Is Your First Impression Reliable? Trustworthy Analysis Using Facial Traits in Portraits

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Abstract. As a basic human quality, trustworthiness plays an important role in social communications. In this paper, we proposed a novel concept to predict people's trustworthiness at first sight using facial traits. Firstly, personality-toward traits were designed from psychology, including permanent traits and transient traits. Then, a mixture of feature descriptors consisting of Histogram of Gradients (HOG), Local Binary Patterns (LBP) and geometrical descriptions were adopted to describe personality traits. Finally, we trained the personality traits by LibSVM to determine trustworthiness of a person using portrait. Experiments demonstrated the effectiveness of our method by improving the precision by 33.60%, recall by 20.33% and F1-measure by 25.63% when determining whether a person is trustworthy or not comparing to a baseline method. Feature contribution analysis was applied to deeply unveil the correspondence between features and personality. Demonstration showed visual patterns in portrait collages of trustworthy people that further proved effectiveness of our method.

Keywords: trustworthy impression, facial traits, portraits, first impression, facial feature extraction.

1 Introduction

As a basic human quality in social activities, trustworthiness gains more and more attentions among friends, couples, and partners in various scenarios such as commercial activities, diplomatic activities and even in life trivia. To build a trustworthy figure at the first sight is quite important factor to start a success relationship. Thus, figuring out what factors influence the trustworthy impression becomes an important issue.

Bar et al. [1] have found that first impressions of people's personalities were often formed by using the visual appearance of their faces and consistent first impressions could be formed very quickly within the first 39 ms. Many researches have

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demonstrated the important influence of facial appearance, such as Sheila et al. [2] have exploited that baby-faced persons and females were more trustworthy than mature-faced persons and males in communications. Christopher et al. [3] have discovered that rapid judgments about the personality traits of political candidates, based solely on their appearance, could predict their electoral success. All these works have made it clear that facial traits are important for judging person's trustworthiness, which have provided psychological evidences to our work in this paper. Thus, our work intends to find out the correspondence between portraits visual contents and trustworthy impression, which has considerable meaning and wide application. Firstly, finding portraits utilizing personality-toward words can implement image retrieval in personality semantic level. Secondly, adding personality into human-computer interaction can improve intelligence of computer and develop the friendliness of interaction.

So far, there are a good number of works related to our work, which can be split into two groups. The first group is on facial traits level, Asteriadis et al. [4] and Jeng et al. [5] have proposed different approaches for detecting facial features. [6, 7, 8, 9] were mainly on facial expression recognition through different ways. Hoque et al. [10] developed a computer system at MIT that could tell you which kind of smile was showing happiness or frustration. However the first group just focuses on face feature detection staying at physical level, while this paper pays attention to trustworthy analysis using facial traits that have achieved emotion level. The second group is on personality impression agreement analysis. Fitzgerald et al. [11] explored characteristics of the profile photographs and their association with impression agreement. Cristani et al. [12] has shown that visual patterns correlated with the personality traits and the personality traits could be inferred from the images latter posts as "favorite". However, compared to this paper, there are two different aspects: 1) images in the second group are all flexible, including animals, plants, and landscape, while images in this paper are single portrait photos without much background, makeup, dresses and so on. 2) The second group focuses on the agreement of personality impression and actual personality, while this paper just pays attention to the trustworthy impression neglecting actual personality.

Therefore, in this paper we aim to find the relationship between facial traits and trustworthy impression. Firstly, personality-toward traits are designed from psychology, including eleven permanents traits and five transient traits from five main facial features, consisting of eyebrow, eye, nose, mouth and face shape. Then, we extract the face area using Active Shape Model (ASM) and adopt a mixture of feature descriptors consisting of Histogram of Gradients (HOG), Local Binary Patterns (LBP) and geometrical descriptions to describe personality traits. Finally, we train the personality traits by LibSVM to determine trustworthiness of a person using his/her portrait. Experiments compare the effectiveness of our method with a baseline method when determining whether a person is trustworthy or not. Feature contribution analysis is applied to deeply unveil the correspondence between features and personality. Each facial trait, combination of all Permanent traits and combination of all Transient traits are evaluated by Precision, Recall and F1-measure. Demonstrations are used to show visual patterns in portrait collages of trustworthy people that further proved the effectiveness of our method.

2 Methods

2.1 Facial traits

From a psychological perspective, we proposed a novel personality-toward feature combining 11 permanent facial traits and 5 transient facial traits (See Fig.1). All 16 traits are extracted from 5 main facial features, consisting of eyebrow, eye, nose, mouth and face shape (numbered from I to V). Permanent traits are on the left side, which are hereditary, inborn and immutable traits. While transient traits are on the right side, which are temporary and changeable with facial expressions, such as happiness, sadness, fear, disgust, surprise and anger [13]. We described transient traits utilizing the status of Facial Action Units (FAU) referred to [14].

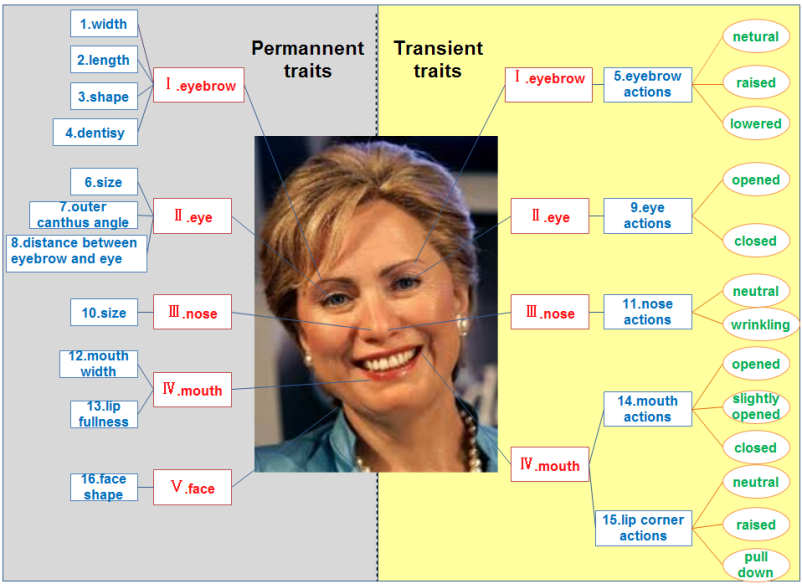

Fig. 1. Facial features are in red and numbered from I to V; feature properties are in blue and numbered from 1 to 16; feature actions are in green

2.2 Features

Feature extraction and description is a pre-process before finding out the correspondence between facial traits and personality. Following Fig.2 shows the workflow of feature extraction and description.

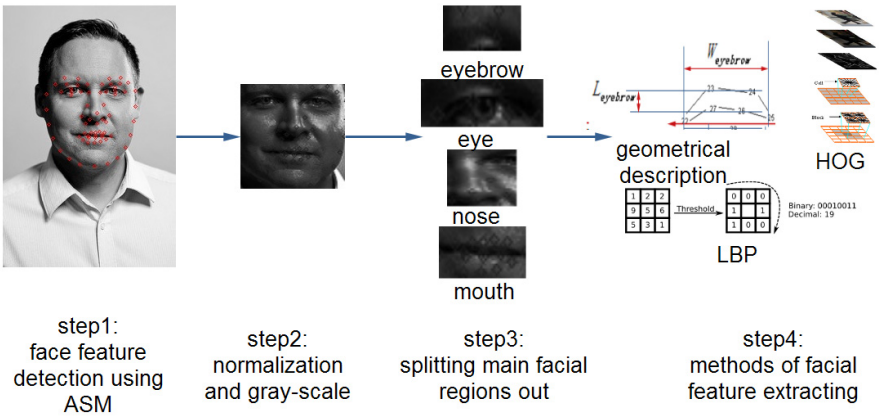

Fig. 2. Workflow of features extraction and description

Step1: Facial feature detection based on Active Shape Model (ASM). We applied method in [15] to detect facial features by utilizing 68 ordered points as shown in Fig.3. By connecting these points in certain order, we obtained the contours of main facial features.

Step2: Face extraction and normalization. We extracted the face area using a bounding box (containing all 68 points) out from a normal portrait. The face area was normalized into 128×128 pixels, and then converted into gray image.

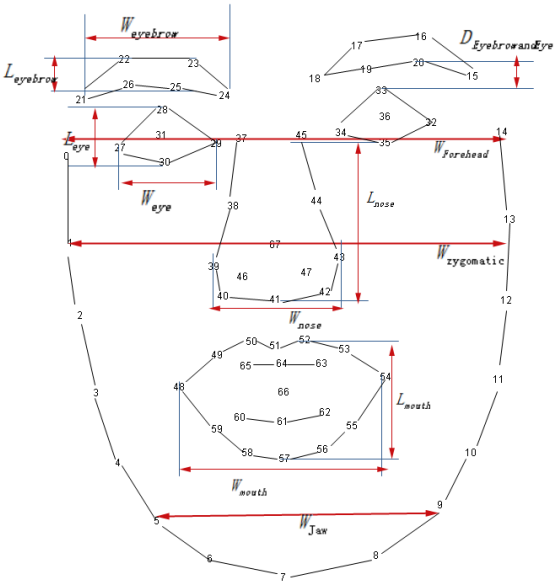

Fig. 3. Facial feature detection using ASMLibrary

Step3: Facial feature extraction. We extracted facial features according to features' contours obtained from step1. For each facial feature, we utilized a bounding box to conclude it as a feature region, in which we applying feature-describing method in following steps. Since eyebrows, eyes and lip corners are most symmetrical, single eyebrow, single eye, and single lip corner were selected to reduce the descriptors' dimensions. Eyebrow, eye and mouth were normalized into 64×32 pixels, and nose and lip corner were normalized into 32×32 pixels.

Step4: Facial feature description. A mixture of features descriptors consisting of Histogram of Gradients (HOG), Local Binary Patterns (LBP) and geometrical descriptions were adopted to describe personality-toward traits. The details of feature description were characterized in Table 1 and Table 2, where permanent facial traits and transient facial traits were described respectively.

Table 1. Detail description of permanent facial traits extracted methods, the column of "Length" represents feature dimensions; $P_{\mathrm{i}}.x$ means the x-coordinate of point i, $P_{\mathrm{i}}.y$ means the y-coordinate of point i, other equations are described in Fig. 3

Regions	No.	Name	Length	Short Description
Eyebrow (Ⅰ)	1	Width	1	$W_{eyebrow} = P_{25}.x - P_{22}.x$
	2	Length	1	$L_{eyebrow} = P_{29}.y - P_{23}.y$
	3	Shape	19	HOG and LBP descriptors
	4	Density	19	HOG and LBP descriptors
Eye (Ⅱ)	6	Size	2	$W_{eye} = P_{30}.x - P_{28}.x$, $L_{eye} = P_{31}.y - P_{29}.y$
	7	Outer canthus angle	19	HOG descriptors
	8	Distance between eye and eyebrow	1	$D_{eb} = P_{29}.y - P_{26}.y$
Nose(Ⅲ)	10	Size	2	$W_{nose} = P_{44}.x - P_{40}.x$, $L_{nose} = P_{42}.y - P_{38}.y$
Mouth(Ⅳ)	12	Width	1	$W_{mouth} = P_{55}.x - P_{49}.x$
	13	Lip fullness	24	HOG and LBP descriptors
Face(Ⅴ)	16	Face shape	3	$W_{forehead} = P_{15}.x - P_{1}.x$, $W_{zygomatic} = P_{14}.x - P_{2}.x$, $W_{jaw} = P_{10}.x - P_{6}.x$

Table 2. Detail description of transient facial traits extracted methods, the column of "Length" represents feature dimensions

Face regions	No.	Name	Length	Short Description
Eyebrow(Ⅰ)	5	Actions	19	HOG and LBP descriptors
Eye(Ⅱ)	9	Actions	19	
Nose(Ⅲ)	11	Actions	12	
Mouth(Ⅳ)	14	Mouth actions	24	
	15	Lip corners actions	12	

3 Experiments

In this section, we conduct comprehensive evaluations of our method. The dataset is described first. Then, experiments are performed to evaluate the proposed approach. We divide our experiments into three parts. First, we compare our method with a baseline method. Second, we analyze contributions of each facial trait to trustworthy impression. Finally, a selection of trustworthy impression portraits is provided to demonstrate the results qualitatively.

3.1 Dataset

To evaluate the algorithm objectively, we built a portrait dataset containing 2010 portraits randomly downloaded from "www.google.com" and "www.flickr.com". Each portrait included one person and none of them was wearing sunglasses.

We labeled the ground-truth by about 250 volunteers. For each portrait, the volunteers were asked to label a tag about trustworthiness or untrustworthiness on it at their first impression. If the consistence of trustworthy by different raters achieved 70%, the image was tagged with "trustworthy".

For this dataset, 1404 images were randomly chosen as the training set and the other 606 images were used as the testing set. The details of the training set and testing set are shown in Table 3.

Table 3. Sample number of training set and testing set

Groups	Training set		Testing set		Total
	Trustworthy	Untrustworthy	Trustworthy	Untrustworthy	
All portraits	522	882	273	333	2010

3.2 Experiments and Discussions

Comparison with Method in Reference [16]. Support Vector Machine (SVM) [17], using RBF as kernel, was used as classifier in our experiments. As the issue in this paper is binary classification, one class is trustworthiness and the other is untrustworthiness.

Table 4 shows the performance of reference [16] as baseline and our method. From the results we can see that our method has significantly outperformed method in [16]. This is because that we have combined the permanent traits i.e. (including eyebrow width, eyebrow length, eyebrow shape, eyebrow density, eye size, outer canthus angle, distance between eyebrow and eye, nose size, mouth width, lip fullness and face shape), and transient traits i.e. (including eyebrow actions, eye actions, nose actions, mouth actions and lip corner actions) together, while method in reference [16] only uses transient traits. Our method gains an improvement of 33.60% in precision, a 20.33% improvement in recall and a 25.63% improvement in F1-measure.

Table 4. Performance comparision using Precision, Recall, F1-measure

Methods	Precision	Recall	F1-measure
Reference [16] method	37.50%	16.67%	23.07%
Our method	71.10%	37.00%	48.70%

Through training different feature combinations, we found that using the combination of features (5, 6, 15 and 16) for female and using the combination of features (8, 9, 11, 14 and 16) for male can achieve high performance. So we grouped the dataset into male and female as shown in Table 5. Table 6 lists the relusts for female and male group respectively. Interestingly, we can see that feature 16(face shape) is both useful for female and male group to build trustworthy impression. For male, transient traits (9, 11 and 14) are more useful to build trustworthy impression.

Table 5. Sample number of training set and testing set

Groups	Training set		Testing set		Total
	Trustworthy	Untrustworthy	Trustworthy	Untrustworthy	
Female	219	552	90	150	1011
Male	303	330	183	183	999

Table 6. Performance of this method on female portraits and male portraits

Groups	Precision	Recall	F1-measure
Female portraits	77.78%	72.41%	75.00%
Male portraits	73.34%	54.10%	62.26%

The ROC curves of female, male performance in Table 6 as well as all portraits performance are showed in the following Fig. 4. From the figure we can see that the performances of female and male group are both higher than all portraits without grouping, and the group of female performs best in this experiment, whose TPR achieves 0.82 while FPR is only 0.28. This result unveils that gender is significantly

important in judging trustworthy impression, and because of physical difference, female can achieve higher agreement of being judged trustworthiness than male using facial traits.

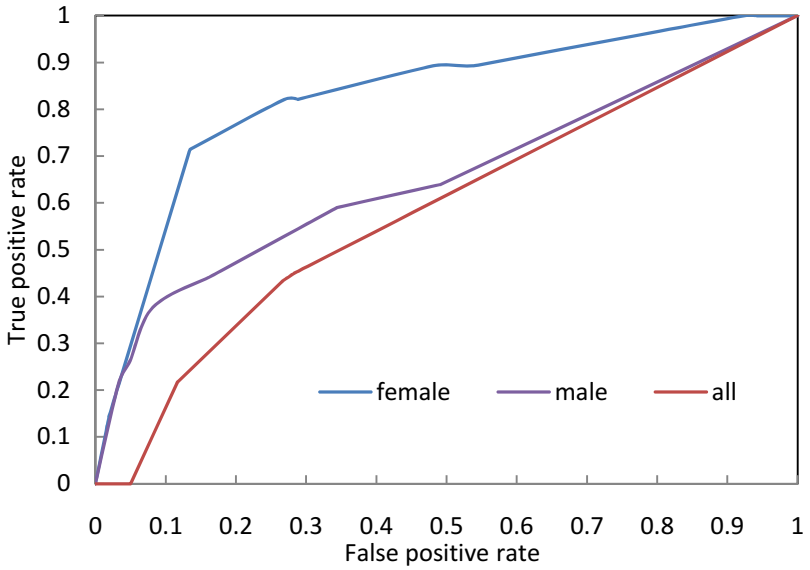

Fig. 4. Performance of trustworthiness prediction on female portraits, male portraits and all portraits

Analysis of Facial Traits Contributions to Trustworthy Impression. To further evaluate the contribution of each facial trait, comparative experiment is performed. See the results demonstrated in Table 7. Transient traits are more useful than permanent traits with the F1-measure decreased about 2%. Interestingly, while the combination of all permanent traits performs worse, single permanent trait (eyebrow width, distance between eyebrow and eye, mouth width and face shape) is useful to form trustworthy impression. This result unveils that specific combination of permanent traits is more useful than all permanent traits together. While the combination of all transient traits performs better, the single transient trait is useless to form trustworthy impression. We can indicate that the transient traits always appear together in facial expression.

Qualitative Evaluations. Furthermore, to demonstrate the results qualitatively, we highlight the performance in Fig. 5. In Fig. 5, it's interesting to see that almost all trustworthy people are smiling with lip corner raised, mouth slightly open. To indicate the qualitative results, we also use quantitative method for further analysis. For female, people with short eyebrows (55.26%), small eye (60%) and big nose (52.63%) are always tagged as trustworthiness. Male with trustworthy impression are always with narrow eyebrows (52.90%), long distance between eye and eyebrow (54.72%) and long (52.12%) face shape. For both trustworthy female and male, they are both with flat eyebrows (52.13%, 52.02% respectively), sparse eyebrows (61.33%, 52.17% respectively), thin lips (57.27%, 52.54% respectively), slightly open mouth (52.70%,

57.81% respectively), raised lip corners (54.46%, 51.12% respectively) and square face shape (52.17%, 52.50% respectively). Hence without cosmetic operation, just changing your transient traits, such as keeping a slightly smile also can improve your trustworthy impression.

Table 7. Contributions of different facial traits to trustworthy impression on all portriats; The row of All Traits means performance of all sixteen facial traits together; Permanent Traits row means the performance of removing all pernanent traits; Transient Traits row means the performance of removing all transient traits; The column of single facial trait means performance of removing this facial trait. If performance of the row is lower than All Traits, the trait in this row is useful to build trustworthy impression (%).

Facial traits	No.	Precision	Recall	F1-measure
All Traits		**71.10**	**37.00**	**48.70**
Permanent Traits		**53.27**	**50.71**	**50.09**
Eyebrow Width	1	55.00	44.80	48.11
Eyebrow Length	2	60.94	46.44	50.96
Eyebrow Shape	3	59.73	45.62	49.72
Eyebrow Density	4	58.16	45.62	49.83
Eye Size	6	55.32	46.44	49.28
Outer canthus angle	7	57.71	48.16	51.13
Distance between eye and eyebrow	8	57.15	42.34	46.46
Nose Size	10	58.07	46.44	50.02
Mouth Width	12	55.08	43.08	47.11
Lip Fullness	13	56.39	46.44	49.36
Face shape	16	53.27	42.34	45.37
Transient Traits		**56.35**	**40.19**	**46.73**
Eyebrow Actions	5	60.61	47.26	51.34
Eye Actions	9	57.36	45.62	49.39
Nose Actions	11	57.86	46.44	50.19
Mouth actions	14	52.55	46.27	49.11
Lip corners actions	15	60.00	43.07	48.50

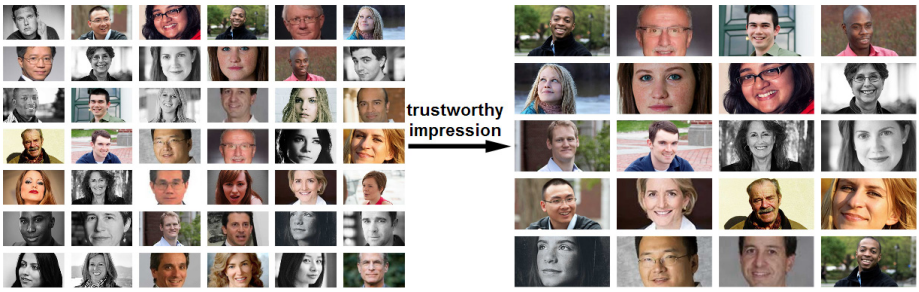

Fig. 5. Demonstrate trustworthy impression qualitatively

4 Conclusions

In this paper we propose a novel trustworthy impression analyzing method using facial traits in portraits. First, sixteen facial traits including permanent traits and transient traits from face region are introduced. Then, the trait features are described by combing HOG, LBP, etc. Experimental results demonstrate that our method can get satisfactory results. Future work would be interested in features refining and design, and more personality-oriented features will be proposed for further improving the prediction accuracy.

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