Pareidolia analysis of architecture:

Reading the emotional expression of a building façade.

Michael J. Ostwald, Kenny Hong, Stephan Chalup

Abstract

The psychological phenomenon wherein the human mind recognises particular images in otherwise unrelated visual stimuli is called pareidolia. One of the most common examples of pareidolia is the identification of illusory face-like forms that, through their particular geometric configuration, are able to suggest emotions. While the majority of famous examples of facial pareidolia involve landscapes, clouds or other natural forms, pareidolia reactions can also be triggered by the type of artificial geometric compositions that are found in architecture. The present paper demonstrates a new way of investigating facial pareidolia in architecture. The research uses software which has been trained using a database of images of human faces, to identify the presence of face-like forms and then classify these forms by their expressions. In the paper this method is demonstrated in an analysis of the emotions expressed by facial pareidolia detected in the facades of two famous houses; the Villa Savoye and the Robie House.

Introduction

Throughout history there have been many accounts of people experiencing distinct and immediate emotional responses to building façades (Pallasmaa 2005). The majority of past research which has been undertaken into this issue has been framed around phenomenological ideas or responses; arguing that certain buildings fail to stimulate the full range of the human senses, leaving the mind with only a limited connection to the architecture (Norberg-Schulz 1980). Yet, what if there was another possible explanation for this emotional reaction to architecture? What if the mind subconsciously interprets the geometric configuration of various façade forms as expressing particular emotions?

Research in cognitive science has suggested that large areas of the human brain are concerned with recognising faces and with interpreting the emotional content of facial expressions (Vuilleumier et al. 2003; Engell and Haxby 2007; Vuilleumier 2007). Recent results also propose that the processing of facial information is a special task that, in contrast to information about other objects, can be handled sub-cortically, non-consciously and independently of visual attention (Johnson 2005; Finkbeiner and Palermo 2009). This suggests that the human visual system is optimised in some way for associating abstract, face-like patterns with emotions of corresponding human facial expressions. This phenomenon is responsible for the pareidolia effect, wherein the human mind is drawn to intuitively identify face-like shapes and forms in a wide range of natural and synthetic systems (Figure 1). While there are many reasons that might explain why some architectural façades trigger emotional responses in observers, the presence of facial pareidolia is one possible explanation that is worthy of more detailed consideration (Chalup and Ostwald 2010).

The present paper describes an analysis of the capacity of two famous house facades to be read, through the presence of pareidolia, as suggesting an emotional state. The houses are the Villa Savoye (1928) by Le Corbusier and the Robie House (1908) by Frank Lloyd Wright. The analysis is undertaken using software and methods developed by the authors for correlating facial expressions and emotions. Importantly, this is not an investigation of the capacity of a building façade, viewed in its totality, to resemble a complete face; ¬the so-called physiognomy of the façade (Porter 2004; Ots 2010). Instead, this is an analysis of all possible facial pareidolia present in an elevation, at any scale or viewing distance. This approach has been taken because the problem of identifying illusory features has no single, optimal solution, but rather it is dependent on the scale at which the elevation is viewed and the sensitivity of the viewer. Thus, an objective and repeatable method for the examination of pareidolia in architecture is necessarily based on statistical probability derived from a large set of data. The end result of this process is not a single answer, but rather a complex profile for each elevation that encapsulates the complete range and type of different expressions.

While the ultimate purpose of the present paper is to demonstrate and refine a method, the results of this study, however provisional, are also of interest. This is because various critics and scholars have already offered intuitive explanations for the emotions that these buildings evoke. For example, a "common indictment of modern architecture" is that it has a "blank" face or "vacant" expression (Porter 2004, 5) which evokes a negative emotional response. In contrast, the conventional pitched roof house, with its central chimney and wide eaves, is thought to possess a more neutral or positive set of expressions (Hildebrand 1999). Thus, it might be hypothesised that the Villa Savoye will possess pareidolia that expresses a higher proportion of negative emotions than those found in the Robie House.

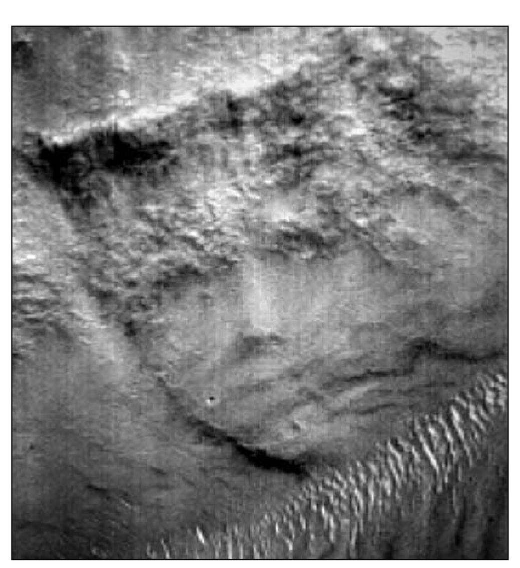

Figure 1: Example of Facial pareidolia in Landscape

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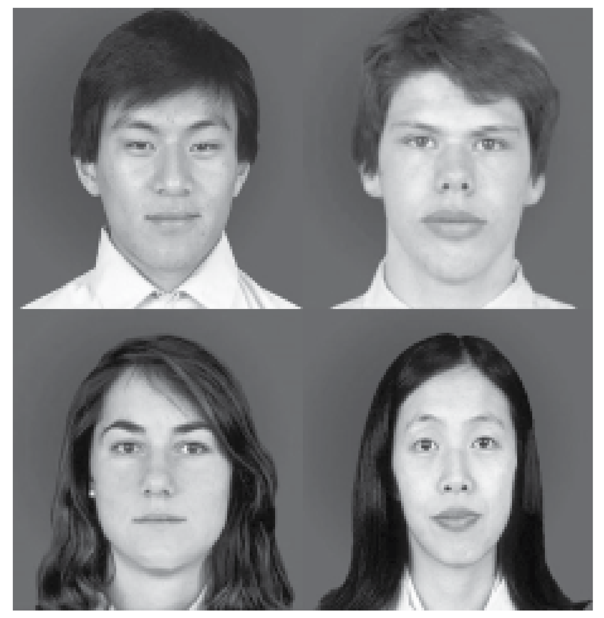

Figure 2: Image prior to face detection and expression classification.

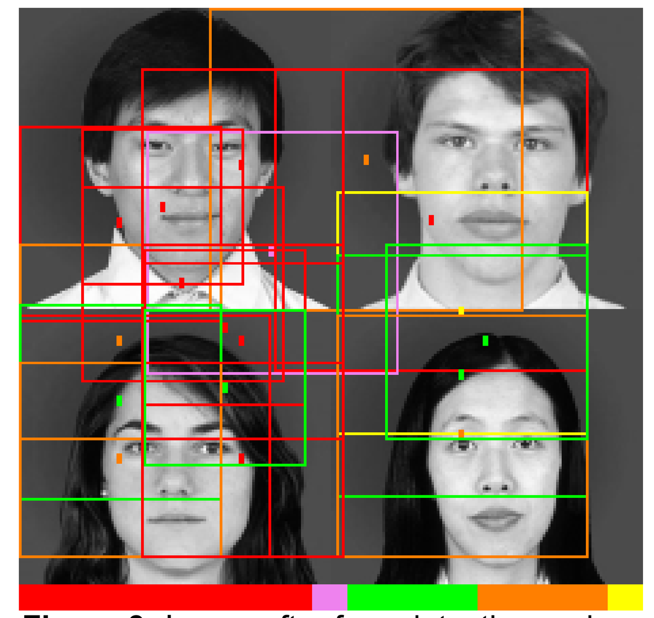

Figure 3: Image after face detection and expression classification.

Background

The software used in this paper, to identify the presence and suggested emotional state of facial pareidolia, relies on two interconnected systems; face detection and expression classification. The detection system uses a type of machine learning called a one-class Support Vector Machine (SVM), while the expression classification system uses a Pairwise Adaptive Support Vector Machine (pa-SVM); a specially modified multiclass SVM (Hong et al. 2012). Both of these systems were trained using sets of images of faces and of faces expressing particular emotions (Chalup et al. 2008; 2010). The key data used for training was a set of 280 images of human faces, which were taken from the research image data sets of Japanese and Caucasian Facial Expressions of Emotion (JACFEE) and Japanese and Caucasian Neutral Faces (JACNeuF) (Ekman and Matsumoto, 1993). All of the images from these data-bases were cropped and resized prior to training so that each showed a full individual frontal face in such a way that the inner eye corners of all faces appeared in exactly the same position (Figure 2).

The first stage of the process commences with the starting image being processed through one of three different filters; binary, greyscale and sobel equalisation. These filters are used because the results of each different approach to image pre-processing can be compared for statistical validity. The software is then set to scan across the filtered image, at multiple scales, examining every configuration of geometry or form in an image to see if it conforms to the facial patterns in the training data. The software is capable of identifying multiple faces in an image with a high degree of accuracy, although as images become more abstract the faces being detected have a lower mathematical level of confidence. Once a face is detected, a box is drawn around its extent.

Once the complete set of faces have been detected, then Ekman's, Friesen's and Hager's (2002) facial expression classification system (FACS) is used to code the facial pareidolia. While acknowledging that there is ongoing debate about the fundamental nature and understanding of emotions (Panksepp, 1998; Barrett, 2006) the use of eight classes of facial expression allows the results of this paper to be compared with that of previous research. The eight emotional states recognised in FACS are anger, contempt, disgust, fear, happiness, neutral, sadness and surprise. The software classifies each face detected in the previous stage into one of these expressions and colour codes the box according to the following scheme: angry = red; contemptuous = orange; disgusted = green; fearful = black; happy = white/yellow; neutral = grey; sad = blue; and surprised = violet. As a graphic representation of the proportion of expressions in a complete image the software then produces a colour bar across the base of the figure (Figure 3).

Method

Using CAD models of the Villa Savoye and the Robie House, four versions of the south elevation were produced for each. The four versions, all of which were orthographic views, replicate the facades under different natural lighting conditions; (1) Winter solstice (December 22) 10.30am and (2) 3.30pm, (3) Summer solstice (June 20) 10.30am and (4) 3.30pm. For the face detection process, several image formats were evaluated across a number of resolutions where the images used for training the classification models are resized to n x n pixels. After testing, the most favourable outcome for visual confirmation was identified as the binary edge image using the Canny edge operator. Once the models were trained for detection and expression classification, a search was performed on the image looking for possible faces. A detection window of n x n pixels was then scanned across the image at multiple scales and locations. The size of the detection window corresponds to the resolution of the training images. During this process a number of images scales are gathered together with the original image being resized until it is no smaller than the size of the detection window. The scale factor used for resizing down was 0.8, or 1.25 for up scaling. At each scale the detection window of n x n pixels is moved from top left to bottom right and, rather than examining every pixel location, a step size is defined of roughly 10% of the width or height of the current image scale, whichever is smaller.

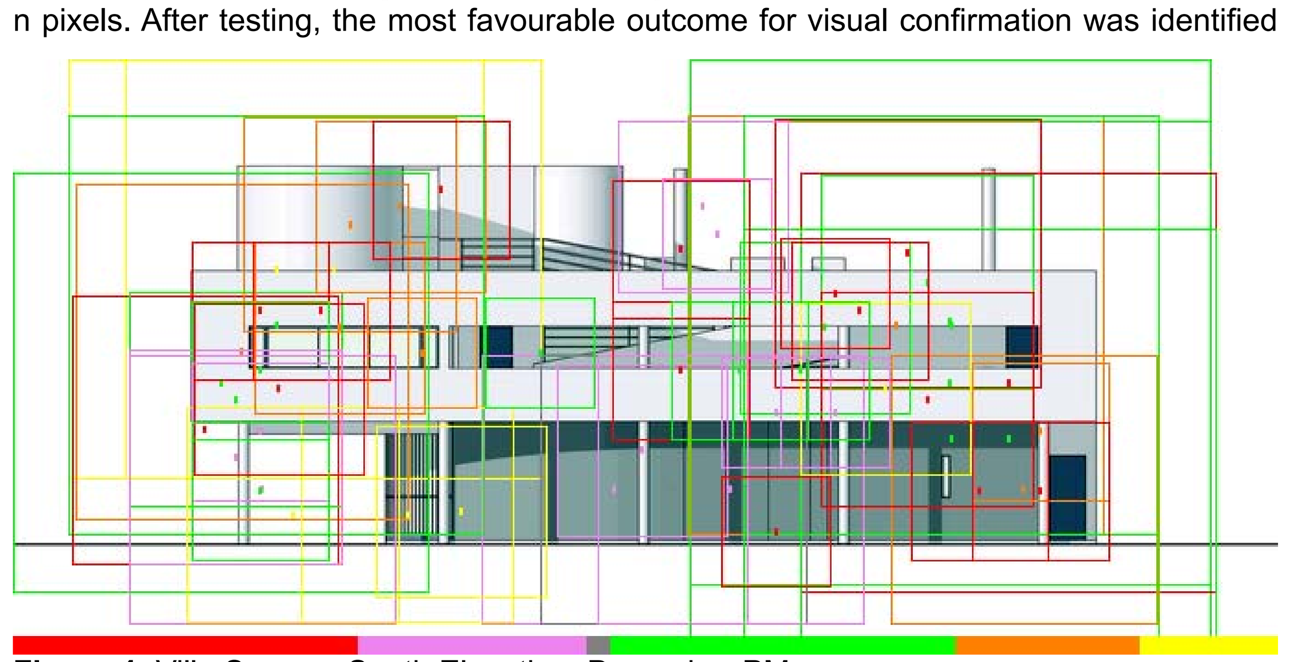

Figure 4: Villa Savoye, South Elevation, December PM.

Figure 6: Robie House, South Elevation, December AM.

Results

The most stable sets of results were produced using the binary detection system with binary expression classification. The detection and expression classifier were trained on binary edges using a Histogram equalized Grayscale. For the Villa Savoye, during the month of December, with shallower sun angles in the simulation, 57 facial pareidolia were detected in the morning and 57 in the afternoon. In Summer, with higher sun angles casing deeper shadows, 64 were detected in the morning and 59 in the afternoon. When the expressions of these pareidolia are calculated a proportion of the whole, and then averaged across the complete set, the single expression with the strongest results is anger (30.92%) followed by disgust (23.94%) and Surprise (19.5%). During the morning (both December and July) the proportion of disgust expressions is lower (approx. 7% less) while the proportion of angry expressions is higher (approx. 6% more) (Figures 4 - 5).

For the Robie House, on average 54.25 facial pareidolia were detected in the façade, a figure which is slightly lower than the average for the Villa Savoye of 58%. However, the Robie House shows substantially more diversity in these results, with a low of 38 pareidolia detected on a winter morning whereas on a summer afternoon, with many elements in the house casting strong shadows, 75 pareidolia were detected. An average, the expression with the highest presence was anger (24.44%) followed by disgust (19.80%) and contempt (18.99%). While anger and disgust also featured strongly in the results for the Villa Savoye, they are less pronounced in the Robie House, and the higher results for contempt and happiness, provide a more balanced set of expressions. Moreover, the high average result for anger is dominated by one particular time, June afternoon, when the shadows are more pronounced, whereas on a December morning, the highest response is surprise (23.65%) and a relatively high proportion of happy expressions (21.05%) (Figures 6 - 7).

Conclusion

This paper demonstrates the use of software for face detection and expression classification for images which have only a "weak" correlation with the standard human face. By definition, the pareidolia effect is largely concerned with situations where the correlation is weak and thus this approach to analysis is ideal for architectural images that are not expected to possess a single face with a fixed emotion. The results of the tests of the Villa Savoye and the Robie House do also clearly demonstrate that pareidolia presence is sensitive to season and lighting conditions; because shadows change the way the building appears and evoke different numbers of potential pareidolia and different emotions. Finally, if we return to the initial hypothesis – that the Villa Savoye would express a higher proportion of negative emotions than the Robie House – the results are inconclusive (Figures 8 and 9). The two houses ultimately have the same average proportion of happy and surprised expressions (rounded to 30% for each) although the Villa Savoye has a higher proportion of anger and disgust (55% verses 45%). The primary difference between the two is seasonal, with the Robie House evoking more pareidolia and being notably more negative only at certain times of the year, whereas the Villa Savoye has less seasonal variation.

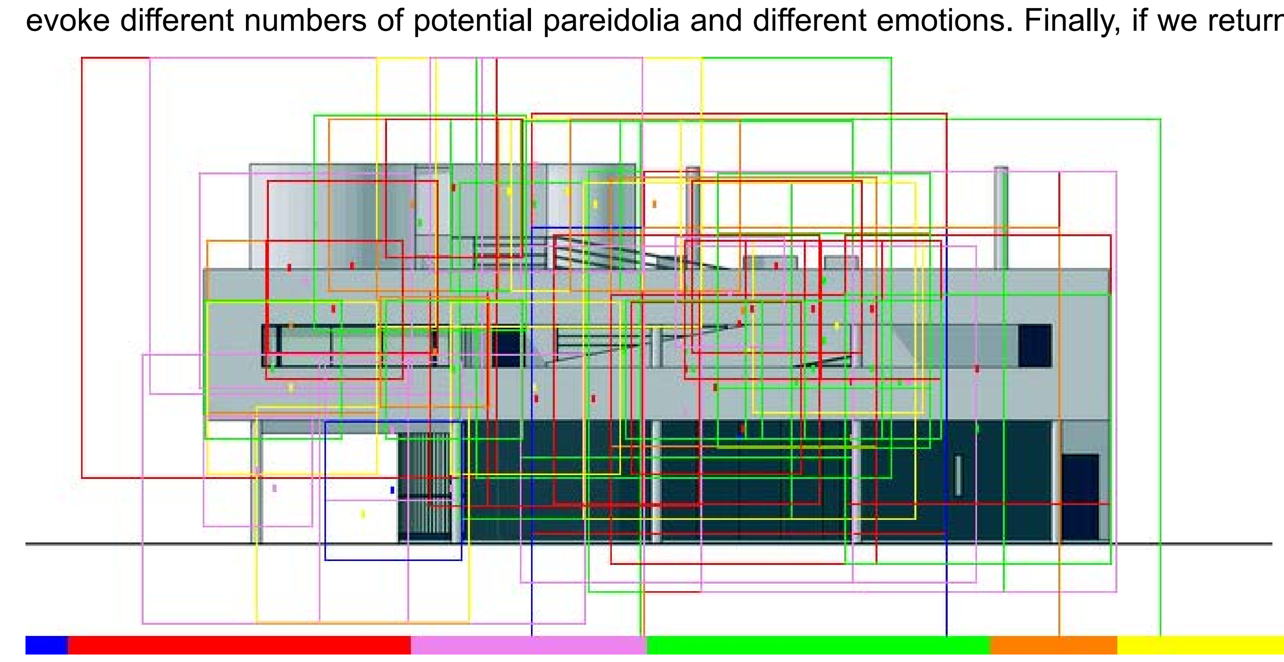

Figure 5: Villa Savoye, South Elevation, June PM.

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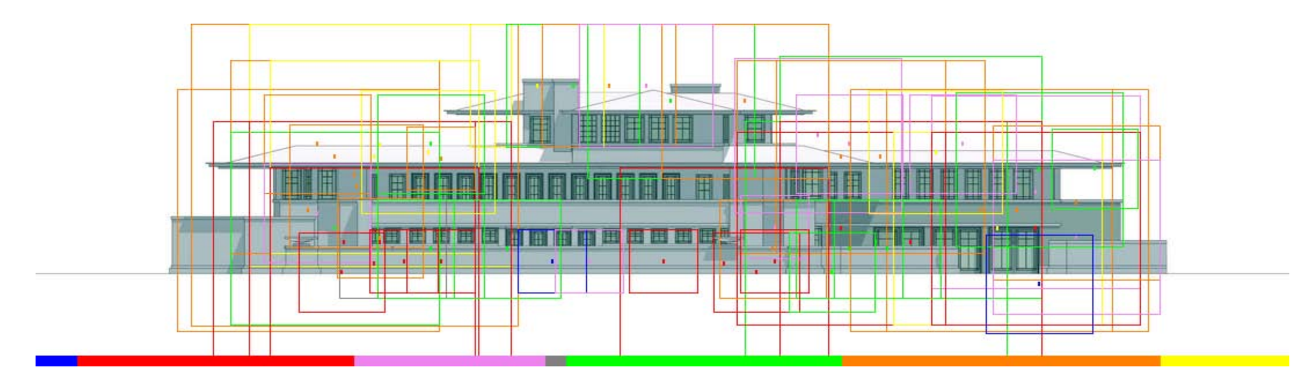

Figure 7: Robie House, South Elevation, June AM

Figure 8: Villa Savoye – average results for expression classification.

Figure 9: Robie House – average results for expression classification