Intensity of Facial Expressions in Virtual Reality

Volodymyr Loyko
University of Washington
Seattle, Washington
vloyko@uw.edu

Travis Chen
University of Washington
Seattle, Washington
tchen96@cs.washington.edu

Yue Teng
University of Washington
Seattle, Washington
tengyued@cs.washington.edu

ABSTRACT

In this paper we explore the effect of viewing stylized characters in VR has on the perception of intensity of the facial expressions on that character. We use three cardinal expressions that work with our character the best and we insert them into a VR testing environment where the user is able to compare both the expression on a 2D plane and the some on as a 3D model in VR. Our conclusion that the facial expressions in VR read more intensely is based on the data collected via the VR testing environment.

CCS CONCEPTS

• **Computing methodologies** → **Perception**; **Virtual reality**;

KEYWORDS

Virtual Reality, facial expressions, film

1 INTRODUCTION

Our work is motivated by studying how facial expressions are perceived in animated storytelling. Believable and accurate facial expressions are important for engaging the audience in the characters and story. Specifically, we are interested in the readability of facial expressios using stylized characters, e.g. characters with exaggerated or limited facial features. A character can display a given facial expression with different levels of intensity (e.g. slightly angry, extremely angry, etc) which are placed according to what the story calls for, yet ultimately determined by the viewers. It is important to match the intended intensity of the expression with what the viewer experiences.

In terms of facial expressions, our work is focused on the 2017-2018 UW Computer Animation Capstone production, The Tyrant. The main character in the film, Blue Eyes, is a stylized character whose face consists of just two eyes and brow masses (**Fig 1**). Despite his limited facial features, the story requires him to convey emotions such as sadness and fear that must be easily readable by the viewer.

In addition to the animated film, the capstone is producing a VR version of the same story. When in VR, the viewer will not be seeing the character projected onto a flat screen, but in a three dimensional space. This creates a few issues in terms of readability of Blue Eyes' expressions: the viewer may perceive the facial expressions slightly differently in VR, however, both the traditional and VR versions of the story must invoke the same emotional response from the viewer. This means the facial expressions of our characters need to match in terms of intensity. Our goal is to understand how the change of medium (flat screen to VR) will affect the perceived intensity of the characters facial expressions, as well as how the intensity relates to both the shape and animation of the facial features.

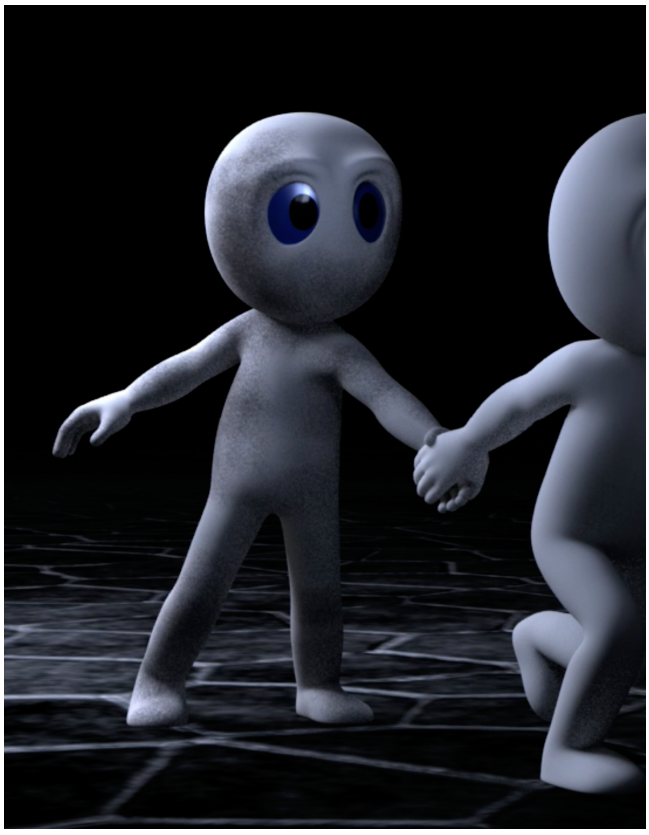

Figure 1: Rendered version of Blue Eyes from The Tyrant

2 RELATED WORKS

Yu et al [1] studied the recognizability of facial expressions on stylized characters when occluding different parts of the face. When occluding the mouth of a character, leaving it with just eyebrows, eyes, and a nose, they found that users were still able to identify sadness, anger, and fear at a high rate.

3 METHODOLOGY

All of the expressions that were to be tested in VR needed to be constructed using the Blue Eyes rig, which created a few hurdles. The lack of any mouth or nose features turned out to be a limiting factor in which expressions we could test. During the process of the creation of the expressions we ran a user study to help determine which expressions we could actually test. To have effective intensity tests we needed to have expressions that were as clear as possible to start with.

Publication date: March 15, 2018

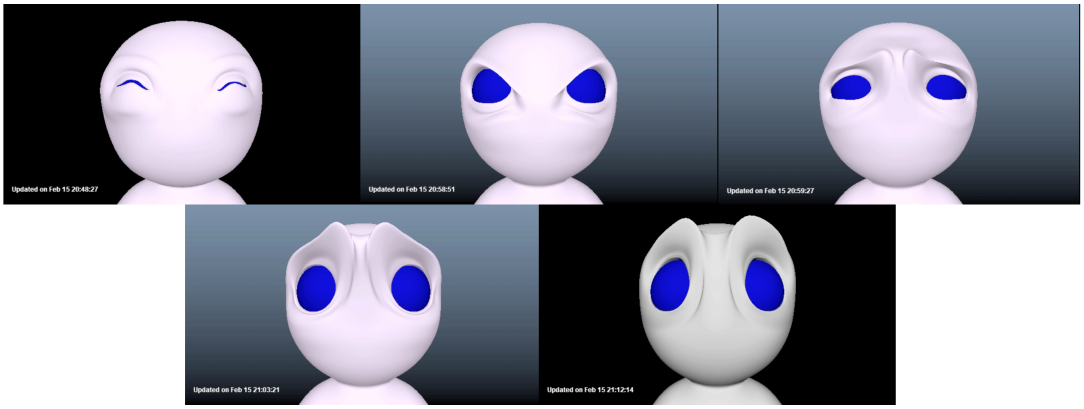

Figure 2: Five cardinal expressions on the old Blue Eyes rig. Starting from the top right the expressions are: joy, anger, sadness, fear and surprise.

Figure 3: The final expressions that were chosen to be tested.

Once the expressions were set, we had to design a way for users to take a perceptual study of VR characters. To address this, we developed our own software for running user tests in VR, where the user can choose which version of a given expression is more intense by using simple gestures in a short amount of time.

3.1 Constructing the Expressions

In general, facial expressions are formed through some combination of the eyes, the brow, and the mouth. Some expressions rely more on the mouth, while others rely more on the eyes and brow. Expressions that rely more on the mouth, e.g. joy and disgust, are more difficult or impossible to pose in a way that people will consistently understand them. Joy relies heavily on the smile, but by curving the eyes up in an imitation of the way the eyes crease in a smile, the expression can work to a certain extent using only the eyes. Disgust, on the other hand, requires a specific interaction between the mouth and the nose where the lip is pulled up. Without a mouth or a nose, there is no way for disgust to be understood.

At the opposite end of the spectrum are sadness and anger. Both of these rely mostly on the brow and eyes, and so they can be posed fairly easily without a mouth. Fear and surprise have a different challenge, which is that in both the amount of eye white is very important for understanding the expression. If the eyes donâĂŹt have a pupil, simply making the eyes wider doesnâĂŹt tend to read as more afraid because thereâĂŹs no frame of reference, usually given by the pupil. Fear has more tension than surprise, so some of it can be brought out by tightening the lower lids and turning the brow up, but these traits are also present in sadness. Typically, the mouth is useful for distinguishing these two since the shape of the mouth is noticeably different, but without the mouth and without a pupil fear and surprise are easily confused.

Initially we planned on testing all six cardinal expressions: joy, anger, sadness, fear, surprise and disgust. Fairly quickly, we realized that disgust was completely impossible to do due to the lack of the nose, thus we only created the five with the initial rig (**Fig 2**). We ran these expressions through a user study and found that we could only reliably do joy, sadness and anger. The final expressions are shown in **Figure 3**.

3.2 Ensuring Readability

In order to test the readability of the facial expressions of our character in 2D, we set up a Mechanical Turk (MT) test. The user was presented with five different facial expressions of the character, and asked to label it with the correct emotion. We wished to test whether the expressions were reading clearly enough in 2D before testing them in VR.

In our initial group of 10 users, we found 100% of participants were able to identify anger correctly. However, only 70% of participants were able to correctly identify sadness and happiness, which indicated that we needed to focus on clarifying these two expressions.

However, during our research study several changes to the character rig were made: the shapes of the head and eyes were modified, and pupils were added to the character. However, we still focused on clarifying the expressions for sadness and happiness, as the MT

Figure 4: Example of the clipping issue.

study indicated that these expressions were most difficult to read for characters with only eyes.

3.3 VR Testing Environment

We realized early on that running a user study in VR was going to be fairly difficult. Setting up the Oculus Rift hardware requires a fair amount of time, and also requires a VR capable computer and an accommodating space. Thus we tried to ensure that the actual test would be simple and intuitive.

When the user put on the headset he would initially be presented with short directions on what to do. If they turned around they would see three sets of floating planes with the animated Blue Eyes expressions. Next to the planes they would see the full 3D models of blue eyes, exactly mimicking the expressions on the planes. The user would then choose which version looked more intense.

We ran into a few issues transferring the 3D models from Maya to Unity. The models were all made using quads yet in order to transfer them to Unity we had to export the mesh as a triangle mesh. This ended up tearing the mesh when it was animated (**Figure 4**) which we took into account when analyzing the study results.

4 RESULTS

We were able to collect data from 10 users. These users came from different backgrounds, some not having the context of the capstone film, some only ever seeing the 2D version of the film, and some working on the 2D film directly. Along with the categorization, we asked users about the reasoning behind their choosing the expressions that they did.

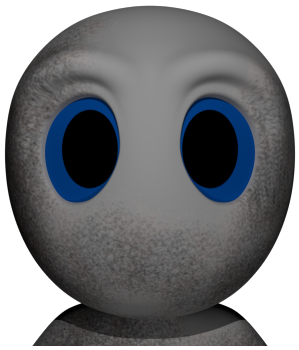

Figure 5: Blue Eyes's neutral face has a tendency to look sad.

Joy: As the only expression that did not have any clipping issues, we expected the VR version of this expression to read more intensely that the version that was on a 2D screen. This turned out to be fairly accurate as 70% of people who took the test said that the VR version did feel more intense. Some users said this was because the facial expression read better with the added depth that VR supplied.

Notably, this expression read more intensely in VR while in the MT tests, joy only scored at 70% accuracy. Our character model does not provide the best way to create joy due to the largeness of the eyes and and the mass under the eyes. The fact that joy reads more intensely in VR implies that the facial features that might be creating confusion in 2D might be adding to the expression when seen in 3D.

Sadness: There was an 80% agreement that sadness reads more intensely in 2D than in VR. We think this is due to the fact that the clipping removes the fragility and the precision of the expression that was crafted in Maya and leaves the user with a disturbing image of the eye going through the brow mass above. It is important to note that our theory was that sadness was going to read much more intense in VR due to the natural disposition of our character to look sad in their neutral state (**Fig 5**).

Anger: This expression had the most issues with clipping and the users split evenly in half in terms of their judgment of intensity. Yet one could argue that the clipping had the least amount of influence on this expression in particular due to the fact that the clipping almost made the face of Blue Eyes scarier to look at, which should have intensified his expression of anger.

5 CONCLUSION

Overall we think that expressions do read more intensely in VR. When the model was displayed correctly without any issues this was verified. We think that the reason for the users voting for the 2D version of the expression was mainly the clipping and mesh tearing. This is an important discovery because it is important to realize that some adjustment will most likely be needed when transferring animated stylized characters from tradition film mediums to the VR world and most likely the facial expressions among other things will need to be toned down. The added level of depth, and the viewer's ability to move their head in 3D space, creates a much more personal and realistic viewing environment. This needs to

be taken into account as we are seeing the effects of this in our intensity of facial expression study.

6 FUTURE WORK

Many improvements can be made to this study of intensity that will make the results clearer than what we gathered here. First of all, the clipping issues must be resolved. Our current rig did not allow for an easy solution for this problem because it was never made to be transfered to VR. Solving this clipping issue will provide more accurate data for the rest of the expressions. As we also discovered later, the addition of pupils allows for a cleared expression of fear and surprise. Testing the intensity of the extra two cardinal expressions would also allow for a more general conclusion.

ACKNOWLEDGMENTS

The authors would like to thank Barbara Mones, Cody Wilcoxon, Deepali Aneja and Gary Faigin for providing feedback on the facial expressions, providing technical support and helping run the user studies.

REFERENCES

[1] Jeannette Yu and Cherry Zhou. 2016. Minimal Facial Design on 3D Stylized Characters. (2016).