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Patients Tremble Analysis under different Camera Placement in Critical Care

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Abstract – This paper presents an integrated system for detecting facial changes of patient in a hospital in Intensive Care Unit (ICU). In this research we have considered the facial changes most widely represented by eyes and mouth movements. The proposed system uses color images and it consists of three modules. The first module implements skin detection to detect the face. The second module constructs eye and mouth maps that are responsible for changes in eye and mouth regions. The third module extracts the features of eyes and mouth by processing the image and measuring area and distance dimensions of eyes and mouth regions with different camera space. Finally the results of this work were tested with Neural Network

Keywords – Detection of facial changes, ICU patient, Camera Distance, Neural Network classifier

1. Introduction

During the last decade, the detection and localization of facial changes become the most crucial in imaging applications such as forensic, psychology, crime detection and driver safety [1-6]. However, the application of medical imaging to monitor patient who are under coma and patient after complicated surgery laid in intensive Care Unit (ICU) have been found in sufficient [4-5].

The coma-patients who are in ICU to be carefully monitored by nurses for any body movements. Since the nurses have multiple responsibilities in ICU, they may miss such events. Same situation arises when a patient, highly sedated after a complex surgery, brought to ICU, little changes in face such as eye opening; lip motion and facial color are very welcome for surgeons to take next clinical step. For this also, the nurses are made to be responsible. The importance of automated systems to assists the nurses in these responsibilities are very eminent.

Recent advances in vision technology offer new ways to present information about patient’s coma in intensive care unit (ICU). Some research focuses on identifying information that needs to be conveyed and has led to configural graphic displays that show relations between sensed measures and physiological functions [5]. Other research focuses on improving information delivery to the clinician. For example, head mounted displays (HMDs) present monitored information directly to the anesthesiologist’s field of view and may be a more effective way of monitoring patients. Alternatively, sonification, a non spatialized auditory display that represents data as relations between the dimensions of sound, may serve a similar purpose [6].

However there are challenges that impede the development of effective solutions to the facial tracking and recognition problem. They include poor image quality, obscuration, deformations, clutter, texture variation, and many more. We describe some of them in this paper.

The rest of the paper is structured as follows: Section 2 discusses about the overview of the system. Section 3 provides details about the face detection algorithm, the selection of color space and the construction of eyes and mouth maps. Section 4 describes the facial detection, feature extraction and validation module, while Section 5 provides experimental results. Finally, Section 6 ends with some concluding remarks.

2. System Overview

The complete block diagram representation of the proposed system is as shown in Figure 1.After inputting a facial image; a skin color based algorithm is applied to detect the patient face in the image [6-7].A Microsoft Life cam VX7000 was implement and associate with Window XP Professional with an Intel® Core™ 2duo CPU E7400@2.8gHz,1.96GB of RAM. The feature extraction of the eyes and mouth of the image are cropped from the face. The conditions of the patient were determined based on a Neural Network classifier.The system will issues a signal to draws the conclusions for the medical staff if the eyes are found open, half open or closed for consecutive frames. All the codes are written in MATLAB software.

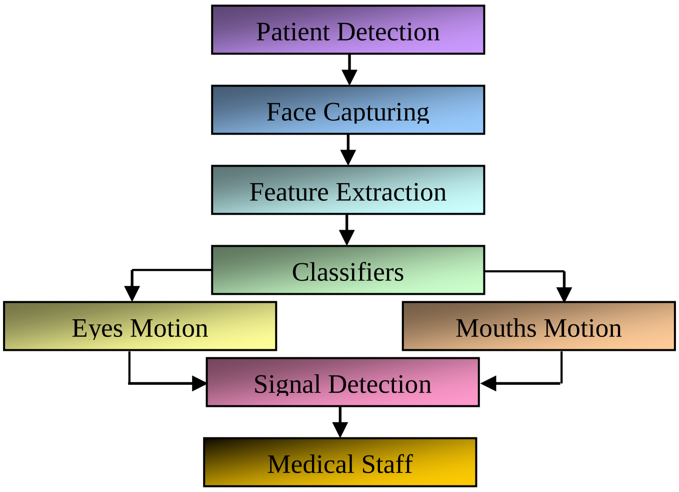
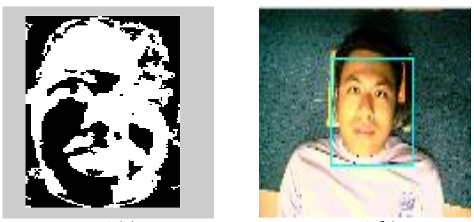


Figure 1. Flowchart of Patient Monitoring System

3. Face Detection

A good level of research has been documented in the area of human face detection [1-8]. The authors have used skin filter method to detect the face [8-9]. The face detection is performed in three steps. The first step is to classify whether a test pixel in the given image is a skin pixel. The second step is to identify different skin regions in the skin detected image by using connectivity analysis as shown in Figure 2 (a). The last step is to decide whether each of the skin regions identified is a face skin. They are the height to width ratio of the skin region and the percentage of skin in the rectangle defined by the height and width Figure 2(b).



2(a) 2(b)

Figure 2. Face detection

3.1. Eyes Detection

From a segmented face image, two separate eye maps are built, one from the chrominance component (EyeMapC) and the other from the luminance component (EyeMapL). These two eye maps are then combined into a single Map (Eye Map).The chrominance eye map is based on the fact that high Cb (blue) and low Cr (red) values can usually be found around the eyes. The EyeMapC is constructed by [8].

$$EyeMapC = \frac{1}{3}\left(Cb^2 + Cr^2 + \frac{Cb}{Cr}\right) \quad (1)$$

Here the values of Cb^2, Cr^2 and Cb/Cr are normalized to the range [0,255]. The 1/3 scaling factor is applied to ensure that the resultant EyeMapC stays within the range of [0,255].

Eyes usually contain both dark and bright pixels in the luminance component, so grayscale operators such as dilation and erosion can be designed to emphasize brighter and darker pixels in the luminance component; around eye regions. The EyeMapL is constructed by [8].

$$EyeMapL = \frac{Dilation(Y(x,y))}{Erosion(Y(x,y)) + 1} \quad (2)$$

3(a) 3(b) 3(c)

Figure 3. Eyes detection

Figure 3 details eye detection. Eyes are considered in the top of the image. Chrominance of eyemap Fig 3(a) and Luminance of eyemap Figure 3(b) are added pixel by pixel to gain eyemap Figure 3(c).

3.2. Mouth Detection

The color of the mouth region contains stronger red component and weaker a blue component in facial regions (Cr >Cb), in the Cr/Cb feature, but it has a high response in Cr^2 [8]. The Mouth Map is constructed as follows.

$$MouthMap = cr^2\left(Cr^2 - n\frac{Cr}{Cb}\right)^2 \quad (3)$$

where

$$n = 0.95\frac{\frac{1}{k}\sum Cr(x,y)^2}{\frac{1}{k}\sum Cr(x,y)/Cb(x,y)} \quad (4)$$

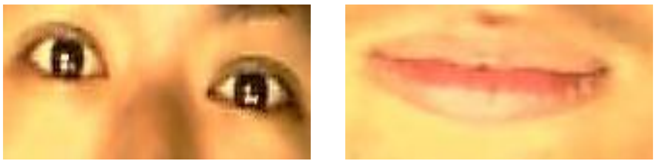
Cr^2 and Cr/Cb are normalized to the range of [0,255], and k is the number of pixel within the face region. The parameter *n* is the ratio of the average Cr^2 to the average of Cr/Cb. The mouth equation (3) emphasis high Cr^2 but low Cr/Cb. Figure 4 shows a constructed Mouth Map.

Figure 4. Mouth map

4. Facial Detection and Validation module

The facial detection and validation module is based on the estimation of the facial features of the eyes and mouth. Various approaches and discussions in facial estimation can be found in [8-11].

Instead of each frame, this system only observed selected frames since successive frames have same information Figure 5 Feature extraction can be performed only on the crop image portion of eyes and mouth Figure 6, in order to check whether the eyes and mouth are closed, half closed or open we some classifier. Distance and area are given as an input to the classifier module for calculating the motion probability for the system.



(a)Eyes (b) Mouth

Figure 5. Crop images from a frame.

4.1. Distance and Area

Distances were measured between eyelids from the coordinate of top of eye contour (x_1, y_1) to the bottom coordinate of the eye contour (x_2, y_2) as shown in Figure 6. A similar experiment is performed to the mouth using Euclidean norm equation.

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} = d_1 \quad (5)$$

So the new value $(d_1)......(d_n)$ are the distances for every eye and mouth in consecutive images in image test.

4.2. Area of Eyes and Mouth

Area was measured from the whole of the eye using moment (M_{00}) as

$$A = \sum_{n=1}^{m} \sum_{y=1}^{n} I(x, y) \quad (6)$$

The new value…A_n was the area for every subject tested. Finally there are six feature extractions F_1 to F_6 for both eyes and mouth as shown in Table 1.

Table 1. Feature extraction measures in different region of interest.

Feature Extraction	Region of Interest(ROI)
F1	Area Left Eye (ALE)
F2	Area Right Eye (ARE)
F3	Distance Left Eye (DLE)
F4	Distance Right Eye (DRE)
F5	Area Mouth (AM)
F6	Distance Mouth (DM)

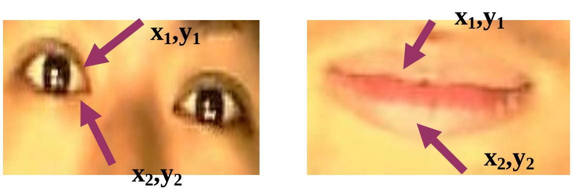


Figure 6. Distance and area estimation from the upper lids to the lower lids for eyes and mouth.

5. Neural Network Classifier

Artificial Neural Network (ANN) provides alternative form of computing that attempts to mimic the functionality of the brain [12] Feed forward neural networks have been the subject of intensive research efforts in recent years because of their interesting learning and generalization properties. The back propagation method is a learning procedure for multilayer feed forward neural networks. In this paper, a simple neural network model is developed for the classification of facial changes in ICU to classify the motion of eyes either it open, half open or close. A four layer neural network with 2input neurons represents distance and area in the first layer. Other 2 hidden layer consist (16 hidden in second layer, 16hidden in third layer) and finally 2output in output layer are considered. The hidden neurons have a bias value of 1.0 and the output an hidden neurons are activated by binary sigmoidal activation function. 210 samples are randomly chosen from the database and used as training patterns and tested with 90 samples. Five trials were performed. The learning rate and momentum facto are chosen as 0.1 and 0.9 respectively.

6. Results and Discussions

A simple feature extraction method based on area and distance was proposed for determining the condition of the eyes such as open, half open and close. All the three classifier were compared for the proposed features as shown on Figure 7. The advantage of using the proposed feature extraction method is easy and fast to determine. The simulation results show that all the three classifier give the highest accuracy for the first 0 angle. However, all those distance decreasing between each of the trial. Finally at 0° gives the best accuracy about 96.33% among all other trials.

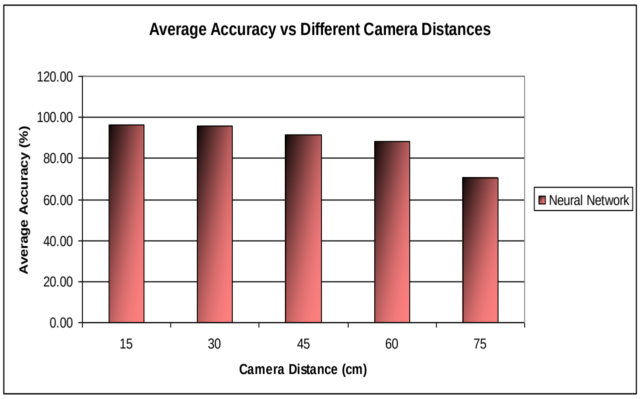


Figure 7. Accuracy versus Different Camera Distances

References

[1] Yang, M., Kriegman, D.J., Ahuja, N.: “Detecting faces in images: A survey”. IEEE Trans Pattern Analysis and Machine Intell. Vol 24, pp. 34–58, (2002).

[2] Singh, S., Chauhan, D.S., Mayank, V., Singh, R.: “A Robust Skin Color Based Face Detection Algorithm”. Tamkang Journal of Science and Engineering 6(4), pp. 227–234, (2003).

[3] Hus, R.L., Mottaleb, M.A., Jain, and A.K.: “Face detection in color images”. IEEE Trans. Pattern Analysis and Machine Intell, Vol 24, pp. 696–706, (2003)

[4] Behnood Gholami, “Agitation and Pain Assessment Using Digital Imaging Pain,” Manag. Nurs, Vol. 7, pp. 44–52, (2006).

[5] Tinker JH, Dull DL, Caplan RA, et al. “Role of monitoring devices in prevention of anesthetic mishaps: a closed claims analysis”. Anesthesiology Vol.71, pp. 541– 546, (1989).

[6] Gong, Shaogang, Stephen J. McKenna, Alexandra Psarrou. Dynamic Vision: “From Images to Face Recognition,” Imperial College Press, (2000).

[7] Ilias Maglogiannis u.a. “Face detection and recognition of natural human emotion using Markov random fields”. In Personal and Ubiquitous Computing. Springer London, (2007).

[8] S. Jin S.-Y. Park · J.-J. Lee, “ Driver Fatigue Detection using Genetic Algorithm .” 11th International Symposium on Artificial Life and Robotics, Oita, Japan, pp. 23–25, (2006).

[9] R.S. Parsai, P.R.Bajaj, “Intelligent Monitoring System for Driver’s Alertness (A vision based approach)”International Conf. Italy, (2007).

[10] K. Yammamoto and S.Higuchi, "Development of drowsiness warning System", J.Soc Automotive Eng. Japan, pp. 127-133, (2002).
[11] Keller, J. M., Gray, M. R., & Givens, Jr. "A fuzzy k-nearest neighbor algorithm". IEEE Transactions on Systems Man and Cybernetics, Vol 5, pp. 580–585, (1985).
[12] Gonzale R.C., R.E. Woods and S.V. Eddins, Digital image processing using MATLAB, Pearson Education, Delhi, (2004).

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