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Development of an alert software of laptop for fatigue warning and health care

Abstract

Employee health care is a focusing topic these years. Using the laptop for a long time will damage human's health seriously, especial to human's eye, for example, will cause maculopathy. Using the alert software of laptop, we can warn user to take a rest when he detects tired symptom of user.

Benefit

There are many businesses that require their employees to work for long hours in front of the laptop, which can cause physical discomfort to them. In order to prevent that, companies can install anti-fatigue software in their laptop. The design ergonomically and thus benefits employees and reduce stress, as the software can reduce fatigue and stress from the eye of workers who sit for long durations in front of laptop. Using that, user can release the stress of whose eye.

Method

This will be achieved using data acquired from a camera facing the laptop user. Images are captured, pre-processed and analyzed using image processing techniques. This results in the detection of the laptop user's pupils and the duration of eye blinking, if who is a sleepy laptop user, their absence is detected.

Classification of the results are made to determine the level of fatigue which the laptop user is experiencing. If the level of detected fatigue exceeds different safe level, the system will make necessary remedies to reduce this through an alarm procedure.

Algorithm

A CMOS camera is in front of the laptop to view the user's face and can catch the eye as well. The frame grabbed from the camera is in the form of digital image and allows access

to the data for processing. This procedure is repeated at the start of every cycle once the previous frame is processed.

The image is reduced in size to the region surrounding the eyes, using cropping software filter. After that, the cropped image is converted from RGB (Red Green Blue) color to a greyscale image with 255 levels of intensity. This reduces the amount of data in the image while retaining much of the critical information needed. After that, it is put into Hough Transform engine. The data is analyzed further for the detection of diameter of pupil of eyes and duration of blink in the image in a time slice. This involves the application of the geometric features of the eye to the data, resulting in a more accurate detection.

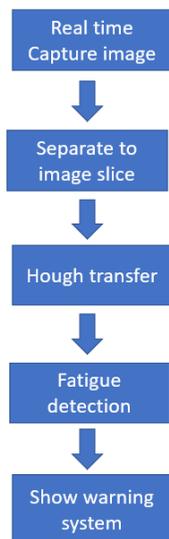
Hough transform is a technique of finding any shape in a digital image. It is usually used to find lines and curves or shapes that can be described by a set of parameters. The Hough transform was initially patented as US Patent 3,069,654 in 1962 under the name Methods and Means for Recognizing Complex Patterns.

The simplest form of the transform is the line transform, where lines are the desirable elements sought by the transform. Representing a line in polar form, following equation specifies its normal passing through (X, Y) drawn from the origin to (rho, theta) in polar space.

$$X\cos(\theta) + Y\sin(\theta) = \rho$$

For each point in the (X, Y) plane and on the line, the values of rho and theta are constant. Therefore, for a given point in the (X, Y) plane we can calculate the lines passing through the point in terms of rho and theta. Passing a range of lines at varying angles $[0, 2\pi]$ and varying theta accordingly it is then possible to calculate the value for rho. By taking a set of lines through a point and calculating the rho and theta values for the lines at the point a Hough space can be created. Combining the resulting image information, the fatigue detection system is able to decide whether the alarm procedure is activated or returns to the start where it re-initializes, and the process starts over again.

The functionality of this system should be unobservable to the laptop user during normal conditions as a background software service and the laptop user should only be aware of the system, when specific condition is trigger, the alarm or warning procedure is activated. The following is the flow chart.



In the following section, let's describe the important component of human's eye and its behavior which is related with the pattern. Human's eye has many components, the iris makes up the colored part of the eye. Its function is to control the amount of light that enters the eye. This is achieved by regulation of the pupil, the dark center spot in the iris which allows light to enter the eye.

The pupillary sphincter muscle controls the size of iris, automatically adjusting to control the amount of light which is entering the eye. The action is called as the pupillary reflex. In low light the pupillary sphincter muscle causes the pupil to dilate allowing more light to enter the eye and hit the retinal layer. The retina is the nerve layer that lines the back of the eye, senses light and pass signal through the optic nerve to the brain. Diameters of a healthy pupil in dim conditions can be enlarged to around 7mm. In bright light the pupillary sphincter muscle causes the iris to contract. The behavior makes the pupil smaller, in the region of around 1.4mm, which allows the eye to function more efficiently. In ambient light conditions a normal pupil will range from 2 to 3 mm in diameter.

After excessive stress on any of the functions of the eye, especially over long work day, visual fatigue arises. The blink of eye is increasing, and the diameter of pupil is increasing. The symptoms include painful feeling of the eye, reddening of the eye, double vision and headaches. Visual fatigue also reduces the powers of accommodation and convergence of the eye.

All types of visual work can contribute to visual fatigue. To create a system to inform and alert a laptop user they are suffering from fatigue, we must look at laptop user reaction to determine the most appropriate method to do this.

The laptop user 'Fatigue Detection' software can be divided up into several function blocks, Image preparation, Hough transform, sensor coding and decision algorithm. Taking the Image Preparation block of the program we can see it as being two separate parts, pre-Hough transform and post-Hough transform. The pre-Hough Transform section initializes the video input adaptor and applies default settings to the image when initializing. These setting are updated by the feed forward results of the previous frame for successive iterations through the images.

The diameter of pupil is positive correlation with the fatigue. On the other hand, the eye blink duration is negative with the fatigue. The core part of algorithm is to use get thresholds, Td1 and Td2 for diameter (reparent by D) and Tb1 Tb2 (reparent by B) for blink duration to judge the fatigue.

Thresholds are set on the first iteration and remain constant for the duration of the detection period. These 4 boundaries, Tb1 and Tb2, Td1 and Td2. If the signature of eyes met following condition 1:

$$((\Delta B \geq Tb1) \text{ and } (\Delta D \geq Td1))$$

A warning is given to the laptop user .

If the signature of eyes met following condition 2:

$$((\Delta B \geq Tb2) \text{ and } (\Delta D \geq Td2))$$

An alarm is given to the laptop user. Waring message is soft remind to relax; Alarm message is aggressive suggestion for the user. The pseudo code is as following:

```
Initial method()
{
  Get Base line Bb
  Get base line Db
}
```

```
Main()
{
  Get real time Br;
  Get real time Dr;
  delta B= Br- Bb;
  delta D= Dr- Db;

  If ((delta B >= Tb1) and (delta D >= Td1))
  {
    Trigger waring message;
  }
  If( (delta B >= Tb2) and (delta D >= Td2))
  {
    Trigger alarm message;
  }
}
```

Disclosed by David Ke, Louis Lee, Eric Lin and Stanley Lai, HP Inc.