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Posture Monitoring and Warning System

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***Abstract*—In this era computers are becoming a necessity in most of the office environments. So people working in front of computer for long hours is a common scenario which exposes them to health risks such as eye strain as well as musculoskeletal issues such as neck, shoulder pain, etc.**

In this system, we will be using integrated as well as external webcams available in the workplace to provide correct ergonomic feedback to the workers. We use a webcam to track a user's face with the help of face tracking algorithms thereby calculating the distance from the computer screen, his head movements as well as blink rate. Other camera can be used to capture social interaction of the workers. For this purpose every user need to calibrate the webcam according to its body features where we capture users image and mark the central reference line .We will monitor the user's posture, if there is any variation from the central line for a long period of time, we will notify the user that he has been sitting in a bad posture. We can suggest the user to take a break periodically.

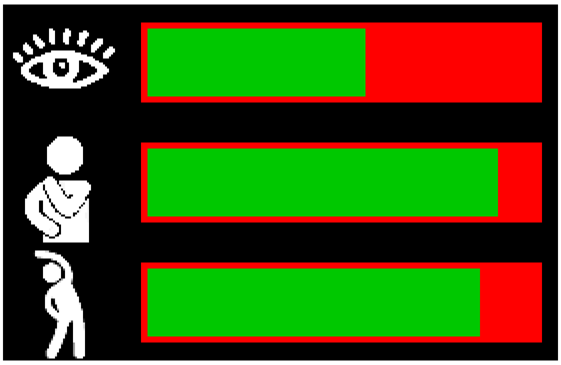
So our software can be used in every scenario where people need to work before the computers for a longer period of time. It will help in maintaining good posture and reduce many ergonomic problems.

***Keywords*— integrated webcam, face tracking, posture, ergonomic feedback**

I. Introduction

Our system is camera-based which will give correct feedback to workers about their habits and postures. Our system consists of two cameras, built-in camera in computers and a side-camera. With the help of built-in camera, we will monitor the user's face using face tracking algorithms thereby calculating his distance from the computer screen, his head movements, blink rate, as well as their work and break periods. We will be using the side-cameras for monitoring the body posture and social interactions of users. We will monitor the user periodically, if he is sitting in a bad posture for a long period of time, we will notify the user that he has been sitting in a bad posture. We present a graphical representation of the processed information to the user, so that the users can be aware of their wellbeing.

With the help of built-in camera we will track the user's face using face tracking algorithms. FaceAPI helps to track face under various poses. Face tracking algorithms provide the gaze direction, head location, head orientation etc. Using the result of face tracking algorithms we can then compare the face tracked image with the calibrated image to see if there was any head movement. We can also calculate the distance



(a)

Fig. 1. (a) Graphical Feedback Personal information collected from the video is aggregated by our system, and can be presented to the user as graphical health bars.

From the screen using built-in camera.When the user calibrated his/her face the size of the image is captured. If the user is too close to the screen his image size will enlarge and if he goes backward his image size will become smaller. We can also calculate the work periods and breaks by finding gaps in the video sequence. We can calculate the blink rate of the user using eye-lid state algorithm. Bars can be used as a graphical representationof the duration of use of the eyes, head mobility, and presence in front of the computer. Additional notifications can be used to remind the user to maintain a proper distance from the computer, to rest their eyes, to stretch, and to take a break.

Our system also estimates posture and neck-angle using the Side-camera. Posture is estimated from the foreground silhouette, and neck angle can be estimated by calculating Euler's angle.

II. Related Work

Over the past two decades, the number of papers in the field of monitoring body posture has grown significantly. This is mainly due to the increasing number of health problems such as musculoskeletal disorders and neck pain syndromes occurring to people working for long hours in a wrong posture in front of a computer or a laptop. These factors brought about a need to bring about systems wherein the posture of a person working for long hours can be monitored and the person can be alarmed if the posture he/she is sitting in is incorrect.

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Face tracking and detection have been a well-studied field and has many applications. There are various software's which detect and recognize faces accurately such as FaceAPI, Visage SDK. Also there are various face tracking algorithms such as Haar Cascade Classifier which uses Haar like features to detect objects,Viola-Jones Algorithm which uses simple features based on pixel intensity to detect faces.

For Head Movement Detection various Head trackers are available such as Cachya which analyses input video stream and determine head position and movement. There are various Models which have been developed for head tracking such as Rekimoto'sModel whichfirst segments the user's head from the background in the current image, then it detects the position of the head bycorrelating the resulting image of the user's head against a templateand the other model is Tang et al Approach.

Eye Detection Algorithms can be used to estimate gaze direction and blink rate can be used to determine the eye fatigue .some of the algorithms used are Adaptive Boost,Kalman filter,Open and Close eye template, SIFT Feature tracking,Eyelid's State Detecting

Neck-Angle Calculation can be used to estimate the position of the head with respect to neck. Some of the algorithms related to it are Euler/Cardan method and Helical axis method.

Data Fusion Algorithms are used to integrate the data retrieved from multiple cameras preferably used for surveillance purposes. The algorithm used is Beliefpropagation which is an efficient algorithm for solving the inference problem by passing messages between nodes in graphical models, which provides a rigorous way for the communication in multi- camera tracking.

User posture is estimated by segmenting the foreground silhouette.Foreground detection is one of the major tasks in the field of Computer Vision whose aim detect changes in image sequences. Many applications do not need to know everything about the evolution of movement in a video sequence, but only require the information of changes in the scene.

Detecting foreground to separate these changes taking place in the foreground of the background. It is a set of techniques that typically analyze the video sequences in real time and are recorded with a stationary camera.Detecting foreground has been a problem long studied in the field of computer vision. There are many techniques that address this problem, all based on the duality of dynamic and stationary background.

Temporal average filter is a method that was proposed and the Velastin. This system estimates the background model from the median of all pixels of a number of previous images. The system uses a buffer with the pixel values of the last frames to update the median for each image.

III. PROPOSED SYSTEM

In this system, we will be using computer webcams and cameras available in the workplace to provide correct medical feedback to the workers. We use built-in cameras in computers to track a user's face with the help of face tracking algorithms thereby calculating the distance between the computer screen, his head movements as well as blink rate. Other side cameras can be used to monitor the body posture and social interaction of the workers. We can suggest the user to take a break periodically.

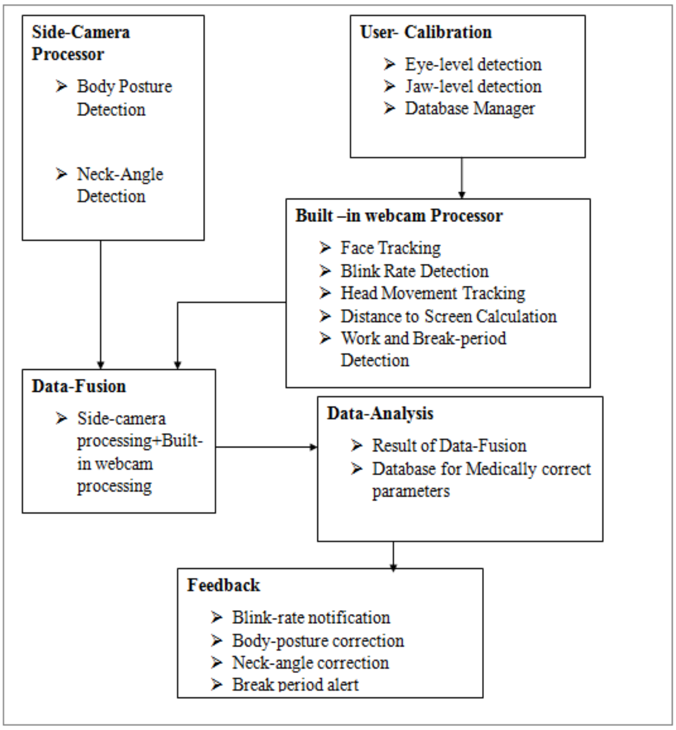

Fig 2. System Design

To carry out this process, our system consists of four major modules:

1. Built-In Camera Processing.
2. Side- Camera Processing.
3. Data Fusion.
4. Analysis and Feedback.

1. *Built-in camera processing*:
The built-in front-facing camera in the user's personal computer is used to track the face location, distance from the computer, head movement, gaze direction, blink rate, as well as their duration.

<u>This module has further five sub-modules:</u>

A.Face Tracking & Head Movement Detection.
B.Distance to the Screen Calculation.
C.Blink Rate Calculation.

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D.Work Periods & Breaks.

A.Face Tracking & Head Movement Detection:

Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary (digital) images. It detects facial features and ignores anything else, such as buildings, trees and bodies.

Our system requires a face tracking algorithm such as FaceAPI[1] which tracks faces in various head poses, since worker's don't look directly into the monitor all the time, especially when they are performing other tasks at their desk[2]. We use the haar cascade classifier for face tracking. The core basis for Haar classifier object detection is the Haar-like features. These features, rather than using the intensity values of a pixel, use the change in contrast values between adjacent rectangular groups of pixels. The contrast variances between the pixel groups are used to determine relative light and dark areas. Two or three adjacent groups with a relative contrast variance form a Haar-like feature. Haar-like features are used to detect an image.

Haar features can easily be scaled by increasing or decreasing the size of the pixel group being examined. This allows features to be used to detect objects of various sizes [3].

Head Movement Detection

Sitting in front the computer can cause excess muscle tension in the neck, shoulder, and back. Stretching and short exercise can effectively relieve affected muscles and prevent strains from accumulating.

We require our head movement tracking system to track the Following head movements:

1) Head translation in the image plane, i.e., the (x,y)-plane parallel to the monitor;

2) Head translation towards and away from the monitor, along the z-axis; and

3) Head rotation in the image plane, i.e., about the z-axis (roll), in the clockwise and counter clockwise directions [11].

To achieve our goal of tracking head movements, we perform head pose detection for every captured image in a sequence. By assuming slow, contiguous, and continuous head movements, we can predict the position and orientation of the head pose in the next image of the scene using the detected position and orientation of the head pose in the current image. By comparing consecutive head poses, we can infer, using our head movement model, the occurrence and the type of head movement in the scene [11].

1) *Rekimoto's Model*

An example of such a tracker is the system developed by Rekimoto, which detects and tracks the head position of a computer user for the purpose of implementing a fish-tank virtual reality workstation. Using image subtraction, Rekimoto's system first segments the user's head from the background in the current image, then it detects the position of the head by correlating the resulting image of the user's head against a template, i.e., a portion of the captured image selected by the user [4].

2) *Tang et al Approach:*

Often user intervention in a head tracking system is seen as a disadvantage as it prohibits the system from fully automating the tracking process, and as it increases the possibility of errors due to invalid user-supplied input to the system. Tang et al. propose a "user intervention free" solution in which the shape of a user's face is modeled by an ellipse as opposed to a user-selected template [5].

B.*Distance to Screen*

It is important to maintain a proper distance between a user and a computer screen to avoid eye strain in the workplace. We can use Haar-like feature classifier in OPENCV to detect user's Face. However, the size of the user's face will be different due to the location of the user. When user's location is nearer to the camera, the user's face is bigger, when user's location is far away the camera; the user's face is smaller. So we can only set the lower bound with a small value to guarantee the system can detect the user's face in every distance.

C.*Blink Detection*

Blink detection will be useful to understand whether the user is tired.

1) *Eyelid's State Detecting*

ESD (Eyelid's State Detecting) value, which is a measurement used to classify the state of eyelid, open or close. The value can be computed by using the ESD algorithm. The objective of the algorithm is to find the minimum threshold, which brings the binary image having at least one black pixel after applying median blur filtering. In this algorithm, we use a half-bottom eye image from the selected area by the previous algorithm. We then threshold the image with the threshold value (begin with 0). After that, we apply a median blur filter to the threshold image and check whether at least one black pixel appears. If there is no black pixel, we increase the threshold value and follow the same sequence, but if there is more than one black pixel, we terminate the process and get the ESD value as that threshold. For a faster computation, a binary search implementation is suggested [6].

2) *Kalman filter*

For eye tracking, a strong tracking finite-difference extended Kalman filter algorithm, and overcome the modeling of nonlinear eye tracking was presented [7]. The filter uses finite-difference method to calculate partial derivatives of nonlinear functions to eye tracking.

3) *Open and Close eye template*

For eye blink detection, open and close eye templates are used for blink pattern decisions based on correlation measurement. The method was specifically useful for people with severely paralyzed [8]. Normal flow and deterministic finite state machine (DFSM) with three states, steady state, opening state and closing state, use for calculating eye blink characteristics [9].

D.*Work periods and Breaks*

Taking regular breaks during sedentary work is another important activity recommended by medical experts to promote health and reduce fatigue. To determine a user's work and break habits, we usethe presence of a user in our camera view to determine if he is working or on break. In order to obtain a clear picture of a user'shabits, we will have to process the raw presence data provided by faceAPI or other face tracking algorithms by first finding gaps in the presence data by taking successive differences between detection times, and then filtering out all breaks that were shorter than a presetthreshold, for our evaluation we used a threshold of 10 seconds. Fromthe starting and ending times of the work breaks, we could then find the times and distributions of the work periods of the user.[10]

2. *Side-Camera Processing:*

The side-camera monitors the body posture of the user as well as calculates the neck angle of users.

I) *Body Posture Monitoring:*

For this purpose every user need to calibrate the webcam according to its body features where we capture users image and mark the central reference line .We will monitor the user's posture, if there is any variation from the central line for a long period of time, we will notify the user that he's being sitting in a bad posture.

II) *Neck-angle calculation:*

Euler/Cardan method

The Euler transformation has become a golden standard within biomechanics and medicine. Euler angles are easy to interpret. The segment's rotation is described by three angles and the reference system can be aligned with the body segment so that the three angles (α, β and γ) describe flexion-extension, abduction-adduction and inward/outward rotation respectively.

In the Euler convention, the change of orientation is described as a sequence of three successive rotations. Finite rotations are not commutative (AT·B≠BT····A), so different orientation sequences can be used to describe the displacement.

3. *Data Fusion:*

The use of multiple cameras is often preferable in many surveillance and sports analysis applications not only for resolving occlusions but alsofor extracting useful information such as precise target trajectories and events of interest. In general, multi-camera tracking is a data fusion problem that integrates image measurements from different cameras to detect and recursively localize targets of interest in a scene.

Belief propagation (BP) is an efficient algorithm for solving the inference problem by passing messages between nodes in graphical models, which provides a rigorous way for the communication in multi-camera tracking.

4. *Analysis and Feedback*

Once the measurements are derived from the tracked head location and orientation, statistics can be provided to the user for self-reflection, or can be reviewed by medical experts for identification of potential risks. If contextual information is available, the observations can be further analyzed. For instance, if the user feeds his schedule to our system, the measurements can be correlated with the different tasks the user is engaged in, and a detailed breakdown can be generated. The user can then identify which activities require more intensive computer use, and what the corresponding unhealthy habits are. Furthermore, the user can optimize his schedule to increase his productivity while minimizing risk of injury [10].

IV. APPLICATIONS

Our system has wide applications. Our system can be widely used in offices where employees work on computers for long hours. Our system can provide them correct ergonomic feedback which can help them to pay attention on their health along with doing their work. They also will know when they should take a break. Using our system employees can work efficiently thus avoiding musculoskeletal problems.

Our system can be used in other places like call centers, banks, colleges etc.

V. CONCLUSIONS

In this paper, we describe a real-time system that extracts Useful personal ergonomic information to promote healthy Habits and work productivity. Using our algorithms, personal Data are derived from a head tracker, such as activity level, Posture, eye fatigue, and attention. Unhealthy habits can be Identified by analyzing the data, by providing feedback to users. Our systemlearns the user's behavior pattern, and provides reminders based on the inferred user activity. The model is adaptive, and can incorporate observations from multiplecameras.

Our system can be made more complete by modeling moreattributes related to the overall wellbeing of office workers,such as including social wellbeing metrics.

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