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# Practical Approach of Fragmentation of Face Components based on Facial Expression

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**ABSTRACT-**
In this paper, we present an effective vision-based worker fatigue detection method. Firstly, the inter frame difference approach binding color information is used to detect face. If exists, the face area is segmented from the image based on a mixed skin tone model. Then we simulate the process of crystallization to obtain the location of eyes within face area. Later, average height of the pupil and width to height ratio are used to analyze the eye's status. Finally, the worker fatigue is confirmed by analyzing the changes of eye's states. The experimental results show validity of our proposed method.
***Keywords –***worker fatigue detection, face segment, eye location, eye states analysis

## I. INTRODUCTION

The increasing number of accidents in workplace due to a diminished worker's vigilance level resulting from sleep deprivation has become a serious problem for society. Statistics show that between 10% and 20% of all the accidents in work-place are due to workers with a diminished vigilance level [1]. Moreover, accidents related to worker's declined level of vigilance are more serious than other types of accidents, since drowsy workers often do not take any avoidable actions prior to a collision [2]. With this background, how to supervise the worker's level of vigilance and avoid fatigue working is essential to the accident prevention. The rest of the paper is organized as follows: Section 2 provides a brief survey of related researches on worker fatigue detection. In section 3, the outline of our proposed vision-based automatic worker fatigue detection system is presented. Face location method including face existence detection is described in section 4. Section 5 describes a novel method of the eyes location and eye template generation. The experimental result for worker fatigue detection is shown in section 6. Conclusion and future work are discussed in the last section.

## II. OVERALL ALGORITHM

We present an algorithm of detecting driver fatigue by analyzing the changes of eye's status. The approach contains five phases:

(1) Judgment of face existence
(2) Face location based on mixed skin tone model
(3) Eyes Location and eye template generation
(4) Eye state analysis based on pupil height, area of the eye and width to height ratio
(5) Confirmation of worker's vigilance.

## III. DETECTION OF FATIGUE

To distinguish the worker's status the eyes' states should be recognized ahead. There is two factors which can affect the size of the eyes in the frames. On the one hand, human eyes are always different in size. On the other hand, the distance between worker and the camera is the other reason. So we normalize the eye template to a fixed size of 12×30 before feature extraction. For each eye template, eye area, average height of pupil, width to height ratio are the most important features to judge eye's status which is shown in Table 1. The eye states can be divided into three types: full open, half open and closed. From the table below we can see that eyes of different states present different features. The experiments also proved that the three indicators (Area, Height and Ratio) are efficient for the eye's states recognition. By analyzing the worker's eyes' states changes while working we discovered two principles which can indicate worker drowsiness. Firstly, if a worker's eyes keep closed over 4 consecutive frames it is believed that the worker is drowsy. Secondly, fatigue can be confirmed if a worker's eyes only change between half open and closed over 8 consecutive frames. Before the system is put into use we trained it in advance to get different states parameters for the worker aiming at improving the accuracy of the worker's status analysis.

TABLE 1. Eye states and features

| | Eye Region | Area (pixel) | Average Height | Ratio |
|---|---|---|---|---|
| Full open |  | 200 | 7.6 | 2.8750 |
| Half open |  | 155 | 6.8 | 3.0000 |
| Closed |  | 114 | 6.0 | 3.1667 |

## IV. GAZE MOVEMENT

According to the thermodynamic principle, for a closed system the minimum of Helmholtz free energy f (E) is used to describe the equilibrium state instead of maximum entropy. It is easy to see that the larger the free energy gap between different particles the smaller the probability that they can reach the same level. When the free energy gap is same the higher temperature the larger the probability it will. By considering the diversity to the nearby pixels and the similarity to the eye pixels sufficiently, the specific region of the eyes can be obtained. After this step, projection method is used again to detect the eyes' precise boundaries. The method has been adopted frequently in the eye detection so we needn't describe the de- tails. Our method starts from both sides, left and right, to find eyes, therefore we can detect the eyes separately.

(a) Left eye (b) Right eye

Fig. 2: Eyes detected

Then we segment the eyes from the image and use them to generate an eye template, by this means we obtain a rather stable eye template for the status analyzing and reduce the influence of light reflections. The eye template is generated as follows.

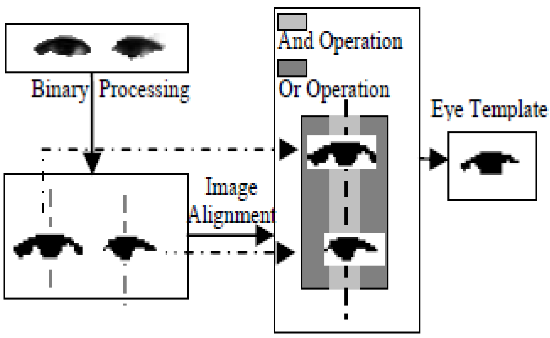



Fig. 3: Eye template generation process

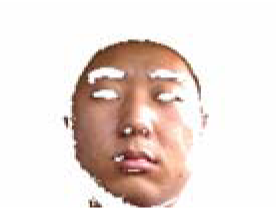
Also the two eyes' positions are re- corded, the eyes can be detected in the next frame based on these positions. The searching area expanding 6 pixels in four directions from the eyes' centers in the current frame. If the distance between two eyes detected in the next frame changes greatly, the eye tracking is regarded as failure. Then the face detection and eyes location procedures will be restarted.

## V. LOCATIZATION OF THE FACE

When working in an industry, the worker's eyes' position and change constantly. To search and locate the worker's eyes directly in the whole image will not be easy. Moreover, the back- ground is usually complex and unpredictable especially when the worker is working with machines. So the first step we detect face in order to reduce the range of eye detection, besides, the procedure will improve the veracity and speed of eyes location and reduce the interference of background. For purpose of reducing the blindness of face searching, we calculate inter-frame differences to decide whether there is a moving object. When some object is detected and in the local area there contains skin color information in YCbCr color space, we believe there is a person before the camera. Although people of different races distinguish in skin color, the distribution of human skin color in YCbCr color space can be approximated by a planar Gaussian distribution [12]. Specifically, face area can be segmented from a image by skin color information. To improve the accuracy of detection, in this paper, we use a mixed skin model based on YCbCr and HSI color Space. Because in the HSI color space hue is independent of brightness, the brightness factor can be excluded from colors. This mixed skin model is more suitable for distinguishing skin and non-skin colors no matter the face is under light or shadowed.

The three components (Cb, Cr and H) have different abilities to represent various skin colors and they can be complemented by each other. By using this method, it is easy to separate face region from the origin image, as is shown in fig below. By performing vertical and horizontal projections on skin pixels, the right, left, top and bottom boundaries of the face can be confirmed if the projection values exceed some threshold which has been set based on experience, as is shown in Fig. 2(c). Usually the normal position of the eyes will be in the upper half part of the face region, as is shown in Fig. 2(d), further- more, the area is sufficient for us to detect eyes later.

(a) Original Image



I. (b) Face Skin

(c) Face Region

(d) Eyes Region

## VI. TEMPLETE MATCHING METHOD

In this methodology extraction of eye spacing takes place with the help of improved adaboost algorithm. Eye spacing means distance between upper and lower eyelid. Eye spacing is the important parameter to calculate the degree of weariness. Distance means the levels of learners' fatigue. Distance [6] get calculated by this formula

$$Distance=C–D+A–B/2$$

Where, **A-**Vertical coordinates of midpoint of the right upper eyelid. **B-**Vertical coordinates of midpoint of the right lower eyelid. **C-V**ertical coordinates of midpoint of the left upper eyelid. **D-**Vertical coordinates of midpoint of the left lower eyelid. When fatigue level increase means, the eye spacing (distance) becomes smaller even if closes eyes. Then the eye spacing is zero. Through the changes of the eye spacing, take appropriate fatigue detection strategies.

## VII. FLOW OF IMPLEMENTED PHASE

a. Take input image from a standard data set.
b. Convert the picture into appropriate size for further processing.
c. Perform steps to segregate the components of face.
d. Remove the skin colour.
e. Convert the image in binary format.
f. Dissect the image.
g. Compare the components on the standard parameters for fatigue.

## VIII. EXPERIMENTAL RESULTS

From the camera fixed in the workplace we acquired the tested images in the natural working conditions. The average correct rate for eye status recognition can achieve 91.16%. The different eye states of full open and half open sometimes cannot be well distinguished which has caused most false judgements and the fast movement of worker's head can result in the worker's eyes tracking failure. The correct warning rate for worker dozing is 100%. Here, a 100% correct warning rate doesn't reveal a absolute robustness of the algorithm. If during a period of dozing time the system can detect worker's drowsiness and alarm then we consider this a successful fatigue detection.

## IX. CONCLUSION

In this paper, we present a new worker fatigue detection method for working safety. The inter frame difference approach is used to decide whether the frame exists a face. Then a mixed skin color model is used to detect face. In the face region we use a novel method by simulating the crystallization process to segment the eyes from the face. By performing projections the eyes can be located precisely. The detected two eyes are used to generate an eye template. We use eye area, average height of the pupil and width to height ratio to distinguish the eye's status. Finally, worker fatigue can be detected based on the rules we discovered. The experimental results show validity of our proposed method for worker fatigue detection under realistic conditions. The future research will focus on obtaining more elaborated eye regions and improving the accuracy of eye states distinction and we also should do more work on detecting the eye's flickering status in the nearly future which can be used to describe fatigue status more precisely.

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