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ESTIMATING TASTE APPRECIATION FROM FACIAL EXPRESSIONS IN COMPARISON USING CNN

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Abstract :

The level of taste liking is an important measure for a number of applications such as the prediction of long-term consumer acceptance for different food and beverage products. Based on the fact that facial expressions are spontaneous, instant and heterogeneous sources of information, this paper aims to automatically estimate the level of taste liking through facial expression videos. Instead of using handcrafted features, the proposed approach deep learns the regional expression dynamics, and encodes them to a Fisher vector for video representation. Regional Fisher vectors are then concatenated, and classified by linear SVM classifiers. The aim is to reveal the hidden patterns of taste-elicited responses by exploiting expression dynamics such as the speed and acceleration of facial movements. To this end, we have collected the first large-scale beverage tasting database in the literature. The database has 2970 videos of taste-induced facial expressions collected from 495 subjects. Our large-scale experiments on this database show that the proposed approach achieves an accuracy of 70:37% for distinguishing between three levels of taste-liking. Furthermore, we assess the human performance recruiting 45 participants, and show that humans are significantly less reliable for estimating taste appreciation from facial expressions in comparison to the proposed method.

1. INTRODUCTION

FOOD is one of the primary necessities of life. Nowadays, the quality of food (e.g. lower fat and sugar) is important to prevent obesities and promote healthier ingredients. To obtain different food composition (e.g. lower fat, sugar and salt) with similar taste liking, the challenge is to measure the appreciation of food in an objective, spontaneous and instant way. In general, the human face can be used as a cue to determine if someone likes a particular taste or not as it offers rich and spontaneous data in terms of facial expressions. Previous studies show that the face reveals appreciation or dislike while eating and drinking. Such spontaneous facial expressions can be used to measure quality and intensity of the taste. In contrast to above studies based on human observations, in this paper, the aim

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is to automatically recognize taste-induced facial expressions for taste liking. Many studies in human facial analysis categorize facial expressions and connect them to emotional states. In tasting, however, facial expressions are not directly indicative of these inner emotional states, but rather a spontaneous motor response to flavor.

2. LITEATURE SURVEY

"Ans responses and facial expressions differentiate between the taste of commercial breakfast drinks,"

The high failure rate of new market introductions, despite initial successful testing with traditional sensory and consumer tests, necessitates the development of other tests. This study explored the ability of selected physiological and behavioral measures of the autonomic nervous system (ANS) to distinguish between repeated exposures to foods from a single category (breakfast drinks) and with similar liking ratings. In this within-subject study 19 healthy young adults sipped from five breakfast drinks, each presented five times, while ANS responses (heart rate, skin conductance response and skin temperature), facial expressions, liking, and intensities were recorded. The results showed that liking was associated with increased heart rate and skin temperature, and more neutral facial expressions. Intensity was associated with reduced heart rate and skin temperature, more neutral expressions and more negative expressions of sadness, anger and surprise. Strongest associations with liking were found after 1 second of tasting, whereas strongest associations with intensity were found after 2 seconds of tasting. Future studies should verify the contribution of the additional information to the prediction of market success.

"Facial and affective reactions to tastes and their modulation by sadness and joy,"

This study examined adults' affective and facial reactions to tastes which differ in quality and valence, and the impact of sadness and joy on these reactions. Thirty-six male and female subjects participated voluntarily. Subjects each tasted 6 ml of a sweet chocolate drink, a bitter quinine solution (0.0015 M) and a bitter-sweet soft drink. Following a baseline period, either joy or sadness was induced using film clips before the same taste stimuli were presented for a second time. Subjects rated the drinks' pleasantness and intensity of taste immediately after each stimulus presentation. Facial reactions were videotaped and analysed using the Facial Action Coding System (FACS [P. Ekman, W.V. Friesen, Facial Action Coding System: Manual. Palo Alto, CA: Consulting Psychologists Press; 1978., P. Ekman, W. Friesen, J. Hager, Facial Action Coding System. Salt Lake City, Utah: Research Nexus; 2002.]). The results strongly indicated that the tastes produced specific facial reactions that bear strong similarities to the facial reactivity patterns found in human newborns. The data also suggest that some adults' facial reactions serve additional communicative functions. Emotions modulated taste ratings, but not facial reactions to tastes. In particular, ratings of the sweet stimulus were modulated in congruence with emotion quality, such that joy increased and sadness decreased the pleasantness and sweetness of the sweet stimulus. No emotion-congruent modulation was found for the pleasantness and intensity ratings of the bitter or the bitter-sweet stimulus. This 'robustness' of bitter taste ratings may reflect a biologically meaningful mechanism.

“Differential facial responses to four basic tastes in newborns,”

The distinctiveness and recognizability of taste-elicited facial expressions in newborns were examined in 2 studies. Sucrose, sodium chloride, citric acid, and quinine hydrochloride solutions were presented to 12 infants at 2 hours of age. In Study 1, the anatomically based Facial Action Coding System adapted for infants (Baby FACS) was used to obtain detailed, objective descriptions of the infants' videotaped facial responses to each solution. Facial responses to sucrose were characterized primarily by facial relaxation and sucking. The responses to salty, sour, and bitter solutions shared the same hedonically negative upper- and midface components but differed in the accompanying lower-face actions: lip pursing in response to sour and mouth gaping in response to bitter. There was no distinctive facial expression for sodium chloride. These findings demonstrate that newborns differentiate sour and bitter from each other and from salt, as well as discriminating sweet versus nonsweet tastes. In Study 2, untrained adults viewing videotapes of the infants' facial reactions made forced-choice judgments identifying the stimuli presented and rated the hedonic tone of the infants' responses. While the judges accurately identified the newborns' responses to sucrose, there were systematic errors in their judgments of the 3 nonsweet stimuli. The judges' hedonic ratings, on the other hand, clearly differentiated between the infants' responses to the bitter stimulus and the other 3 tastes. The findings are discussed in terms of the possible functional origins and communicative value of taste-elicited facial expressions in infants.

“Taste-elicited changes in facial signs of emotion and the asymmetry of brain electrical activity in human newborns,”

Recent evidence suggests that frontal brain electrical activity reveals asymmetries in activation in response to positive vs negative affective stimuli. This study was designed to evaluate whether this asymmetry is present at birth. Newborn infants were presented with water followed by a sucrose solution and then by a citric acid solution. Facial expression was videotaped during the presentation of the liquids and EEG was recorded from the frontal and parietal scalp regions on the left and right side. Usable EEG data were obtained from 16 newborn infants in response to these taste conditions. Videotaping of facial expression in response to these stimuli indicated the presence of disgust during both water (the first taste introduced) and citric acid. EEG was Fourier Transformed and power in the 1-3, 3-6 and 6-12 Hz bands was computed. The findings revealed that the water condition produced reductions in right-hemisphere power in the two higher frequency bands in both the scalp regions compared with the other two conditions. The sucrose condition produced greater

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relative left-sided activation in both regions compared with the water condition. These data, in conjunction with our previous findings of asymmetries in 10-month-old infants, indicate that stimulus-elicited affective asymmetries in brain electrical activity are present at birth.

“Universal facial expressions of emotion,”

Presents a theoretical framework reconciling the controversy between culture specific and universal elements of facial behavior. 2 experiments are described which firmly establish pan-cultural elements in facial expressions of emotion. The 1st experiment involved os from brazil, the united states, argentina, chile, and japan who were shown photographs of 30 facial expressions and asked to identify the emotion associated with the expression. Responses were rated on the facial affect scoring technique. The majority of os chose the same emotion for 29 of the expressions. Because these os had probably been exposed to mass media portrayals of facial behavior, a 2nd group of 189 adults and 130 children from a preliterate culture in new guinea were shown 3 photographs, told a story about a particular emotion, and asked to pick the picture which fitted the story. Results conformed to those of the 1st group. A study is also described of students monitored for facial response to videotapes showing stress and neutral stimuli. Correlation between groups for frequency of expressions of anger, fear, disgust, surprise, sadness, and happiness .

3. EXISTING SYSTEM

Facial regions are proposed corresponding to important parts of faces to incorporate locality as pixels within these regions move together. Per frame, deep learned regional dynamics are obtained using stacked denoising auto encoders, which are then coded into a Fisher vector for video representation. The regional Fisher vectors are concatenated and used as input of an SVM classifier to classify taste liking. Overview of the proposed approach is visualized . Unfortunately, no large-scale taste datasets of facial expressions are available today. Therefore, to test and compare the proposed method, a new large-scale taste database has been collected containing spontaneous facial expressions while drinking different types of beer. Such a database is a milestone to automatically interpret taste-induced facial behavior in real-life scenarios. To differentiate from using hand-crafted features, deep learning is applied to obtain efficient feature representations.

4. PROPOSED SYSTEM

People are quite reliable and accurate in distinguishing between emotional facial expressions, however, human ability to predict taste appreciation from facial expressions has not been investigated yet. To this end, we have recruited 45 participants, and assess human performance for this task in comparison to the proposed method. Furthermore, we propose to encode perframe dynamics of a given tasting video to a Fisher vector to model their pattern of co-occurrence for different appreciation levels. Since this paper aims to reveal the importance/informativeness of inner-facial movement dynamics in the analysis of taste-elicited expressions, appearance (facial texture) features are not employed in the proposed method.

4.1 ADVANTAGES:

These frame-based shape and texture features are fed to two parallel convolution blocks. Their responses are fused, and followed by two additional X convolution layers and a fully connected layer. This paper aims to reveal the importance/informativeness of inner-facial movement dynamics in the analysis of taste-elicited expressions, appearance (facial texture) features are not employed in the proposed method. Deep architectures can learn efficient feature representations and are able to cope with high dimensionality and redundancy of data.

5. MODULES DESCRIPTION

5.1 Facial Landmark Tracking

For a detailed analysis of the inner facial dynamics, we track 3D locations of 429 facial landmark points using a state-of-the-art tracker recently proposed . The tracked 429 facial fiducial points on the eyebrows, forehead, eyes, cheeks, and mouth are shown. The tracker employs a combined 3D supervised descent method, where the shape model is defined by a 3D mesh and the 3D vertex locations of the mesh. A dense parameterized shape model is registered to an image such that its landmarks correspond to consistent locations on the face. The accuracy and robustness of the method for 3D registration and reconstruction from 2D video was validated in a series of experiments.

5.2 Taste liking

FOOD is one of the primary necessities of life. Nowadays, the quality of food (e.g. lower fat and sugar) is important to prevent obesities and promote healthier ingredients. To obtain different food composition (e.g. lower fat, sugar and salt) with similar taste liking, the challenge is to measure the appreciation of food in an objective, spontaneous and instant way. In general, the human face can be used as a cue to determine if someone likes a particular taste or not as it offers rich and spontaneous data in terms of facial expressions. Previous studies show that the face reveals appreciation or dislike while eating and drinking. Such spontaneous facial expressions can be used to measure quality and intensity of the taste. In contrast to above studies based on human observations, in this paper, the aim is to automatically recognize taste-induced facial expressions for taste liking.

5.3 Convolution neural network

Models temporal appearance and shape of basic expressions using a deep Convolutional Neural Network (CNN), and a two-hidden-layer neural network, respectively. Yet, since such networks require a fixed input dimensionality, the duration of facial videos is downscaled to a fixed length. Obtained frames are then fed to a CNN so as to use each frame as a different input channel. Normalized coordinates of the fiducial points in these frames are combined into a single vector and fed to a feed forward network to model facial shape. In, 3-dimensional (3D) CNNs are used for learning regional changes in facial appearance during emotional expressions. However, the size of spatio-temporal blocks needs to be equal for 3D convolutions. Thus, the method is applied to videos using a sliding window approach. Once the whole video is processed, estimations for all windows are fused to obtain the final prediction.

5.4 Learning Face Representation

The computation of location, speed, and acceleration measures for the facial representation may be complex and redundant due to tracking noise or correlated movements of the facial points. Deep architectures can learn efficient feature representations and are able to cope with high dimensionality and redundancy of data. Since we do not have additional information (i.e. class label) to learn per-frame facial representation, an unsupervised approach is required. Deep learners can progressively reveal low-dimensional, nonlinear structures in an unsupervised manner. To this end, we employ the Stacked Denoising Auto encoders (SDAE) to learn a transformation of raw features to an effective representation that is able to capture discriminative facial cues for classifying different levels of taste liking.

6. Conclusion

In this paper, we have proposed the first approach for automatic estimation of taste liking from facial expression videos. Instead of using handcrafted features, the proposed approach deep learns regional facial dynamics per frame, and encodes them to a Fisher vector per region to describe videos. Regional Fisher vectors are then concatenated and classified by linear SVM classifiers. We have presented the first large-scale beverage tasting database (2970 videos of 495 subjects) in the literature for detailed and precise analysis of taste-elicited spontaneous facial expressions. On the collected database, the proposed approach has achieved an accuracy of 70:37% for distinguishing between three levels of taste-liking (liking, being neutral, and disliking), outperforming all other methods by more than 8:65% (absolute). The results have indicated that the combined use of regional dynamics are more discriminative than the global face representation for this task. Relying on SVM scores, the most discriminative facial responses of six young adults for taste-liking estimation have been obtained, and shown to be similar to those reported in previous studies.

7. Future work

Our experiments for distinguishing between spontaneous and posed enjoyment smiles have confirmed the generalization power of the proposed method, suggesting that deep learning can indeed provide efficient representations of regional facial dynamics. Recruiting 45 participants, we have evaluated the ability and reliability of humans for estimating taste appreciation of others' from their facial expressions. Our findings have shown that humans are significantly less reliable for this task in comparison to the proposed method.

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