Screen Guard Project

1. Introduction

Digital eye strain or computer vision syndrome (CVS) is a condition resulting from focusing the eyes on a computer or other display device for protracted, uninterrupted periods of time and the eye's muscles being unable to recover from the constant tension required to maintain focus on a close object. CVS is becoming a prevalent medical condition today with the recent transitioning to an online environment. Correct posture, frequent blinking, ideal lighting conditions and focusing on far away objects from time to time can reduce the effect of digital eye strain to a certain extent. This project attempts to implement a properly integrated hardware and software design t' bvo avoid digital eye strain.

2. Related Work

A. Tobi

Tobii has 2 devices made for eye tracking-

- One was made to track the eye and head to improve gaming performance. This is an external device attached to the screen in use and it has a camera and an infrared sensor to track the pupil.The problem in this method is inability in tracking the blinking and the position of the eye relative to the screen. It's also inconvenient in situations where the user is using several screens.
- The other one is a wearable glass. There are 2 cameras integrated to each lense of the glass. This way the accuracy of tracking the eye is high. It even has a gyro and accelerometer to assess the position. In this design it is convenient to make it usable with several screens at once. But this device is unable to track the blinking.

B. Pupil

This is an open source head mounted eye tracker. It has a lightweight headset with two high resolution cameras.

•Scene camera - Captures a video stream of a portion of the users FOV. By syncing with the eye camera this can guess what the user is looking at and it can guess the distance to the object too.

•Eye camera - Use dark pupil detection method in which it captures a video within a specific range of the IR spectrum after illuminating the eye with a surface mounted IR LED.

This product is very similar to what we expect as our end product, but it is not able to track the blinking rate of the eye.

C. Elucent

This is a small eyelid sticker that is designed for detecting blinking. When blinking the eyelid creates a small crease and it creates a pressure increase and decrease on this device. This can detect intentional blinking as well as involuntary blinking upto 90% of accuracy. This system tracks the user's eyelid movements by monitoring changes in sensor capacitance values.

D. Magnetic-based Contact Lens

An eye motion tracking system is simulated using MATLAB Mathworks Software. A magnet is embedded to the contact lens which moves with the eye movements. Three static magnetic sensors are positioned on the spectacles to track the relative position of the moving magnet. However, if the contact lens is tilted even by 5 degrees, the accuracy level drops noticeably.

3. Motivation

Due to the rise of using screens on a regular basis we identified few groups with high risks due to longer periods of screen use.

- Workers at IT firms who are constantly working with screens.
- Students who had to go online due to pandemic.
- Stock market analysts.
- Teachers and lecturers.

By this glasses we will be able to make sure of that,

- They are following the 20,20,20 rule.
- Tracking the performance of workers through their eye tracking data and making them more productive.

4. Objectives

- Implementing a method to monitor eye fatigue of an individual taking the blink rates, the time spent focusing away from screens into consideration.
- Determining whether the posture of the subjects, viewing angle and the distance to the screens comply with the relevant standards.
- Integrating a feature to prevent glare and unnecessary light from projecting to the eyes.
- Examining the screen usage habits and patterns to determine the eye health of the individuals.
- Acquiring the performance metrics of individuals by analysing the collected data.
- Capability of integrating the designed device to the other devices such as google glass.

5. Considerations

- **The impact of the IR of the inner camera towards eye health.**

Risk of causing cataracts due to near-infrared radiation. Prolonged exposure to IR radiation causes a gradual but irreversible opacity of the lens. Moreover, scotoma, which is a loss of vision due to the damage to the retina, redness of the eye, swelling, or hemorrhaging may arise. Radiation between 800 and 1,200 nm is most likely responsible for temperature increases in the lens itself because of its spectral-absorption characteristics. Visible wavelengths may also contribute to the problem, since the heat absorbed by the iris could result in heat transfer to the lens.

- **Removal of the Scene camera for the initial solution.**

Only blinking and distance from the screens are taken into account for the phase I.

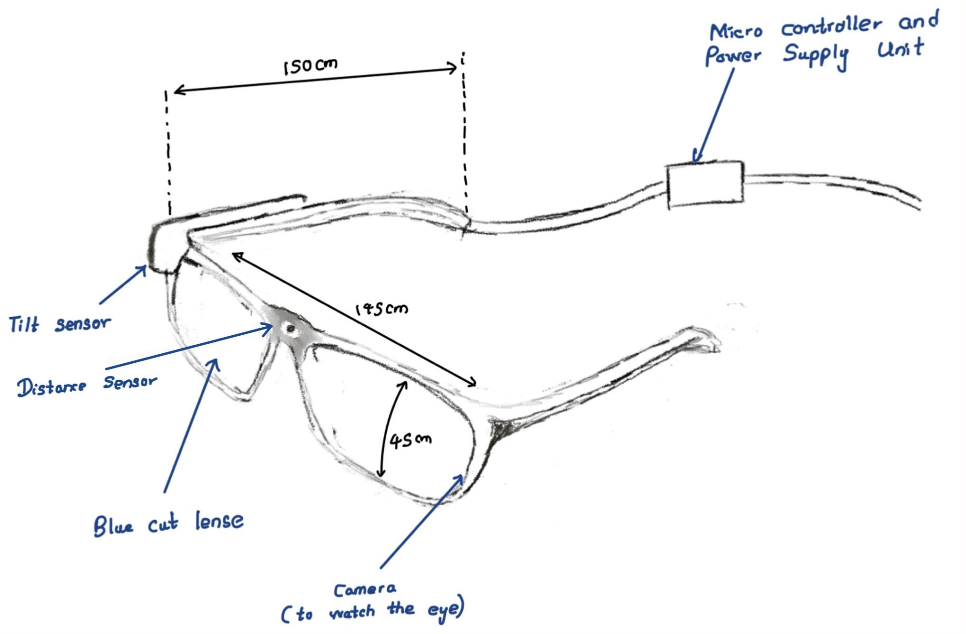
- **Integrating a single inner camera to track blinking.**

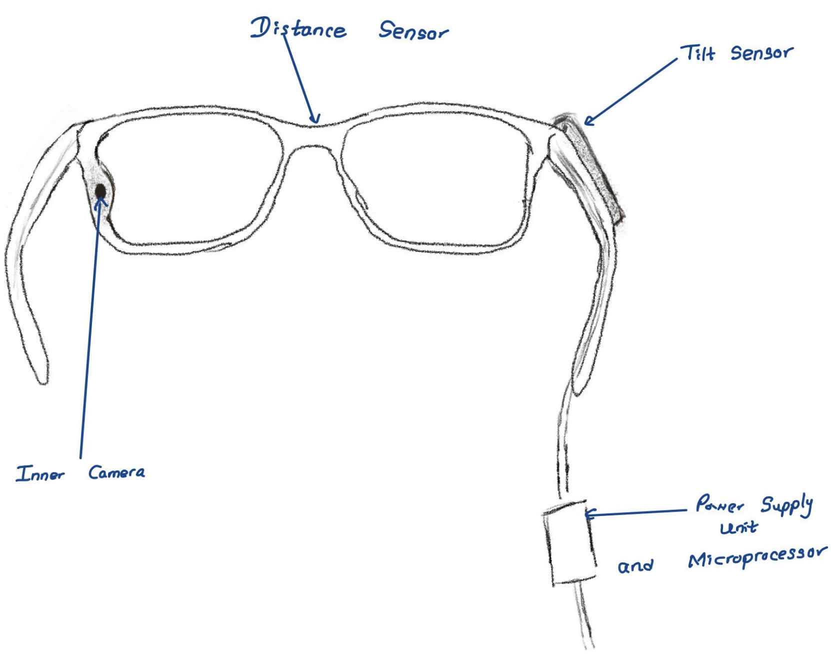
It is sufficient to track the movements of one eye.

- **Minimizing the sensors as per the battery power limitations.**

6. Initial Solution

In the terms of the hardware setup, the initial solution is in the form of spectacles which have adjustable/swappable lenses. A blu cut glass is primarily integrated to the spectacles to minimize the effect of eye strain. However, the user is facilitated to integrate the lenses that are recommended to him. The enclosure is selected as below in the form of spectacles as it is more stable and convenient to use. A camera is integrated on the inner side of the frame to track lid positions and blinking. An IMU sensor can be integrated to facilitate posture tracking. In addition to the above features, a small speaker can be used to produce audio outputs such as alarms. Apart from the cameras, a battery and a microprocessor are imperative to power up the device and process.





7. Components

The hardware components for the primary version of the initial solution are below.

- Microcontroller
- Battery

- Inner Camera
  Choice 1:
  https://www.adafruit.com/product/3508
  https://ams.com/naneyec
  Choice 2:
  A CMOS Sensor Camera Module or a Spy camera
  https://www.indiamart.com/proddetail/raspberry-pi-v2-1-cmos-camera-module-21945051733.html
  https://www.amazon.com/Wireless-Cameras-Security-Streaming-Detection/dp/B0821S2YVW
  https://www.indiamart.com/proddetail/wireless-hidden-spy-camera-18944652530.html

- Distance Sensor
  https://www.maxbotix.com/documents/LV-MaxSonar-EZ_Datasheet.pdf

  https://www.seeedstudio.com/Grove-Time-of-Flight-Distance-Sensor-VL53L0X.html?utm_source=blog&utm_medium=blog

- IMU sensor
  https://www.microchip.lk/product-tag/accelerometer/
- Speaker

- IR cameras
    - 192x192 px IR illumination
    - Uses an IR bandpass filter and a surface mounted IR LED at 860nm wavelength to illuminate the eye.
- Scene camera - https://www.alibaba.com/product-detail/Mini-Camera-Hidden-Amazon-Hot-Sale_1600142000508.html?spm=a2700.7735675.normal_offer.d_title.7dee356651dJsv&s=p

Give specifications for each of the components you have included (find distance measuring sensors that suit this project as well) - ultrasound? ToF laser?

Using the specifications of the components, we will build the proposed MVP on solidworks design software

Include a section about possible future considerations (discussed at the meeting today)