Computer Science Senior Thesis

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Abstract

Researchers have been doing experiments in the field of Human Robot Interaction for a while now. When dealing with their involvement, most researchers have been trying to maximally increase human comfort around robots by changing different factors and asking human subjects how they feel after. However, comfort and willingness to do a task are not the same thing. Throughout my research, I wanted to figure out if changing different factors about a robot's physical appearance will increase human involvement in finishing a task and achieving a set goal. I tested their willingness by approaching people with a robot with a face and without a face. Rather than increase human comfort, I wanted to see if one would lead to a more successful interaction between human and robot.

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1 Introduction

Robots are not advanced enough yet to do as much as people generally think they can. They are not the things we see in movies that can do pretty much everything. One example of a robot-like invention would be Siri; she is a computer program that works as an intelligent personal assistant. She is only programmed to do that one thing, as most modern robots are.

Robots are not advanced enough yet to do certain tasks. For example, a robot without an arm will not be able to push an elevator button. This is a relatively simple task for a person that is not possible for this kind of robot. So, the robot can approach a human to help them accomplish this simple task. Previous research would show that humans react better to more human-like behavior in robots, for example they would prefer a robot that is shaped like a human. However, if it looks too much like a human, it provokes an uneasiness in the human being approached, as experienced in the uncanny valley.

It is important to look into what will lead to a successful interaction over what will make a human more comfortable. However, social norms are still useful when determining where to approach someone from. For example it is not appropriate to approach a human from behind as it might make them feel uncomfortable. We also know that we do not want to approach a human at a pace that is too slow since the robot will not reach the human in time to have a successful interaction.

While it is important to choose the person who is most willing the help to approach, the goal here is to find out what factors will make people who may not be willing to interact more willing to by changing different factors to get their attention. Even if the person does not necessarily feel comfortable, it is worth looking into these factors that people may regard as strange. It is important to find out if something that does not make someone feel comfortable can still lead to a more successful interaction. The goal is not to make the people we approach more comfortable but to make them want to interact.

This being said, I wanted to approach people with a robot with a face and a robot without a face to see if one will lead to more successful interactions. My initial hypothesis was that either people would think the face was more approachable or it was too scary and the one without a face would be less jarring.

2 Related Work

Since their creation, robots are getting closer to becoming widely used in every day life due to their helpful nature. However, people still feel fear towards these machines. People that feel fear towards these robots may tend to feel unsafe in their presence, physically and/or mentally. A lot of research has been done on safe planning and collision detection, so that humans will feel more safe around robots. People have created these safety and visibility grids to show the robot from where to approach the human. Safe zones and visibility zones are mostly in front of the human, since that is where the subject will be able to see the robot. They found that people prefer to be approached from the side rather than the front (or the back) [7].

Research will indicate that people feel less hostility towards the robots that act the most "human-like". People prefer to stand at a distance that is most acceptable for human-human interaction when approaching a robot, unless the robot is not perceived as a social entity, in which case they will stand extremely close. [8]. It has been suggested that people feel safer with a more humanoid robot. One study evaluated blood pressure to get peoples mental stress when interacting with different movements of a robotic arm and found that people felt more secure when the motions were the most human-like. In another study, it was found that people responded better to robots whose body turned with the arm, in other words a more human-like gesture [3]. Therefore, humanoid robots seem to be better suitors as coexisting robots than any other type of robot.

Others have been doing research regarding robotic facial expression. One project used gaze control to see if humans would be more responsive. Gaze control moves the camera direction of the robot to the person and shows human that the robot expresses intentions. This was supposed to make the subject aware of the robot as a social entity rather than just an object, which should make people more likely to interact with it. While their initial hypothesis that gaze control promotes human robot interaction rang true, they also found that people with more computer skills judged robots with gaze control low in performance [1]. Robots are being created for developing Active Human Interaction that can, with real communication between human and robot, replicate human facial expressions for the human to have a more familiar conversation with the robot [2].

This concept of familiarity has been explored previously. If people use an object for a long time, say a

childhood teddy bear, they might develop an emotional attachment to that object. So, if someone interacts with a "pet" robot and it behaves in an emotional manner, it will release positive emotions in the person. One study created a contact interaction robot (CIR), that touches and is touched by the human subject. They found that the CIR they created relieved anxiety and moderated painfulness, stemming from this sense of familiarity the human felt toward the object when touching it [6, 5].

3 Methods

Throughout my project, I wanted to find out if approaching people by changing different physical factors about the robot would result in more or less effective interaction between human and robot. I decided to put the robot in an environment with unsuspecting humans to get the most natural possible reaction from the subjects.

3.1 The Design

I used the robot that Eric Rose designed called SARAH (Socially Appropriate Robot that Approaches for Help) pictured in Figure 1. The base of SARAH is the Pioneer 3DX, which is a small robot with good mobility. Attached to the base are metal rods with a screen at the top that was used to display the experiment to the unsuspecting humans [4].

I conducted my experiments in the Peter Irving Wold Center. I was up on the second floor by the Starbucks looking down upon the bottom floor, where I placed the robot by the elevator. My view is pictured in Figure 2. Since Eric figured out that the approach distance that was most appropriate to approach humans with was 30 feet, I measured out where that was and started approaching people when they reached the distance just before the stairs.

The two faces I approached people with were

1. Normal face
2. No face (with a screen that says something like will you help me?)

Figure 1: The robot I will be approaching humans with, with an example of a possible face

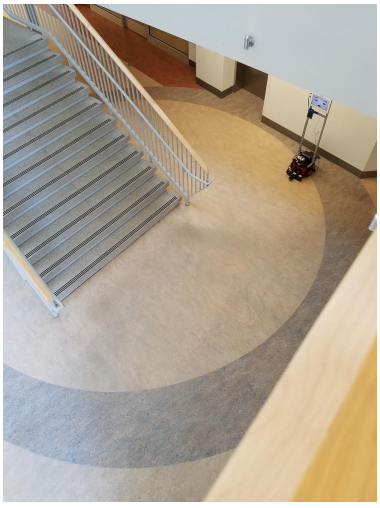

Figure 2: The robot I will be approaching humans with, with an example of a possible face

I controlled the robot using Wizard of Oz technology (WoZ). This means the robot looked as though it was performing autonomously, rather on its own. I acted as the ”wizard” behind the curtain controlling the robot from a nearby location. This way, people thought that the robot was moving on its own and really needed their help.

3.2 The Interaction

The screen displayed on the robot that was seen immediately by the human being approached is displayed in Figures 3 and 4, with a face and without a face respectively. It is an image that either has a face or is a black screen with a speech bubble that says ”Can you help me with a simple task? Press 5 to accept”. The number coincides with the number pad plugged into the robot displayed in Figure 1.

If the human chose to accept, the interaction began with the question screen, displayed in Figures 5 and 6. They are screens with and without a face respectively that say ”Are these pictures the same? press1 for no press 3 for yes” because the task I asked the humans to help SARAH with was a simple yes or no question.

The random images displayed to the human are displayed in Figures 7, 8, and 9. Two are the same images side by side and the third is the two different images side by side. When displayed, the human pressed either 1 or 3 on the number pad, coinciding with whether or not the pictures displayed next to each other are the same image or not. However, the answer does not matter in this experiment, all that matters is that the human interacted with the robot.

Once the person presses either 1 or 3 on the number pad, the robot displays a screen thanking them for the help, displayed in Figures 10 and 11. This let the human know that the interaction was over. After this screen was displayed, it would go back to the opening screen and I would move the robot back to its starting position.

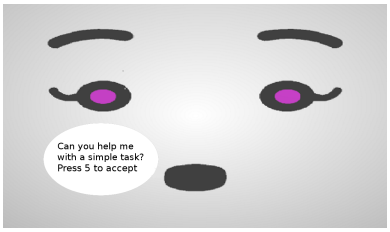

Figure 3: The opening screen with the face

Figure 4: The opening screen without a face

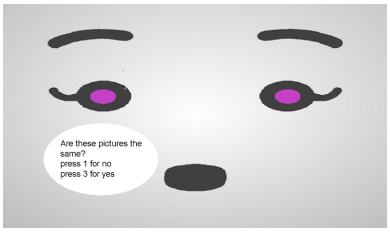

Figure 5: The question screen with the face

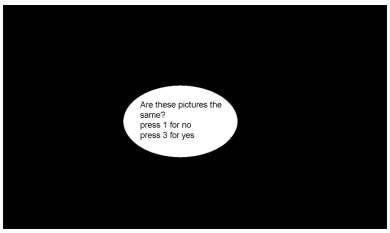

Figure 6: The question screen without a face

Figure 7: One of the images that is the same

Figure 8: The other image that is the same

Figure 9: The image that displays different images

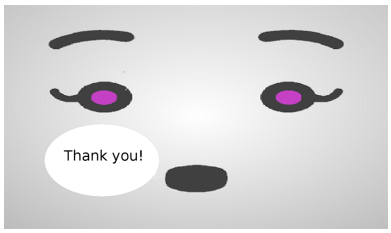

Figure 10: The ending screen with a face

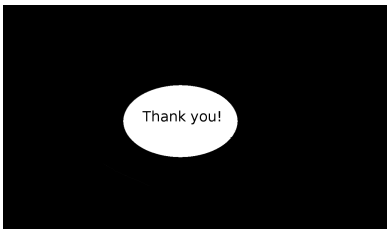

Figure 11: The ending screen without a face

4 Results

For this experiment, I wanted to see people's reaction to the robot with and without a face. This means I have some qualitative data worth discussing before getting into the numbers. Throughout the week, I heard a lot of people say things such as "that's super creepy" and "is that trying to kill me?" while no one was scared enough to actively run away. In fact, most of the people I heard say that went out of their way to interact with the robot, since most were not in the position to be approached. Most people thought SARAH was completely autonomous. I watched a number of people trying to Figure out where they needed to stand to make her move forward. I noticed that this happened most often when SARAH had a face, that is more people stood in front of her for longer. I watched one person so fascinated he did the experiment five times. Another person would come downstairs every 5 minutes, walk around her for a few minutes to get her to move, and take a bunch of pictures. A lot of people would do the experiment, run away, and come back with a few friends saying "look at this! This is so cool!" This alone showed me that the face did in fact have an affect on whether or not people would interact with a robot.

The numbers also show this fact. A larger percentage of people interacted with the robot with the face vs without as seen in Figures 12, 13, and 14. Over 50 percent of people interacted with the robot with a face vs a little over 30 percent of people interacted with the robot without a face.

I noticed that the robot without the face did not get nearly as much attention, positive or negative. A lot of people treated SARAH's faceless form as a human trying to get by. Most people when approached by faceless SARAH would immediately get out of the way without looking at what was on the screen. This was extremely different to the version of SARAH with a face. More people stopped to look at what was on the screen when SARAH had a face. Even when they did not interact with her, there was a larger amount

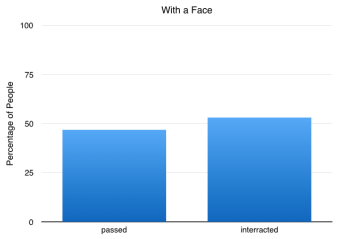

Figure 12: The percentage of people who interacted with the robot vs passed by the robot with a face

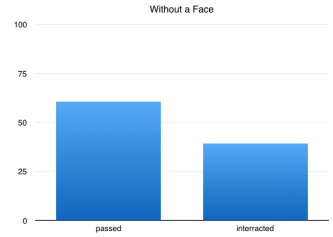

Figure 13: The percentage of people who interacted with the robot vs passed by the robot without a face

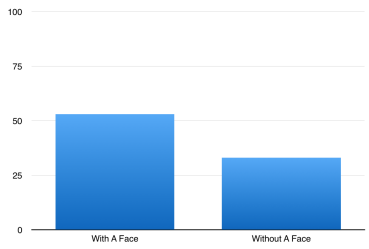

Figure 14: The percentage of people who interacted with the robot with a face vs without a face

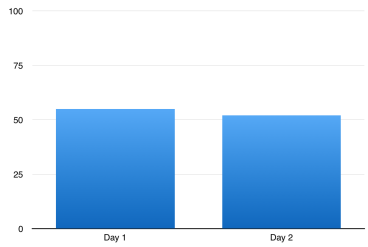

Figure 15: The percentage of people who interacted with the robot with a face by day

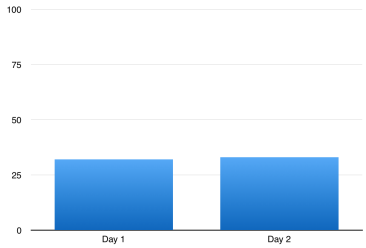

Figure 16: The percentage of people who interacted with the robot without a face by day

of people who stopped just to read what was on the screen.

Another thing I noticed was that people grew accustomed to having the robot in the Peter Irving Wold Center. My interaction percentage went down as the week went on, but not significantly, and went up with the robot without a face as shown in Figures 15 and 16. While one would think the magic of having the robot was gone, people were still excited to see SARAH there, especially people that had seen her before. I continued to see people walking in with their friends and say "I love this robot! You have to try this." People believed this robot's autonomy so much that when I was walking back into the lab with SARAH, one girl in front of me turned to her friend and said "I love this robot" and both of them stopped and did the experiment without noticing that I was standing behind them with an Xbox controller. They were so wrapped up in the idea of the robot that they did not spoil it for themselves.

From what I noticed as the wizard, faculty and staff were more willing to interact with SARAH. This might be because some of the students were on their way to class and did not want to be late and the faculty was generally getting off work. Another thing I noticed mainly with students was they would be on their phones and headed for the stairs and would turn up to the stairs without even noticing a robot coming

towards them. Some walked straight by SARAH without noticing because they were on their phones. Since my sample size was mostly millenials due to being on a college campus, it is possible I got fewer reactions than I possibly would have at a graduate college or in a workplace. A lot of people were so focused on their phones they were entirely not phased by the robot in front of them.

4.1 Technical Difficulties

While I was trying to approach people to interact with the robot, a lot of interactions were from onlookers who were not at the point of approach who walked up to SARAH and read what was on the screen. Some people saw her from the stairs and were interested enough to walk over and interact. As stated before, sometimes people would run off and grab their friends without SARAH having to approach them herself. However, even in cases of people who were not approached, it was still true that more people approached the robot with the face more than the one without a face.

Another thing I noticed was because I was asking people to press 1 and 3 for no and yes, a lot of people would get to the picture, stare at it for a minute, and then forget which number was associated with which answer. With a better system in place, I would have been able to test the humans level of engagement based on whether or not they answered the question correctly, but I saw a good majority of people standing for a while trying to figure out which was which or turn to their friends and say things like ”do you remember which one was yes?” followed by a shrug from their friend.

While most people were fooled by my location and completely assumed SARAH was running autonomously, a few people saw her moving and immediately started spinning around to figure out where I was sitting. Only one person who did not already know of my experiments found me, however a lot of people seemed to not believe that SARAH would be able to move on her own. Also regarding my identity, a few people who knew of my experiment would find me and yell to me about ”your robot” and I would then have to wait a few minutes so that no one who heard or saw would be part of my experiment, since that would defeat the purpose.

5 Conclusion

Throughout my experiment, I concluded that the face does play a role in whether or not people will interact with a robot. My original thought was people would prefer it because it reminded them more of a human, however what I found was it did not feel more human-like but caught more attention. Because the face was so non-human-like, it made people feel uneasy and this uneasiness led them to want to investigate. While the robot provoked fear in some of the people who saw it, this fear generally led to successful interactions rather than a lost one. In fact, most of the people who did not interact either seemed disinterested or did not notice the robot at all. While my initial hypothesis that the one without a face would be less jarring was correct, it was because of this fact that less people interacted with it. The lack of a face generally provoked no reaction to a way less extreme reaction than the reactions to the robot with the face.

Based on my findings, it is important to note that the face did not get more attention because it was more human-like but because it was more eye catching. People thought it was ”creepy”, but because they felt this way, they were more likely to interact with SARAH. Previous researchers put a lot of work into figuring out what made humans feel more safe and comfortable, but the work they are doing should take into account more what humans will respond to better, not necessarily what makes them more comfortable.

5.1 Future Work

In the future, it would be interesting to look into changing the screen without a face to have a brighter color since it is possible the black did not catch enough attention. I would also like to look into the face more and see if a moving, more interactive face would lead to more successful interactions or if it would be too creepy and would scare people away. Another thing I would like to look into regarding my experiment would be buttons that say ”yes” or ”no” since I witnessed people forgetting which button was which and just pressing randomly. It would also be interesting to look into human controlled factors such as group size and gender. It is possible that people are more likely to interact with the robot when they are in a group of people, maybe because they are less threatened. It also seemed as though more male students were willing to interact so it would be interesting to look more into that. Speed would also be worth looking into, since I had originally wanted to experiment with this but did not have time. I think in this

scenario, people would be most comfortable with the robot approaching them at a relatively human speed since a faster speed would probably invoke more fear and make someone feel as though SARAH is chasing them. However, I would have liked SARAH to have gone faster in my experiment to catch more people before they reached the stairs, so it is extremely possible that would have helped lead to more successful interactions. If not speed, then location could be the issue. The only way to know that one for sure would be to do experiments in a completely closed hallway. I also believe that adding a sound while approaching people would be helpful because it would get the attention of people who did not notice SARAH due to being wrapped up in their phones.

6 Acknowledgments

This project was approved for human subject testing by the Chair of the Human Subjects Review Committee at Union College. A very special thanks to Eric Rose for creating and teaching me how to use SARAH. Also, thank you to Tom Yanuklis for his help with the computers associated with the experiment.

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