The Yume Project: Artists and Androids

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Abstract. Creating believable androids is not just a technological feat, but an artistic one. The Yume Project addresses the challenge of creating lifelike androids by developing complex character. The authors demonstrate the unique perspectives artists can bring to the humanoid robot design process through costume, character, and story development. The authors hope to show that it is a focus on believability rather than realism that is needed to advance the field of humanoid robotics.

Keywords: humanoid robotics, interdisciplinary teams, animatronics, art, human-robot interaction, entertainment technology, android.

1 Introduction

The Yume Project takes a unique approach to the challenge of creating androids that appear human in both appearance and interaction. We are not designing new systems, but rather seeing how existing android technology can be enhanced by artistic disciplines [1]. This strategy is worth examining because it brings a new perspective to a field that can prosper from greater interdisciplinary teamwork [2,3,4]. We seek to show that android design would benefit from a shift in focus from realism to believability. We propose that to engage humans, a compelling, believable character is as important as an accurate simulation of human physiology and intelligence [5]. Preliminary data will also be presented that suggests that the enhancements made resulted in audience members finding the robot more appealing on initial viewing.

1.1 Project Scope

The Yume Project was a semester-long endeavor. The team was composed of artists specializing in theater and film production, a writer, and a computer programmer. This mix is unusually art-heavy for a robotics project. This provided the team unique perspective of the issues encountered when working with androids. The hardware used on the project was Kokoro Robotics' DER-1 Actroid. The Actroid is a pneumatically driven female android covered with a partial silicone skin. Throughout the course of the semester, the team focused on creating inexpensive proofs-of-concept that could be rapidly implemented and iterated upon.

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2 Believability versus Realism

When making attempts at verisimilitude, slight inaccuracies become large distractions as a more realistic form creates ever higher expectations about mobility and intelligence [3,4]. Total realism then, would only be achieved in the completely accurate recreation of the human form. Our knowledge of the human form, especially the mind, is not complete. Coupled with technological limitations, meeting expectations with realism becomes a complex and tedious task.

Believability however, comes in the successful communication of the human condition. Consider memorable characters created in novels, theater, and film. They seem full of life; they meet our expectations, because we identify with their challenges and struggles [6]. For the creators of these characters, realism becomes a tool in service of believability [7].

By making believability, rather than realism, the ultimate goal of android development, we are not abandoning the quest for ever more perfect technology, we are simply attempting to meet human expectations of androids with a new set of tools. In the Yume Project, technology was held constant. This provided us the opportunity to focus on character and story in order to increase the believability of an android.

3 Building Character

An understanding of character is the starting point for believability. Thinking about character: a person's goals, quirks, and background [8], can help inform the required functionality, appearance and personality of an android. These character goals can also be designed to meet research goals. Because the Yume Project is working with pre-existing hardware, a character was developed that also embraced our system's limitations.

3.1 Character

Humans naturally perceive some degree of personality in robots [9]. By developing character for androids, we are embracing this tendency. To develop our Actroid's personality we drew from our own experiences, personalities, and objectives [10]. We named the robot Yume (pronounced you-meh or you-me), the Japanese word for "dream."

Using a character sheet [8], we developed a background for Yume. The character sheet serves as a history to reference in order to keep voice, personality and appearance consistent across interactions. In Yume's character sheet we describe her appearance, occupation, and personality in detail, including grooming habits, favorite band and idiosyncrasies. Not every facet of character needs to be revealed to a person interacting with the robot. The information has value as subtext, providing reason for a character's actions [11]. Without this subtext, any response generated by an android has the potential to seem disingenuous and unbelievable [12].

One advantage of exploring character in this manner is that technical limitations can be incorporated into personality. For example, the Actroid is pneumatic which can cause jerking movements, and does not always make eye contact with viewers.

We looked for humans that act similarly and found anecdotally that members of the Goth subculture dance with jerking movements and avoid making eye-contact. We felt that making Yume a member of this subculture would turn these limitations into character traits that make sense to viewers.

3.2 Story

Character will reveal itself through an android's interactions [6]. Reactions that are consistent with character satisfy expectations and create believability. These traits could certainly be incorporated into AI systems, but believability can also be enhanced by simplifying interaction. As an example, the Actroid is equipped with voice recognition software which we chose to disable. Currently, voice recognition technology is not as accurate as natural human conversation. By removing this potentially awkward interaction, a technical limitation disappears and a space is created for the viewer to perceive interaction in carefully designed scripts.

The Yume project used Rogerian therapy techniques similar to those used in the ELIZA program [13] to develop scripts that create the illusion of interaction and intelligence. These techniques simulate interaction by asking rhetorical questions and asking the audience to perform actions. Pauses in dialogue are added to give the impression of thought. These pauses also allow viewers to attribute complex reasoning and emotion to the robot's ambiguous actions [3].

Like our choice of a Goth character, story decisions were made that downplay the Actroid's technical limitations. Because the robot is elevated on a base, we wrote stories that center around addressing a small crowd. Because she is addressing a crowd she should not be making constant eye contact, or interacting heavily with any one person.

4 Bringing Character to Life

In the Actroid, motion is generated through the playback and blending of animations. The team investigated three techniques for creating these animations: face detection feedback loop, motion capture, and traditional character animation.

4.1 Face Detection

When interacting with the Actroid, lack of eye contact was often noted as distracting. To eliminate this distraction, techniques were borrowed from animation and puppetry. A webcam was used to pick faces randomly out of a captured image, then using the animation principle of anticipation [14], the Actroid procedurally turns its eyes followed by its head and then shoulders, to the chosen face. To create the illusion that a character is focusing its gaze ("convergence" in human vision), puppets are built with slightly crossed eyes. This same technique was implemented in the Actroid. In action, motions generated by this feedback loop appeared robotic and extreme.

4.2 Motion Capture

Motion capture has been proposed as a means of duplicating human motion in androids because of its widespread use in film and video games. Attempts to implement such systems have met with unsatisfactory results [15]. Reasons cited for this poor performance include the difference between human and android joint structures, and limited speed and range of joint motion [16]. We propose a more basic reason for these unbelievable performances. In the film and video game industries, raw motion capture data is never translated into final animations. Instead, animators devote hundreds of hours to enhancing motion captured performances. Artists take a completely realistic recreation of human motion and must exaggerate, tweak and accent the performance before audiences find the motion believable and acceptable. Likewise, the completely realistic data generated by motion capture is not the key to believable motion in humanoid robotics without some amount of artistic interpretation.

4.3 Character Animation

Because believable motion is such a large part of conveying understandable character [17], the team decided to put motion creation in the hands of professionals. Animators are motion specialists: expert actors who use the twelve principles of animation originally developed by Walt Disney Studios [14] to convey believable action and character with subtlety.

The Actroid's original animation interface is an internally developed system that does not incorporate the conventions of modern animation software. In order to allow animators to easily apply their skills to android animation, we needed to develop a tool using the vocabulary and conventions of their trade. To meet their needs, we have developed a custom animation rig using Maya (see Fig. 1). Maya is an industry standard animation tool that contains the features animators need to create engaging, believable motion. Maya has been suggested as an animation interface by Hanson robotics [4] and is currently in use for animatronics animation at the Walt Disney Company.

Using the rig we developed, animators now have a three dimensional view of the Actroid that can be directly manipulated. Maya also contains preexisting tools that speed up the content creation process such as the ability to synch sound files with

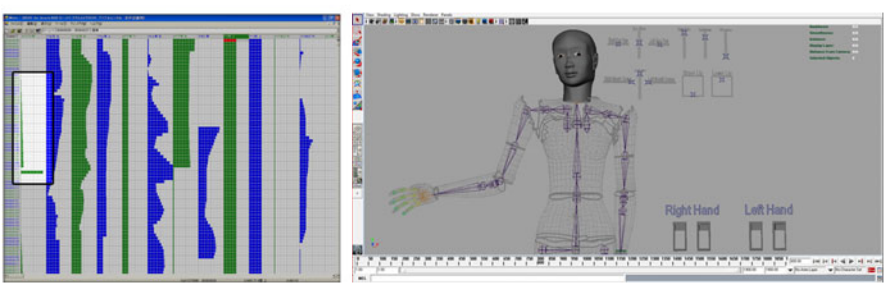

Fig. 1. In the original interface (*at left*), colored curves represent air pressure in actuators. One curve (*highlighted)* represents an eye blink. In our rig (*at right*), a scale model of the Actroid can be animated through direct manipulation. The model simulates the robot's outer skin, range of motion, and internal joint structure. Animation with sound can be previewed at anytime. Facial and hand controls are displayed beside the model to allow animators to more easily see the results of their work.

animation, the ability to interpolate between two keyed poses, and the ability to save libraries of movements that can be blended to create complex actions. Animations can be previewed without the robot present, although the imprecision of the physical world requires animators to tweak their work to play as intended on the Actroid.

5 Presenting Character

Costume is a visible expression of character, it serves as an indicator of social status, style, occupation and age [18]. By carefully designing what our character wears, we can further influence an audience's perception of the Actroid. When this perception is supported by character and story, audience expectations are satisfied, further contributing to believability. For the Actroid, costuming also became an opportunity to downplay distracting physical features (see Fig. 2).

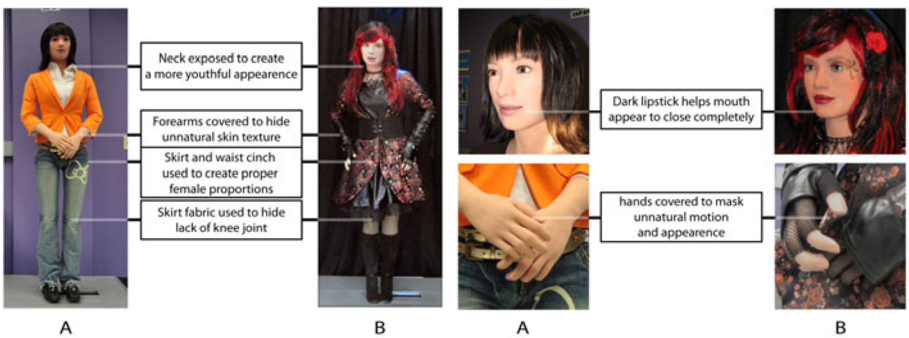

Fig. 2. The Actroid's original clothing (*on left and right center*) and our final costume design (*on right and left center*). Notice the pattern and shine of the final costume's fabric. This helped draw audience attention to the Actroid.

When animated, the Actroid's hands are its least believable feature. In Fig. 2, it is shown that covering the hands with lace and long leather gloves lowers their contrast, making them less likely to attract audience attention. Several casual observers found the Actroid's inability to completely close her mouth unsettling. Dark lipstick corrected this issue by darkening shadows in the mouth, making it less likely a viewer would notice the robot's teeth. The Actroid has no joint at the knee, making weight shifts look unnatural. The design of the skirt hides the robot's upper legs and hips, creating more feminine proportions while moving in a natural way during a weight shift.

5.1 Setting

Setting and lighting can deeply affect a subject's reaction to an android. In film, location and light are used to set a tone and convey emotion. Starlets are lit with warm, soft lights that hide skin flaws and flatter the figure. Taking the same care in presenting androids can be an inexpensive and effective way of preparing an audience for the interaction it is about to have.

Androids are most often encountered in laboratory, academic, and other research environments (Hanson Robotics' PKD android [4] is a notable exception). These settings remind viewers that they are looking at technology. By presenting the Actroid in a manner similar to theater, we hope to evoke the experience of seeing a character in performance (see Fig. 3).

The Actroid is presented surrounded by a semicircle of curtains and bathed in warm lights. Once again, we are attempting to overcome the Actroid's technical limitations. Gold colored lights make the robot's silicon skin look warm and focus audience attention by accenting the costume's gold pattern. Curtains both hide the robot's hardware and suggest a theater environment. When attending a performance, audiences expect to be told a story with little interaction from actors. Recreating this environment prepares the audience for the Actroid's character and limited interaction.

Fig. 3. If the audience feels that they are attending a show instead of witnessing an experiment, they should be less critical of the eccentricities of interacting with an android

6 Audience Response

Over the course of the project, audience members were asked to record their initial reaction to the animated Actroid. Each costume was viewed by a different group of 16 participants. This sample size is too small to draw formal conclusions, but did provide preliminary data which guided the design process.

Reactions were recorded along a 7-point Likert scale (disturbing - unappealing - slightly unappealing – neutral - slightly appealing – appealing - engaging). Upon examining our data, we decided that "disturbing" and "engaging" were misleading word choices, so those responses were treated as "unappealing" and "appealing" respectively, creating a 5 point scale. This did not change results of the analysis.

As can be seen in Figure 4, the final costume elicited an improved response over the initial costume design, $t(15) = 7.66$, $p < .001$. Audience attitudes moved from under "slightly unappealing" to over "slightly appealing," which suggests that our attempts to increase believability by focusing on character and costume had a positive impact on audience perception of the robot.

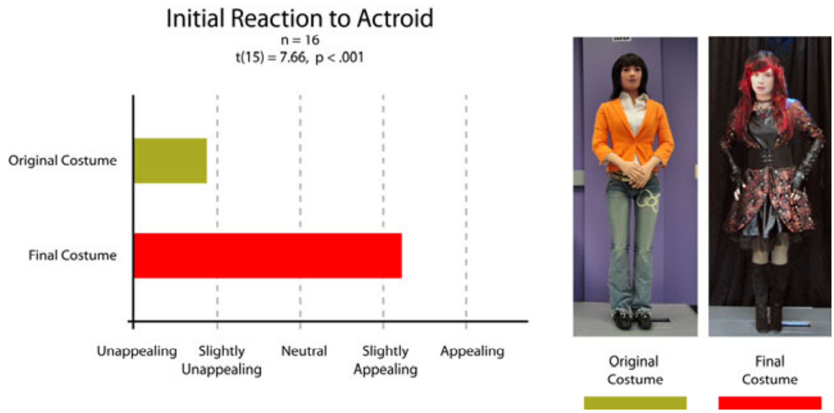

Fig. 4. Participant reactions to different costume iterations, rated from Disturbing to Engaging

7 Conclusion

A perspective shift is needed in android design. Scientists striving for realism are slowed by technology's limits in duplicating the minutia of the human form. By embracing the challenge of creating believability, we feel we can endow androids with strong character that engages audiences while deemphasizing physical and AI weaknesses that would otherwise distract during encounters.

We want researchers to see that artists can have an integral role to play in overcoming the challenge of creating believable humanoid robots. It is not a task engineers and programmers should have to tackle alone. The development of believable androids like Yume requires more than just technical knowledge. Aesthetics, character, and presentation are all equally essential parts of a satisfying human-robot interaction.

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