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Burnout Recognition for Call Center Agents by Using Skin Color Detection with Hand Poses

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Abstract**—**Call centers have been expanding and they have influence on activation in various markets increasingly. A call center's work is known as one of the most demanding and stressful jobs. In this paper, we propose the fatigue detection system in order to detect burnout of call center agents in the case of a neck pain and upper back pain. Our proposed system is based on the computer vision technique combined skin color detection with the Viola-Jones object detector. To recognize the gesture of hand poses caused by stress sign, the YCbCr color space is used to detect the skin color region including face and hand poses around the area related to neck ache and upper back pain. A cascade of clarifiers by Viola-Jones is used for face recognition to extract from the skin color region. The detection of hand poses is given by the evaluation of neck pain and upper back pain by using skin color detection and face recognition method. The system performance is evaluated using two groups of dataset created in the laboratory to simulate call center environment. Our call center agent burnout detection system has been implemented by using a web camera and has been processed by MATLAB. From the experimental results, our system achieved 96.3% for upper back pain detection and 94.2% for neck pain detection.

Keywords**—**Call center agents, fatigue, skin color detection, face recognition.

I. Introduction

A call center agent is one of the important jobs in customer service. The call center agents stay for a long time in front of the monitor daily. Being seated for a long time in front of screens has changed working behaviors and significantly reduced workers physical movements. Some studies revealed that call center agents often suffer from a neck and shoulder pain. Burnout is a complex psychological syndrome that results from chronic emotional, mental, interpersonal, and/or physical stress within the call center. Burnout and chronic stress interfere with a call center agent's ability to attend to remember information. This is because when they are under a significant amount of stress, their attention is consumed by the stressor. The neck pain, upper back pain, and headache are facial signs of burnout. It is often the cause of low morale, low productivity, and high agent attrition rates [1]-[6]. In this paper, we propose a fatigue detection system that is able to detect neck and upper back pain.

II. Literature Review

Burnout recognition for call center agents is one of the new topics in fatigue detection research. The most popular topic is driver fatigue detection system. Researchers mainly focus on detecting driver's vigilance level. In the past research, many efficient algorithms have been proposed to monitor face features in especially eyes status using a wide range of feature extraction and classification methods such as color-space transformations, edge detections, Haar-like features, template matchings, and neural networks, etc. [7]. Viola and Jones presented a machine learning approach for visual object detection which achieved high detection rate [8]. The YCbCr color space is widely used for skin color detection, in Abdel-Mottalab et al., de Dios, Garcia and Bouzerdoum et al. [9]. Lin et al. published a study about visual fatigue as one of VDT worker problems [10]. Chen et al. proposed an approach for chronic fatigue syndrome diagnosis using feature extraction based on image processing [11]. Sharara et al. evaluated the practical efficiency of Viola-Jones object detector and skin-color detection to build the fatigue detection system for VDT workers. Their study has confirmed that the skin color detection can be used for detecting the hand posture in combination with Viola-Jones object detector. As the results, effectiveness of detecting the facial features of fatigue achieved 100% in hand posture detection by skin color detection. Furthermore, Viola-Jones object detector also achieved 100% in the front face detection using a dataset of color images including face, head and hands poses [12]. Sharara et al. presented upper back pain detection system by monitoring eyes status and hand poses [13].

III. Proposed System

We propose a burnout recognition system for call center agents aimed to recognize a neck pain and upper back pain. It is helpful to manage agent's health condition to notice fatigue by myself. The system is able to assist the call center agent to take a break or do physical exercise. We realize with inexpensive and efficient software tools such as general web camera and computer vision software. Our developed system has four main stages as below. Fig. 1 shows a simplified flow chart of the proposed call center agent burnout detection system:

A. Face Area Detection
B. Skin area detection.
C. Upper Back pain detection.
D. Neck pain detection.

Every stage has sub-steps will be explained in next section.

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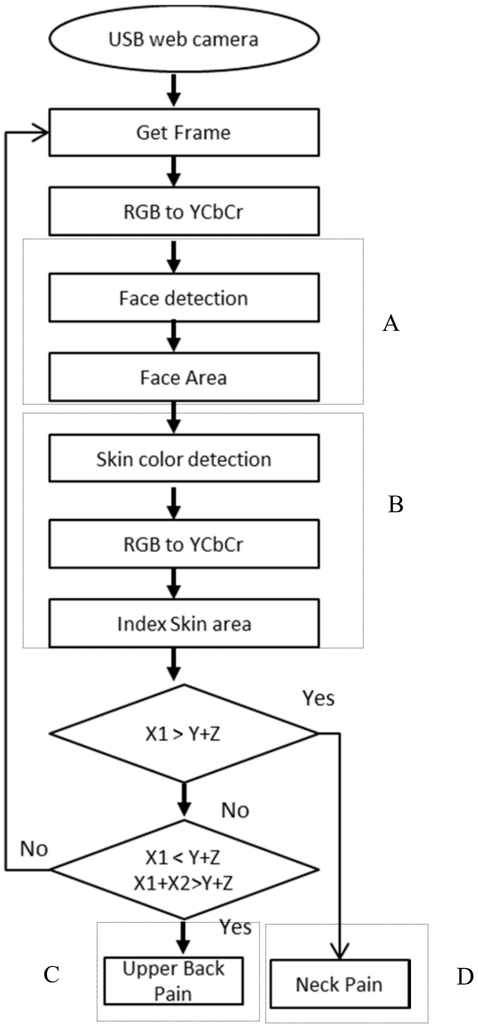

Fig. 1 The flowchart of proposed call center agent burnout detection system

A. Face Area Detection

The object detector by Viola and Jones [8] is used as a face detector because it is accurate and faster than other face detection algorithms, i.e. SIFT, SURF and Ellipse detection [7]. Fig. 2 shows the face region detected and color space converted results from RGB to YCbCr.

B. Skin Area Detection

Skin-color detection: many color space models can be used for skin-color detection purpose. In this paper, the YCbCr color-space model is used to Change the RGB image to YCbCr color-space as in (1).

In this stage, the algorithm indexes the skin areas detected and stores the two biggest areas as X1 and X2. Figs. 3 and 4 shows the skin color detected and color space converted results from RGB to YCbCr.

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} + \begin{bmatrix} 65.481 & 128.553 & 24.966 \\ -37.797 & -74.203 & 112 \\ 112 & -93.786 & -18.214 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

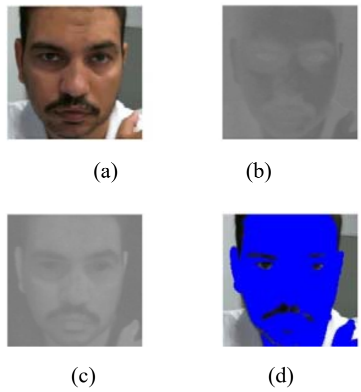

Fig. 2 The face region detected and color space converted results from RGB to YCbCr. (a) Original image (b)Cb Image (c) Cr image(d)Mark skin Pixels

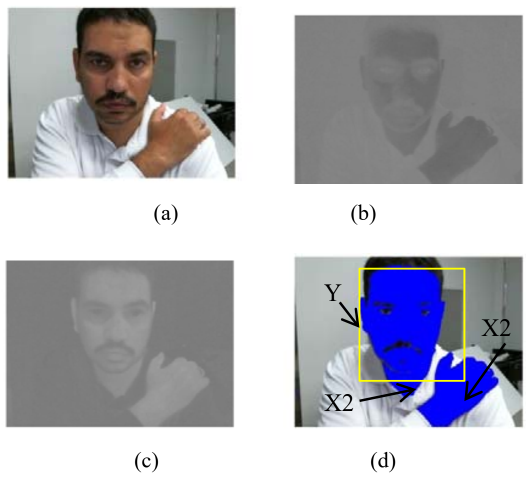

Fig. 3 The skin color detected for upper back pain pose and color space converted results from RGB to YCbCr. (a) Original image, (b) Cb Image, (c) Cr image, and (d) Mark skin pixels

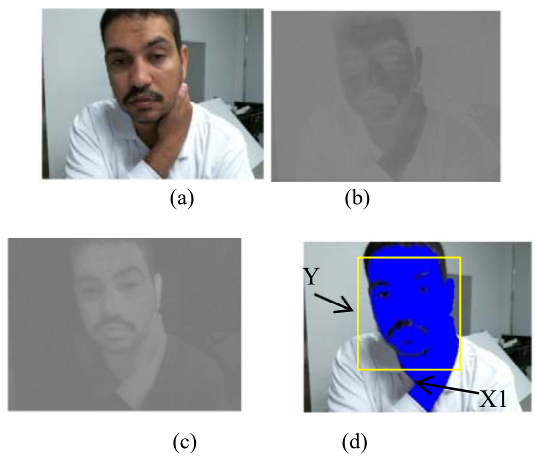

Fig. 4 The skin color detected for neck pain pose and color space converted results from RGB to YCbCr. (a) Original image (b)Cb Image (c) Cr image (d)Mark skin Pixels

In the skin-color, Y is discarded, and ranges of Cb and Cr are calculated as [1]:

$$80 \leq \mathrm{Cb} \leq 120 \text{ and } 133 \leq \mathrm{Cr} \leq 173$$
Cb = rgb2ycbcr (:,:,2)
Cr = rgb2ycbcr (:,:,3)

C. Upper Back Pain Detection

To detect the upper back pack, the poses by pain are that the hand is on the shoulder right or left side. To detect the hand pose, first the face region should be detected using the object detector by Viola and Jones [8], and then we mark up the skin pixels after calculating the total marked pixels on face Y. Next step is detecting and indexing the two large skin areas X1 and X2. In order to recognize upper pack pain pose, the algorithm compares the face region area with the skin detect area based on the conditions in (2). Fig. 5 shows the results of upper back pain detection.

$$\mathrm{X1} < \mathrm{Y} + \mathrm{Z} \,\&\, \mathrm{X1} + \mathrm{X2} > \mathrm{Y} + \mathrm{Z} \tag{2}$$

where X1, indexed 1st large skin area, X2, indexed 2nd large skin area, Y, detected face area, Z, detected 20% from face area.

The skin area (X1) is less than the face area (Y) and the total of the skin area (X1) and skin area (X2) is more than the face area (Y.) It means that the hand is on the shoulder, then the system can recognize the upper back pain pose.

D. Neck Pain Detection

In order to recognize a neck pain pose, the algorithm compares the face region area with the skin detect area based on the conditions described in (3). Fig. 6 shows the results of neck pain detection.

$$\mathrm{X1} > \mathrm{Y} + \mathrm{Z} \tag{3}$$

where X1, indexed 1st large skin area, Y, detected face area, Z, detected 20% from face area.

If the skin area indexed (X1) is more than the face area detected (Y), it means that the hand catches the neck, then the algorithm recognizes the neck pain pose. Finally, the call center agent burnout detection system proposed can be differentiated between neck pain and upper back pain according to (2) and (3).

IV. Experimental Environment

The system performance evaluated using two groups of dataset created in laboratory to simulate the call center environment. Table I shows the experimental environment in details. Fig. 7 shows the examples of dataset.

(a)

(b) (c)

Fig. 5 Results of the upper back pain detection (a) Original image, (b) Face region, and (c) Skin color area

(a)

(b) (c)

Fig. 6 Results of neck pain detection. (a) Original image, (b) Face region, and (c) Skin color area

(a) (b)

(c) (d)

Fig. 7 Examples of dataset, neck pain pose (a) Right side and (b) Left side, upper back pain pose (c) Right side and (d) Left side

TABLE I
EXPERIMENTS ENVIRONMENT

Upper Back Pain Dataset	433 Frames
Neck Pain Dataset	192 Frames
Frame size	320x240
Illumination	400 ~ 500 Lux
Web cam	Logicool HD1080p
Processed by	Matlab R2016a
Processor	Intel Core i7-6700 ,340 GHz
RAM	8 GB
Operating system	Windows 7 Enterprise

TABLE II
EXPERIMENTAL RESULTS OF SYSTEM EVALUATION WHICH PRESENTS BURNOUT DETECTION OF THE UPPER BACK PAIN AND NECK PAIN

	Total	Correct	Failed	Results
Upper Back Pain	433	417	16	**96.3 %**
Neck Pain	192	185	11	**94.2 %**

(a) (b)

Fig. 8 Examples of failed detection, (a) No neck pain, (b) No upper back pain

V. EXPERIENTIAL RESULTS

Our call center agent burnout detection system has been evaluated based on the performance using two groups of datasets created in the laboratory to simulate the call center environment. Table II shows the experimental environment. The dataset has 433 frames. The system achieved 96.3% Upper Back Pain detection rate successfully in real time. The failed images exist because of the hand near the shoulder, not on the shoulder. In the second dataset group for neck pain pose. The dataset has 192 frames. The system achieved 94.2 % detection rate in real time. The failed images exist because the hand near the neck does not catch it. Fig. 8 shows the examples of failed detection.

VI. CONCLUSION

We proposed the burnout recognition system for call center agents aimed to recognize a neck pain and upper back pain. Our system can be realized easily by using a webcam connected in front of the agent and it can analyze the hand poses. The system is able to send an alert to the call center agent to take a rest or do some exercise if the system recognized a neck pain or upper pack pain. In future, we will improve the algorithm to detect a headache and drowsiness. To build complete fatigue detection system, we would apply health monitoring for employees while they are working in front of the screens.

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