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# Predictive Model to Detect Digital Eye Strain using Smart Goggle

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**Abstract**

The proposed innovation is an effort to design a system which would be useful for anyone using a computer for prolonged hours such as students and IT professionals. Technology has made our lives easier by enabling us to work and access information from anywhere and anytime but it comes with its own set of limitations. One of the major limitations for computer users is the strain caused to eyes due to the persistent screen time. The proposed idea helps the users to identify the eye strain and fatigue caused by long working hours on the computer and enables them to take appropriate steps to prevent eye diseases caused by the same. Computer users experience various symptoms when their eyes get strained. Some of them can be easily noticed through video footage (traceable) but some of them cannot be trapped through visuals (non-traceable). We have proposed a model based on both traceable and non-traceable symptoms to predict eye strain or fatigue and send alerts to the users on the basis of the symptoms detected. The model has been developed by using deep learning algorithms. The model is trained by feeding the data monitored through frames and input collected from users through live streaming. The process starts with recording the user video using the webcam. The video is then used to extract frames and further factors/symptoms (traceable) are extracted from the frames. On the basis of extracted symptoms, further inputs are collected from the users (for non-traceable symptoms). The symptoms to be detected from the frames have been pre decided and the proposed algorithm detects whether the symptoms are present in the recorded video. In case symptoms are absent, the process is repeated for the time period for which the user is using the computer. In the presence of symptoms, the user is alerted about the eye strain and fatigue and guided to take further steps. This innovation can be developed into a useful system for a large population of computer users and prevent them from getting eye diseases as it would identify the cause of eye problems due to increased screen time in the current scenario.

**Keywords:** Computer Vision Syndrome, Deep Learning Algorithm, Online Learning or Working, Eye Strain Symptoms

## 1. Detailed Description of the Proposed Invention

### 1.1 Background Study:

Some work has already been done in this field where eye strain is detected through eye blinking rate only. Literature has evidence that some of the researchers have worked in the same area but all of them have considered only one factor i.e. blinking rate for predicting eye strain. In one approach, a system is proposed to detect strain in eyes due to prolonged exposure of screens. Blink rate and eye sclera are considered as two major factors to detect eye strain. Blinking rate is calculated by monitoring state transitions from open to closed eyes. Sclera region is detected using Otsu's thresholding and colour tracking. A modified Otsu using colour tracking is proposed which has an accuracy of 83%. Another approach is proposed previously where a system detects eye fatigue of the driver and alerts him/her if he/she feels drowsy to avoid a road accident. System through a web camera will continuously monitor blink rate to detect eye fatigue. This project analyzes driver behavior-based Eye Aspect Ratio (EAR) in order to reduce preventable road accidents. Increasing number of people are affected by Computer Vision Syndrome (CVS) due to the time spent on the computer screen. One study presented the remedy to this problem by designing a prototype of a computer vision system for real time eye blink based detection of eye strain. Experimental results show that the system is able to detect the eye strain and thus helps in reducing the CVS symptoms. To detect eye strain due to long hours spent on computers, laptops or smartphones, a system is proposed in literature which provides a solution which is based on histogram back projection. This project detects the opening and closing state of the eyes and compares the blinking rate with threshold value. If it is determined to be less than normal, it raises flag for computer vision syndrome. The approach is tested on different data sets under various lighting conditions and its performance is compared and analyzed.

**1.2Utilities of Proposed Innovation:**

- Detecting Eye Strain due to prolonged use of computer screen.
- Proposed system can detect and predict "**Eye Strain or Fatigue**" accurately as it considers both traceable symptoms through video recording like blinking, watering, redness and squeezing and non-traceable symptoms like headache, eye pain, blurred vision and itching.
- Appropriate alert messages can make users aware about eye strain status and take appropriate action.

**Key Features of Proposed Invention:**

1. The key feature of the invention is to detect symptoms of eye strain due to continuous use of computers and alert the users about the presence of these symptoms.
2. Detecting eye strain while online learning/working is done on the basis of a combination of factors/symptoms namely blinking, redness, watering and squeezing. The work already done in this area is based on only one factor /symptoms like eye blinking.
3. More accurate predictions are obtained from this system as the results are based on traceable factors/symptoms monitored and user inputs obtained for non traceable factors/symptoms .
4. Eye strain detection system works in two stages. First the factor/symptom monitoring is done from live video to detect the factors/symptoms depicting eye strain and secondly the input collection is done from the user to correlate with the factors monitored.
5. The system is designed to raise alert when the machine detects eye strain based on threshold value for the factors. When the value of the factor varies from the threshold, the person is alerted immediately.
6. Alerts will be sent in the form of customized messages depending on the values of factors detected and input data collected from the user.

**1.3 Description of Proposed Invention:**

Proposed model is based on the following factors:

**Table 1:** Factors for Eye Strain Prediction

| **Traceable Factors** | **Non-Traceable Factors** |
|---|---|
| Watery Eyes | Eye pain |
| Redness | Headache |
| Blinking Rate | Blurred Vision |
| Squeezing | Itching |

Proposed Innovation works on three stages:


1.

**Stage 1:**
The system is designed to take input through a web camera. Live video is converted into frames and traceable factors are detected.

**Stage 2:**
On the basis of factors/symptoms monitored, inputs are collected from the user for non-traceable factors to correlate with the traceable factors.

**Stage3**
All detected factors and inputs are fed into deep learning algorithms to predict eye strain. On the basis of the output generated by the algorithm a customized alert is sent on the user machine.

**2. Methodology Adopted:** Proposed method uses multiple factors (both traceable and non-traceable) to detect eye strain or fatigue from live streaming videos. As the proposed system works in stages, different methodologies are adopted to execute tasks at each stage. At first an API is used to extract frames from the videos recorded on the webcam (approximately 20-30 frames each second). A classifier is used to detect faces in the frame and further eyes are detected using point coordination with other facial features Like nose, forehead and ears. Then detailed observation is done at eyes to monitor their blink rate, eye color, water level and squeezing level. Different steps are adopted in OpenCV and Dlip to detect these factors/symptoms. The monitored factors are stored in numeric form to do comparison with threshold. The threshold for each factor is decided on the basis of recommendations and parameters decided by medical experts . Once the factors (traceable) are monitored then input collection is done from the user through pop up windows during live streaming. All

monitored factors/symptoms are stored in dynamic memory (Arrays) and fed into the deep learning algorithm (RNN) to predict eye strain. On the basis of output generated by the RNN, a customized alert is sent to the user's machine. The complete code is executed through Python and its various libraries.

## 3. Basic Flow and Diagram of Proposed Invention

### 3.1 Diagram

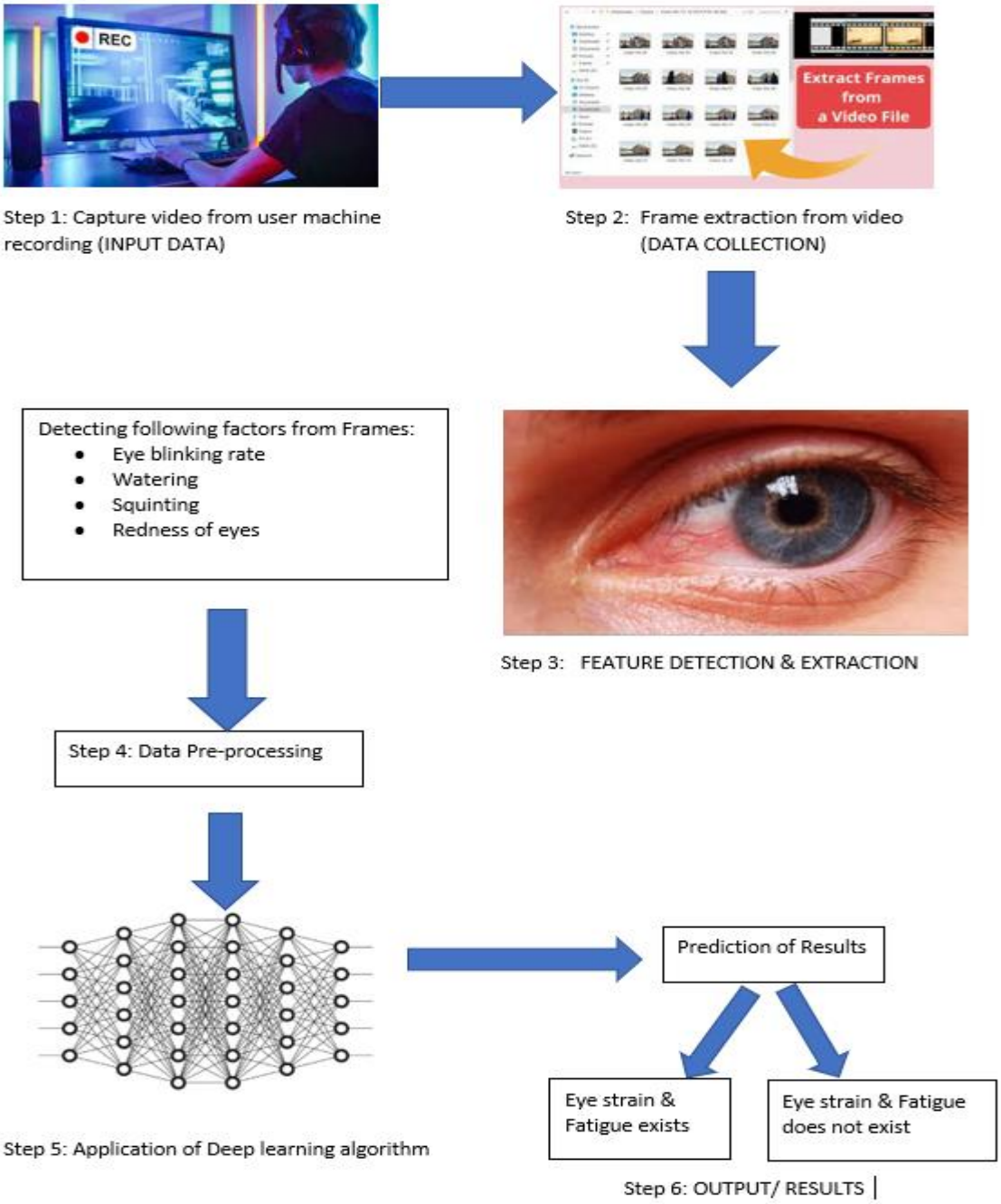


**Fig 1: Block Diagram of Proposed Model**

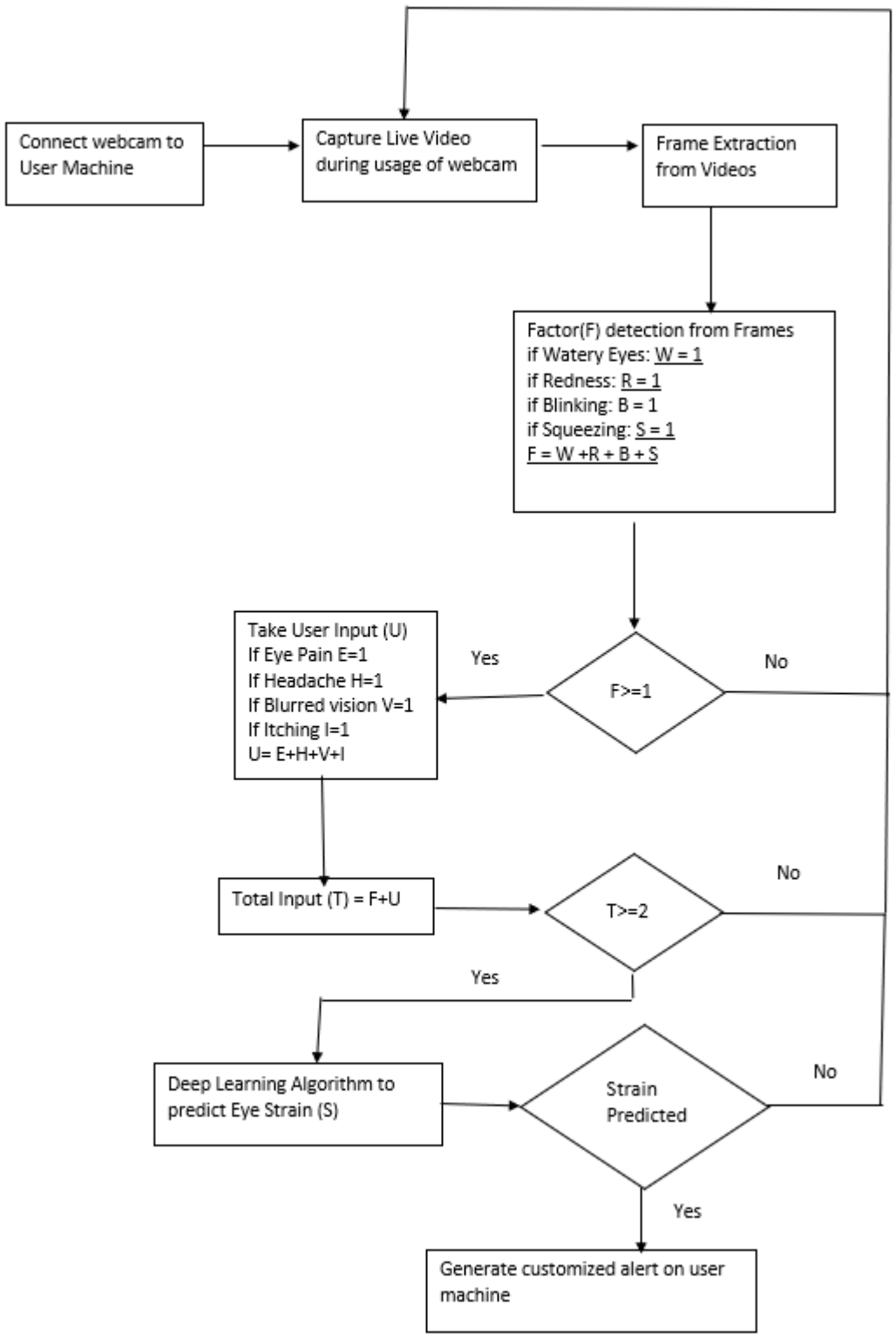


**Fig 2: Flow Chart of Proposed Model**

### 3.2 Basic Flow of Information

The above diagram is explained as below:
1. A web camera is connected to user machine's to capture the LIVE video continuously.
2. Frames are extracted from live video stored on a webcam. These frames will then be used to detect eye frames.
3. Four factors: watery eyes, redness, blinking rate and squeezing are detected from the frames extracted in step 2.
4. Factors extracted are then compared to the threshold values and if threshold value is reached , the presence of factor is confirmed. Presence(1) and absence(0) is recorded through binary value.
a. if Watery Eyes: W = 1

b. if Redness: R = 1
c. if Blinking: B = 1
d. if Squeezing: S = 1
F = W +R + B + S
5. If F > =1, Go to Step 6
Else, Go to Step 1
6. Input will be taken from the user to record non traceable factors: eye pain, headache, blurred vision and itching in the form of binary value: Presence(1) and absence(0).
User Input (U).
If Eye Pain E=1
If Headache H=1
If Blurred vision V=1
If Itching I=1
U= E+H+V+I
T = F + U
7. If T >=2, Go to step 8,
Else Go to step 1.
8. Collected factors and input are fed into a Deep learning algorithm to predict eye strain or fatigue.
9. If the system predicts eye strain, a customized alert will be displayed on the user's screen.

**Conclusion:** Proposed framework considers multiple factors like (blink, water level, redness and squeezing) to predict eye strain and further the input from users about the symptoms (Eye pain, headache, blurred vision and itching) that can not be monitored through videos. Each symptom/factor is monitored in numerical terms and compared with threshold. These numeric weights are fed into the Machine Learning algorithm RNN to predict eye strain. On the basis of predictions made by RNN, customized alerts are sent to help the users to take appropriate actions to prevent eye disease due to eye strain or fatigue.

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