of force. For example, when a tennis ball comes in contact with a wall, its shape is elongated along the axis in the direction of the impact. We can see it when playing a game of squash using a soft rubber ball. Soft rubber balls such as squash and rocket balls have much more squash and stretch than hard and heavy balls such as baseballs. Stretch happens when a force pulls one object or character from one or both ends to elongate it. It is the opposite of squash.

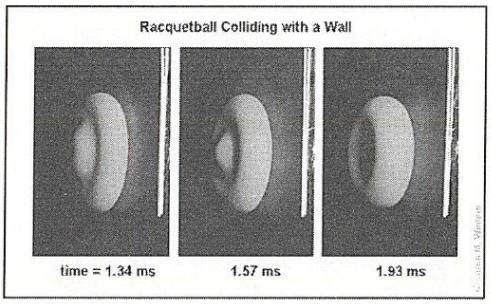


Fig. 2. Racquet Ball Colliding with a Wall

Stretch happens with the same squash ball after it's squashed, when the ball starts to gain speed. The important thing to remember is that during a squash and a stretch, the mass of the object stays constant. Think of a bag of flour, half-full, being moved and dragged around. The shape is changing, although its mass and volume remain the same.

3.3 The Shape of Movement

Path of Action: The path of action is the trajectory of an object going through space and time. It is best described when looking at photographs of car lights at night shot with long exposures. When taking photographs of stars at night, with the camera pointing to the northern star, the path of action of the stars will be recorded as a series of concentric circles. The path of action is the direction in which the object is moving through space.

In animation, just like in real life, everything should be moving in arcs. Only machines have angular, mechanical, robotic movement. When humans are concerned, everything moves in arcs. This is especially true in animation, where the path or the arc of motion is exaggerated to give fluidity to the movement. The most important part of the shape of movement is to create harmonious lines. One way to do this is to plot it on paper, or by drawing directly on your monitor, as a series of dots or as an action path. If some points are not aligned with the others, there will be a jump in the animation, making the action look jerky.

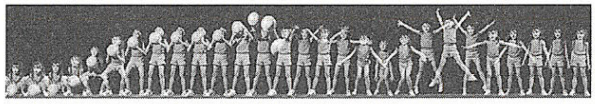


Fig. 3. Movement-When these images are viewed in one single frame, it is easy to see and understand how animation works.

Line of Action: The line of action is the essence of movement. It shows the action in its most simplified mode. The line of action is the motion line going through the body, explaining the movement. It is the fist step in drawing the key frame or positioning a character. It is the energetic flow of an action.

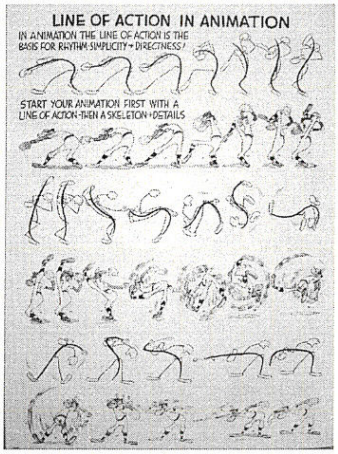


Fig. 4. Line of Action

3.4 Movement

Anticipation: Anticipation is the preparation for action which we all recognize when we see it. Anticipation is a kind of communication of what is going to happen and a kind of realistic action because for almost every action we make there is anticipation. We think about things first then do them. Unless it's a pre-programmed response like shifting gears on a car or getting dressed, we know that we think of something first then do it. As with speech, we know that our brain fixes upon the sense of what it wants to say and then goes into a very complex series of muscle selection to say it. Anticipation sells the shot. It acts like a visual cue that something important is going to happen. Anticipation makes it very easy for the viewer to understand what is happening. Anticipation is the oldest trick in the theatre. The audience understands and goes with the animation. It is a used to attract the attention of the viewer at the right part of the screen, at the right moment of the action.

The anticipation is always in the opposite direction to where the main action is going to go. Any action is strengthened by being preceded by it's opposite. Usually, the anticipation is slower than the action. Anticipation should match the action: A small anticipation for a small action, a large anticipation for a big action. Anticipation is 'realistic', and it also works well in film because the moment of anticipation prepares the audience for the action which is going to follow. This is why, in cartoon films, the anticipation is often stronger than the action itself.

Action and Reaction: After anticipation, audiences can see the main movement which is a real action. Above I mention anticipation which is a precursor of action. For every action, there is anticipation and a following reaction. So the steps are: precursor (tells or shows them what you're going to do), action (Do it), and reaction (Tell or show them that you have done it). In action, every meaning of each scene is decided and catches the audience.

Overlap: An overlap is a delayed action. When energy moves through a body or an object, it is displaced through the joints in a sequence of events. Overlapping action means one part starts first and other parts follow which then 'follow through'. When a figure goes from one place to another, a number of things take place and everything isn't happening at the same time. We hold back on an action. Things don't start or end at the same time. Moving each part of the body at the same time would look robotic and Frankenstein like, and the end result would feel very un-natural. To give it life, it is important to delay the action of the moving parts. Never move an arm or a leg all at once, but rather move first the arm, then the forearm, then the wrist, then the figures. It is the same with the legs as well as for the whole body. Overlapping action gives fluidity and weight, as well as naturalness to animation.

4. Experiment result for Walk

4.1 Set the Tempo

Walking is the basic action, but one with many variations. In real life, a person's walk expresses character, and this can be reflected in the animation. The carriages of the body, arms, and head have to be considered with the feet and legs. In general, there is a high and low position for walk cycle. First of all to make an animation walk a beat is set is set. Generally People walk on 12 frames which is called March time-half a second per step, two steps per second. But all walks are different. No two people in the world walk the same. And we should also consider people's age, character, circumstance, and sex so that the number of frames can be different to set the beat.

Table 1. Result of setting a beat

Frame	Result	Step & Time
4 Frames	a very fast run	6 steps a second
6 frames	a run or very fast walk	4 steps a second
8 frames	slow run or cartoon walk	3 steps a second
12 frames	brisk, business-like walk-natural walk	2 steps a second
16 frames	strolling walk-more leisurely	2/3 of a second per step
20 frames	elderly or tired person	almost a second per step
24 frames	slow step	one step per second

The best way to time a walk (or anything else) is to act it out and time with a stop-watch. Also, acting it out with a metronome is a great help.

4.2 Contact Point and Passing Position

Generally all walks are different but when a person walks, there is a high and low position for the walk cycle. When making an animation walk, first make 2 contact positions. In a normal, conventional walk, the arms are always opposite to the legs to give balance and thrust. Next put in the passing position-the middle position or break down-on the half way phase. When making the passing position, the location of the head is slightly higher than the 2 contact positions because the leg is straight up. Next set the down position between the first contact position and the passing position. The position of head for down position is slightly lower than the first contact position because the bent leg takes the weight. Finally put the up position between passing position and the second contact position because the foot pushing off lifts the pelvis body and head up, to its highest position. So, in a normal 'realistic walk', the weight goes 'down' just after the contact and the weight goes 'up' just after the passing position. As a result of different frames, the passing position and contact position are changed.

(1) Walking cycle with 12 frames

If the contact point is set at the 1st and 13th frame, make the passing position at the 7th frame, and put the up position at the 10th frame, the walking cycle will makes a fluid movement.

(2) Walking cycle with 16 frames

If the contact point is set at the 1st and 17th frame, make the passing position at the 9th frame, and put the up position at the 5th frame, the walking cycle will makes a fluid movement.

(3) Walking cycle with 8 frames

If the contact point is set at the 1st and 9th frame, make the passing position at the 3rd frame, and put the up position at the 7th frame, the walking cycle will make a fluid movement.

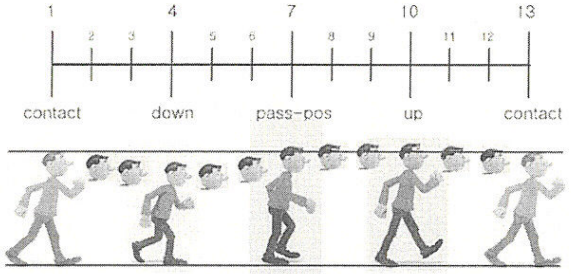


Fig. 5. Walking cycle with 12 frames

5. Conclusion

In this paper, we present basic motion and the elements to enable the understanding of making stop-motion animation. In order to make a fluid walking cycle, we suggest how to set the tempo and where to put contact points, passing position, down position, and up position properly on frames.

References

[1] Yoon Chel Choi, Guen Go, and Soon Byum Yim, Multimedia Study" Sangyeung Publishing, 2000

[2] Kyung Mi Min, "The Study of Special Effect Using Stop-motion", MFA Thesis, 2003

[3] Jong H Ahn, "Lets Make Animation", Sigongsa, 2001

[4] Ricard Williams, "The Ainmator's Survival Kit", Faber and Faber, 2001

[5] Jean Poulet, "Clay Animation Notes", 2002

[6] Peter Load & Brian Sibley, "Creating 3-D Animation", Aardman Animation Ltd. 1998

[7] Richard Taylor, "The Encyclopedia of Animation Technique", Quarto Publishing PLC, 1996

[8] Brian sibley, "Chicken Run Hatching The Movie", Harry N. Abrams, Inc. 2000

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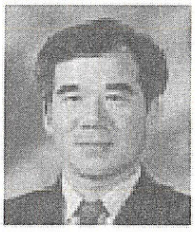

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