Providing Gender to Embodied Conversational Agents

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Abstract. Communication, along with other factors, varies with gender. Significant work as been done around embodied conversational agents (ECAs) verbal and non-verbal behaviour but gender issue has often been ignored. Yet, together with personality, culture and other factors, gender is a feature that impacts the perception and thus the believability of the characters. The main goal of this work is to understand how gender can be provided to ECAs, and provide a very simple model that allows for existing tools to overcome such limitation. The proposed system was developed around SAIBA Framework using SmartBody as the behavior realizer and tries to address this problem by adding a set of involuntary gender specific movements to the agents behaviour in an automatic manner. This is achieved by revising and complementing the work done by the existing non-verbal behaviour generators. Focusing mainly on non-verbal behaviour, our agents with gender were tested to see if users were able to perceive the gender bias of the behaviours being performed. Results have shown that gender is correctly perceived, and also has effects when paired with an accurate gender appearance.

1 Introduction

Animated films is a medium that requires the suspension of disbelief: the audience enjoys the mental illusion that the characters are actually gifted with life. However, in order to achieve such "illusion of life", each animated character should have, not only believable appearance, but also perform human-like facial expressions, gestures and body movements.

In the area of virtual agents, we also aim at achieving characters with believable behaviour. Research in embodied conversational agents (ECAs) has significant work in gaze models, gestures, postures, and facial expressions, just to mention a few. Some of these works take into consideration the influence of individual factors in the generation of behaviour, such as personality and culture. In this work we will address gender differences, starting with the hypothesis that if we have ECAs with body language and physical appearance matching in gender, the perception of male or female will be more accurate than just having a gender appearance.

We start with a brief overview of gender differences in non-verbal communication and relevant work in the area of ECAs. Then we present our model for gender in ECAs and its implementation. Finally, we discuss the evaluation results and draw some conclusions.

2 Gender Differences in Non-verbal Communication

Non-verbal communication is one major subject when studying human behaviour. Between 60-80 percent of our messages are communicated through our body language and only a small percentage is attributable to the actual words of a conversation [13]. Non-verbal communication codes include physical appearance, gestures, postures, facial expressions, gaze, touch, and space [8]. In this paper, gender is considered to be the physiological, social, and cultural manifestations of what people perceive to be the appropriate behaviours of females and males [5]. Gender differences are assumed to be present for both verbal and non-verbal communication.

Studies have found that women are in general considered more communicative [3]. They tend to use both verbal and non-verbal cues more frequently, and they use more distinct gestures than men. Men tend to use fewer gestures and postures, but they change the gesture or movement that they are performing more frequently (often repeating previous movements). Further, the biggest differences are present in gestures categorized as adapters (involuntary movements). Woman tend to gesture towards the body and their gestures are considered to be more positive. On the other hand, men tend to use less positive, larger (space-consuming) and sweeping gestures. Concerning posture, women use less physical space. They usually assume a forward position when sitting, legs and feet together, and lean forward when listening. By contrast, men tend to stretch arms and legs away from their body. They assume more reclined positions when sitting and lean backward when listening. If we consider gaze and head movements, women spend more time looking at their target of conversation than men which avoid their target frequently [1] [5] [6] [15].

3 Related Work

Many systems that embed ECAs use different models for men and women, like Mission Rehearsal Exercise (MRE) [7] or Façade [10]. However, when we compare body languages and gestures there is hardly any difference between them, apart from the pre-authored animations that are build specifically for each character. Other systems, such as Greta [12], exhibit generic non-verbal behaviour synchronized with speech, but do not aim at specifically model different factors like culture, personality or gender. Despite Greta being represented as a woman there seems to be no gender driven movements considered.

Further, there are currently several non-verbal behaviour generators. The majority of them are systems that automatically add different types of non-verbal behaviour to a given dialogue script that involves multiple human-like agents [4] [2]. But researchers are also considering other conscious and unconscious habits that intervene in the content of our discourse and define our non-verbal behaviour [11]. Our work looks at non-verbal behaviour variations concerning gender.

4 A Model for Gender Adaptation in ECAs

We aim at creating distinct individual characters which can perform the exact same script, with the same proposed gestures, but behave somehow differently according to their gender. Overall, most gender differences are involuntary movements observed at different levels: (a) gestures and postures that are socially attributable to man or woman (mutually exclusive); (b) gestures and postures that are performed by both male and female, but in a different way; and finally (c) differences between the amount of gestures and postures performed during a conversation.

The process of generating behaviour in ECAs usually considers three stages: intent planning, behaviour planning and behaviour realization [9]. Since we are interested in involuntary movements, which do not have any specific semantic meaning, they are somewhere in-between the behaviour planning and the behaviour realization. As such, we introduced these involuntary movements at the body level of our characters. Since we do not want to redesign the existent behaviour generators but rather to complement them, and use the currently available tools, our model extends the current behaviour generation pipeline adding a *behaviour reviser* and an *involuntary behaviour generator* (see Figure 1).

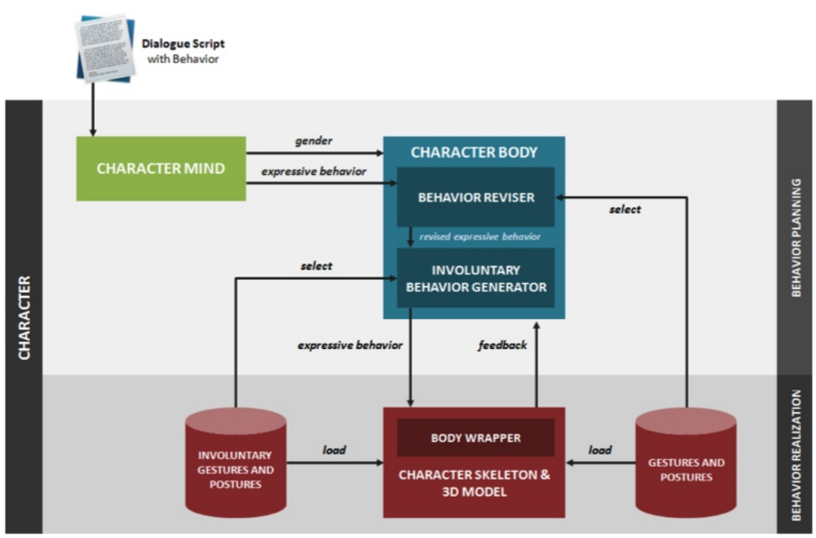

Fig. 1. Model for a Character's body processing model with gender

The *behaviour reviser* looks at the previous generated behaviours and, if necessary and possible, replaces gestures or postures which are inaccurate in gender.

Thus, it adapts or performs gender variations by selecting the appropriate gesture or posture whilst keeping the intended semantic meaning.

The *involuntary behaviour generator* generates gender specific involuntary movements. Previous generated behaviours are not overridden or replaced. The inclusion takes place in the empty spaces, in which no concrete behaviour was generated. The process considers the differences between genders: female characters will use more distinct gestures than male characters, and male characters will change from gesture to gesture more frequently reusing previous used gestures.

5 Implementation of the Model

Our implementation uses scripts in BML (Behaviour Markup Language) as input, and SmartBody [14] with the Panda3D BML Realizer[1] as behaviour realizer. Panda3D BMLR offers a limited number of characters with both female and male appearances. Each character can perform a pre-defined set of gestures and postures which were marked as feminine or masculine and stored in the animation library.

When a character receives a BML script, the *behaviour reviser* searches for behaviour inconsistencies (an inconsistency occurs when a selected gesture or posture does not match the character's gender). If an inconsistency is found, it looks into the animation library and tries to replace the gesture or posture for appropriate ones.

Then, the revised BML script goes through the *involuntary behaviour generator* which finds empty spaces and fills them with involuntary movements: gestures, postures, gaze and head movements.

Finding Empty Spaces. The algorithm for finding empty spaces looks at start and end points of each BML element: lower and higher bound of the interval for gestures, and lower bound of the interval for postures (the higher bound is always infinity). Then overlapping intervals are resolved. Finally we obtain a number of empty spaces, and their duration and position within the BML block.

Generating Involuntary Gestures. Based on the studies presented in section 2, the algorithm for generating involuntary gestures selects which percentage of total empty time will be used according to gender. If the empty time is too small, no involuntary gestures will be added. Then, it selects appropriate gestures from the animation library and inserts them into the available empty spaces.

Generating Involuntary Postures. Generating involuntary postures is similar to generating involuntary gestures. However, since postures do not have a pre-defined duration, characters can remain in a specific posture forever. Therefore, the algorithm takes into account not only the available time to maintain a

[1] http://cadia.ru.is/projects/bmlr/

specific posture, but also its intended duration, which varies with gender.

Generating Involuntary Gaze and Head Movements. Since SmartBody can blend gaze and head movements with other behaviours, there is no need to calculate empty spaces for them. The generator inserts multiple head nods (which vary with gender) along a BML block when a character is listening.

Finally, the resultant BML block is sent to the Panda3D BMLR to be realized and rendered.

6 Evaluation and Results

We conducted an on-line evaluation in order to study the impact of our approach in the perception of gender in an ECA.

6.1 Design

The evaluation process was divided into two parts. In the first part, we wanted to assess our assumptions concerning the gender of the proposed characters (if the female looking character was rated as female, the androgynous as neutral and the male as male). Users were asked to classify the characters in a 5 points Likert scale ranging from *very feminine - 1* to *very masculine - 5*, including a neutral classification. We considered that female and male perception would fit, respectively, the intervals [1, 2.5] and [3.5, 5]. Androgynous look would be in the middle. The characters were presented with different poses (see Figure 2).

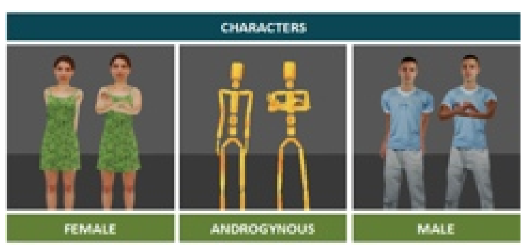

Fig. 2. Characters used for the evaluation process

The second part of the evaluation was performed with videos displaying behaviour generated with our model. Six conditions were considered corresponding to the permutation of two independent variables: "look" which refers to the physical appearance of the character (female, androgynous, or male), and "behaviour" which refers to the generated behaviour (female behaviour or male behaviour). We used within-subject design (questionnaires with repeated measures) where users were asked to do the same classification as before (5 points Likert scale).

6.2 Participants

The on-line questionnaires were completed by eighty four participants (46 male and 38 female).

6.3 Results

In the first part, the results show that the chosen look for our androgynous body did not fall in the interval we defined for the androgynous representation [2.5, 3.5] with a mean of $\mu = 3.54$ and standard deviation $\sigma = 0.61$. The female body had a mean of $\mu = 2.38$ and standard deviation of $\sigma = 1.01$, thus the character was rated as less feminine than expected. On the other hand, the male body fell in the desired interval with a mean result of $\mu = 4.13$ and standard deviation $\sigma = 0.63$.

In the second part, we conducted Mauchlys sphericity tests to validate that we could apply repeated-measures ANOVA. The ANOVA shows significance in two main effects: how "look" influences the perception of gender ($F(1.820, 151.069) = 14.807, p < 0.001$), and how "behaviour" influences the perception of gender ($F(1, 83) = 355.806, p < 0.001$). There is also a significant interaction between "look" and "behaviour" ($F(2, 166) = 35.359, p < 0.001$). Therefore, the variation on gender perception when combining look and behaviour is higher than the sum of the effects of each variable separately. In other words, it means that gender is better perceived when the body of the character matches the bodily behaviour being performed.

6.4 Discussion

Overall we can say that gender was correctly perceived in the different conditions. The physical appearance of our characters is perceived as being more masculine than expected. This is probably due to the use of a common internal skeleton, which does not take into account gender differences.

Concerning the modified behaviour, the ANOVA results support, at least in part, our approach. We also looked at the individual conditions, used the mean values of each look as a baseline and compared those values with the characters with feminine and masculine behaviour. The perception of gender is seen as more feminine or more masculine as expected. However, this analysis has yet to be supported with pairwise t-tests.

7 Conclusions and Future Work

In order to achieve more believability in embodied conversational agents (ECAs), agents must have not only a believable physical appearance but also perform believably in both verbal and non-verbal behaviours. Our approach has taken the view that if we have ECAs with body language and physical appearance matching in gender, the perception of male or female would be more accurate and eventually more believable. Our results showed that gender is indeed better perceived, which in part supports our hypothesis.

Finally, one should stress that our approach uses mostly involuntary movements, which does not cover all aspects of gender. Our behaviour generation pipeline can also be improved to take into consideration the interaction with other agents. Finally, crossing gender with emotions, personality and most importantly culture should be investigated in the future.

References

1. L. Brannon. *Gender: Psychological Perspectives.* Pearson Education (6th edition), 1993.
2. W. Breitfuss, H. Prendinger, and M. Ishizuka. Automated generation of non-verbal behavior for virtual embodied characters. In *ICMI '07: Proceedings of the 9th international conference on Multimodal interfaces*, pages 319–322. ACM, 2001.
3. N. Briton and J. Hall. Beliefs about female and male nonverbal communication. *Sex Roles*, 32:79–90, 1995.
4. J. Cassell, H. Vilhjlmsson, and T. Bickmore. Beat: the behavior expression animation toolkit. In *SIGGRAPH '01: Proceedings of the 28th annual conference on Computer graphics and interactive techniques*, pages 477–486. ACM, 2001.
5. P. Ekman and W. Friesen. The repertoire of nonverbal behavior: categories, origins, usage, and coding. *Semiotica*, 1:49–98, 1969.
6. L. Glass. *He Says, She Says.* Perigee Trade Publisher, 1993.
7. J. Gratch and S. Marsella. Tears and fears: Modeling emotions and emotional behaviors in synthetic agents. In *Proceedings Of The 5th International Conference On Autonomous Agents*, pages 278–285. ACM Press, 2001.
8. M. Knapp and J. Hall. *Nonverbal communication in human interaction.* Wadsworth Publishing, 2005.
9. S. Kopp, B. Krenn, S. Marsella, A. Marshall, C. Pelachaud, H. Pirker, K. Thorisson, and H. Vilhjalmsson. Towards a common framework for multimodal generation in ecas: The behavior markup language. In *Proceedings of the Intelligent Virtual Agents 2006*, pages 205–217. Springer, 2006.
10. M. Mateas and A. Stern. Faade: An experiment in building a fully-realized interactive drama. In *Game Developers Conference, Game Design Track*, 2003.
11. V. Maya, M. Lamolle, and C. Pelachaud. Influences and embodied conversational agents. In *AAMAS '04 - Proceedings of the Third International Joint Conference on Autonomous Agents and Multiagent Systems*, page 13061307. ACM, 2004.
12. C. Pelachaud. Multimodal expressive embodied conversational agents. In *13th annual ACM international conference on Multimedia*, pages 683–689. ACM Press, 2005.
13. W.-P. Su, B. Pham, and Wardhani. Personality and emotion-based high-level control of affective story characters. *IEEE Transactions on Visualization and Computer Graphics*, pages 281–293, 2007.
14. M. Thiebaux, S. Marsella, A. Marshall, and M. Kallmann. Smartbody: behavior realization for embodied conversational agents. In *AAMAS '08: Proceedings of the 7th international joint conference on Autonomous agents and multiagent systems*, pages 151–158. IFAAMAS, 2008.
15. C. Tiljander. Social gender norms in body language: The construction of stereotyped gender differences in body language in the american sitcom friends. Technical report, Karlstads universitet, 2007.