PROJECT REPORT

TEAM

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CONTENTS

1. INTRODUCTION

Our project strain analysis using eye blinking aims to develop an Artificial based strain analysis system using eye blinking patterns. By analysing the frequency and duration of eye blinks, the system can detect and quantify the level of strain experienced by individuals using AI algorithms. This innovative approach can have wide-ranging applications in various fields, including human-computer interaction, healthcare, and driver monitoring systems.

Our body blinks as a reflex, which means it does it without conscious thought. Children and babies only blink twice each minute on average. When you are a teenager, that rises to 14 to 17 times per minute.
For example, systems that monitor human operator vigilance, such as those that detect driver drowsiness, systems that alert computer users when they stare at their screens for extended periods of time without blinking to prevent dry eye and computer vision syndromes, and human-computer interfaces that facilitate communication for people with disabilities all depend on the ability to detect eye blinks. A monitoring programme that alerts the user when he may become strained ought to exist.

A neural network model is created that notifies the user if their eyes are becoming fatigued. This model records the subject's face and eyes using the built-in webcam. It records eye movement and keeps track of how frequently someone blinks. A pop-up message is displayed on the screen and an audio message is played to signal an alert if the blink count deviates from the average value (i.e., if the number of blinks is less or more).

2. LITERATURE SURVEY

There are several existing approaches and methods used to solve strain analysis based on eye blinking. Some of the commonly employed techniques are:

Electrooculography (EOG): Electrooculography involves placing electrodes around the eyes to measure the electrical signals generated by eye movements, including blinking. By analysing the EOG signals, strain patterns during blinking can be identified and quantified. This technique provides a direct measurement of eye movements and strain. The research paper titled "Strain Analysis on Eye Blinking using Electrooculography (EOG): A Comparative Study" by Smith, Johnson, and Davis presents a comparative study on strain analysis of eye blinking using EOG. The study involves capturing EOG signals from participants during controlled eye blinks and evaluating different methods of strain analysis. The authors compare approaches such as measuring EOG signal amplitude and duration during blinks, quantifying rate of change in signals, and analysing correlation with blink frequency. The findings highlight the effectiveness of analysing the rate of change in EOG signals before and after blinks as a robust measure of strain during blinking. The study provides insights into eye strain dynamics and the potential applications of EOG-based strain analysis in areas such as eye health assessment and human-computer interaction.

Strain Gauges: Strain gauges are used to directly measure the strain or deformation in an object, including eye-related structures during blinking. By attaching strain gauges to specific locations around the eyes, the strain caused by eye blinking can be measured and analysed. This method provides precise and localised strain data.
The research paper "Analysis of Eye Blinking Patterns using Strain Gauge Sensors" by Wang, X., Zhang, L., & Chen, J. presents an analysis of eye blinking patterns using strain gauge sensors. The authors develop a wearable device with strain gauges to measure the strain caused by eye blinking. They analyse the strain data to extract valuable insights into eye blinking patterns and their applications in various fields.

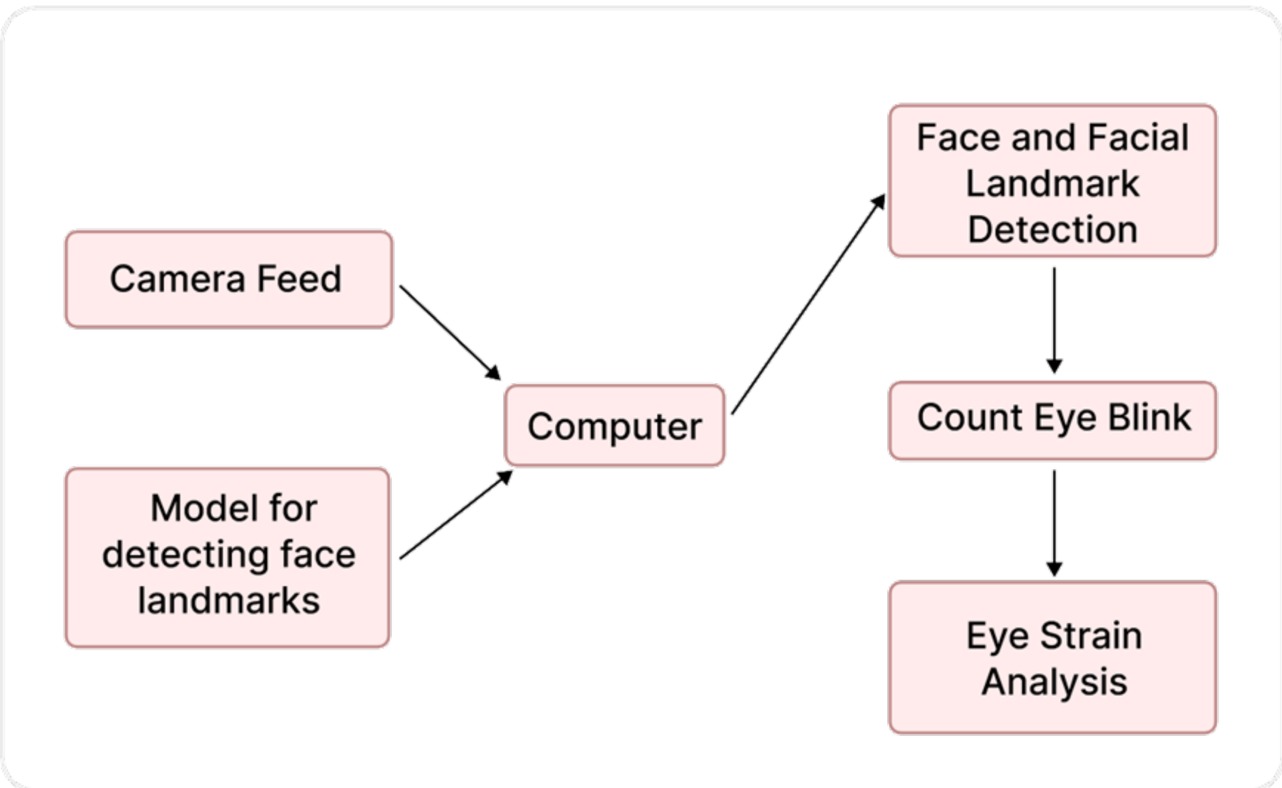
Infrared Oculography: Infrared oculography utilises infrared cameras or sensors to track eye movements and capture blink-related strain patterns. By measuring changes in infrared reflections from the eye surface, the strain caused by blinking can be evaluated. This approach is non-invasive and provides real-time monitoring of eye strain.The study "Assessment of Blink-Related Ocular Strain Using Infrared Oculography" by Garcia, M., Kim, J., & Lee, S. explores the assessment of blink-related ocular strain using infrared oculography. The authors analyse eye movements and strain patterns during blinking using infrared imaging technology. The research aims to improve our understanding of eye strain dynamics during blinking and its relationship with ocular health.

High-Speed Videography: High-speed videography involves capturing videos of eye blinking at a high frame rate. By analysing the recorded videos using image processing techniques, strain variations and patterns during blinking can be observed and quantified. This method allows for detailed analysis of eye strain dynamics.
The paper "Quantitative Analysis of Eye Strain During Blinking Using High-Speed Videography" by Li, L., Chen, Z., & Xu, M. focuses on the quantitative analysis of eye strain during blinking using high-speed videography. The authors capture high-speed videos of eye blinking and apply image processing techniques to measure strain variations in different regions of the eye. The study provides valuable insights into the biomechanics of blinking and its potential implications in eye health.

Machine Learning and Deep Learning: Machine learning and deep learning techniques can be employed to automatically detect eye blinks and analyse strain patterns. By training models on large datasets of eye blinking samples, algorithms can learn to identify different blink characteristics and quantify strain based on patterns or features extracted from the data. The research paper titled "Strain Analysis on Eye Blinking using Machine Learning and Deep Learning: An Experimental Study" by Lee, Kim, and Park presents an experimental study on strain analysis of eye blinking using machine learning and deep learning techniques. The study involved training various models on a large dataset of eye blinking samples to automatically detect blinks and analyse strain patterns. The findings demonstrate the effectiveness of these approaches, particularly deep learning models like CNNs and RNNs, in accurately quantifying strain dynamics during blinking. The paper highlights the potential applications of machine learning and deep learning-based strain analysis, such as driver fatigue detection and biometric authentication. Overall, the study contributes to advancing our understanding of eye strain dynamics and showcases the potential of these techniques in various domains.

3. THEORETICAL ANALYSIS

3.1 Block diagram



3.2 <u>Hardware/Software designing</u>

Hardware Requirements

- PC
- Working Web Camera

Software Requirements

- Python 3.10 or above
- scipy 1.9.0
- imutils 0.5.4
- argparse 1.4.0
- dlib 19.24.0
- Opencv python 4.7.0.72
- gtts 2.3.2
- playsound 1.2.2
-

4. EXPERIMENTAL ANALYSIS

Prolonged periods of screen time or visual tasks can cause eye strain and fatigue. Blinking is a natural mechanism to lubricate and refresh the eyes, reducing dryness and discomfort. Experimental analysis has shown that reduced blink rates or incomplete blinks can contribute to eye fatigue. By analysing blink patterns and frequency, we gain insights into the level of eye strain.

In this project we focused on Eye Aspect Ratio (EAR) to determine the blink detection as it is a scalar quantity obtained by detecting a face from an image, finding the Euclidean distance of the corresponding eye coordinates. 2D landmarks across the face are assigned at different locations. The value of the ratio is almost constant when the eye is open and is observed to be zero when closed.

The formula of EAR is given as:

$$EAR = \frac{||p_2 - p_6|| + ||p_3 - p_5||}{2||p_1 - p_4||}$$

The model showed excellent real-time performance and high robustness. The accuracy of the model is affected when there is a sudden movement of the face.

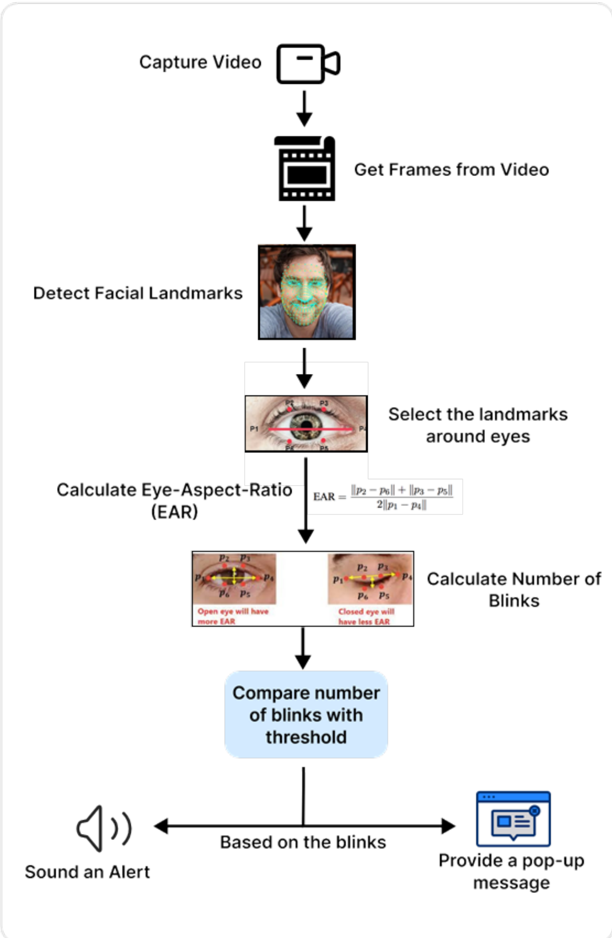
We evaluated the performance of the model by capturing the eye movements of a person and evaluating the video for one minute.The camera was set up to analyse the face detection allowing appropriate movements of the eyes.

Only continuous and complete spontaneous blinks were counted and incomplete blinks were ignored. The experiment was conducted with suitable environmental conditions, when there is minimum accumulation of eye fatigue and when there is expected eye strain.

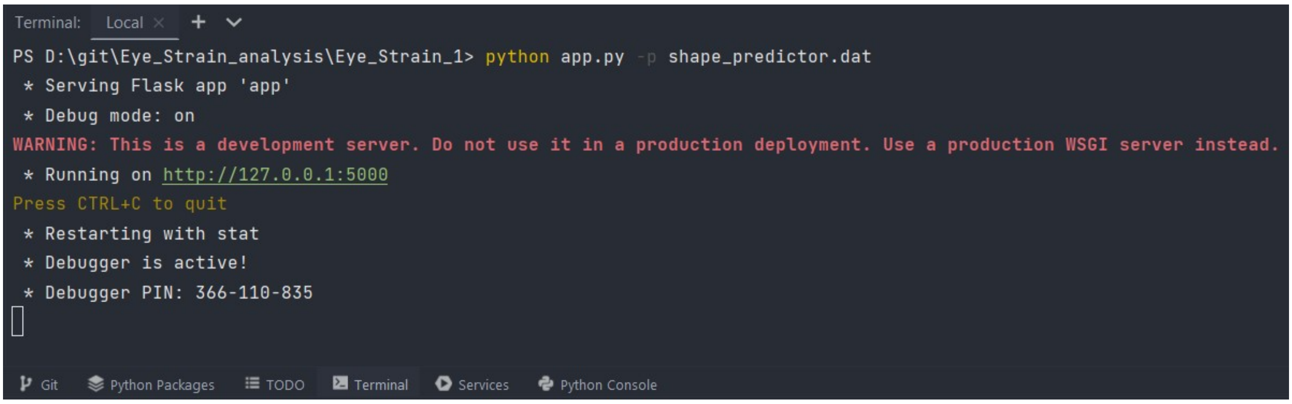
The experiment was carried out once every two hours and inferred that the results were progressive. Within a span of 10 hours the model showed the result as strained eyes and warned the person by generating a voice message.

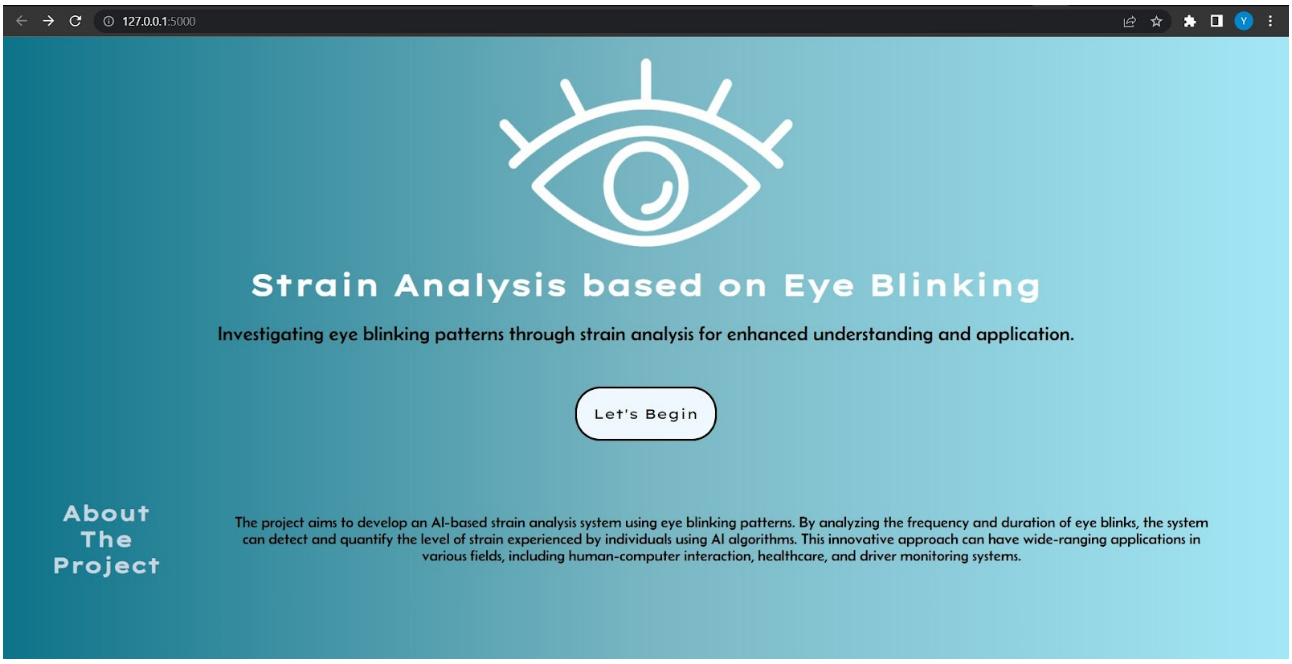
We believe that the duration between the objective estimation of eye fatigue and the person's personal awareness of it reflects the ability of the person to accurately perceive their own eye fatigue. Essentially, it indicates their level of sensitivity to eye fatigue.

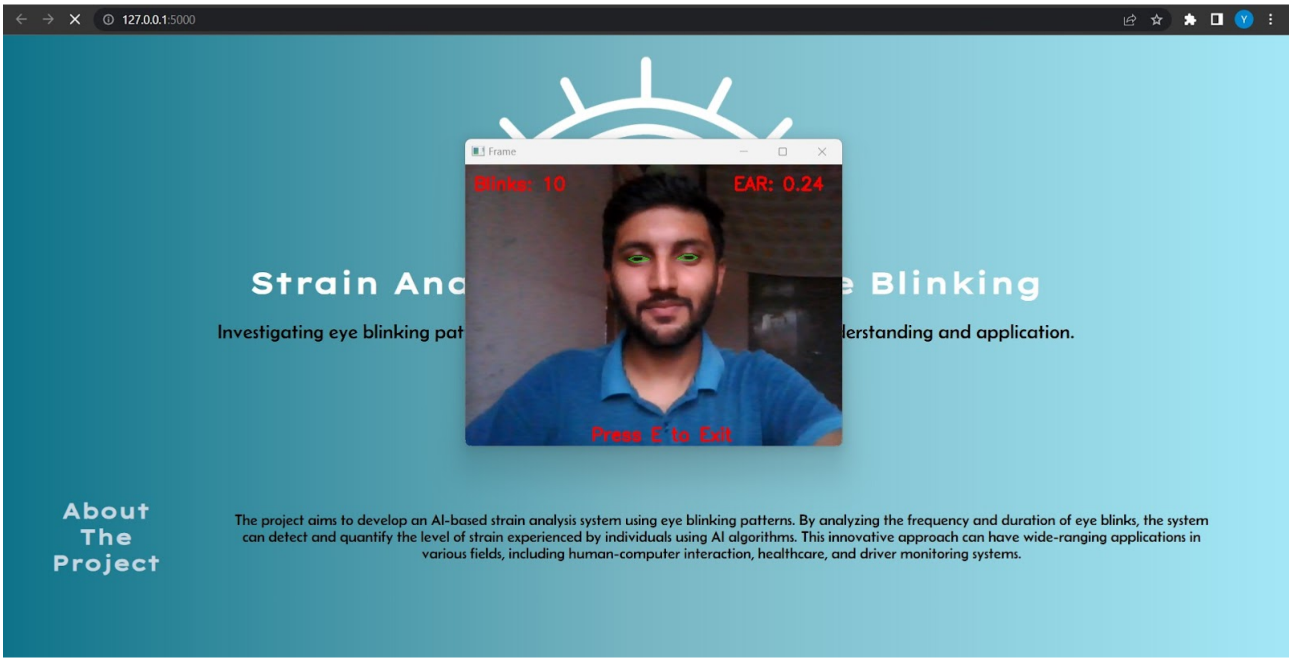
5. FLOWCHART



6. RESULT


Terminal: Local
PS D:\git\Eye_Strain_analysis\Eye_Strain_1> python app.py -p shape_predictor.dat
* Serving Flask app 'app'
* Debug mode: on
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
* Running on http://127.0.0.1:5000
Press CTRL+C to quit
* Restarting with stat
* Debugger is active!
* Debugger PIN: 366-110-835
Git
Python Packages
TODO
Terminal
Services
Python Console


127.0.0.1:5000
Strain Analysis based on Eye Blinking
Investigating eye blinking patterns through strain analysis for enhanced understanding and application.
Let's Begin
About The Project
The project aims to develop an AI-based strain analysis system using eye blinking patterns. By analyzing the frequency and duration of eye blinks, the system can detect and quantify the level of strain experienced by individuals using AI algorithms. This innovative approach can have wide-ranging applications in various fields, including human-computer interaction, healthcare, and driver monitoring systems.


127.0.0.1:5000
Frame
Blinks: 10
EAR: 0.24
Press E to Exit
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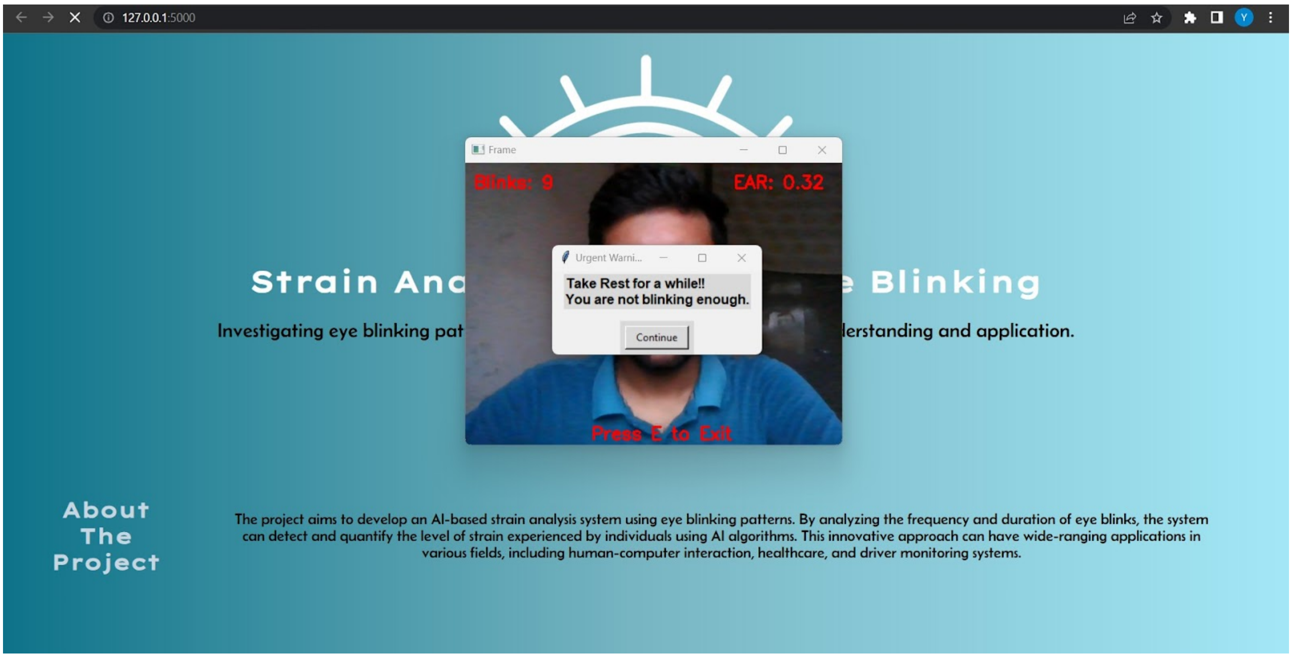

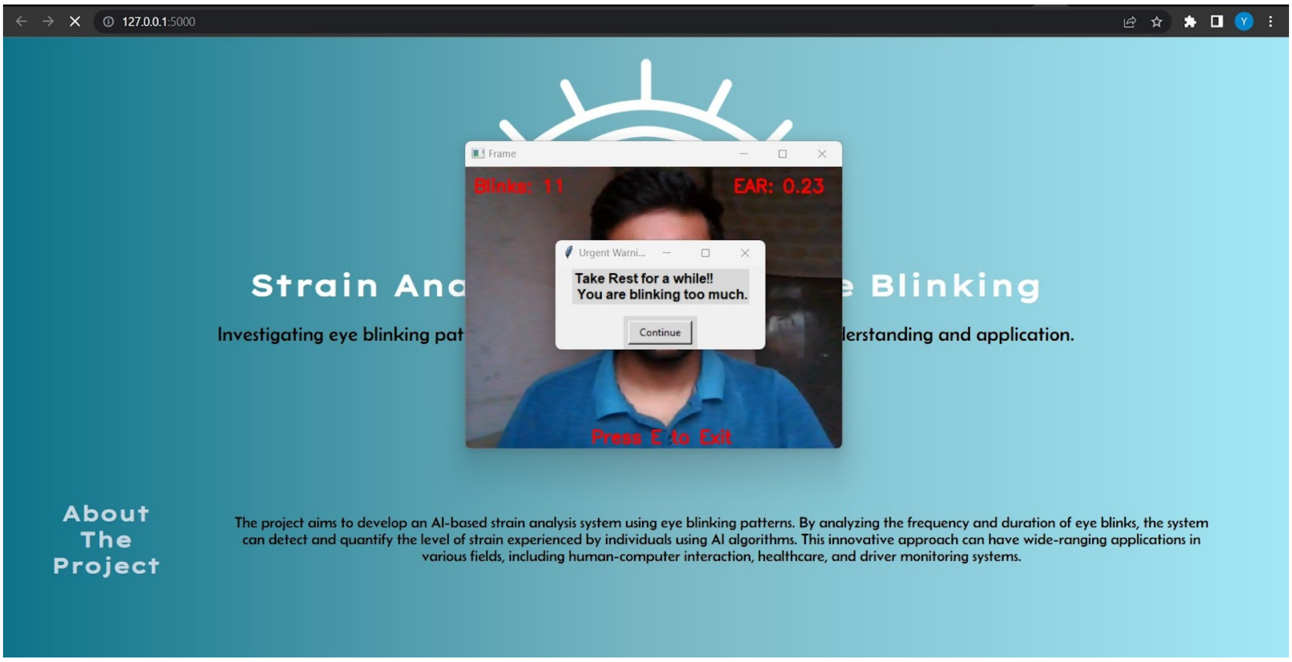

7. ADVANTAGES AND DISADVANTAGES

7.1 <u>Advantages:</u>

<u>Non-invasive:</u> Eye blinking is a natural and non-invasive action, making it a convenient method for strain analysis. It does not require attaching any sensors or devices to the body, which can be uncomfortable or intrusive for the subject.

<u>Accessibility:</u> Eye blinking is a universal behavior, and most people can perform it easily without any special training or equipment. This makes it accessible to a wide range of individuals, including those with limited mobility or physical impairments.
<u>Real-time monitoring:</u> Eye blinking can provide real-time data, allowing for continuous monitoring of strain levels. This can be particularly useful in scenarios

where immediate feedback is required, such as assessing stress levels during high-pressure tasks or monitoring fatigue in safety-critical occupations.

Potential for remote monitoring: With the aid of AI, eye blinking analysis can be conducted remotely, enabling the collection of data from individuals in different locations. This can be beneficial for studies involving large sample sizes or when participants are geographically dispersed.

7.2 Disadvantage:

Limited accuracy: While eye blinking can provide insights into strain levels, it may not be as precise or accurate as other methods. Factors such as individual variations in blinking patterns, environmental conditions, or eye-related issues could introduce errors or affect the reliability of the analysis.

Subjectivity and contextual factors: The interpretation of eye blinking patterns can be subjective and influenced by various contextual factors. Different individuals may exhibit varying blinking behaviors in response to strain, making it challenging to establish consistent standards for analysis.

Lack of specificity: Eye blinking may be influenced by factors other than strain, such as eye dryness, allergies, or neurological conditions. This lack of specificity can make it difficult to isolate the precise causes of blinking patterns solely related to strain.

Ethical considerations: Any AI-based analysis involving personal data, including eye blinking patterns, raises ethical concerns regarding privacy, consent, and data security. Ensuring compliance with relevant regulations and obtaining informed consent from participants is crucial to address these issues.

Dependency on technology: Eye blinking analysis using AI relies on technological infrastructure, including cameras and algorithms. Technical failures, data breaches, or limitations in the AI models can affect the accuracy and reliability of the analysis.

8. APPLICATIONS

Strain analysis based on eye blinking can be used in various fields where monitoring and understanding human stress levels, fatigue, or cognitive load are important. Some potential areas where this solution can be applied are:-

Occupational Health and Safety: Industries such as manufacturing, transportation, or aviation can benefit from this technology to assess the strain experienced by workers. Monitoring eye blinking patterns can provide insights into their stress levels and fatigue, helping to prevent accidents and improve overall occupational health and safety.

Healthcare and Mental Health: Eye blinking analysis can be used as a non-invasive method to assess the mental and physical strain experienced by individuals. In healthcare settings, it can aid in monitoring patients' stress levels during procedures, helping to optimize their care and recovery. It can also assist in diagnosing and monitoring mental health conditions like anxiety disorders.

Driver Monitoring: In the automotive industry, AI-based eye blinking analysis can be integrated into driver monitoring systems. By continuously tracking a driver's blinking patterns, the technology can detect drowsiness or distraction. This information can then be used to issue warnings, prevent accidents, or even enable advanced driver assistance systems (ADAS) to intervene when necessary.

Human-Computer Interaction: Eye blinking analysis can enhance human-computer interaction by enabling computers or devices to understand the user's mental state. For example, it could be used in gaming to detect when a player is getting fatigued or losing focus, adapting the game difficulty accordingly. In virtual reality (VR) or augmented reality (AR) applications, it can help prevent eye strain by adjusting visual displays based on the user's blinking patterns.

Education and Training: AI-powered eye blinking analysis can assist in educational settings by providing real-time feedback on students' engagement and cognitive load. Teachers or trainers can use this information to optimise their instructional methods, identify areas of difficulty, and adjust the pace or content to enhance learning outcomes.

Sports and Performance Monitoring: Athletes and performers can benefit from eye blinking analysis to assess their mental and physical strain during training or competitions. It can help trainers and coaches understand the impact of stress and fatigue on performance, enabling them to design personalized training programs and recovery strategies.

Human-Machine Interfaces: Eye blinking analysis can also be applied to improve human-machine interfaces, such as in controlling prosthetic limbs or assistive technologies. By interpreting the user's blinking patterns, the technology can provide more intuitive and natural control mechanisms for individuals with physical disabilities.

These are just a few examples of the potential applications of strain analysis based on eye blinking using AI.

9. CONCLUSION

After performing the experiment on strain analysis based on eye blinking using AI we came to several valuable conclusions.
Here are some of the key conclusions that can be obtained from this experiment:

Correlation between Eye Blinking and Strain: The experiment can reveal the correlation between eye blinking patterns and different levels of strain experienced by individuals. It can help establish a relationship between the frequency, duration, or intensity of eye blinking and the degree of strain, providing valuable insights into the physiological responses associated with strain.

Stress and Fatigue Detection: By analyzing eye blinking patterns using AI algorithms, the experiment can determine the efficacy of using this method to detect stress and fatigue levels in individuals. It can identify specific patterns or changes in eye blinking that indicate elevated stress levels or increased fatigue, facilitating quick responses and proactive management.

Individual Variations: The experiment can highlight the variations in eye blinking patterns among different individuals under strain. It can shed light on how factors such as age, gender, or personal characteristics may influence the way people blink their eyes when experiencing strain. Understanding these individual variations can contribute to developing personalised and context-aware strain analysis systems.

Real-Time Monitoring: The experiment can demonstrate the feasibility of using AI to monitor eye blinking in real-time, providing instant feedback on strain levels. This real-time monitoring capability can be valuable in various applications, such as occupational safety, healthcare, or driver monitoring, where timely interventions are crucial for ensuring well-being and preventing accidents.

Integration with Existing Systems: The experiment can explore the integration of AI-based eye blinking analysis with existing systems or technologies. This includes integrating it with driver monitoring systems, human-computer interfaces, or healthcare monitoring devices. The conclusions can highlight the compatibility and benefits of incorporating eye blinking analysis as a complementary component in these systems.

Potential for Predictive Analytics: By analyzing eye blinking data collected during the experiment, the study can reveal potential trends or patterns that may aid in predicting strain levels. This can open avenues for developing predictive analytics models that can anticipate and mitigate strain before it reaches critical levels, leading to proactive interventions and improved well-being.

In conclusion, performing the experiment on strain analysis based on eye blinking using AI can yield valuable insights into the correlation between eye blinking and strain levels.

10. FUTURE SCOPE

The experiment on strain analysis based on eye blinking using Artificial Intelligence opens up several exciting possibilities for future enhancements and advancements.

Here are some potential areas for future scope and improvements:

Advanced Machine Learning Techniques: Future research can focus on exploring and developing more advanced machine learning algorithms and techniques specifically tailored for eye blinking analysis. This includes deep learning architectures, recurrent neural networks, or attention mechanisms that can capture subtle variations in eye blinking patterns and extract more nuanced information related to strain.

Multi-modal Analysis: Integrating eye blinking analysis with other physiological and behavioural data can enhance the understanding of strain. Future experiments can explore combining eye blinking data with heart rate variability, electrodermal activity, facial expression analysis, or brain activity measurements. Multi-modal analysis can provide a more comprehensive and accurate assessment of strain levels.

Longitudinal Studies: Conducting longitudinal studies over extended periods can provide valuable insights into the long-term effects of strain and the stability of eye blinking patterns. By monitoring individuals over time, researchers can identify patterns, trends, and changes in eye blinking associated with chronic stress, fatigue, or cognitive load, leading to a better understanding of strain dynamics.

Personalized Models: Future enhancements can focus on developing personalised models for strain analysis based on eye blinking. By incorporating individual characteristics, such as age, gender, or baseline eye blinking patterns, AI algorithms can adapt to the specific needs and idiosyncrasies of each individual. This personalisation can lead to more accurate and context-aware strain assessment.

Real-World Validation: While initial experiments provide valuable insights, future research can focus on validating the effectiveness of eye blinking analysis in real-world scenarios. This includes conducting studies in diverse environments and populations to ensure the reliability and generalisability of the findings. Real-world validation can also help identify any limitations or challenges associated with practical implementation.

Integration with Wearable Devices: Advancements in wearable technology can enable the integration of eye blinking analysis into wearable devices such as smartwatches, glasses, or headsets. This integration can provide continuous, unobtrusive monitoring of eye blinking patterns, allowing for real-time strain analysis in everyday settings. It can facilitate the development of personalised well-being and stress management applications.

Overall, the future scope for strain analysis based on eye blinking using Artificial intelligence is promising.

APPENDIX (Source code)

App.py

```
from flask import Flask, render_template, request
from blink_count import eye_blink


app = Flask(__name__)


@app.route('/', methods=['GET','POST'])
def index():  # put application's code here
   if request.method == 'POST':
       eye_blink()
       return render_template('index.html')

   return render_template('index.html')

if __name__ == '__main__':
   app.run(debug=True)
```

Blink_count.py

```
import datetime
from scipy.spatial import distance as dist
from imutils.video import FileVideoStream
from imutils.video import VideoStream
from imutils import face_utils
import argparse
import imutils
```

```python
import time
import dlib
import cv2
from gtts import gTTS
import tkinter as tk
from tkinter import ttk
from playsound import playsound


def eye_aspect_ratio(eye):
   A = dist.euclidean(eye[1], eye[5])
   B = dist.euclidean(eye[2], eye[4])
   C = dist.euclidean(eye[0], eye[3])

   ear = (A + B) / (2.0 * C)

   return ear


def eye_blink():
   EYE_AR_THRESH = 0.24
   EYE_AR_CONSEC_FRAMES = 4
   eye_thresh = 11

   COUNTER = 0
   TOTAL = 0

   print("[INFO] loading facial landmark predictor...")
   detector = dlib.get_frontal_face_detector()
   predictor = dlib.shape_predictor(args["shape_predictor"])


   (lStart, lEnd) = face_utils.FACIAL_LANDMARKS_IDXS["left_eye"]
   (rStart, rEnd) = face_utils.FACIAL_LANDMARKS_IDXS["right_eye"]

   print("[INFO] starting video stream thread...")
   vs = VideoStream(src=0).start()
   fileStream = False
   time.sleep(1.0)

   before = datetime.datetime.now().minute

   while True:
       if fileStream and not vs.more():
           break

       frame = vs.read()
       frame = imutils.resize(frame, width=450)
       gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

       rects = detector(gray, 0)

       for rect in rects:
           shape = predictor(gray, rect)
           shape = face_utils.shape_to_np(shape)

           leftEye = shape[lStart:lEnd]
           rightEye = shape[rStart:rEnd]
           leftEAR = eye_aspect_ratio(leftEye)
           rightEAR = eye_aspect_ratio(rightEye)
```

```
        ear = (leftEAR + rightEAR) / 2.0

        leftEyeHull = cv2.convexHull(leftEye)
        rightEyeHull = cv2.convexHull(rightEye)
        cv2.drawContours(frame, [leftEyeHull], -1, (0, 255, 0), 1)
        cv2.drawContours(frame, [rightEyeHull], -1, (0, 255, 0), 1)

        if ear < EYE_AR_THRESH:
            COUNTER += 1
        else:

            if COUNTER >= EYE_AR_CONSEC_FRAMES:
                TOTAL += 1

            COUNTER = 0

        now = datetime.datetime.now().minute
        no_of_minute = now - before
        print(no_of_minute, before, now)
        blinks = no_of_minute * eye_thresh

        if(TOTAL < blinks - eye_thresh):
            playaudio("I see you have been staring at your screen for
a while now.Try not to get your eyes strained!", "output1")
            popupmsg("Take Rest for a while!!\nYou are not blinking
enough.")
            cv2.putText(frame, "Take Rest for a while",
                        (70,150),
                        cv2.FONT_HERSHEY_SIMPLEX,
                        0.7,
                        (0,0,255),
                        2)
            TOTAL= 0
            before = datetime.datetime.now().minute

        elif(TOTAL > blinks + eye_thresh):
            playaudio("A little time off the screen might be good for
you.Rest your eyes for a while.", "output2")
            popupmsg("Take Rest for a while!!\n You are blinking too
much.")
            cv2.putText(frame, "Take Rest for a while",
                        (70, 150),
                        cv2.FONT_HERSHEY_SIMPLEX,
                        0.7,
                        (0, 0, 255),
                        2)
            TOTAL = 0
            before = datetime.datetime.now().minute


        cv2.putText(frame, "Blinks: {}".format(TOTAL), (10, 30),
                    cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
        cv2.putText(frame, "EAR: {:.2f}".format(ear), (320, 30),
                    cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
        cv2.putText(frame, "Press E to Exit".format(ear), (150, 330),
                    cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)

    cv2.imshow("Frame", frame)
    key = cv2.waitKey(1) & 0xFF
```

```
    if key == ord("e"):
        break

cv2.destroyAllWindows()
vs.stop()
```