The Extent to Which Familiarity Aids Facial Recognition in Low-Resolution Images

UUN: s1709906

The University of Edinburgh

Abstract

Research conducted on the human facial recognition system has uncovered that the ability to recognise faces even in the most degraded of images is affected by the social saliency of the individual being identified in the image. Some studies suggest that humans have this ability nevertheless, and whilst others argue that familiarity plays a great role in our ability to recognise faces in low-resolution images.

Keywords: facial recognition, low-resolution, familiarity, social saliency

The Extent to which Familiarity Aids Facial Recognition in Low-Resolution Images

Research dating back to the 1970s (~~Leon D~~. Harmon, 1973) have indicated that human beings possess the ability to recognise familiar faces in very low-resolution images. It has been speculated that we have this ability because we are able to identify familiar faces from a distance or while in motion. Since then, plenty of research has been done to hypothesise the plausible explanations behind how familiarity affects recognition accuracy, and how can we create digital recognition systems that will outperform our ability through machine learning algorithms. Facial recognition has a large number of applications in the research field as well as real-world applications, such as surveillance through closed-circuit cameras and automatic photo-tagging in social media sites. However, some of these applications face a series of limitations, mostly caused by the degradation of the image or video quality due to the non-strategic placement of capturing device, poor lighting or unsuitable environmental conditions. This paper will discuss three scientific papers focusing on how humans can easily recognise socially-salient individuals even in low-resolution images, describing experiments as well its outcomes. It will first concentrate on Leon D. Harmon's paper (1973) that explores the minimum visual information required for humans to be able to recognise any face accurately. Then it will move to a more recent paper by Guntupalli, J. S., & Gobbini, M. I. (2017) which tries to address the process by which human beings identify familiar faces. The final paper will explore the experiment conducted by Roark, D. A., O'Toole, A. J., & Abdi, H. (2003, October), which aims to find ways to gauge familiarity of a particular face to their test subjects.

by whom? citation needed

vague

It would be more useful to explain why the findings you report on are important to the field of facial recognition than to explain why facial recognition is important in general. The former would more clearly demonstrate your understanding

Literature Review

One of the earliest research regarding facial recognition in low-resolution images was conducted by Leon D. Harmon (1973). He wanted to know how 'little' information was needed for a human being to be able to recognise faces. In his experiment, he took a high-resolution portrait and degraded it under controlled conditions by dividing the picture into n x n squares of uniform size, appointing an average brightness to a cluster of squares, creating what is called a 'block portrait'. The results show that human beings are able to identify faces at a minimum spatial resolution of only 16 x 16 squares. However, he adds that the positioning of the grids matters just as much - hence the final picture has to be re-adjusted by shifting the 16 x 16 matrix. Another intriguing finding from his research suggests that humans recognise faces better when they are placed at a much further distance. Harmon modelled this situation by blurring the block portrait. He explains that by passing the already degraded image through a low-pass filter eliminates the high-frequency 'noise' that tends to obscure the image. Harmon also points out that a more conventional method of blurring images would be by taking portraits that are out of focus. However, this method cannot be precisely controlled. Hence, Harmon tried to use a computer-controlled operation that involves dividing a portrait into 256 x 256 elements and appointing a group of squares of size n x n ('averaging window') with an average brightness and varying the size of n each time. The results showed that humans can recognise faces with almost up to 60% accuracy with portraits which washes out the facial features completely (51 x 51-point window, which is approximately 20% of the width of the original image) (Leon D. Harmon, 1973). Although the results left some of his initial questions unanswered, he was able to infer from his findings that human beings do not rely heavily on facial features for recognition.

just as much as WHAT?

This is interesting but hard to visualise. A figure to show the difference would be helpful.

This point seems to come from out of nowhere; use the evidence you have drawn from Harmon et al. To justify it.

This is a point you really need to back up. What initial questions? In what way did Harmon et al. fail to answer them.

Please avoid direct quotations. Explain things in your own words. Remember that the thing that gains you marks is not the mere presence of correct stuff, but rather the clear demonstration of understanding – which copying and pasting words cannot do.

Please be concise

A more recent study conducted by Guntupalli, J. S., & Gobbini, M. I. (2017) suggests that "the human neural system for facial recognition is designed for rapid, invariant recognition of people who are salient in our social life". It also proposed that the human ability to recognise familiar faces is much greater than that of unfamiliar faces. This follows that we have the ability to identify familiar faces quickly and accurately even in its most degraded conditions, and not so much in identifying unfamiliar faces from low-resolution images. The research by Guntupalli, J. S., & Gobbini, M. I. (2017) further supports the idea that the recognition of faces (specifically familiar faces) does not depend on facial features. In fact, the information retrieval of the identity of a familiar face involves the retrieval of the knowledge we have of the person as well as the emotional responses towards that person. This means that the more information we have of a person, both visual and non-visual, affects our response time when it comes to facial identification. Guntupalli, J. S., & Gobbini, M. I. (2017) insinuates that for the recognition of familiar faces, there is a process of disentanglement of the facial identity from the variable visual features of a person, and this process is similar to that of other primates' such as the Macaque's (a monkey of the genus Macaca from Asia) face patch system. In humans, view-invariant identity representation appears in the right inferior frontal face area (rIFFA), allowing the activation of the information we have of the person as well as our emotional response to the familiar face (Guntupalli, J. S., & Gobbini, M. I., 2017).

?? Do you mean "It follows from this that..."?

et al

Again, you are asserting that this finding of the degradation-tolerance of facial recognition is evidence that facial features are unimportant to recognition.You actually need to argue for this; you also need to be much clearer about what you *mean* by it.

This is a poor word choice; it is not a synonym for 'states' or 'claims'; it implies that they suggested this indirectly, in a sneaky, underhand sort of way

4

With regard to Guntuppalli & Gobbini, you talk only about the things they conclude, but give nothing of the arguments or evidence to support these claims. Some of the claims (particularly regarding the comparisons to non-human primates, and the neurophysiological localisation of the representations) are interesting, but the whole section is of exceedingly limited value to a reader with a research interest in this field, because a claim is only as good as the evidence that supports it, and you don't provide any. Moreover, the paper you chose was a two-page discussion piece responding to Chang & Tsao (2017), rather than a paper reporting original research. This made it a poor choice

Furthermore, an experiment conducted by Roark et al. (2003, October) explores the minimum requirements needed to familiarise their test subjects to a particular face. Their experiment involved presenting the same face in the same format (in the form of facial speech video or a static frontal image) repeatedly without any variations. The subjects' ability to recognise the faces did indeed improve after every learning. Therefore, it was concluded that even a small amount of increased experience the subject has with the face is enough to trigger

??

Good - nicely explained

a familiarity benefit in recognition, despite the lack of variety of the experience, such as by using different angles (Roark et al., 2003, October). Roark et al. (2003, October) also suggested that the requirements of familiarisation lie closely to developing the strength of the memory the subject has of the faces we encounter frequently. In addition to that, Roark et al. (2003, October) discovered that increased familiarity will allow accurate recognition even after a certain image has undergone photometric inconsistencies and parameter changes. Their experiment confirms that familiarity gained from experiencing multiple exposures of a certain face improves the subject's recognition to a great extent, and that they are able to use this familiarity to map this identity information onto degraded photographs and moving bodies that are initially unfamiliar, possibly explaining how human beings are able to recognise familiar faces in low-resolution images (Roark et al., 2003, October).

What do these mean? How was this implemented in Roark et al's experiments? This needs to be explained!

I'm not convinced this constitutes an explanation; it seems like Roark et al have quantified the human ability to recognise familiar faces in degraded images - but to *explain how* would require some account of the mechanisms involved.

"It has been speculated". Why should a reader care about what has been speculated? You have repeated this speculation a few times, but can you give an argument for this, based on evidence?

Conclusion

From all of the research that has been conducted so far, it is apparent that familiarity does help humans recognise faces to a significant extent, especially when the images are presented in poor conditions. The question of how good should a face recognition algorithm be to surpass the human recognition system depends greatly on how the human observers are familiar with the faces that they are trying to identify. It was also found that humans perform rather badly when it comes to recognising unfamiliar faces in less than stellar resolutions and that there are existing algorithms that may outperform our performance. In addition to that, it has been speculated that the familiarity obtained from the frequency of experience encountering a particular face helps the human recognition system to rely less on facial features for identification, and that the process involves activating parts of the brain which contains the information about said socially-salient person and the respective emotional responses, hence any form of photometric inconsistencies that degrades the image quality should not present any difficulty in recognition. Nevertheless, further research should be conducted in order to fully understand the human recognition system as well to explore the ways in which the current knowledge can be implemented to improve the existing digital recognition systems.

You appear to be making the same point repeatedly, framed in different ways.

This is an interesting point which I would love to see some supporting evidence for

"More research is needed" really isn't an interesting conclusion. When *isn't* more research needed?

References

Guntupalli, J. S., & Gobbini, M. I. (2017). Reading faces: from features to recognition. *Trends in cognitive sciences*, *21*(12), 915-916.

Harmon, L. D. (1973). The recognition of faces. *Scientific American*, *229*(5), 70-83.

Roark, D. A., O'Toole, A. J., & Abdi, H. (2003, October). Human recognition of familiar and unfamiliar people in naturalistic video. In *Analysis and Modeling of Faces and Gestures, 2003. AMFG 2003. IEEE International Workshop on*(pp. 36-41). IEEE.

Sinha, P., Balas, B., Ostrovsky, Y., & Russell, R. (2006). Face recognition by humans: Nineteen results all computer vision researchers should know about. *Proceedings of the IEEE*, *94*(11), 1948-1962.

6