The Importance of Natural Movements in Virtual Patients

Lorraine Lin
Clemson University REU, DREU
Mississippi State University
P.O. Box 1685 MSU, MS 39762
ll322@msstate.edu

ABSTRACT

A virtual pediatric patient system gives student nurses the opportunity to practice through realistic scenarios as often as they would like without time restraints. Many components are involved in making this system realistic, including voice recognition, text to speech, high fidelity models, and realistic animations. In order for a virtual patient to be as realistic as possible, besides being able to understand the nurse's questions and return the proper verbal answers, the virtual patient must also exhibit natural nonverbal human behavior. The lack of body language in a model that is otherwise realistic results in a natural misinterpretation of the virtual patient's well-being: interpretations of the patient's stiffness range from being unwelcoming to exhibiting disease conditions. A virtual character who looks like a human and speaks like a human but lacks subtle natural animations can fall into Mori's "Uncanny Valley," where users feel repulsion or eeriness because the character's movements or lack of movements suggest human mortality. These characters fall deeper into the Uncanny Valley for medically trained users than for casual users because the medically trained users are taught to look for signs of anomalies in human health.

Keywords

Virtual Patient, Student nurse, Modeling, Animation.

1. MOTIVATION

The Virtual Pediatric Patient System (VPPS) is a dialogue-based human project that Clemson Graduate and Undergraduate Research students created in 2010 to give student nurses the opportunity to practice interview skills with virtual pediatric patients. Having a virtual patient system could be beneficial to student nurses because these students come across many dilemmas in training. First, many parents will not allow student nurses to train on their children. Secondly, student nurses must make appointments with other student nurses to practice; schedule conflicts make these appointments less frequent than nurses would like to have them. Finally, the practice student nurses receive from professors and each other are not entirely realistic because, when playing the parts of either patients or nurses, each party is already trained to know what the other will say. The VPPS gives nurses the chance to practice scenarios over and over again until they are comfortable with them.

2. FIRST ITERATION

The first VPPS prototype was built to see if all of the components needed to create a virtual patient interaction system would work together [4]. These components included voice recognition, text to speech, database, modeling the virtual environment and characters, and animation. Since characters in the first prototype could respond correctly to questions that users phrased in several ways, the first prototype was a successful proof of concept. [5]

We ran a usability study with nursing faculty after the first prototype was created to see if we were on the right track. The VPPS is a simulation of a mother, Mrs. Jones, and her daughter, Sarah. In the simulation, Mrs. Jones brings her daughter to a medical clinic because Sarah has an earache. The user sees Mrs. Jones and Sarah sitting on a couch in a medical examination room; the entire scenario is viewed on a large screen (52") display [1].

Figure 1: The first prototype of the VPPS.

The nursing faculty spoke directly to Mrs. Jones and Sarah through a microphone headset. After nurses asked a question, the correct verbal and/or nonverbal response was retrieved from a database and executed [1].

The first usability study raised important issues about changes that needed to be made. The nurses could not tell if the room was an at-home visit or a pediatric room. This detail is important since nurses ask different questions depending upon the location. Also, lifelike animations were more important to the nurses than originally expected. Focus on the first iteration of the VPPS was directed towards voice recognition, verbal communication, and verbal expressions. Simple animations were implemented to run with Sarah's and Mrs. Jones' responses, but all of the nurses were watching for more subtle ranges of nonverbal communication. In the first iteration, Mrs. Jones sat on a couch with her arms and legs crossed. Along with speaking, Mrs. Jones could nod and shake her head, change facial expressions, and look at Sarah from time to time. Sarah could also speak, and gestures such as nodding, shaking her head, pointing, or waving sometimes accompanied her voice. To make Sarah appear more child-like, she was also given animations such as swinging legs or looking around the room [1].

These minimal animations returned more negative views of the characters from the nurses than we intended or expected. Mrs. Jones was supposed to appear motherly. The nurses took Mrs. Jones' sitting position as being unwelcoming. One nurse tried to convince Mrs. Jones to un-cross her arms and look more comfortable as the interview continued. The same nurse also almost started asking questions related to autism because Sarah did not seem to be paying attention or recognizing that she was in the room. The nurses were looking for more signs of communication between the mother and child as well, and they interpreted the lack of compassionate behavior and interaction as a possible sign of an abusive relationship [1]. Sarah was supposed to have an earache. Nurses thought Sarah's lack of subtle body language was an indicator of serious disabilities or psychological problems, not a result of her being a minimally animated virtual character. The first VPPS accidentally created a case of Mori's hypothesized "Uncanny Valley" [6], an area where a user feels eeriness or repulsion instead of the intended empathy the creator hopes for.

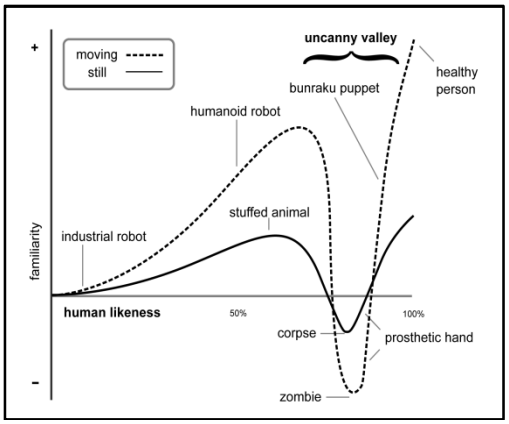

Figure 2: Mori's "Uncanny Valley," the relationship the robotics professor Masahiro Mori hypothesized between human emotional response and the anthropomorphism of a robot. The graph has recently been applied to animated characters as well [2].

The Uncanny Valley for users has been suggested to result from motion artifacts such as stiff body motion or unchanging faces [2], and MacDorman raised the possibility that strange animations can revolt a user since the user might naturally attribute a disease condition or human mortality to the animation [3]. Interestingly, the conditions proposed by nurses such as child abuse or autism resulted not from strange animations, but rather from the absence of animation.

3. CONTRIBUTIONS AND RESULTS

My focus on the project was to make the simulation and characters appear as natural as possible. I created a new room with modifications suggested by the nurses and new animations to make the characters more lifelike. I also created new high fidelity character models for this second iteration of the VPPS.

The first part I revised was the pediatric room. Several nurses suggested that the room should have a pediatric table with the child sitting on it and the mother sitting in a chair beside her [1]. I modeled the pediatric room and all the objects within it using the open source three-dimensional content creation suite Blender.

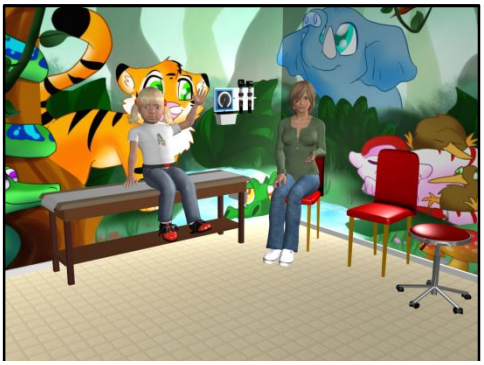

Figure 3: The New Pediatric Room.

A tile pattern was placed on the floor to emulate the floors found in medical settings. Nurses suggested that the room's background should be colorful and reflect a theme. I used a Wacom Bamboo tablet and the art program Paint Tool SAI to create two-dimensional images for the wallpaper. The first wallpaper was pirate themed, complete with a ship and treasure on a beach. However, it was changed to a jungle themed background to reflect a more gender neutral environment. I created all of the objects the nurses suggested to add to the room: a pediatric table; two chairs; a holder on the wall containing an otoscope, ophthalmoscope, and pulse oximeter; and a doctor's swivel chair.

The next step was to remake the mother and daughter models. These new models are high fidelity and more realistic than the first models, and they were created using the three-dimensional figure design and animation program, Poser. The new mother and daughter models were then imported into Blender for adding animations to make Mrs. Jones and Sarah appear as natural and healthy as possible.

Figures 4 and 5: Sarah and Mrs. Jones.

Both of the new models begin with a default neutral position sitting with their hands in their laps. I gave Sarah the same animations she had in the first iteration of the VPPS: nodding and shaking her head, looking at the nurse, and looking at her mother. Additions to make Sarah "real" include different idling positions such as leaning back on the pediatric table, different variations of swinging her legs, rocking from side to side, patting her knees, drumming her fingers, and curiously regarding the room she is in. Finally, to show that she has an earache, Sarah can also hold her ear and tug on it from time to time.

Figures 5 and 6: Sample animations for Sarah.

I transferred simple animations from the first iteration to Mrs. Jones as well: she can nod and shake her head, and she can look at her daughter. Mrs. Jones is already facing in the direction of the user, so a separate animation to look at the user is not required. I also gave Mrs. Jones several different idling animations, such as

crossing her legs and putting a hand or both on her hips. Finally, Mrs. Jones has ten new arm-moving gestures she can use while she talks, as opposed to having her arms crossed at all times in the first iteration. In fact, her arm crossing animation was left out this time.

Figures 7 and 8: Sample animations for Mrs. Jones.

Finally, both models also have a subtle breathing animation at all times, making them appear more lifelike.

5. CONCLUSION

I have drawn two main conclusions from this project. First, nonverbal communication is as important as verbal communication for patient simulations. For a medically trained user, the lack of body language in a model that is otherwise realistic results in a natural misinterpretation of the virtual patient's well-being.

Secondly, minimally animated characters fall deeper into the Uncanny Valley for medically trained users than for casual users. Clemson students and guests who viewed to the VPPS expressed neutral or curious reactions to Mrs. Jones and Sarah, a reaction that ranges from neutral to fairly positive on the Uncanny Valley graph. Faculty nurses who viewed the VPPS expressed confusion or negative feelings towards Mrs. Jones and Sarah. The nurses' reactions, interestingly, lie on the opposite (negative) spectrum of the Uncanny Valley, opposing the reactions of casual users. Medically trained users are taught to look for signs of anomalies in human health, so they may literally interpret minimal animations as disease conditions. Further research may be conducted to explore how a character with a single animation set may be perceived on the Uncanny Valley graph by different user groups.

6. FUTURE WORK

The pediatric room, animations, and characters will be imported into Unity. We will carry out further work to combine all the components such as the characters, animations, and verbal responses in this program.

Besides revising animation, changes to the question-answer algorithm will be made as well. After all the revisions are complete, we will run a second usability study with experienced nurses to gain more modification suggestions. When the VPPS is sufficiently realistic and usable, we will conduct a large scale user study with a class of nursing students and compare their current training methods to our systems.

A long term goal of the VPPS is to include a wide range of virtual patients of different ages, genders, ethnic backgrounds, and physical characteristics. Pediatric nurses would receive even more training by viewing different parent-child relationships. For example, if the father were bringing his child instead of the mother, the child may be shyer towards the nurse if the child feels closer to her mother. The ethnicity and genders of both characters will undoubtedly elicit different questions from the nurses and different responses and behaviors from the virtual characters.

Communication is an important skill in many fields, and the VPPS can be modified and applied to training programs involving many other different relationships including those between teachers, children, and parents, or for practicing job interviews. The platform could also be used for more open interactions such as creating friends for hospital patients or the elderly.

7. ACKNOWLEDGEMENTS

My participation in this project was sponsored by the Distributed Research Experience for Undergraduates (DREU) Program and the National Science Foundation (NSF) Research Experience for Undergraduates (REU) Site Grant CNS-0850695.

Many thanks to everyone at Clemson University who helped me through the course of this project:
Dr. Larry F. Hodges – My mentor
Toni Bloodworth – Ph. D student
Jeff Bertrand – Ph. D student

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