Save Yourself

A Project Report submitted to
Microsoft Engage 2022
By

Tanya Anupam

Content:

1. Introduction

Workers' fatigue is a significant problem in modern industry, largely because of high demand jobs, long duty periods, disruption of circadian rhythms, and accumulative sleep debt that are common in many industries with an increasing need of fatigue risk management system (FRMS). It is developing rapidly in the high safety demand jobs; especially truck drivers, pilots, and power plant workers. It is noticeable that sleepiness and fatigue can exist simultaneously as a consequence of sleep deprivation in workers.

Adults are supposed to get between seven and nine hours of sleep; however, the CDC reports that 35% of Americans get less than the necessary seven hours. Insufficient sleep is one major cause of excessive daytime sleepiness, which is thought to affect up to 18% of the U.S. population. Overly sleepy employees are 70% more likely to be involved in workplace accidents. Drivers who get six hours of sleep or less are 33% more likely to have an accident on the road.

Some examples of such accidents are-

- **Air India Express Flight 812**: In 2010, an Air India Boeing 737 crashed in southern India, killing 158 people. According to the official inquiry, the pilot had been asleep for nearly three hours of the just before the landing at 6:30 a.m. local time.
- Three Mile Island Nuclear Plant Meltdown
- Davis-Besse Reactor near Oak Harbor, Ohio
- Rancho Seco nuclear reactor near Sacramento, California
- Exxon Valdez Oil Spill

2. Problem Statement

With less sleep, reaction time slows. This means you make decisions less quickly and accurately. You're also more likely to misjudge your own abilities and take unwise risks. Sleep deprivation in pilots, truck drivers, shift workers, and medical residents, for instance, leads to an increased risk of dangerous errors or near misses. Majority of workers are reluctant to express their feeling of fatigue. This is an increasing cause of workplace accidents. A serious need to take steps in the direction of workplace fatigue or sleepiness to avoid such accidents.

3. Solution Proposed

- Monitor user's eyes continuously while Working.
- To ring an alarm bell as soon as drowsiness is detected.
- If user doesn't wakes up even after a certain threshold number of times the alarm rings, a message alert is sent to the saved Emergency contact numbers.
- The alert message consists of the user's current location.

- ‘My profile’ tab keeps a record of the user’s total number of trips, total number of drowsy alerts and the percentage of alert trips.

4. What it does?

We have created a system that ensures the safety of workers and the people around them as well, by keeping them alert during long working hours by gauging their sleepiness via facial recognition.

5. Overview of Working

At first the user has to sign up on the website. After that, he/she is directed to the profile page where he/she has to fill some basic demographic questions and details of his 5 emergency contacts. Then the website redirects the user to the login page.

After logging in, the user must click on the “Start Working” button. The camera of the device starts monitoring the user’s eyes. As soon as drowsiness is detected, an alarm plays and if the user doesn’t open his eyes even after a threshold number of times of alarm, an alert is sent to the user’s emergency contact numbers along with his location.

User also has an option to check his profile using the “My profile” tab which keeps a record of the user’s total number of trips, total number of drowsy alerts and the percentage of alert trips

6. Algorithm

To build our blink detector, we used a metric called the eye aspect ratio (EAR), introduced by Soukupová and Čech in their 2016 paper, Real-Time Eye Blink Detection Using Facial Landmarks.

Unlike traditional image processing methods for computing blinks which typically involve some combination of:

- Eye localization.
- Thresholding to find the whites of the eyes.
- Determining if the “white” region of the eyes disappears for a period of time (indicating a blink).

The eye aspect ratio is instead a much more elegant solution that involves a very simple calculation based on the ratio of distances between facial landmarks of the eyes. This method for eye blink detection is fast, efficient, and easy to implement.

The facial landmark detector included in the dlib library is an implementation of the One Millisecond Face Alignment with an Ensemble of Regression Trees paper by Kazemi and Sullivan (2014).

The pre-trained facial landmark detector inside the dlib library is used to estimate the location of 68 (x, y)-coordinates that map to facial structures on the face.The indexes of the 68 coordinates can be visualized on the image below:

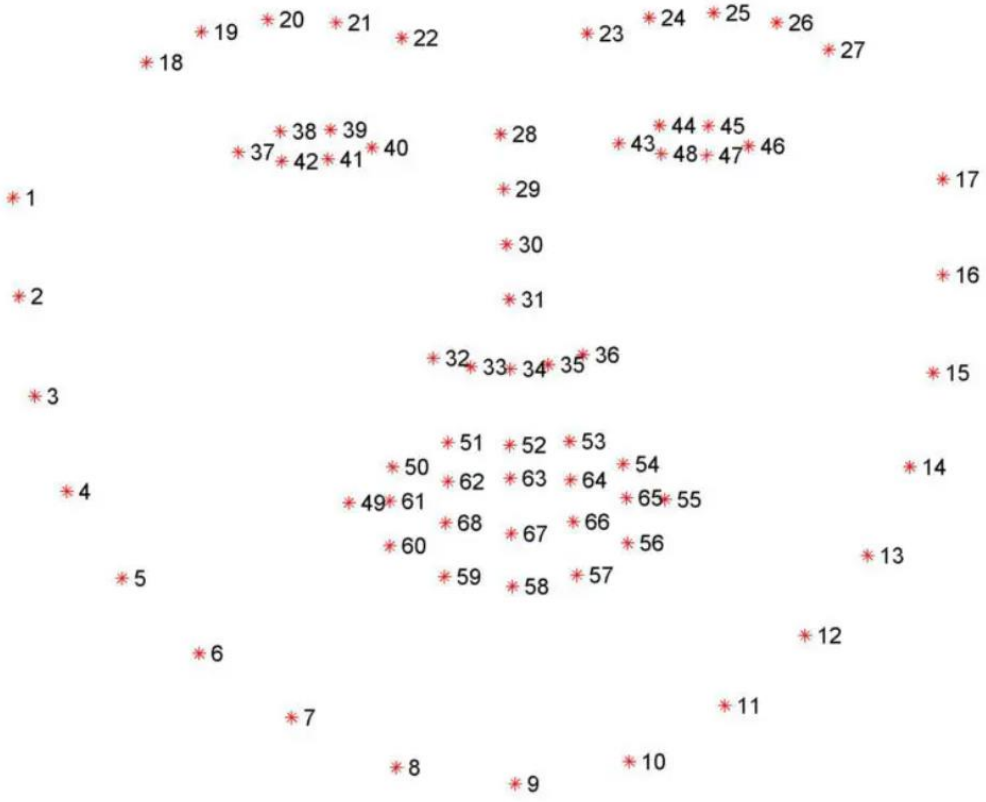


Figure: The full set of facial landmarks that can be detected via dlib

In terms of blink detection, we are only interested in two sets of facial structures — the eyes. Each eye is represented by 6 (x, y)-coordinates, starting at the left-corner of the eye (as if you were looking at the person), and then working clockwise around the remainder of the region:

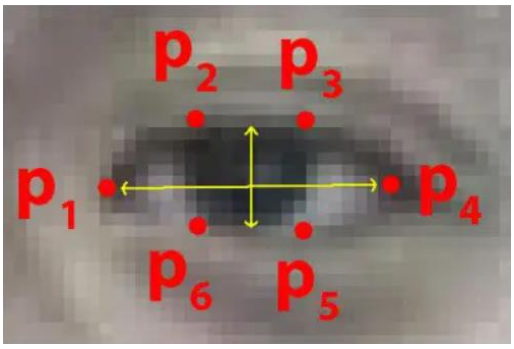


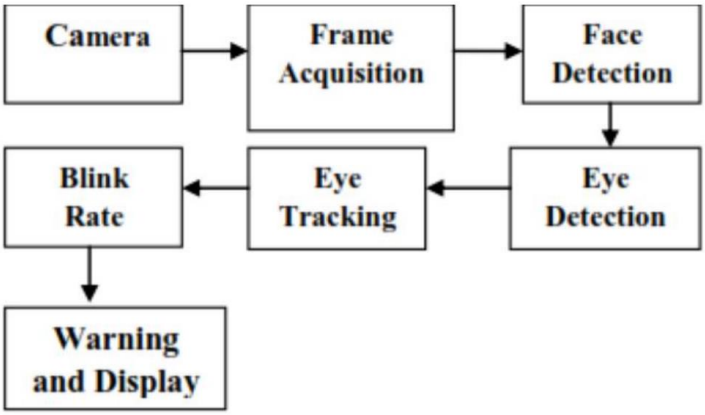
Figure: The 6 facial landmarks associated with the eye

There is a relation between the width and the height of these coordinates

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

Where p1, …, p6 are 2D facial landmark locations.

The numerator of this equation computes the distance between the vertical eye landmarks while the denominator computes the distance between horizontal eye landmarks, weighting the denominator appropriately since there is only one set of horizontal points but two sets of vertical points.

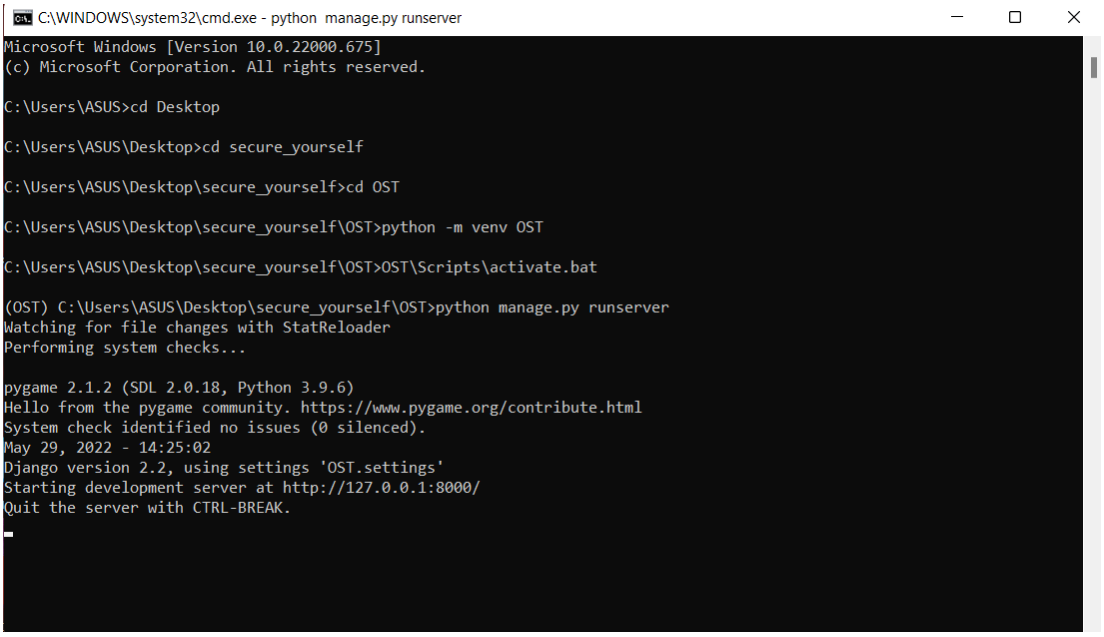


7. Technologies(Packages) used:

7.1. FRAMEWORK: Django(2.2)
7.2. opencv-contrib-python (4.5.5.64)
7.3. geopy (2.2.0)
7.4. imutils (0.5.4)
7.5. numpy (1.22.4)
7.6. scipy (1.8.1)
7.7. Setuptools(56.0.0)
7.8. twilio (7.9.1)
7.9. Geocoder(1.38.1)
7.10. pygame (1.9.5)

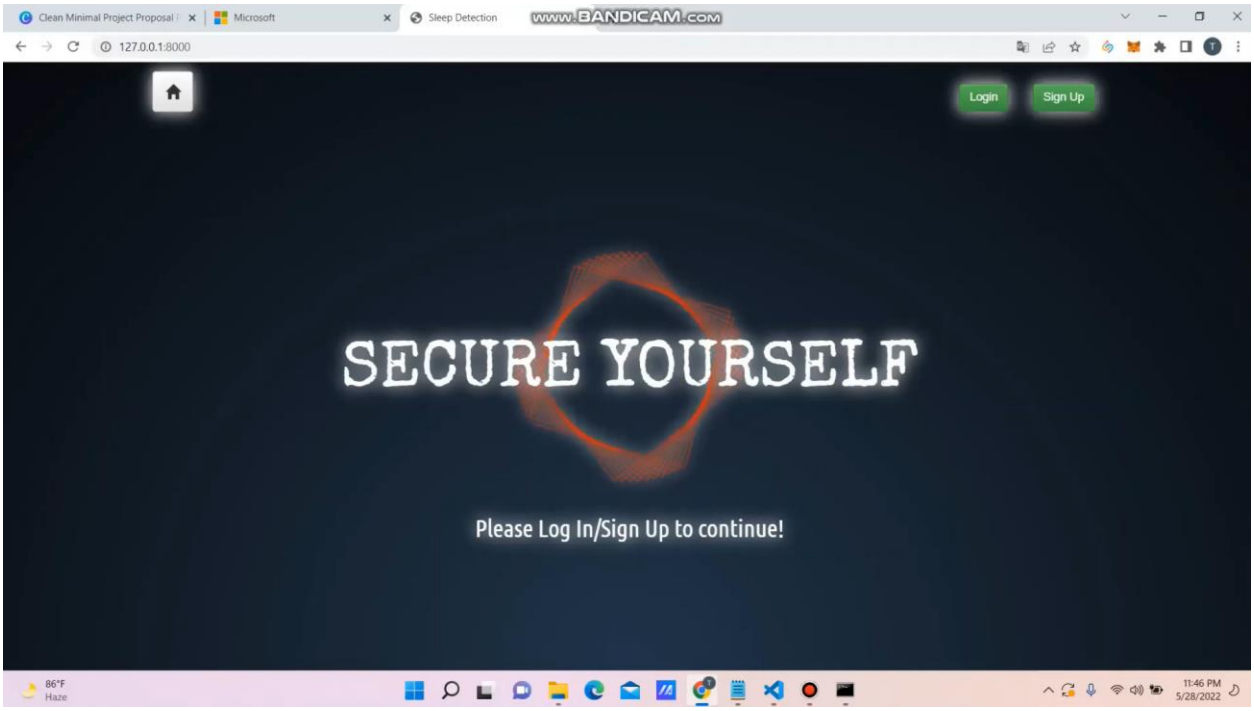
8. How to Run:

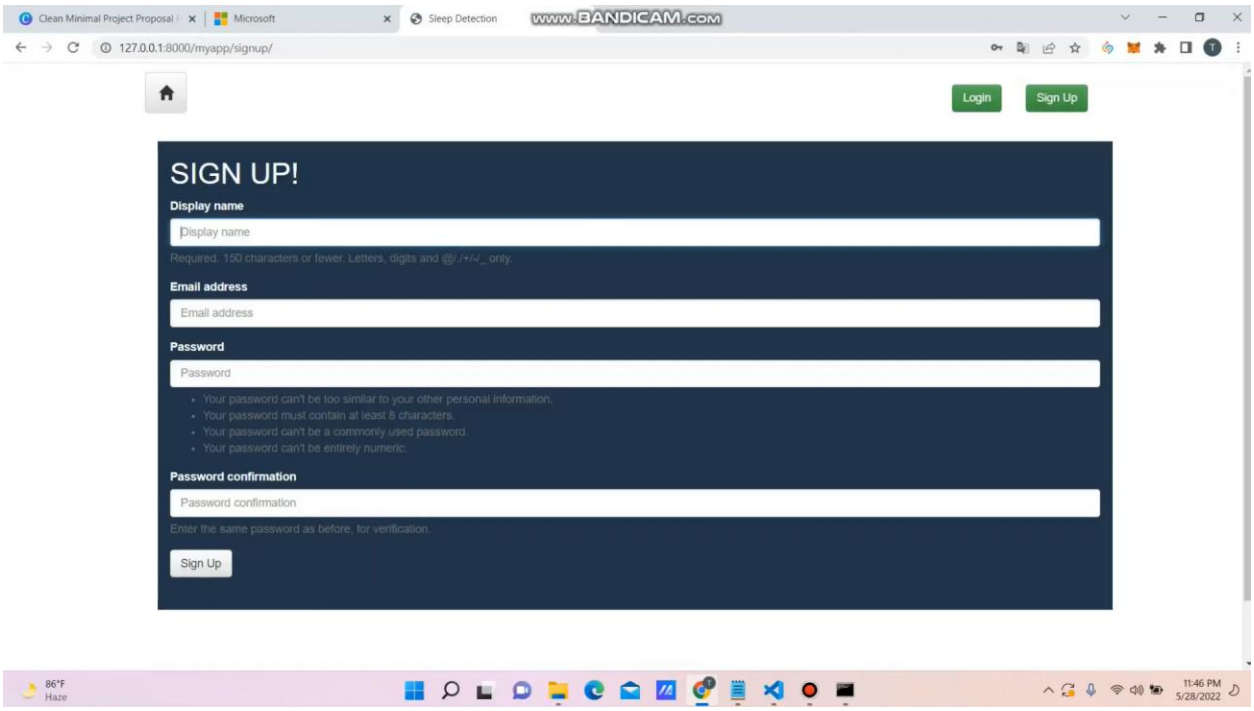
1) Change the directory to the respective project folder OST
2) Activate the virtual environment by using the command "python -m venv OST" followed by "OST\Scripts\activate.bat"
3) Run the command "python manage.py runserver"
4) Copy the URL from the terminal and paste it in a browser of your choice



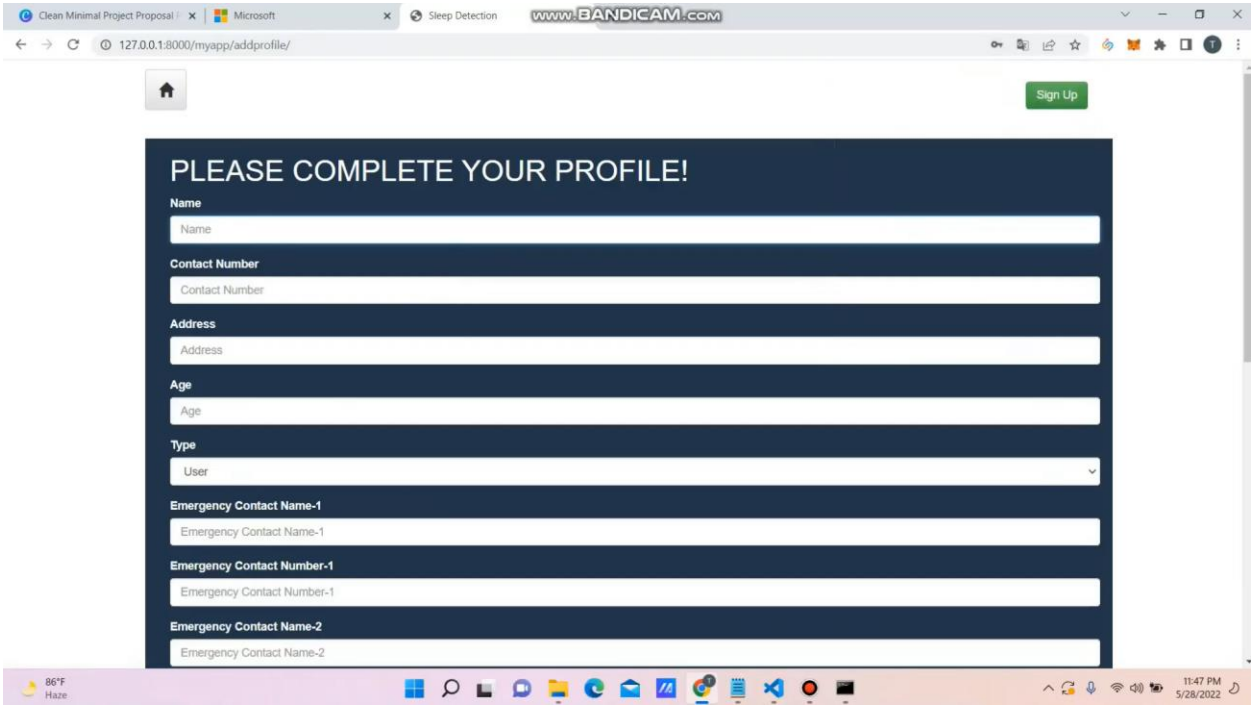
Step 1: Sign up/ Log in

If you are a new user, then you must Sign Up first. It is necessary before going further to prevent the site from unauthorized access. If you had already Signed Up then you can continue by login directly.

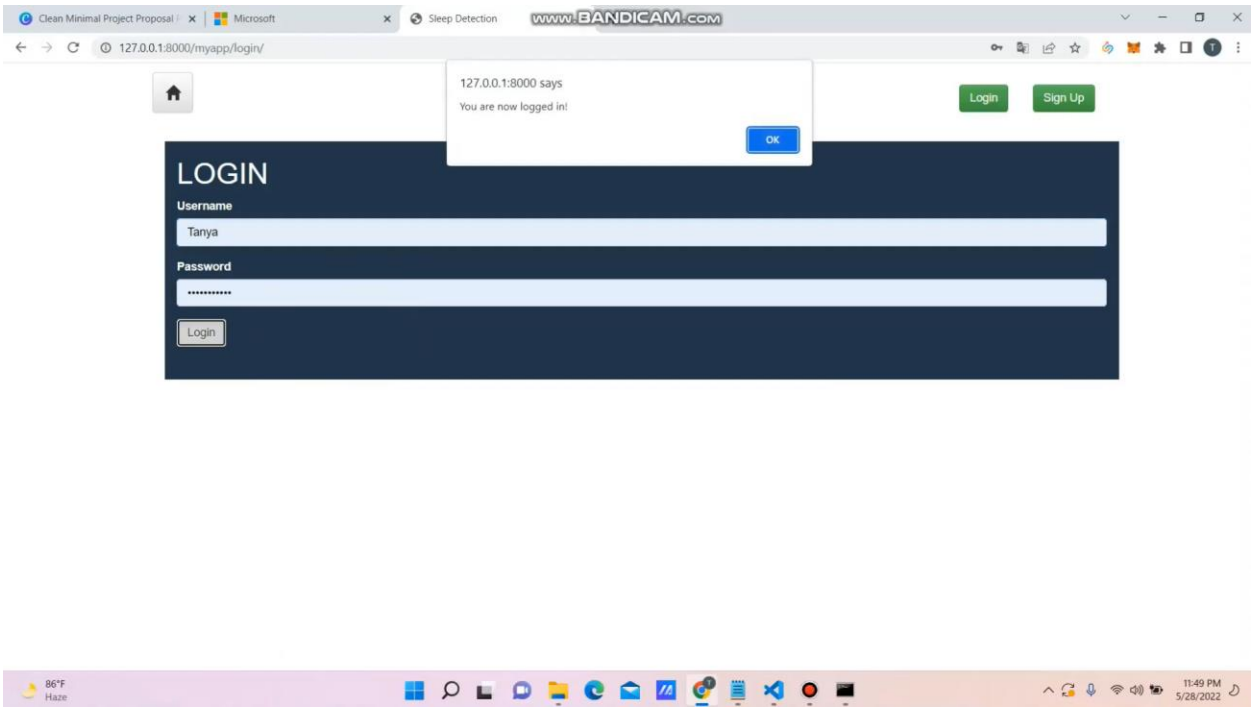




After SignUp you will be taken to the “Complete your profile” page, in which you have to give your 5 relative/ colleague’s contact details so that our app can send alerts to them if you are in any danger.



You will be redirected to the Login page.

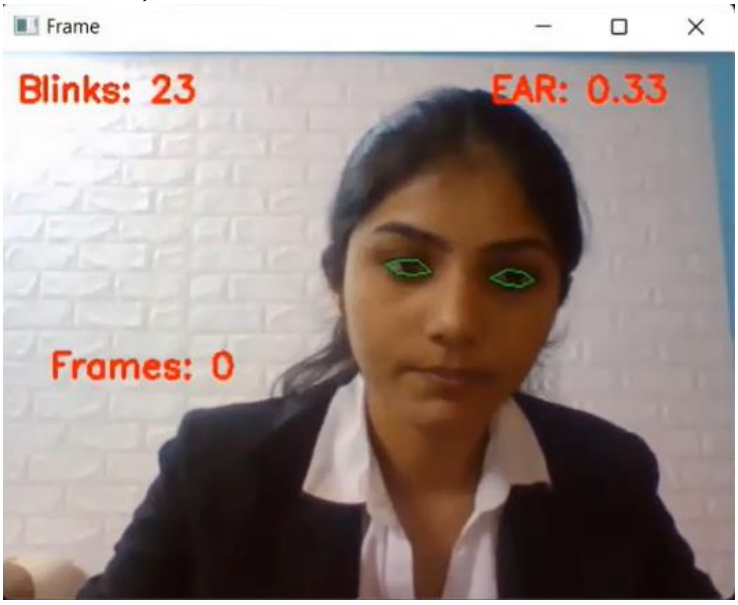


Step 2: Start Working
Click on the start Working button whenever you start your work.

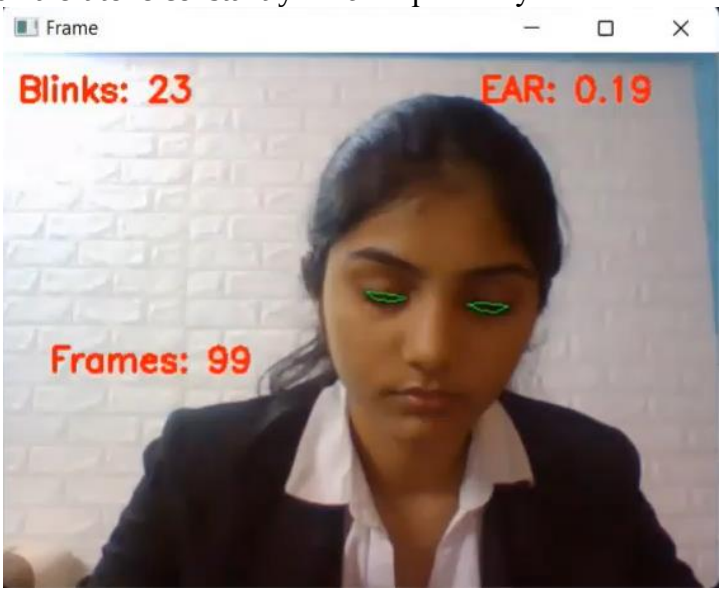
After clicking, a new window open, which will monitor you all the time.

Threshold EAR for the project is 0.3

- When EAR > threshold, no blink detected.



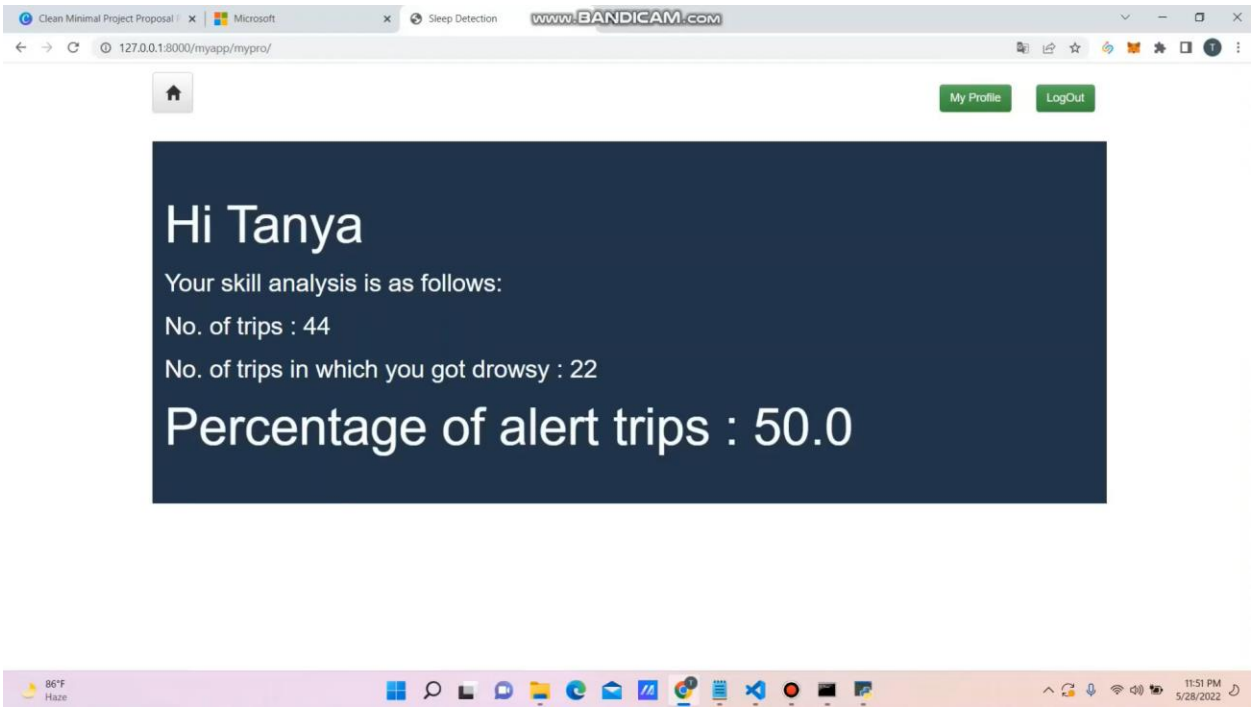
- When EAR < threshold, blink is detected.
- Whenever you close eyes for more than 99 frames i.e. almost 10 seconds it will start ringing an alert tone constantly for 5 loops until you don't wake up.



- Even after 5 loops of alarm you don't wake up or open your eyes, then it will send an alert message to all the 5 registered contacts along with your location.

Step 3: Stop Working
When you complete your ride, click on the stop Working button.

Step 4: Analysis
You can also see your percentage of alert trips by clicking on the "My Profile" Tab.



9. Future Scope

Developing support for Android and iOS so that the system can be more accessible to the people by simply using their phone.

To fit different working conditions we can extend the system to use camera as peripheral device, connecting it to Raspberry Pi and with the help of IoT to generate response. This will make it more compact and scalable.

10. Conclusion

Risk of workplace accidents developing rapidly in the high safety demand jobs; especially medical residents, air traffic controllers, pilots, and power plant workers. An increase in the need of fatigue risk management system (FRMS). The proposed system safeguards the workforce from accident that may take place because of the drowsiness or sleep at the time of work. The system is economically viable. Also, it can be easily installed in workplace. It can detect if the eye is closed or open and based on it, issues warning to the worker. The eye detection capability can be increased using a hybrid of different algorithms which uses edge detection techniques, machine learning concepts, and good support from open-source libraries like Open CV.

11. References

- https://www.sleepfoundation.org/excessive-sleepiness/workplace-accidents
- https://www.pyimagesearch.com/2017/04/24/eye-blink-detection-opencv-python-dlib/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4525425/

- http://www.wseas.org/multimedia/journals/information/2015/a105709-447.pdf
- https://github.com/akshaybahadur21/Drowsiness_Detection
- https://github.com/Kavita309/Jhapki
- http://vision.fe.uni-lj.si/cvww2016/proceedings/papers/05.pdf
- https://www.irjmets.com/uploadedfiles/paper//issue_4_april_2022/21321/final/fin_irjmets1650865685.pdf