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Research paper

A Study on the Psychological Analysis System Using Machine Learning

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Abstract

Real-time facial expression recognition and analysis technology is recently drawing attention in areas of computer vision, computer graphics, and HCI. Recognition of user's emotion on the basis of video and voice is drawing particular interest. The technology may help managers of households or hospitals. In the present study, video and voice were converted into digital data through MATLAB by using PCA(Principal Component Analysis), LDA(Linear Discriminant Analysis), KNN(K Nearest Neighbor) algorithms to analyze emotions through machine learning. The manager of the psychological analysis counseling system may understand a user's emotion in an smart phone environment. This system of the present study may help the manager to have a smooth conversation or develop a smooth relationship with a user on the basis of the provided psychological analysis results.

Keywords: *Emotion Recognition, Speech Recognition, Image Recognition, PCA, LDA*

1. Introduction

As the number of single person household and dual income family is increasing, conversation between family members has been decreased due to the busy life of each one. According to the data of the questionnaire survey entitled, "With whom do you talk about your own concerns?", conducted with adolescents at the age of 13 to 18 years, 46.6% of the subjects share their concern with their friends, 22% of the subjects do not share with others, and another 22% of the subjects share their concerns with their parents (Statistics Korea, 2013). This result indicates that the youths talk more with their friends. One thing notable is that the ratio of the subjects who shares their concerns with their parents was equal to the ratio of the subjects who do not share their concerns with others. The decrease of conversation in families may bring about a bad result in the future [1].

The statistical dat about the 'death causes of adolescents (age from 15 to 24) (2001 to 2011), the number of casualties of transport accidents was 156,000 in 2001. However, in 2011, ten years later, the number of casualties of intentional self-injury (suicide) was 130,000, while the number of casualties of transport accidents was 78,000, indicating that the number of casualties of intentional self-injury was two times of the he number of casualties of transport accidents. The following death causes were malignant neoplasm (cancer, 38,000) and heart diseases (10,000) [2].

Adolescents talk with their friend about the stress caused by school work and the school life more and more. However, if they have a problem that they may not share even with their friends, such as violence or bullying, they may be unable to solve the problem by themselves and commit suicide. After suicide is committed by adolescents, more than half of their parents often say that their children were not the kind of adolescents to commit suicide or that they have never expected that their children would commit suicide. Having genuine interest in other is really difficult in the modern society where everyone is busy [3,4]. Artificial intelligence has been a big issue recently. The focus of the present study is to understand one's psychological state by recognizing and analyzing emotions through machine learning, which is the basis of artificial intelligence [5,6]. A psychological analysis counseling system was proposed in the present study to measure the emotion of a user on the basis of facial expressions and voice and analyze and save the results, enabling the manger to understand the user's emotion through the analyzed psychological state.

2. Related Research

2.1.Emotion Recognition

Emotion recognition is still inaccurate and the error rate is high. Many engineers have developed and improved machine learning algorithm. The emotion recognition systems developed until now are based on machine learning technologies, such as Linear Discriminant Analysis(LDA), k-Nearest, Neighbor(kNN), Multi Layer Perceptron(MLP), Gaussian Mixture Model(GMM), Decision Tree(DT), Neural Network(NN), Support Vector Machine(SVM), Adaboost, Hidden Markov Model(HMM), Bayesian Network(BN), and Gaussian Process(GP) [7].

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2.2. PCA (Principal Component Analysis)

PCA was the first recognition algorithm used for face recognition in 1990. Due to the advantage of diminishing dimensions, PCA has been used and is still used by many researchers of face recognition. PCA is a method converting high-dimensional data into low-dimensional data. Samples of a high dimensional space that may be correlated with each other are converted to samples of low dimensional space without linear correlation (principal components) through orthogonal transformation. The number of dimensions of the principal components is equal to or less than the number of dimension of the initial samples [8].

2.3. LDA (Linear Discriminant Analysis)

LDA is to optimize the classification of given classes by maximizing the ratio of within-class variance of given data to between-class variance. The fundamental difference between LDA and PCA is that LDA diminishes the data dimension for the optimized classification, while PCA diminishes the data dimension for the optimized expression of the data [9].

3. A Psychological Analysis Counseling System

3.1. System Design

In the present study, a psychological analysis doll was prepared to modify the existing system into a new direction. The psychological analysis doll was used to remotely understand the key interests and emotions of a user in a smart phone environment. The psychological analysis counseling system of the present study was proposed with the desire of making smoother conversation. Figure 2 shows the system architecture.

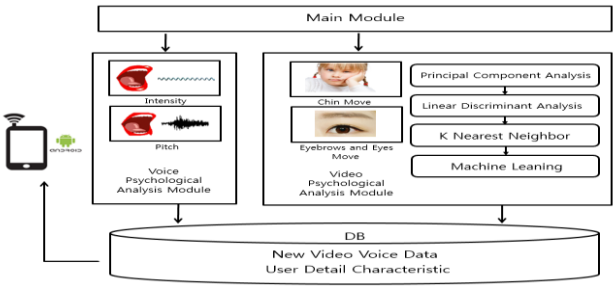


Fig.2: System Architecture

The main module of the system architecture is the psychological analysis doll consisting of a voice psychological analysis module and a video psychological analysis module. The psychological analysis doll receives video and voice data through a miniaturized camera and analyzes the input data simultaneously. In addition, the psychological analysis doll performs learning whenever new data are received to analyze the psychological or emotional state of the current user, helping to have a smooth conversation.

The video module of the psychological analysis counseling system diminishes the dimensions of the video obtained from a user's face through the PCA algorithm. Then, the video module classifies the characteristics representing emotions, such as eyes, nose, mouth, and chin, through the LDA algorithm. After than, the distance between the eyes, nose, and mouth is measured through the KNN (K Nearest Neighbor) algorithm for the grouping of the features representing the same emotions. The final results are saved in the database.

The voice module performs pre-processing of the voice from a user to classify the many features representing various emotions, especially the characteristic vectors of pitch and intensity. The voice module performs learning by grouping the features representing the same emotion. After that, the emotions obtained from the voice module and the video module and saved in the database are integrated for the final psychological analysis. Figure 3 shows the flowchart of the psychological analysis counseling system. The system may understand in advance the emotion of a user through a smart phone as well as the current interests and psychological state. This may help to enable conversation of higher quality.

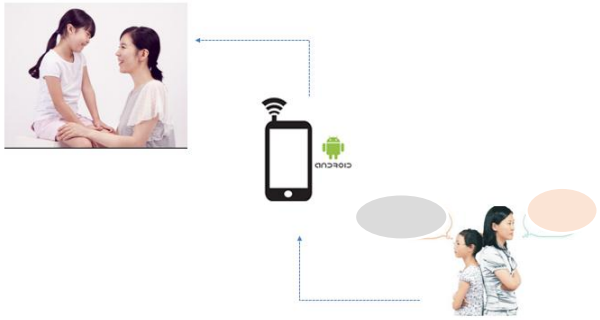


Fig.3. System Flow Chart

3.2. System Implementation

The system of the present study was realized in the Microsoft Windows 7 Home Premium K 64-bit operating system. For the mobile environment, the Android Minimum Required SDK will be realized by using API 14 : Android 4.0 (Ice Cream Sandwich), and the Target SDK by using API 18 : Android 4.4.2 (Kit Kat). The performance and the emotion recognition were realized by using MATLAB. In the present study, the MATLAB software was used to execute the video psychological analysis algorithm described above to compare a happy face and a sad face. In the video module, the above algorithm was used. A photograph consisting of multi-dimensional characteristic vectors is not easy to classify the pattern. Therefore, the characteristic vectors should be downsized to a lower dimension while the information is retained. For example, recognizing the pattern of a photograph of 200 x 233 pixels requires a very long time, and even worthless regions of the photograph are recognized. Therefore, the photographs may be downsized to a picture of 100 x 120 pixels to increase the recognizing speed and degree. In addition, the original data vectors were obtained, and classification standards were re-established to distinguish same kinds of labels so that the emotions may be better classified. This helped to accomplish good expressions according to the original objectives.

3.3. Results of Implementation

The system was operated in MATLAB 7.10. The result of the system realization is shown in Figure 4. Figure 4 shows a partial realization of the system in an image illustrating the down-scaling of the dimensions and classification of emotions, which are the basis of the emotion analysis with the input images from the video module. Several pictures of a happy face and several picture of a sad face were taken, and the pictures were analyzed through the dimension downsizing algorithm(PCA) and the linearity discriminant algorithm(LDA). The blue horizontal line is the reference line of the PCA algorithm, which serves as the reference of dimension downsizing. The blue vertical line is the reference line of the LDA algorithm, which distinguishes each label. An overview of Figure 4 enables to understand common numerical values and positions. In other words, features representing the same emotions may be grouped. Integration of the result with the voice data from the voice module may help to recognize emotions more precisely so that the psychological state of a user may be understood.

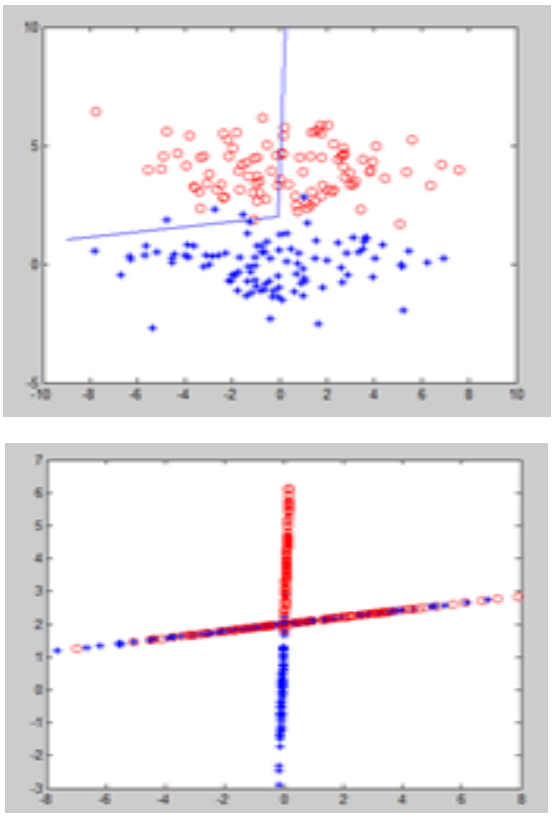
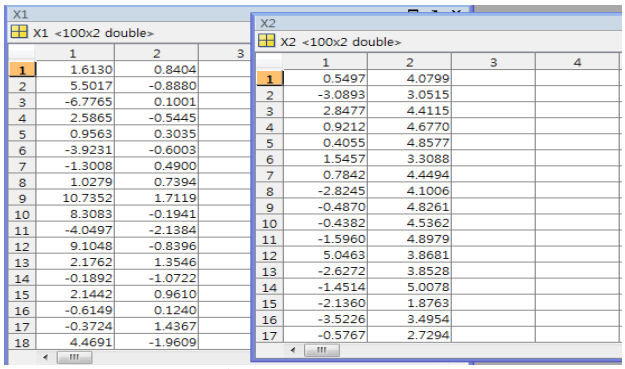


Fig.4: System Implementation Results

4. Performance Evaluation

Figure 5 shows the performance evaluation of the psychological analysis counseling system. The pictures of a happy face and those of a sad face were expressed in numerical values in the first system realization. The results are shown in two axes. The X1 axis is for a happy face, and the X2 was for a sad face. While the two X axes were similar with each other, the y-axis was different. The results showed the basic emotion recognition prior to a complicated psychological analysis. The classification may seem successful. An ROC curve was used to evaluate the results.



X1 <100x2 double>

	1	2	3
1	1.6130	0.8404	
2	5.5017	-0.8880	
3	-6.7765	0.1001	
4	2.5865	-0.5445	
5	0.9563	0.3035	
6	-3.9231	-0.6003	
7	-1.3008	0.4900	
8	1.0279	0.7394	
9	10.7352	1.7119	
10	8.3083	-0.1941	
11	-4.0497	-2.1384	
12	9.1048	-0.8396	
13	2.1762	1.3546	
14	-0.1892	-1.0722	
15	2.1442	0.9610	
16	-0.6149	0.1240	
17	-0.3724	1.4367	
18	4.4691	-1.9609	

X2 <100x2 double>

	1	2	3	4
1	0.5497	4.0799		
2	-3.0893	3.0515		
3	2.8477	4.4115		
4	0.9212	4.6770		
5	0.4055	4.8577		
6	1.5457	3.3088		
7	0.7842	4.4494		
8	-2.8245	4.1006		
9	-0.4870	4.8261		
10	-0.4382	4.5362		
11	-1.5960	4.8979		
12	5.0463	3.8681		
13	-2.6272	3.8528		
14	-1.4514	5.0078		
15	-2.1360	1.8763		
16	-3.5226	3.4954		
17	-0.5767	2.7294		

Fig.5: Performance Evaluation Results 1

Figure 6 shows the results obtained from the video module in an ROC curve. Sensitivity and specificity are also used for the evaluation of the performance of a clinical test giving binary test results of "yes" or "no" [10]. In the plot where FPR and TPR are represented by the x-axis and the y-axis respectively, TPR denotes True Positive Rate (TP rate=TP/(TP+FN)) and FPR denotes False Positive Rate (FP rate = FP/(FP+TN)). The TP rate was denoted as α, and (1-FT) rate was denoted as 1-β.

The Area Under Curve at the top of Figure 6 represents the area under the curve (X) which is in the range $0 \leq X \leq 0.5$. An X value nearer to 0.5 indicates that the expression is better. The current X value was 0.41, indicating that the expression was relatively good. The X value also helps to select the future recognition direction according to the position of the point. Future studies will be conducted to develop a system with a higher accuracy by integrating the voice data.

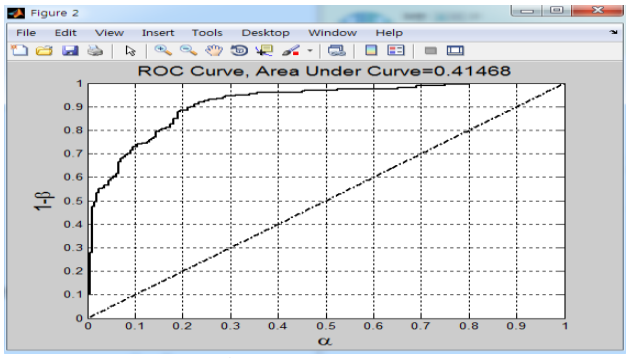


Fig.6: Performance Evaluation Results 2

5. Conclusions

In the present study, the software MATLAB and machine learning were used to develop a psychological analysis counseling system. This proposed psychological analysis counseling system may be used to help to have a smoother conversation in cases where the time for face-to-face conversation is insufficient or the direction of conversation may not be properly determined. The system was realized according to the system architecture and the flowchart. The number of single person or two-person households is expected to increase in the future. Due to the technological development, many people do not talk but use a smart phone even when they are dining with others. This trend prevents people from developing good personality but make their individuality more distinctive. Future studies will be conducted to develop a system and an algorithm that may help humans to wisely use machines in order to maintain and advance humanity.

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