

Developing Design Guidelines for Characters from Analyzing Empirical Studies on the Uncanny Valley

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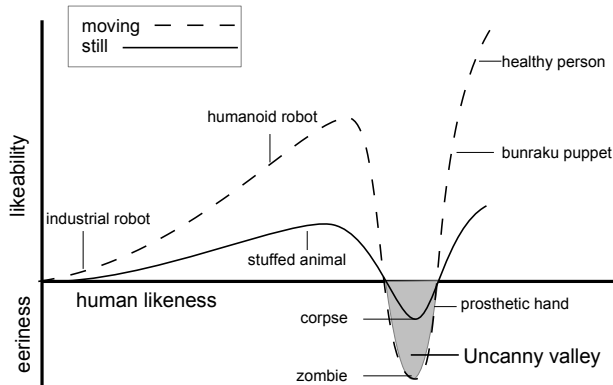


Figure 1: The uncanny valley graph that has been supposed by Masahiro Mori. The illustration is based on [MacDorman et al. 2009] with modified y-axis notation in order to match better the original Japanese meaning.

1 Introduction

The original theory of the uncanny valley (see Figure 1) has been proposed by the Japanese scientist Masahiro Mori in 1970 [1970], where he supposed that likeability of robots does not linearly increase with human likeness. Instead, the likeability increases with human likeness at the beginning but shortly before reaching realism it turns into eeriness creating a valley in the graph. Mori called this valley “*bukimi no tani*”, which has been later translated into “*uncanny valley*”.

Along with the technical improvements of computer graphics and robotics in replicating humans, this theory gained more and more attention during the past ten years. People reported that some humanoids or digital duplicates made them feel uncomfortable, while others did not. Movies like “*Final Fantasy: The Spirits Within*” or “*Polar Express*” are often mentioned as examples that fell into this valley, whereas “*The Incredibles*” or “*Shrek*” could avoid this effect. Designers started to react to this phenomenon and tried to prevent characters that are too close to human appearance. Surprisingly, there was no serious testing of Mori’s theory over the years: Only during the last five years extensive empirical studies have been carried out. The results allow a much better understanding of the observed phenomena and also show that Mori was not completely right. Therefore, we feel the need to review the empirical studies for the uncanny valley and to derive design guidelines in order to avoid unwanted negative perception of humanoids or digital characters.

2 Scientific insights

Hanson [2005] found out that the likeability in a sequence where a robot is morphed into a humanoid and then into a human, can be

modified arbitrarily by selecting different characters. He was able to reproduce curves that either confirm or completely invert Mori’s theory. He showed that the influence of the characters attractiveness on likeability is far higher than its human-likeness, and that it is possible to create positively perceived characters at any level of the human abstraction. However, his research does not explain sufficiently why some characters are described as eery, although they are very similar to humans. The experiments of [Seyzma and Nagayama 2007] and [MacDorman et al. 2009] show that distorting facial proportions have only little influence on the perception of abstract or cartoon characters, while the likeability for photorealistic characters drops significantly if the eyes are enlarged or the facial proportions are modified. Besides the abnormal deformations of a character, [Saygin et al. 2010] confirmed that a mismatch of the degree of realism between the motion and the appearance disturbs human perception of an android.

3 Proposed design guidelines

In contrast to the diagram in Mori’s original work, latest research shows that it is possible to create characters with high likeability at any degree of human-likeness and that designers should pay more attention to characteristics that are perceived as generally attractive (e.g. average face, clear skin, etc.) or as unattractive (e.g. sickly eyes, extreme asymmetry). In order to create appealing realistic characters, artists should identify the characteristics with the lowest degree of realism and keep it constant for the other properties. With increasing realism of the characters, humans become less tolerant to abnormal deformations or the mismatch between the realism of movement, shape and material appearance. The chosen degree of realism should be maintained for the background as well. This advice is less mandatory for cartoon characters and should be inverted for monsters and other eery creatures, in order to achieve the desired effect of antipathy on the audiences side.

References

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