'Uncanny Valley' in Relation to Graphics and User Interfaces

Course Name

Semester

Student Name

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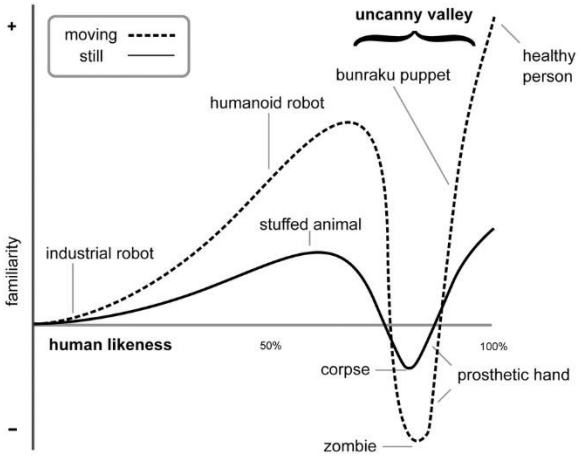
Background Study

As computer technology has evolved over the past few decades, the wall that separates man from machine has got thinner and thinner. Developers constantly try to wow users with more lifelike interfaces and graphics. However, as often as users inherently say they want the most realistic interaction with their computer technology as possible, they are often unprepared for such advancements.

Masahiro Mori (1970) first hypothesized the uneasy and upsetting feelings that users experience when dealing with advanced 'robots' that look and sound almost human, but are not. The term "uncanny valley" was coined to describe the range of hypothesized user repulsion as visualized below.



With widely popular personal assistance applications such as Siri and Google Now that use natural language processing (Muralidharan, 2014), the benefits of highly realistic human computer interaction are evident. Users care more and more for fluidity in design and communication. Replication of the human voice, however, is markedly different from that of human appearance. Humans ability to recognize even minute visual stimuli on the faces of others makes the "uncanny valley' phenomenon a difficult one to overcome.

In the time since Mori's first hypothesized on the topic, computer graphics, motion capture, and digital effects have improved at a tremendous rate. For example, the current generation of game engines can produce photorealistic images and characters.

With such computing and graphical power, bridging the hypothesized "uncanny valley" is very likely in the immediate future (Tinwell, 2009).

Abstract

This study investigates whether the "uncanny valley" is worth crossing over for users and designers. Can the appearance and expressions of virtual characters become too realistic to enjoy? Furthermore, are there methods developers and designers can use to avoid the pitfalls of the valley altogether?

In regards to Human Computer Interaction, improved character animation and graphics can have important implications to how users choose to communicate with the system or application. A user who is not comfortable with a system will be less inclined to use it. (Straight, 2015). This study demonstrates that familiarity with the virtual character is the central issue that most affects the user experience and feelings. In addition, there are methods to use by designers to avoid the pitfalls of advanced interfaces that implement ultrarealistic virtual characters and interactions.

Method

The experiment comprises of all participants subjectively ranking the same images and videos on several criteria. There are a total of nine different visual stimuli and all subjects were created with use of by computer generated imagery.

Participants were first shown the nine images as in Figure A. After initial responses are recorded, they were shown video clips from which the images were captured from. Further details on the procedure are found in the forthcoming section.

Figure A – CGI Subjects

Participants

Twelve students with majors in other fields besides computer science were chosen for the experiment. Their ages ranged from 18 to 29 years old. Seven were male, and five were female.

Apparatus

In order to ensure all participants viewed images and videos on equal terms, the computer machine and visual display were controlled for implementation. The machine is Asus N56V Laptop with an Intel i7 Core, 6 GB RAM, and a NVIDEA GeForce GT 620M graphics card. The monitor is an ASUS VN248H-P IPS Monitor with full HD 1080P display.

Procedure

Participants entered the room with the set-up apparatus. The experiment was administered only by me, and no other individuals were in the room beside the participant and myself. The participants did not any further details about the experiment other than it was opinion-based and could be completed in approximately ten minutes time.

They were first shown a collage of nine still images featuring the CGI subjects. After one minute of viewing the collage, the participants were asked the first question/instruction, which is as follows:

1) ***Please rank the nine images on their photorealism. Disregard the differences amongst the species of the subjects only examine the quality of the photo as it relates to its subject and environment. Rank the photos 1-9 with '9' being the most photorealistic.***

After their responses were recorded, a short video (less than 30 seconds) was played that featured the subject for each corresponding image. The images themselves were taken directly from the video clips so as to not alter the users' original perspective of the subject. All video clips were played with muted volume so as to control sound as a source of influence on the participant. The videos could be replayed as many times as the participant wished. After viewing all videos at least

once, the following questions/instructions were asked of the participant:

2) ***Please rank the subjects of the nine videos on the comfort level you experience while watching them. Consider any perceived uneasiness or 'creepiness' as a sign of discomfort. Please disregard the actions of the subject and the surrounding environment and examine only the subjects' expressions and gestures. Rank the videos 1-9 with '9' being the highest comfort level.***

3) ***Please rank the subjects of the nine videos on their physical likeness to living human beings. Consider not only the appearance subjects' faces and bodies, but also their expressions, movement and mannerisms as they relate to what you expect of human being. Rank the videos 1-9 with '9' being the most human-like subject.***

All responses from the participants were recorded by me. The participants completed the experiment in an average of about 13 minutes. Several participants completed the experiment in less than 8 minutes, with others taking more than 20 minutes in order to view video clips more than once.

Results

Upon completion of the participant portion of the experiment, all collected data was input into Excel and average ranking was computed for each CGI subject on all three sets of questions. For greater visualization of information, the data has been represented as three bar graphs as follows.

Figure B – Response 1

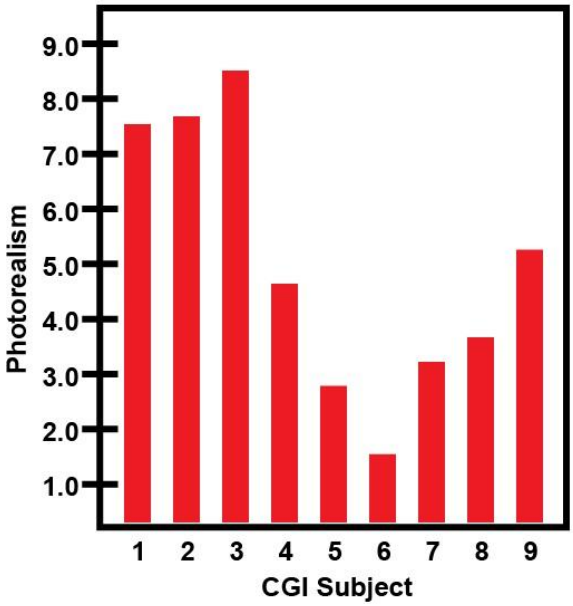


Figure C – Response 2

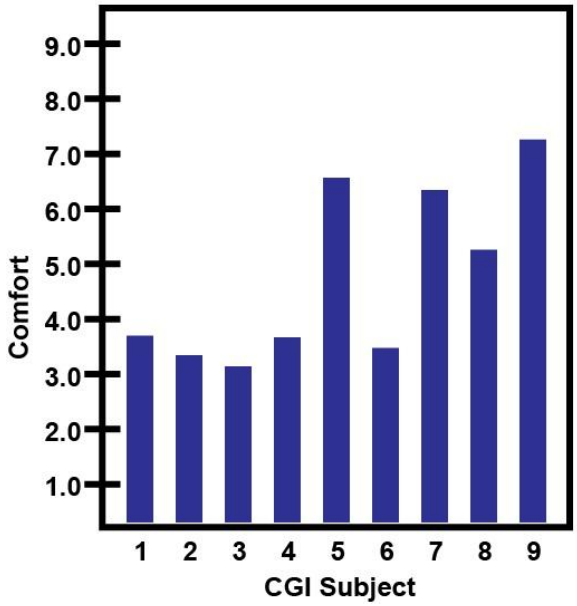


Figure D – Response 3

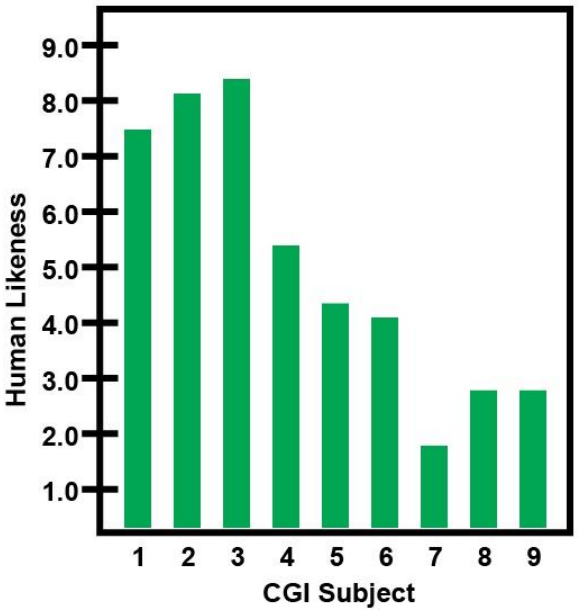


Figure B shows the ranking of the photorealism of the initial still images. This information was intended to establish how participants viewed the sense of aesthetic reality for each image. This was important to establish as it serves as baseline for comparison with the other responses. By identifying which photos look most true to life, we account for the varying levels of CGI quality and detail with each subject prior to viewing them in motion on video.

Figure C shows the ranking of each participants' comfort level with respect to viewing the CGI subjects on video.

Figure D shows the ranking of the CGI subjects and their perceived likeness to living, breathing human beings.

Based on the data its corresponding bar graphs, noticeable trends emerged from the participants' responses. With reference to the nine CGI subjects in *Figure A,* the subjects #1, 2, and 3 far and away exhibited the highest rankings for both photorealism and human likeness. Interestingly, these three CGI subjects were the only three that were found outside video games and films. All three of these subjects were developed specifically by various teams as examples and/demos of current CGI technology. In that sense, these subjects performed as expected.

However, these same subjects (1-3) all ranked within tenths of a decimal point towards the bottom with regard to the participants' comfort levels. This result is the clearest indication of the existence of the hypothesized "uncanny valley" within the experiment. As the subject's perceived humanity increased, the participant's comfort level fell.

The subjects that left the participants at their highest comfort levels were #5, 7, 8, and 9. Three of those four subjects were then ranked as the bottom three for human likeness according to the participants. Furthermore, subject #9 ranked as the fourth highest in terms of photorealism.

All of these figures put together suggest an inverse correlation between a subject's true human resemblance and its ability to stay out of "uncanny valley".

Conclusion

The pitfalls of creating a more humanoid virtual character may not outweigh its innovation and ability to initially impress. The theory of "uncanny valley" is supported through many research experiments (Tinwell, 2009), and this one- even with sample size- does nothing to contradict its existence.

In addition, this experiment functioned to provide suggestions as to avoid the "valley" altogether. By creating virtual subjects that do not quite resemble human beings, we as users are less likely to feel unsettled by the application, program, or (in this case) video. This is the case even when the realism and detail of the non-humanoid subjects is quite high. Additionally, human characters can better avoid falling into "uncanny valley" through exaggerated physical features that do not correspond with their living counterparts. In this context, the familiarity we humans have with each other is a detriment when it comes to realistic computer generated imagery and design.

As Shneiderman (2010) advises through numerous methods, it is essential for a good and functional user interface to minimize stress for the user. This concept applies whether it is reducing user memory load, or reducing anxiety with system interaction. It is undoubtable that technology will continue to improve, and with that so will user interfaces with higher and higher levels of direct manipulation that involve virtual beings. This is already the case when it comes to the natural language personal assistants millions of us have on our phone and use daily without a second thought. And with such advancements and possibilities, UX designers must respect the "uncanny valley".

Sources

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