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Smart License Approval Using AIOT

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Abstract. In India, a driving test consists of only a short duration test on an empty track which does not really assess a person's driving skills when it comes to driving on an actual road. Figures tell that on an average, 415 deaths are recorded per day in road accidents in India. This is relatively a very high number and there is an urgent need to address this issue. On studying the situation carefully, it is observed that the most common reasons for the increasing road accidents in India are distracted driving, over-speeding, not wearing seat belts, breaking traffic rules and tailgating. As pointed out earlier, the driving test conducted to grant a license is not enough to know a person's driving capability and thus, there has to be an additional test in order to monitor the person in a much more realistic and natural environment. With the advancements in technology, this task is highly feasible. Sensors to monitor tailgating, drowsiness detection system to check alertness, deep learning models to detect distraction caused by the use of mobile phones, belt and speed sensors together can be fitted on cars and the candidate put under observation for a period of 1-2 days. Certain parameters that the candidate has to pass in order to obtain the license are laid. The process being fully automated is faster and more wholesome as it monitors the candidate's actual driving on a road.

Keywords: road accidents, license approval, Internet of Things, sensor technology, data collection, automation.

1 Introduction

The rapidly increasing road accidents in India are a matter of concern [4]. 83.38% of publications on road traffic accidents have been written by the Indian authors which shows the severity of the issue [13]. In 2019, 4,49,002 road accidents were recorded all over India out of which 1,51,113 people succumbed to injuries [6]. Out of the fatal road accidents, cases in which the drivers were at fault account for about 56.2% [10]. It is suggested that without any new reforms made, the total number of deaths caused by road accidents is expected to cross the margin of 250,000 by 2025 [11]. There are many other countries with much higher vehicle ownership rates than India but RTI fatality lower rates [12] i.e., increase in vehicle ownership does not account for increased accidents. There is an urgent need to make certain reforms to curb the situation. The case studies suggest some of the major reasons for such accidents to be unethical and distracted driving [1][2]. Obtaining a driving license brings with it a lot of responsibilities

which not only include driving safely but staying alert and keeping the cars moving around you also safe. Therefore, the parameters assessed to issue a license should be much more than driving on an empty track. The candidate should be evaluated based on his alertness, adherence to rules, distraction extent while driving. The current driving license obtainment procedure does not cover the evaluation of all the above mentioned parameters. Thus, many candidates who lack practical sense to drive on roads are granted the license [3]. The license approval procedure needs to be reformed in order to ensure that licenses are issued to responsible drivers.

The solution aims to promote safe driving on roads and check if the drivers are aware of the road ethics before being granted the license. The proposed solution suggests an additional test that should be conducted along with the existing procedure. The additional test should be conducted without any manual intervention to evaluate the candidate in his most natural state. This will help us know the actual driving instincts of the candidate. The test should be conducted in the candidate's personal vehicle fitted with sensors and cameras to record every movement for the duration of the test. The candidate would be expected to drive the vehicle for a stipulated amount of time in the monitoring period of two days. Each time the vehicle is started, the person driving the car is validated using the camera and checked if he is the same applicant as registered. The camera will record the alertness and distraction of the candidate while driving. The sensors include a belt sensor in the form of a LED light, to know if the belt is worn before driving or not. This will be recorded only once as the engine is started. The other sensors are the speed sensor to record the speed of the car throughout the session and a proximity sensor to measure the distance the car keeps from the car in front of it. The camera monitors the alertness with the help of a drowsiness detection model [8] which stores the timestamp when the candidate's eyes were found to be closed. The candidate is considered to be distracted if he is found to be talking over his phone while driving which is a bad practice. The camera uses a Tensorflow model trained to detect mobile phones in the video frame and each time the phone is detected, the time instance stored. The data collected is further analyzed using the grading system laid beforehand. The rules are laid such that higher priority parameters are evaluated first and then the lesser ones. The observation period for each candidate can be for one to two days and data recorded for each session when the car is drove. The entire process is made automated to ease the monitoring and the result generation task and to help in faster processing of license approval. In the current scenario, one slight error, a single instance of over speeding would result in the candidate failing the test whereas the increased monitoring period suggested in the proposed solution would be beneficial to them as the average speed at which he drove the vehicle would be considered and a considerable number of penalties would be allowed. The proposed grading system carefully assesses the parameters necessary for safe driving and if a person fails to meet the parameters, he is not fit for a license issue. If the number of license approvals are reduced by this method, it is because the applicants are unaware of safe driving practices and thus, incapable of driving on roads. The test cannot guarantee that the person won't repeat the action in future and installing the cameras in personal vehicles permanently to have a constant check on the drivers is not possible. But, having a test for a longer duration wherein the

parameters which are very crucial to satisfy while driving safely on roads are assessed does give us a better understanding about the candidate's driving. Thus, by incorporating the proposed solution, the license granting procedure is expected to be more robust and dynamic.

2 Literature survey

2.1 Aggressive Driving Case Studies and Mitigation in India

This paper deals with the increasing road rages in India. In this, road rages have recently been cited as equalling alcohol-impaired driving in the number of resultant motor vehicle accident related injuries and fatalities. Presently Indian roads and driving conditions are a point of discussion as it is regarded highly unsafe. The paper mainly focuses on the reasons which make Indian roads a death trap. The prime reason for the same tends to be the poor implementation of the set laws [1].

2.2 They do not just drive when they are driving: Distracted driving practices among professional vehicle drivers in South India

Driving is a complex task, requiring coordination between multiple mental and physical faculties. Distractions lead to delayed recognition of information needed to drive safely. This paper deals with how certain avoidable distractions taken up by drivers during the course of them being occupied mentally and physically in driving leads to accidents in which they as well as the innocents suffer [2].

2.3 Obtaining a Driver's licence in India: An Experimental Approach to Studying Corruption

This paper focuses on the ill practices which are prevalent in the licence issuing system of the Indian traffic industry. It highlights the ill practices prevalent present in the system which are making the roads a not so safe place to be in. Corruptions and other such malpractices are being practiced at a very high rate in this industry which has led to its major downfall [3].

2.4 Road Safety in India: Challenges and Opportunities

The paper deals with identifying countermeasures for areas in which the total harm caused by crashes can be substantially and readily reduced. The report focuses on two aspects of traffic safety in India: challenges and opportunities. The major challenges mentioned here are limiting the traffic on the roads and improving the law enforcement infrastructure. Another major highlight of this paper is the improvement in the quality of drivers on the roads as what we see around is quantity but not quality [4].

2.5 A Review on Road Traffic Accident and Related Factors

This paper regards India as one nation which experiences the highest rate of road accidents. The core reason again comes out to be the negligence shown by the under qualified drivers abundant on Indian roads and improper law enforcement. This paper reviews various factors and statistics related to road accidents occurring in various countries and also studies different safety measures suggested by researchers [5].

Based on the literature review conducted coupled with the general on road observations, the below listed factors are needed to be dealt in order to improve the driving standards and road safety in India.

The factors are:

1. Improving the law enforcement infrastructure
2. Improving the quality of drivers on the road.

3 Existing driving license issuing system in India

The current driving license issuing system in India is a very simple and straightforward process. A driving test consists of only a short duration test on an empty track which does not really evaluate a person's driving skills when it comes to driving on an actual road.

Description of the existing system[7]:

1. The person applies for DL through a government website.
2. On the website, they first register themselves for the issue of an LL (learner's license).
3. The person gets a date to give the LL test.
4. The test consists of 10 MCQ based traffic laws questions. You need to score a minimum of 60% that is 6 marks to clear the test.
5. Post clearance you are issued an LL for one month.
6. On the completion of the one month, you are eligible for the driving test.
7. The candidate is given a date for the test.
8. On the day of the test, the candidate is required to be present with his/her car and park in a fixed space or go around a circular track or move the car around in a H shape track.

The above mentioned license obtainment procedure only evaluates a person capability to drive slowly on tracks with some turns. Whereas, on driving in a realistic situation on a road full of traffic, the driver has to take care of many things apart from driving slowly. The driver has to take care of tailgating i.e., not drawing too close to the car in front of him and always maintain a safe distance. He also has to be fully alert while driving; not fall asleep, be on his/her phone or involved in any other distraction. The driver should abide by the traffic rules, always wear a seat belt and avoid any kind of rash driving. The driver should always be within the speed limits and avoid over-

speeding at all times. All these parameters to assess are overlooked in the existing license obtainment procedure.

4 Proposed methodology

The proposed solution is to test the drivers in real life driving conditions over a period of time. The focus is to keep the driver in his/ her natural state and then collecting the drive data. The candidate is expected to drive within city limits therefore, expected to drive the vehicle carefully while avoiding any bad practices like over speeding, tailgating and distraction. Monitoring can be done for one or two days within different sessions during different times of the day. The candidate can be asked to drive the car for a certain number of hours on different hours of the day so as to collect enough data for analysis. Based on the collected drive data, a study or an analysis should be conducted and with regard to its output, the license should be granted to the candidate.

In order to collect the drive data, we would require sensors and cameras fitted in a car to record:

1. Speed
2. Distance maintained from other vehicles on the road
3. Belt worn or not
4. Distraction using phones
5. Drowsiness while driving

4.1 Scoring pattern

The model developed gives scores to the person taking the test based on these parameters. Higher priority is given to more important parameters and only if they are satisfied or within a certain threshold, we move down to check other parameters.

The scoring pattern has been discussed below.

Parameter 1- Belt status

If belt not worn at the start of the session

->FAIL

Only if the belt is worn, the next parameter is assessed.

Parameter 2 - Distraction

The phone usage is monitored and the time stamps recorded,

If more than once,

->FAIL

If not, assess the next parameter.

Parameter 3 - Speed

The person is expected to drive within the city limits, therefore average speed is expected to be between 30 to 50 -> Points =10
If above 60 -> FAIL
If above 50 -> Points = (60 – average speed)
If below 30 -> Points = 3

Parameter 4 - Alertness

The drowsiness timestamps recorded are divided into drowsiness sessions; if difference between two recordings are between 1.5 seconds ~ same session, else ~ drowsiness session(count) incremented
If count > 5 -> FAIL
Else 2 points deducted for each count

Parameter 5 - Distance kept from cars

Ideal distance to be kept from vehicle ahead is told to be at least half of your car speed, otherwise it is considered tailgating.
If violated more than 5 times -> FAIL
Else 2 points deducted for each violation
From sides, 1.5 m to be maintained else 1 point deducted for each after >10 violations

Total points

After all parameters are monitored, the total points awarded are out of 30.
If >20 obtained - PASS
Else - FAIL

4.2 Process workflow

FLOWCHART

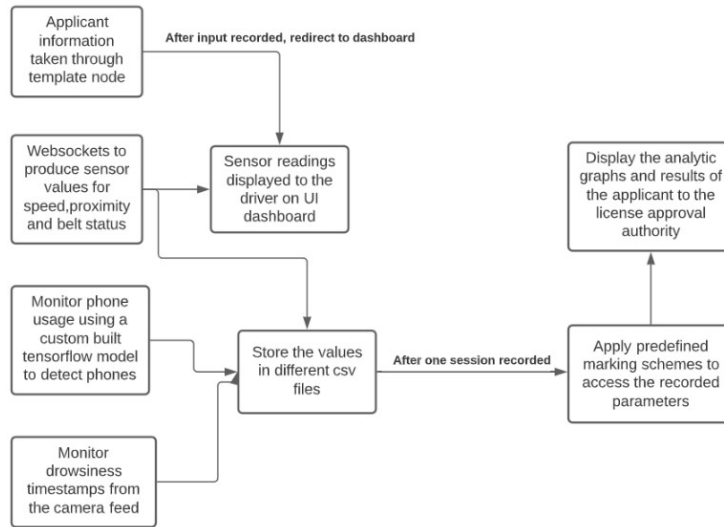


Fig. 1. Flow of the process

Figure 1 represents the complete flow of the Smart License Approval system.

Sensor data generation using web socket. As this project involved no hardware, the sensor readings were generated using web sockets. Three server python files were created to generate data for belt status(IN/OUT), speed , and proximity sensor for all four sides of the car. After a client connection is established, through the node-red http request node, the data generation is done and the values generated through a random function between a certain range, is sent to the node-red flow for displaying the same on the UI dashboard and also written to CSV files to facilitate analytics for result generation. The code facilitating the data generation is shown in Figure 2.

```

host = '127.0.0.1'
port = 6990
s = socket.socket()
s.bind((host, port))
s.listen(5)
c, addr = s.accept()
data2 = "HTTP/1.1 200 OK\n"+"Content-Type: text/html\n"+" \n"+"connection established"
c.send(data2.encode())
data = c.recv(1024)

c.close()

while True :
    try:
        c, addr = s.accept()
        #generate a random speed instance between the range 20-60
        x = random.randint(20, 60)

        sensor="HTTP/1.1 200 OK\n"+"Content-Type: text/html\n"+" \n"+str(x)
        c.send(sensor.encode())
        data = c.recv(1024)

        with open(filename, 'a',newline='') as csvfile:
            row=[datetime.datetime.now()]
            row.append(x)

            csvwriter = csv.writer(csvfile)
            # writing the data to the CSV file
            csvwriter.writerow(row)
    except KeyboardInterrupt:
        break

c.close()
print("\n connection closed!")

```

Fig. 2. Generating sensor data using socket programming

Applicant interface. Node-red was used to simulate the applicant side of information. It consists of taking the applicant information through a template node and storing it in the backend to help in the result generation. The UI dashboard helps the user view the visual representation of the sensor readings: belt sensor, speed sensor and proximity sensor.

The flow handling the data collection and the applicant's details such that it can be utilized for result generation is shown in Figure 3.

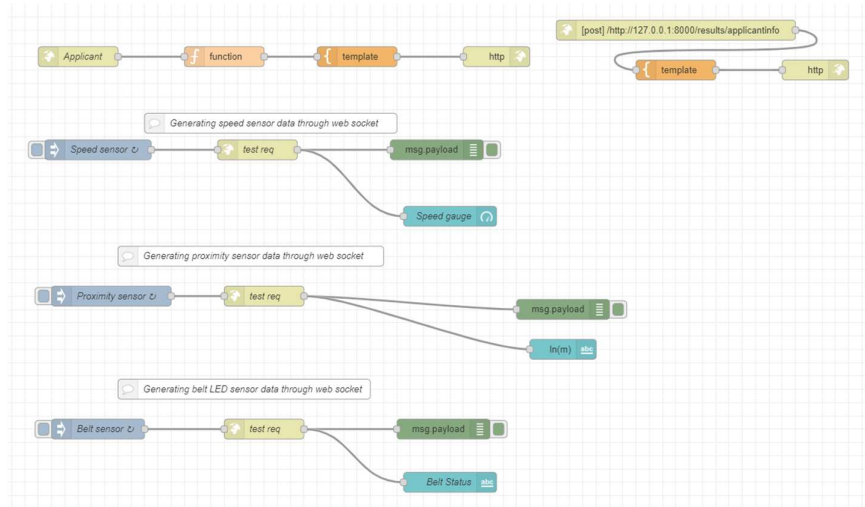


Fig. 3. Flow of information and sensor data collection

Drowsiness detection. A drowsiness detection model uses the `eye_aspect_ratio` function to determine the ratio of distances between the vertical eye landmarks and the horizontal eye landmarks. The eye aspect ratio stays constant when the eye is open and rapidly decreases towards zero on blinking[9]. If the eye is found to be closed, it will become very small. When the eye is found to be closed using the above mentioned function, the timestamp for the same is recorded and stored in a CSV file to be used for result generation.

Distraction caused by phone usage. To capture the distraction of the applicant, a Tensorflow MobileSSD model was trained to exclusively detect a mobile phone in the video frame. MobileSSD model was chosen as it is a comparatively light weight model and doesn't use up a lot of resources while running.

Result generation. The sensor data collected through the web sockets and the data collected from the camera feed is analyzed using the scoring pattern mentioned earlier, the points scored calculated for the candidate and the graphs rendered to give some insights into the analysis carried out on the data.

5 Experiment

The experiment was carried out by building a Django application along with node-red to show the working of the proposed system.

The applicant's details were collected using a registration form, shown in Figure 4, such that it could be used throughout the application process and help keep a track of whose application is being processed.

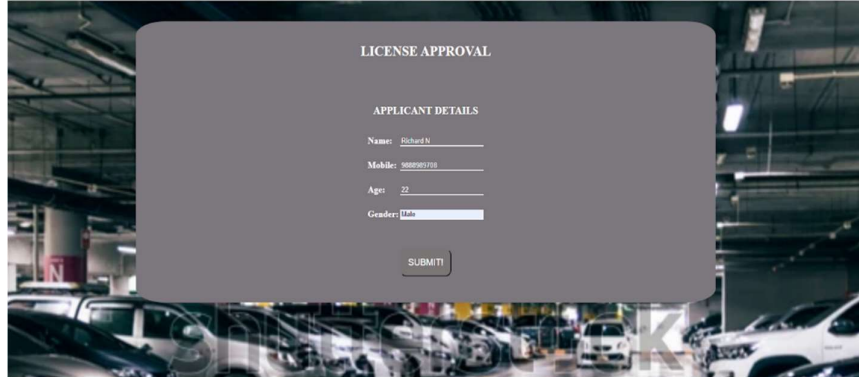


Fig. 4. Applicant details collection form

The sensor data was generated by making appropriate connections to the server script from the http request node to generate data. The generated values were continuously stored in CSV files along with the timestamps. An example CSV with the generated data is shown in Figure 5.

	A	B	C	D	E	F
1	Time	Speed				
2	46:07.2	20				
3	46:08.3	47				
4	46:09.3	24				
5	46:10.3	34				
6	46:11.3	33				
7	46:12.3	41				
8	46:13.3	44				
9	46:14.3	48				
10	46:15.3	48				
11	46:16.3	23				
12	46:17.3	33				
13	46:18.3	32				
14	46:19.4	54				
15	46:20.4	55				

Fig. 5. CSV file generated for the speed of the candidate’s vehicle at different instances.

The Django application consisted of three modules – detecting phone usage, detecting drowsiness and to view results. The phones usage and drowsiness detection modules used the webcam to detect any mobile phone present in the video frame and monitor if the person’s eyes are closed respectively. The timestamps of the instance when the candidate’s eyes were found to be closed were also stored in a CSV file.

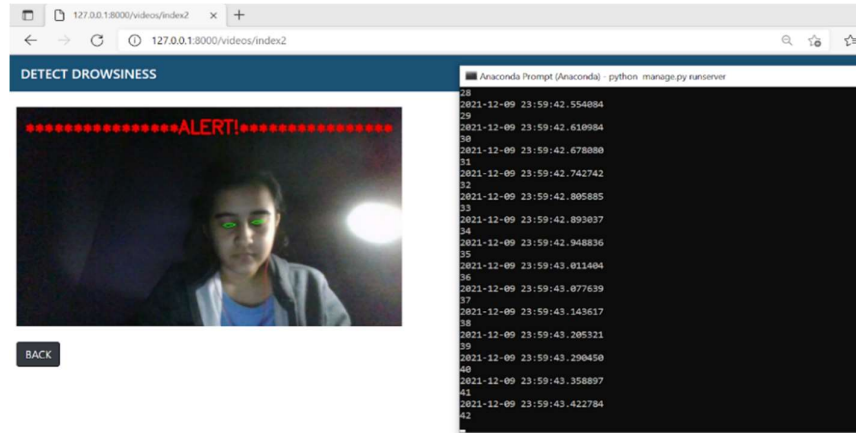


Fig. 6. Timestamp recorded when candidate found to be drowsy.

Figure 6 shows the recorded timestamps displayed in the command prompt.

The live camera feed is taken and the Tensorflow model detects any mobile phones present in the captured frame. Both the modules were tested in a low-lighted environment to test the performance and accuracy of the detection systems. The outputs for the same are shown in Figure 7 and Figure 8.

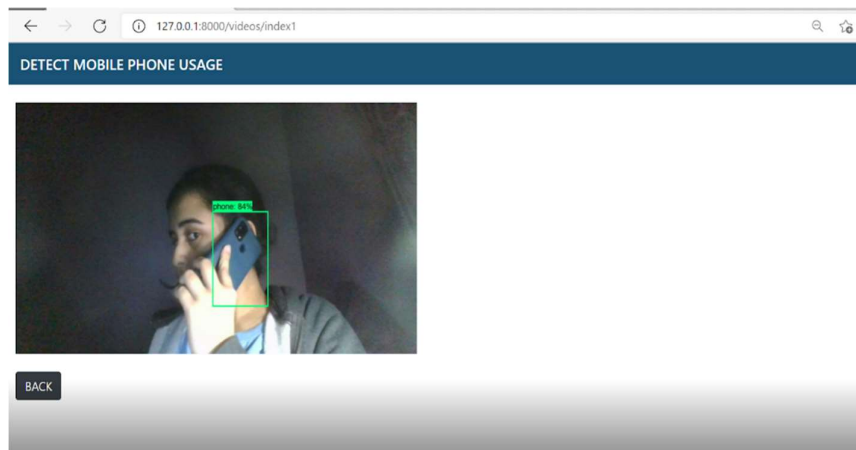


Fig. 7. A visual representation showing the working of distraction monitoring of the applicant. Here, the phone is fully visible in the video frame and detected by the model.

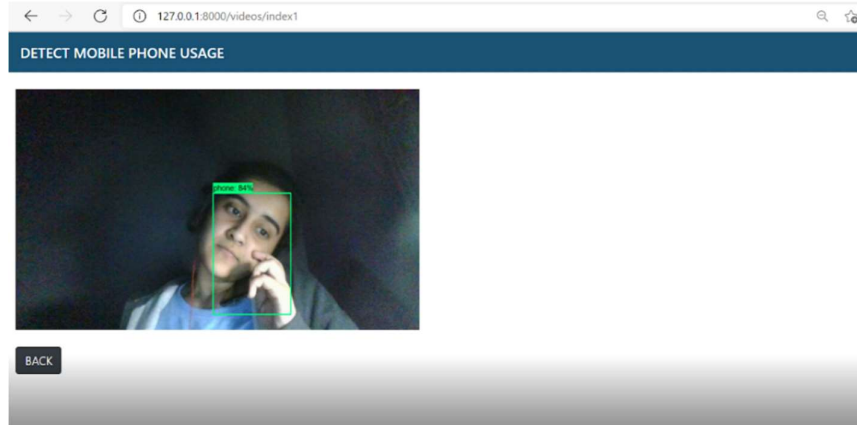


Fig. 8. A visual representation wherein the phone although visible very slightly is still detected by the model with an accuracy of 84%.

6 Results

The collected data is processed and graphical representations provided to facilitate better understanding of the result generation.

The candidate is expected to be driving within city limits therefore, his average speed at all times is expected to be within 30-50 km/hr. Driving slower than 30 km/hr would hamper the traffic flow on roads and above 50 km/hr would be considered as over speeding. Therefore, the scoring pattern directly evaluates the candidate as failed if he has an average speed above 60 km/hr and deducts marks for average speeds between 50 – 60 km/hr. The graphical representation for the candidate's speed variations is shown in Figure 9.

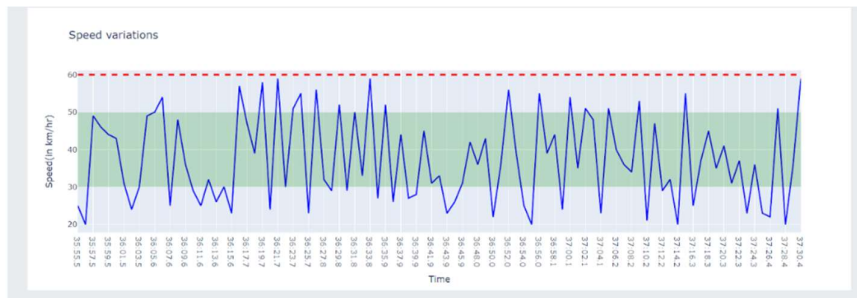


Fig. 9. The speed variations datapoints are plotted and ideal speed expected to be maintained is within the green box i.e between 30-50 km/hr.

It is advised to always maintain a safe distance (in meters), which is calculated as half of the speed (in km/hr), from the car moving in front of you to provide ample of

response time to the driver to brake and stop his car if required. The graph in Figure 10 shows the situations where half of the car speed (in km/hr) is greater than the distance maintained from the vehicle in front are considered to be instances of tailgating. Having a graphical representation makes it easier to find such instances as on those particular timestamps, the peak of the orange line is higher than that of the blue line.

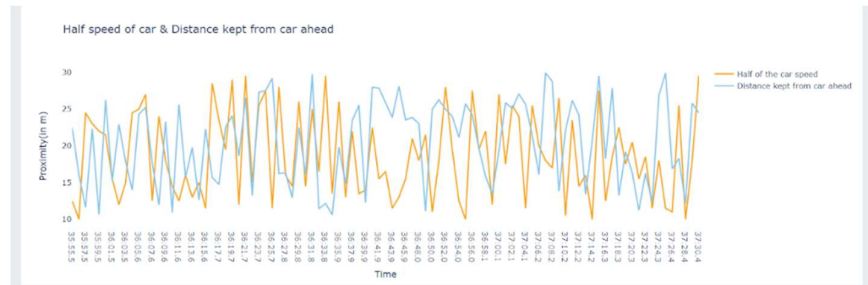


Fig. 10. Plot showing half of the car speed(in km/hr) and distance maintained from car in front(in m).

The timestamps recorded by the system when the person was found to be asleep were grouped to make sessions of drowsiness i.e., if two timestamps recorded were only a second apart, both are considered to be under one session or continuation else, the timestamps were considered to be in different sessions. The recorded timestamps in which the person was found to be drowsy were placed under different sessions which helped in merging the various timestamps in order to count the duration for which the person fell asleep as shown in Figure 11. Frequently falling asleep would result in failing the driving test as lack of attention is risky for the driver as well as other vehicles on the roads.

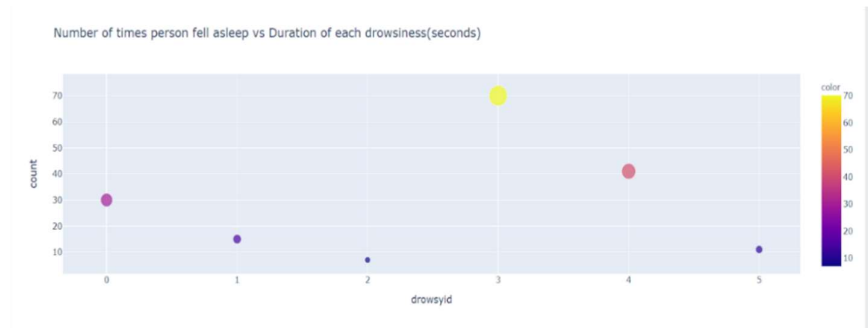


Fig. 11. The recorded drowsiness sessions of the candidate during the assessment.

The candidate’s data obtained from the CSV files was evaluated using the scoring pattern as mentioned in Section 4, and the final scores obtained after each parameter check

added to mark a total score out of 30. The score obtained is displayed on the license authorities' interface along with the candidate's details and the status of his license obtainment test; showing whether he cleared the test or not. On not being able to clear the test, the person is asked to re-appear/ apply for the test after 14 days as shown in Figure 12.

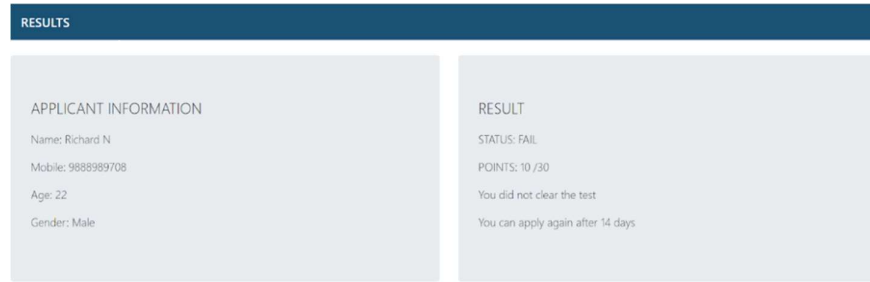


Fig. 12. Auto-generated consolidated report of the candidate

Thus, the marking schema along with the graphical representations helped to arrive at a consolidated decision to evaluate the candidate's driving capability.

7 Conclusion

This test is more dynamic and records much more of the driver's patterns than the one conducted for a shorter span under direct human surveillance. With the alarming rate of rising road accidents, there is a need to refine the standard license obtaining procedures and this solution be a starting point for it. The aim of making the roads safer by bringing in the reliable class of drivers out on the road by the observational test would be achieved if the proposed solution is adapted in its true state without any malpractice encouraged by the citizens and the regulatory authorities.

Although the idea proposed is self-sufficient enough yet there are many ways in which the same can be improved and made a more reliable tool in rolling out driving licenses. As it is clearly seen, in order to present POC (proof of concept) only certain basic check parameters are taken under consideration from the drive data collected. In later stages more and more can be collected by looping in other parameters of driving on roads to increase the efficiency of the project. More the data, more conclusive is the recommendation by the model. Another enhancement possible is in the number of days the test is run for the candidate under consideration. If we figure out a reliant drivable hour for which the data collection has to be done then, the entire process can be made smoother and more reliable. The report generated for the candidate was sufficient and provide enough analysis to the authorities and it can be further extended and made useful to the candidate as well by forwarding the analysis charts to the concerned candidate's email along with his score and some additional comments to help him understand the reason for the not being able to clear the test.

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