Modeling the Interpretation of Animations to Help Improve Emotional Expression

Extended Abstract

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ABSTRACT

More and more synthetic characters are being used in applications worldwide. When designing synthetic characters that interact with human users, the adequate expression of emotions is critical to achieving more believable and effective communication. Yet multiple works show that the correct recognition of emotion in synthetic characters is often hard to achieve and harder to understand.

To better understand how emotions are recognized, we propose the Triad Affect Interpretation (TAI) method that creates a model of how users perceive the animations of emotions of specific synthetic characters, with the additional intent of helping the development of future animations and improving the way emotions are communicated so that they are more easily recognized. The method uses two questionnaires that focus on a set of animations of emotions taken from the synthetic characters under development. The purpose of the first questionnaire is to elicit meaningful constructs from the participants through content analysis. The second questionnaire asks participants to rate the same animations against the selected constructs. By using principal component analysis and cluster analysis, we then create a model of the relevant factors to the perception of emotions that can inform future improvements of the animations related to the expression of emotions.

KEYWORDS

Synthetic Characters; Emotion Expression; Repertory Grid; Emotion Recognition

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1 INTRODUCTION

The emergence of more realistic synthetic characters follows the need to better communicate the emotions they are expressing. Nowadays, more and more applications make use of emotion expression, either for ludic purposes as seen in video games such as *The Sims 4*[1], for education purposes [12] or even health related questions [4, 9, 10]. Yet, emotion expression is not always correctly perceived [1, 2, 6, 11, 15], meaning that the emotion being expressed is not correctly identified by the receiver, which can have a negative impact on the overall interaction. In this work, we are especially interested in communicating emotions through facial expression, and the question: *how can we improve the communication of emotions in a way that they are better recognized by the users interacting with synthetic characters?*

To help answer this question, we designed the Triad Affect Interpretation (TAI) method, which is based on the repertory grid [8], and applied it to the characters from the work of Rodrigues *et al.*[14], where the characters' affective expressions were not recognized as expected by previous side-by-side evaluation. The TAI method helps build a model of how users perceive different expressions of emotions of a specific synthetic character. The model aims at detecting problems and guiding the development of future animations, helping to improve the way emotions are communicated so that they are better recognized by the users. We believe the TAI method can be applied in other contexts, independently of the characters being realistic or cartoon-like.

2 REPERTORY GRID

The repertory grid technique[8] is normally used to explore an interviewee's views on a particular topic with the absence of researcher bias. There are two important concepts when discussing the repertory grid: the *elements* and the *constructs*. Kelly defined an element as *"the things or events which are abstracted by a construct"*[3] as for the latter it is *"a way in which two or more things are alike and at the same time different from one or more things"*.

When applying this technique, the first step is the *selection of elements*. Each element is then written manually on a card and different triads (a set of three elements) are presented to the interviewee until all combinations have been covered, or the interview is terminated. Five or more elements are needed to produce a sufficient number of triads so that construct elicitation can be repeated. For *eliciting constructs* the question *"in what way are two of these alike and at the same time different from the third?"* is asked when showing a triad. A *rating process* is then performed to correlate each element of the study with each construct. A participant is tasked with rating where an element fits in the construct scale. After the rating, this method outputs a model of how participants view each element based on the most commonly selected constructs.

[1]The Sims 4 (2014). Maxis, Electronic Arts

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3 THE TAI METHOD

Our goal is to model how people perceive expressions of emotions in an animation so that we can use it to better understand how to improve it based on similarities with other expressions. To that end, we propose the Triad Affect Interpretation (TAI) method, which consists in using the previously discussed triad analysis[8] in the context of emotion expression. We first choose the *elements* for our repertory grid, in our case, animations of facial expressions. Secondly, we elicit the *constructs*, in our case facial features, from each participant. Finally, participants rate each *element* against a set of selected *constructs*, allowing us to identify how the animations are perceived by the participants and the most important facial features in each animation.

The method involves two different questionnaires (see Figure 1), one for *determining the constructs* through content analysis, and the other for the *rating of the elements* against each construct, these responses will be analyzed using principal component analysis and cluster analysis. These analysis techniques are common types of analysis used in repertory grid [5, 8, 16].

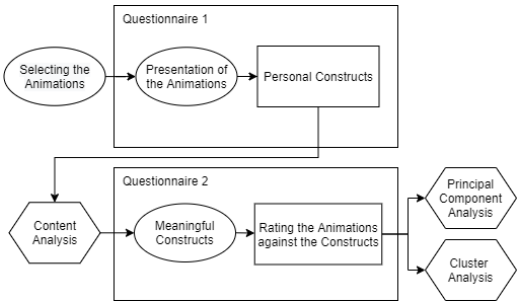

Figure 1: Overview of the TAI method's execution. Round shapes represent steps performed by the experimenter. Rectangular shapes represent the participants' contribution. Hexagonal shapes refer to the data analysis steps.

The first step is choosing the *elements*, in our case, we want to compare different expressions of emotions in synthetic characters. We decided on six animations, each one representing one of Ekman's "basic" emotions[7]: *Anger*, *Disgust*, *Fear*, *Happiness*, *Sadness*, and *Surprise*. The animations and characters were taken from the work of Rodrigues*et al.*[14]. Figure 2 presents snapshots taken from one of the character's emotional expression animations[2].

The second step is selecting how to present the elements to the participants. We show the participant three different animations, in random combinations, until all combinations had been covered, or no more constructs were elicited. To balance the amount of work required by each participant, we decided to display only a fixed number of combinations (six per participant) and created a distribution covering as much variation as possible per participant.

In the following step, we collect relevant *constructs*, in our case facial features, through a questionnaire (Questionnaire 1 in Figure 1)[3]. The questionnaire consists of six sections, each presenting a combination of three animations. Each section of the questionnaire has four questions: (Q1) *"By comparing the three animations presented above, identify the two that are alike"*; (Q2) *"How are two of them alike and at the same time different from the third"*; (Q3) *"Provide us with one characteristic that you found was alike in the two animations"*; (Q4) *"Provide us with the opposite characteristic from the one mentioned above, describing the different animation"*. After gathering all responses, we used *content analysis*[5] to find meaningful constructs by sorting them into themes and analyzing the frequency with which they appeared.

Figure 2: Snapshots from three of the six animations of emotion. From left to right: *Anger*, *Disgust*, and *Fear*.

After selecting the most mentioned elicited constructs, the final step is to ask the participants to rate the animations with the chosen constructs using a second questionnaire[4] (Questionnaire 2 in Figure 1). Each animation would be shown in its individual section and the participants were asked to rate the animation through a 7-point bipolar scale between the two opposing words defining each of the selected constructs (e.g. "mouth opens wide" versus "mouth closes"). We used a *latin square* design to order the animations and avoid any order bias.

After gathering all responses, we create a model of how participants perceive the characters by performing a Principal Component Analysis (PCA). Afterward, using the created model, we do a Cluster Analysis to identify prototypes of the more distinct emotions.

4 CONCLUSIONS

With the TAI method, it is possible to create a model of how people perceive different emotions that can provide insight into the different emotions that may be confused with each other due to specific features of the animation system. We have already conducted an evaluation[13] and plan on improving the emotion recognition of the animations of our synthetic characters. Furthermore, we believe this method can be applied to the development of any intelligent virtual agent with the capacity to express emotions. The approach has also the potential to be applied to other dimensions of the development of intelligent virtual agents. We will, therefore, in the future, adopt and further test this approach in the development of synthetic characters in multiple contexts.

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[2]A video portraying the character expressing *Anger* can be seen here https://drive.google.com/file/d/1gx_dtNPgTG9KJ46Butjifp8Dzfxiri5q/view?usp=sharing

[3]A version of Questionnaire 1 presented to the participants can be found at http://web.tecnico.ulisboa.pt/ist186514/Experiments/SC1-anonymized.html

[4]A version of Questionnaire 2 presented to the participants can be found at https://forms.gle/k1XgM4HdcH6Pttom6

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