Applying 2D Japanese Super-Deformed character to traditional American animation

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Abstract—This project explores how to apply 2D Super Deformed style character expressions from traditional Japanese 2D animation to 3D animated characters. After analyzing Japanese 2D animations including *Naruto*, *Sailor Moon*, *Fairy Tail* and Dragon Ball Z, specific characteristics for each of the six emotions were determined. These characteristics were used to design 3D SD versions of those emotions and then they were applied to a normal 3D character in six separate animations.

Keywords: Super-Deformed cartoon character, Exaggerated Animation, baby schema, Emotion, Facial expression

THE RESEARCH PROBLEM

Introduction

Manga is the Japanese equivalent of what in Europe and the USA are known as comics, but the scope of manga exceeds that of comics in western countries. Far from being aimed at children, it is also viewed by adults. Manga is a varied and widely read form of storytelling. Manga is a prominent feature in mainstream Japanese culture. It dates back to the 19th century, mostly drawings and sketches by famous artist Hokusai. At that time, manga was typically serialized and printed in black-and-white and started to flourish especially in the period of the Second World War [7]. For example, *Astro Boy* is the first of many manga to become popular outside of Japan. It was also made into a serial 2D animation [6].

In the mid-1980s, a new genre of 2D animation emerged, as exemplified by works like *Cultural Cat Girl, Ranma 1/2, Dirty Pair* [5]. These properties feature ' pretty girls' whose character images shift from original condition to super-deformed(SD) version— taking in references to other 2D animations and live-action properties [2]. These characters suddenly become "Super-Deformed"-taking a hyper-cartoony or "deformed" style, to show a strong and exaggerated athletic effect in animations.

Figure A – Normal 2D Character

Figure A – Super Deformed Character expressing sadness (or shock)

In recent years, Super-Deformed style characters gradually became a staple in Japanese animation culture [5]. In Japanese animation there are many moments when characters shift from a "normal" appearance to one of an SD cartoon character. This is an obvious transformational storytelling and expression technique intended to enhance and intensify an expression of characters' strong emotions [12].

SD versions are transformative. They occur at key moments transforming the normal characters in a single frame to express an exaggerated state of emotion. For example, both *Sailor Moon* and *Naruto* are popular Japanese SD 2D animations. This kind of SD style shift enhances the emotional expression of characters and makes characters more exaggerated. After investigating the history of manga and Japanese 2D animations, I have not found any examples of SD for 3D, which is why I'm doing this project. What I will create is a 3D SD style animation. The challenge will be transitioning from a normal 3D character to a SD 3D character. I will focus

on characters' 3D animated facial expressions. I need to explore 3D character pipeline for creating, rigging and animating a 3D character to apply the SD style to the 3D character. I plan to use Mudbox to sculpt and refine the SD style character so that SD style faces can be more flat and smooth. And then, I will put them back to Maya. I plan to use Maya's blend shapes and rigging system to build the transformation between 3D normal character and SD style character. These different aspects will cause different results of my characters. I will explore how to apply a 2D SD character as an element in 3D animation and suggest new ways in which 3D animation might be used to express 3D animated characters' emotions in the future.

The Research Statement

Based on traditional SD Japanese techniques, I seek to develop techniques to facilitate the application of 2D SD style traits to 3D animated characters. I will create 6 normal 3D animations exhibiting the 6 basic emotions and 6 variations with the SD style applied.

Subsidiary Questions

1. How can 2D SD designs be recreated in 3D What functions or 3D software can I use to build and animate transformation of a normal 3D character to 3D SD style character?

2. How should a 3D character transform from normal to SD in an animation.

Terms

Super-Deformed cartoon character: Super-deformed, a.k.a. SD or Chibi, is a specific style of cartoon character design of Japanese manga and animation. They occur at key moments transforming the normal characters in a single frame to express an exaggerated state of emotion. This kind of character makes the animated characters become more exaggerated

Japanese SD style animation: the normal characters shift from realistic in one frame to 'Super-Deformed' cartoon character, which is usually indicative of the character being affected by strong emotions.

The application of SD style characters in 2D animations

As mentioned above, although the Super-Deformed style characters are popular and likeable in Japan, however, SD use for 3D animation has yet to be explored in Japan like 2D usage has. The Super-Deformed style characters are a kind of deformation from general cartoon character. From the storytelling perspective, the 2D characters shift from realistic in one frame to 'Super-Deformed' style character, which is indicative of the character being affected by strong emotions [14], and sometimes it used to express characters' inner feelings.

Since SD style character aim to highlight characters' exaggerated emotions, the relationship between emotions and facial expressions is also an important part of this project. According to Dr. Paul Ekman, there are six basic and universal categories of human emotions: sadness, anger, happiness, disgust, fear and surprise. But how can we recognize each of them correctly? To do so, we will recognize every emotion through their facial expressions. Every facial expression is a combination of changes of each part of the face, such as forehead, eyebrow, eyelids, cheeks, nose, lips, and chin [19]. But different emotions can cause the subtle differences of movement of either every muscle or every part on the face. The features of these emotions, detailed in the Methodology section, will be used to help design the exaggerated facial expressions.

Case study:

Anger

Naruto Episode 2 English Version

Fairy Tail Episode 1

Sailor Moon Episode 10

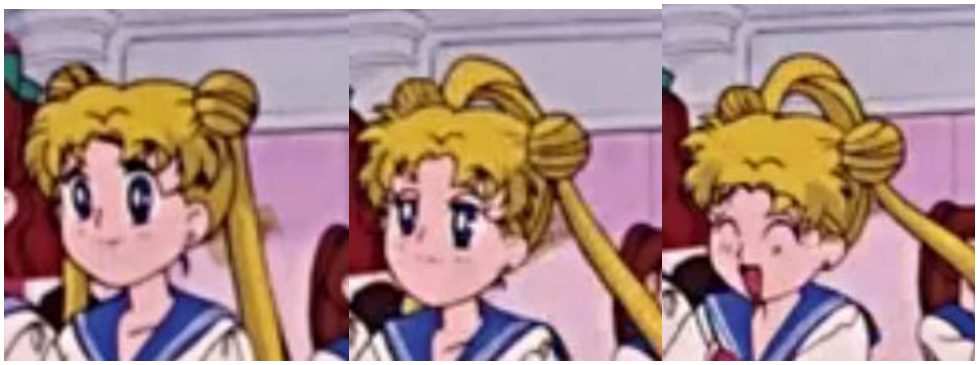
These 3 examples show the Super-Deformed facial expression of anger emotion. The first example is *Naruto*. Uzumaki Naruto, The main character was challenged by a little boy. He was so threatening that he became very angry. The second one is from Fairy Tail episode 1. This girl received a gift that she really hated, so she was very angry. The third one is from Sailor Moon episode 10. She was very angry because she didn't like the drink that was put in front of her. According to Ekman, there are changes in each of three main facial areas during anger. The eyebrows are lowered and draw together. The brow may appear to be angled downward or just to be lowered in a flat way. Second, the eyes are tensed. The mouth is also tensed or parted in a square shape, and the mouth should be open [19]. Therefore, from these three examples, there are three main characteristics of Super-

Deformed anger emotion. First, the inner corners of the eyebrows are lowered and dawn together. The outer corners are raised and stretched. Second, the eyes are very tensed and became bigger and triangular. Third, the mouths became extremely bigger and wider, and the lips may or may not be separated. The biggest feature of the mouths is that the mouths have four sharp corners and parted in a square shape. From these three examples, the lower eyelids in first and second are hard edge, but the third one is round edge, which has a little bit differences, but this is not the most important feature of Super-deformed anger emotion.

SD character design(anger)

According to analysis of surprise emotion, I drew a picture for SD anger facial expression.

Happiness

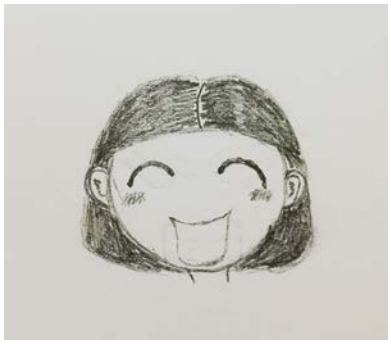


Sailor Moon Episode 1

Dragon Ball Episode 1

Fairy Tail Episode 3

These 3 examples show the Super-Deformed facial expression of happiness emotion. The first example is Sailor Moon. The girl (Tsukino Usagi) went to a shopping mall that she really wanted to go to.. The second example is Dragon Ball. The girl pictured, named Bulma, became delighted when another character agreed to go with her to see the outside world.. The third example is from Fairy Tail. The girl reacted to a young boy whom she liked for a long time. According to Ekman, happiness is shown in the lower face and lower eyelids. The corners of lips are drawn back and up. The mouth may or may not be parted. A wrinkle may run down from the nose to the outer edge beyond the lip corners. The cheeks are increased and the lower eyelid is raised but not tense [19]. Therefore, the main characteristics of Super-Deformed happiness emotion focus on the character's lower face and lower eyelids. These three girls have three opened mouths. The corners of lips go up and the lower lips go down. The lower eyelids of these three girls are raised in a round edge. The third girl shows the cheeks are raised and can be represent by a pink circle. All wrinkles on the happy face are not necessary in Super-Deformed style animations.



SD character design(happiness)

According to analysis of surprise emotion, I drew a picture for SD happiness facial expression.

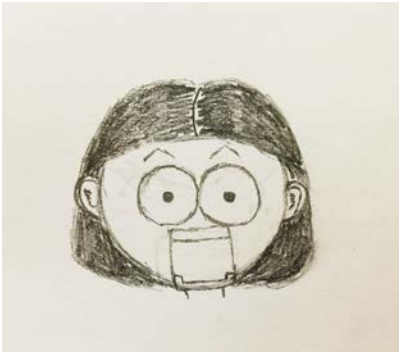
Surprise

Fairy Tail Episode 9

Sailor Moon Episode 8

Magic Girl Episode 1

These 3 examples show the Super-Deformed facial expression of surprise or shock. The first girl was so surprised because she saw a mushroom growing from her friend's head. The second one is from Sailor moon. This girl discovered her cat was peeking at her homework. She was so surprised that she was trying to hide her homework. The third girl was surprised because she saw two boys knelt down in order to appreciate her hospitality. According to Ekman, there is a distinctive change in each of the three facial areas during surprise. The eyebrows are raised and appear curved and high. In addition, the skin below the brow has been stretched by the lifting of the brow. The eyes are opened wide during surprise, and the lower eyelids relaxed and the upper eyelids are raised. The jaw drops during surprise, with the lips and teeth parted. There is no tension or stretching of the mouth [19]. Therefore, from these three examples, there are three main characteristics of Super-Deformed surprise emotion. The eyebrows go up, with the outer corners are hard. Second, The eyes are much bigger and wider; the upper eyelids are raised and the lower eyelids down. The pupil become very small or disappeared. Third, the main feature of the mouths is bigger and relaxed. The jaws drop down without any tension. The corners of the SD surprise mouth mayor may not be rigid. The shape of the mouth can be a square or an ellipse.



SD character design(surprise)

According to analysis of surprise emotion, I drew a picture for SD surprise facial expression.

Fear

Dragon Ball Episode 2

Sailor Moon Episode 5 (1992)

These 2 examples show the Super-Deformed facial expression of fear or panic. The first example is from Dragon ball. This girl was scared because she saw a creepy dinosaur on the TV. The second one is from Sailor Moon. This boy was afraid of that blue cat. His normal version transfer to Super-deformed style when he felt very scared. According to Ekman, there are also three main changes of the three facial areas during fear. First, the eyebrows are raised and drawn together. The brows are raised as they are in the surprise brow, but the inner corners of the brow are closer together in fear than in surprise. Second, the eyes are opened and tense, the upper eyelids go up and the lower eyelids tense. Third, the mouth is open and the lips are tensed slightly and drawn back. [19] Therefore, the characteristics of Super-Deformed fear emotion focus on the character's eyebrows, eyes and the mouth. The eyebrows go up, with the outer corner curved. The inner corners of the brow become closer in fear than in surprise. The eyes are bigger and the pupils become much smaller. The mouths are opened and the lips are a little bit tense. They may or may not parted. The Super-deformed fear mouth has no hard corners.

SD character design(fear)

According to analysis of surprise emotion, I drew a picture for SD fear facial expression.

Sadness

Fairy Tail Episode 3

Sailor Moon Episode 9 (1992)

These 2 examples show the Super-Deformed facial expression of sadness emotion. The first example is from Fairy Tail. The girl was very sad because she lost one of her favorite notebook. The second example is Sailor Moon Episode 9. The girl fell down suddenly and her knees were very painful, so she was very sad. According to Ekman, there is a distinctive appearance in each of the three facial areas during sadness. The inner corners of the eyebrows are raised and may be drawn together. The inner corners of the upper eyelids are drawn up, and the lower eyelid may be

raised. The corners of the lips are down or the lip is trembling [19]. Therefore, from these two examples, there are three main characteristics of Super-Deformed sadness emotion. The inner corners of the eyebrows are raised and the outer corners of the eyebrows are down, and the inner corners may be drawn together slightly. The gap between the eyebrows and the upper eyelids decreased, with the lower eyelids are raised. The mouth may or may not be opened and the corners of the lips are down. The tears should be added on the Super-deformed sadness face.

SD character design(sadness)

According to analysis of surprise emotion, I drew a picture for SD sadness facial expression.

Disgust

Facial action unit--Disgust

For the disgust emotion, it is difficult to find the existing reference images in 2D Japanese animations. Therefore, I used the facial action units to support my Super-deformed disgust facial expression design. Every emotion is a combination of facial action units. Disgust is consists of three facial action units, which are nose wrinkle (Action Unit 9), Lip corner depressor (Action Unit 15) and Lip depressor (Action Unit 16) [19]. In addition, there is the same facial action unit, lip depressor, happened during sadness. Therefore, I will choose the reference images of sadness mouth as my disgust mouth. According to Ekman, disgust is shown primarily in the lower face and in the lower eyelid. The upper lip is raised and the corners of the mouth are down. The nose is wrinkled. The brow is lowered [19]. I draw an image based on the facial action units and Ekman's concepts.

SD character design(disgust)

According to analysis of surprise emotion, I drew a picture for SD disgust facial expression.

Therefore, the moments that SD style characters shifts is when the characters

express some strong emotions or express their inner thoughts. this kind of shift adds more dramatic elements into animations in order to present the 2D characters better.

METHOD

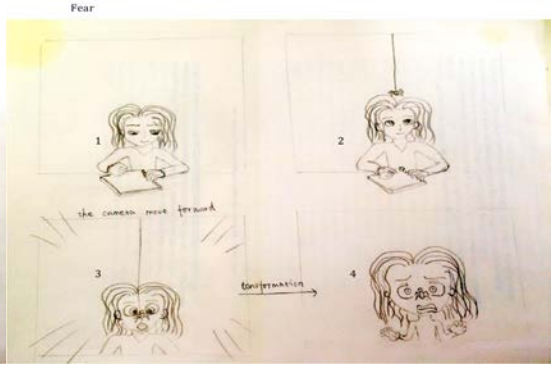
I will model, rig and animate a female character exhibiting the six basic human emotions, *according to Ekman,* of sadness, happiness, fear, surprise, disgust, and anger. Every type of emotion is expressed by one short animation. The animations use the normal female character and one of her SD versions to express emotion. Maya will be used for modeling, rigging and animating. Mudbox will be used for creating normal and Super Deformed facial expressions which will be applied and animated as blend shapes. After Effects will be used for composition.

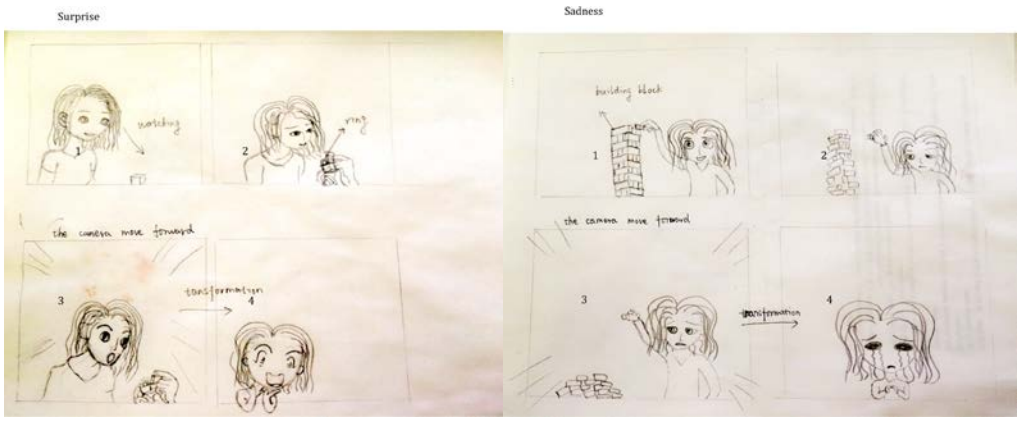
1. Idea

After studying the SD character in Japanese 2D animation, the idea of this project is trying to figure out the characteristics of 6 SD emotions, which can apply to 3D characters.

2. Storyboard

This project had 6 separated animations for 6 different emotion. Every short animation consists of one main camera shot. Therefore, the camera didn't be moved. The animation focus on the motions of character's upper body and facial expressions. The environment of the 6 animations is a play room.





4. Maya Modeling

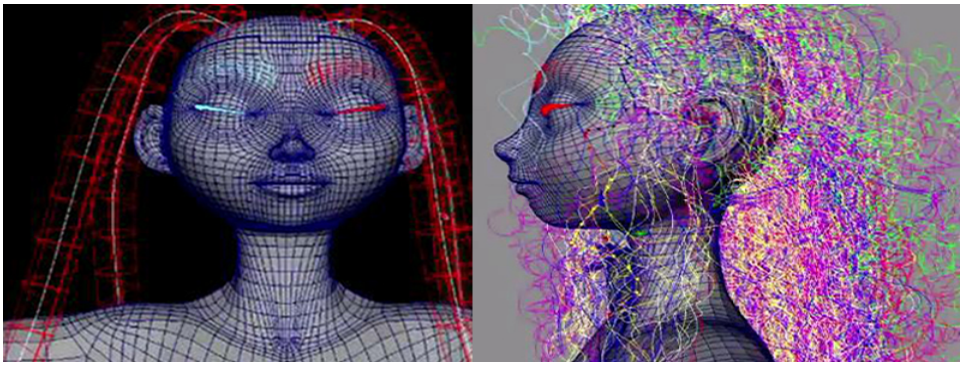
I selected *Brave*, *Frozen* and How to train your *Dragon*, as my examples to guide my normal character design. These three pictures show three character's design in different western animations. The face design of these three girls is similar. They all have a round face, big eyes, small nose and a small mouth.

Elsa from Frozen

Merida from Brave

Astrid from How to Train Your Dragon

This project mainly uses Maya software for this girl character and SD versions modeling. The pictures below are the reference images of front view and side view.



Reference of the normal character design

Due to the fact that SD characters are a special style of character design, it is necessary to study the design rules for 2D SD style character. Their exaggerated physical features distort human body proportions. The details such as noses on the face are ignored, and general shapes are favored [21]. Basically, SD style characters style is more focusing on characters' head shape and exaggerated facial expression design. The rounded and smooth modeling is fit for a SD style character design.

6.Rigging

I will use Maya's skeletal rigging system and Blend shapes to animate the

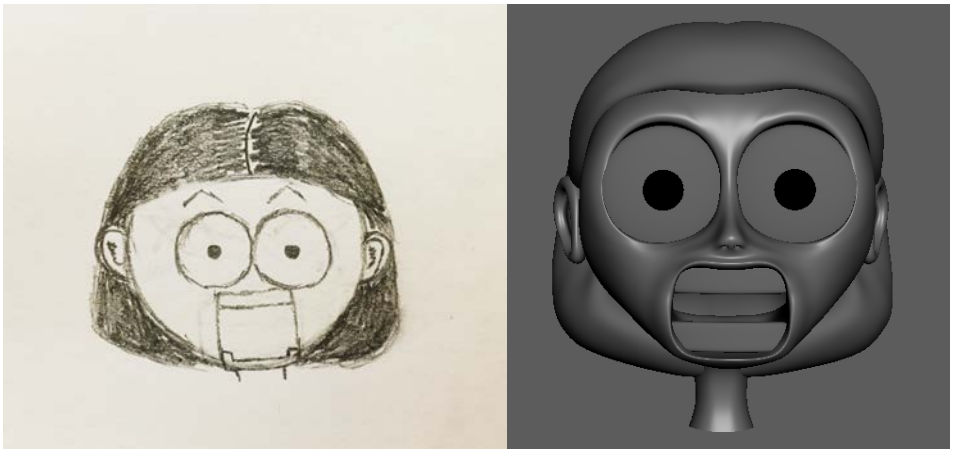
character and control facial expressions.

7.animation

Facial expressions

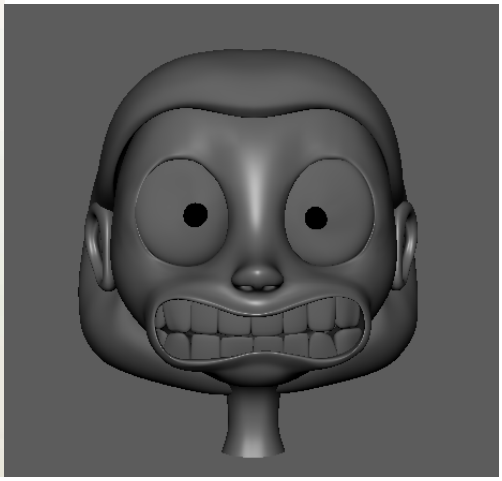
I designed six different emotion animations for this character, including sadness, happiness, fear, surprise, disgust and anger based on research of normal emotional expressions according to Ekman, and 2D Super Deformed expressions in Japanese animation. Each emotion will be expressed by one animation. Moreover, the animations will focus on characters' faces, upper body and hands parts.

Since the SD surprised eyes are extremely big and round, I tried to sculpted the 3D SD surprised eye pockets as similar as the 2D image. It is hard to make the eyes fit a very exaggerated eye pocket. Moreover, the pupils become smaller. For the mouth, I changed the four corners to be round, which is reasonable in 3D.



Concept image of the Surprise SD style character *3D modeling of SD character design according to 2D Japanese animation*

The SD fear eyes are similar to the surprise. They are big and round. The most toughest of SD fear part is building blend shapes for every tooth, every tooth shape transfers to a more wider and bigger shape. The mouth is wider than the jaw in 3D design, which is different from concept 2D image.



Concept image of the Fear SD style character according to 2D Japanese animation

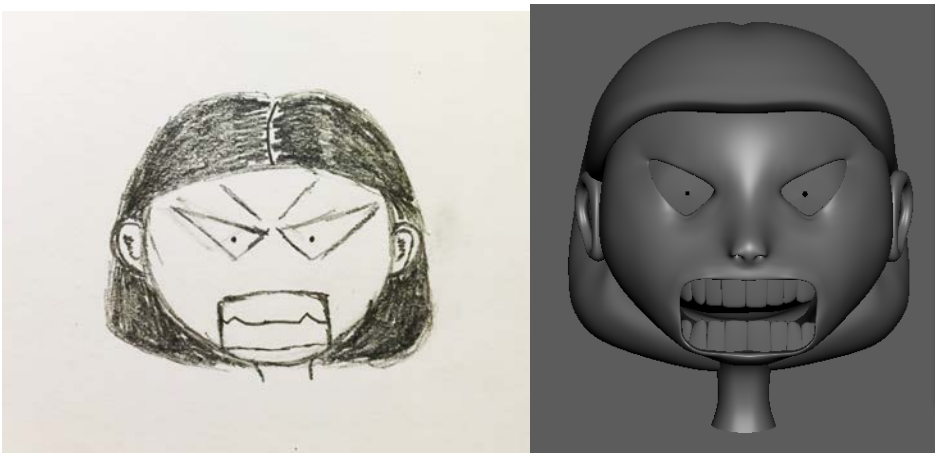
3D modeling of SD fear facial expression design

In my opinion, disgust is a slight anger emotion. Since disgust is asymmetrical[19], I made the left and right blend shape for the eyebrows, nose and the mouth so that left and right side on the face can indicate different shapes.

Concept image of normal character and disgust SD style character

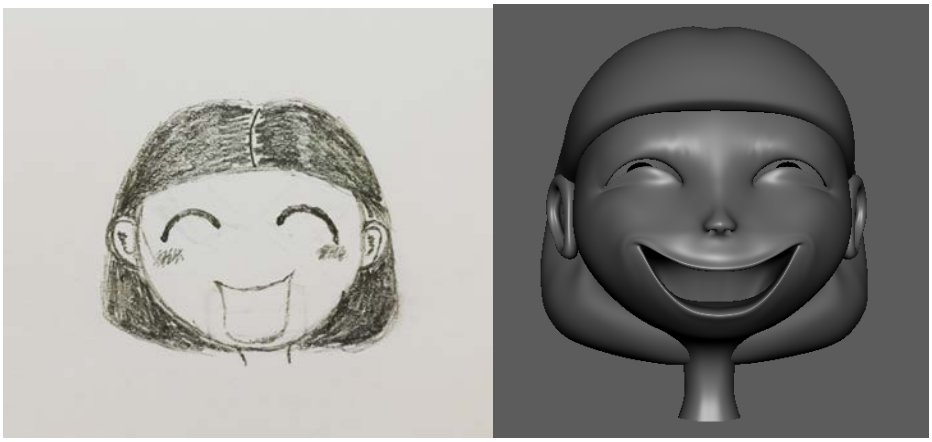
The obvious characteristic of SD anger is triangular eyes. When I made 3D triangular eyes, the outer corner of the eyes bend a little bit in order to fit 3D character's face. In anger 3D SD animation, according to this image, I will focus on changing character's eyes, the mouth, the eyebrows and the teeth. I think the teeth, specifically pointy teeth, showing aggressive intent or potential is very important

part to show the exaggerated SD style anger in this animation.



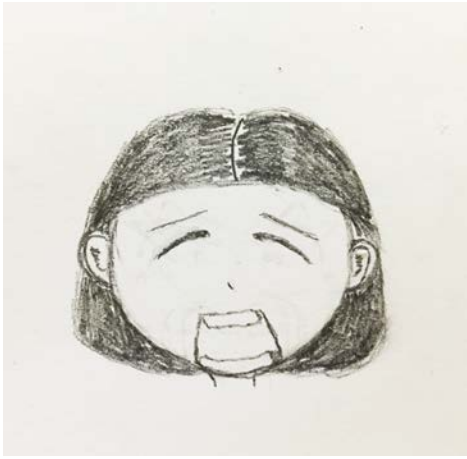
Concept image of the Anger SD style character *3D modeling of SD Anger facial expression design according to 2D Japanese animation*

The eyes of SD happiness look like a moon, and the pupils almost disappear. In addition, the teeth gone.

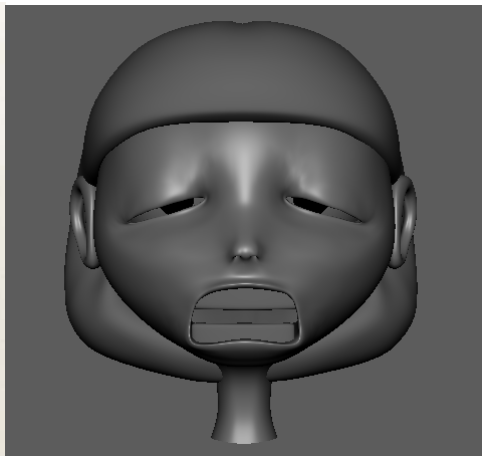


Concept image of the Happiness SD style character *3D modeling of SD Happiness facial expression design according to 2D Japanese animation*

The eyes of 3D SD sadness look like a straight line, and the outer corner go down. Sadness is a kind of progressive emotion that takes time to form. Therefore, 3D SD sadness transformation is the longest time rather than others.



Concept image of the Sadness SD style character according to 2D Japanese animation



3D modeling of SD Sadness facial expression design

Conclusion

This project applied 2D SD style character in 3D character and found the best timing of transformation between normal character and SD character. Therefore, after finishing these 6 short animation, the best time for SD transformation in 3D is 2-3 frames. From the perspective of 3D SD character design, I used Blend shapes for building all normal facial expressions, including the eyebrow, eyelids, nose and mouth. In addition, the blend shape is a effective way to design exaggerated Super-deformed facial expressions. In my opinion, the SD expression in 3D created a new digital tool on expression of the character's emotion. 2D Super-deformed character succeed applying to 3D animation.

Future Work

Beyond this project, I considered three directions that I may develop this project in the future. While Super-Deformed style character applied to a female character, I considered Super-Deformed character may use to other types of characters, such as male, animal, older, etc. On the other hand, I considered using 6 Super-deformed characters in a complete story animation that include happiness, anger, sadness, disgust, fear and surprise emotions. In 2D Japanese SD animation, character's whole body transfer to a very tiny scale or extremely unusual proportion. While this project is focusing on character's facial transformation, I may think it is possible to incorporate character proportion changes in the future work.

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