VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"Jnana Sangama", Belagavi-590 018

A Project Work on

"Driver Drowsiness Detection System using Convolutional Neural Network"

A Dissertation work submitted in partial fulfillment of the requirement for the award of the degree

Bachelor of Engineering

In

Information Science and Engineering

Submitted by

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Under the guidance of

Prof. Chaitra B

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ACHARYA

DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING

ACHARYA INSTITUTE OF TECHNOLOGY

(AFFILIATED TO VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.APPROVED BY AICTE, NEW DELHI, ACCREDITED BY NAAC, NEW DELHI)

Acharya Dr. Sarvepalli Radhakrishnan Road, Soldevanahalli, Bengaluru-560107

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2021-2022

Certificate

This is to Certify that the Project Work entitled "**Driver Drowsiness Detection System"** carried out by **Chethan Holla BV (1AY18IS030)**, **Gagan P Gupta (1AY18IS041)**, **Keerthi I G (1AY18IS052) and Malipeddu Harsha Vardhan (1AY18IS063),** are bonafide students of **Acharya Institute of Technology, Bengaluru** in partial fulfillment for the award of the degree of **Bachelor of Engineering** in **Information Science and Engineering** of the **Visvesvaraya Technological University**, **Belagavi** during the year **2021-22**. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The Project has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering Degree.

Signature of the Guide	Signature of the HOD	Principal
Prof. Chaitra B	**Dr. Chayapathi A R**	
Assistant Professor	Assistant Professor	

External Vivo-Voce:

Name of the Examiners	**Signature with date**
1.	
2.	

DECLARATION

We, Chethan Holla BV (1AY18IS030), Gagan P Gupta (1AY18IS041), Keerthi I G (1AY18IS052), and Malipeddu Harsha Vardhan (1AY18IS063), students of B.E, Information Science and Engineering, Acharya Institute of Technology, Bengaluru - 560107, hereby declare that the project entitled **"Driver Drowsiness Detection System"** is an authentic record of our own work carried out under the supervision and guidance of **Prof. Chaitra B**, Acharya Institute of Technology, Bengaluru. We have not submitted the matter embodied to any other university or institution for the award of any other degree.

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Date:

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ABSTRACT

In past few years, there has been substantial increase in road accidents in India and worldwide as well. The most significant reasons for the same are drowsiness and fatigue. Therefore, driver drowsiness and fatigue detection is major possible area to prevent a large number of sleep induced road accidents. A sleepy driver is arguably much more dangerous on the road than the one who is speeding as he is a victim of microsleeps. Automotive researchers and manufacturers are trying to curb this problem with several technological solutions that will avert such a crisis. This article focuses on the detection of such micro sleep and drowsiness using neural network-based methodologies. In this project, accuracy was increased by utilizing facial landmarks which are detected by the camera and that is passed to a Convolutional Neural Network (CNN) to classify drowsiness. The proposed CNN based model can be used to build a real-time driver drowsiness detection system for embedded systems and ease of use.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Overview

This project is a proposed system where a user can enjoy various genre of movies as well as tv shows by creating a premium account using facial recognition. As like any other movie streaming application, the user doesn't necessarily have to type the credentials to login. They can simply login through facial recognition technique and will be directed to home page on successful verification of their face. In this existing world, time is very crucial so we are implementing facial recognition technique to save the user's time and which also ensures safe login. Also, the proposed system will recommend the user new movies and tv shows on the basis of their watch history which is known as Content Based Approach.

1.2 Machine Learning

Machine learning is a branch of artificial intelligence (AI) and computer science which focuseson the use of data and algorithms to imitate the way that humans learn, gradually improving itsaccuracy. Machine learning is actively being used today, perhaps in many more places than one would expect. Machine learning (ML) is a type of artificial intelligence (AI) that allows software applications to become more accurate at predicting outcomes without being explicitly programmed to do so. Machine learning algorithms use historical data as input to predict newoutput values.

1.2.1 Applications of Machine Learning:

- **Image Recognition**

  Image recognition is one of the most common applications of machine learning. It is usedto identify objects, persons, places, digital images, etc.

- **Virtual Personal Assistant**

  We have various virtual personal assistants such as Google assistant, Alexa, Cortana, Siri. As the name suggests, they help us in finding the information using our voice instruction.These assistants can help us in various ways just by our voice instructions such as Play music, call someone, open an email, Scheduling an appointment, etc.

- **Medical Diagnosis**

  In medical science, machine learning is used for disease diagnoses. With this, medical technology is growing very fast and able to build 3D models that can predict the exact position of lesions in the brain. It helps in finding brain tumors and other brain-related diseases easily.

1.3 Importance of Machine Learning:

Machine learning is important because it gives enterprises a view of trends in customer behavior and business operational patterns, as well as supports the development of new products. Many of today's leading companies, such as Facebook, Google and Uber, make machine learning a central part of their operations. Machine learning has become a significant competitive differentiator for many companies. services. Other services stream music. Video game live streaming uses streaming for online gaming.

1.3.1 Types of Machine Learning:

Classical machine learning is often categorized by how an algorithm learns to become more accurate in its predictions. There are four basic approaches: supervised learning, unsupervised learning, semi-supervised learning and reinforcement learning. The type of algorithm data scientists chooses to use depends on what type of data they want to predict.

- Supervised learning: In this type of machine learning, data scientists supply algorithms with labeled training data and define the variables they want the algorithm to assess for correlations. Both the input and the output of the algorithm is specified.

- Unsupervised learning: This type of machine learning involves algorithms that train on unlabeled data. The algorithm scans through data sets looking for any meaningful connection. The data that algorithms train on as well as the predictions or recommendations they output arepredetermined.

- Semi-supervised learning: This approach to machine learning involves a mix of the two preceding types. Data scientists may feed an algorithm mostly labelled training data, but the model is free to explore the data on its own and develop its own understanding of the data set.

- Reinforcement learning: Data scientists typically use reinforcement learning, to teach a machine to complete a multi-step process for which there are clearly defined rules. Data scientists program an algorithm to complete a task and give it positive or negative cues as it works out how to complete a task. But for the most part, the algorithm decides on its own whatsteps to take along the way.

1.3.2 Advantages and Disadvantages of Machine Learning:

Machine learning has seen use cases ranging from predicting customer behaviour to forming the operating system for self-driving cars. When it comes to advantages, machine learning canhelp enterprises understand their customers at a deeper level. By collecting customer data andcorrelating it with behaviours over time, machine learning algorithms can learn associations and help teams tailor product development and marketing initiatives to customer demand. Some companies use machine learning as a primary driver in their business models. Uber, forexample, uses algorithms to match drivers with riders. Google uses machine learning to surface the ride advertisements in searches. But machine learning comes with disadvantages. First and foremost, it can be expensive. Machine learning projects are typically driven by data scientists, who command high salaries. These projects also require software infrastructure that can be expensive. There is also the problem of machine learning bias. Algorithms trained on data sets that exclude certain populations of contain errors can lead to inaccurate models of the world that, at best, fail and, at worst, are discriminatory. When an enterprise bases core business processes on biased models it can run into regulatory and reputational harm.

1.4 Deep Learning

Deep learning is a subfield of machine learning, which is, in turn, a subfield of artificial intelligence (AI). For a graphical depiction of this relationship. The central goal of AI is to provide a set of algorithms and techniques that can be used to solve problems that humans perform intuitively and near automatically, but are otherwise very challenging for computers. A great example of such a class of AI problems is interpreting and understanding the contentsof an image – this task is something that a human can do with little-to-no effort, but it has proven to be extremely difficult for machines to accomplish.

While AI embodies a large, diverse set of work related to automatic machine reasoning (inference, planning, heuristics, etc.), the machine learning subfield tends to be specifically interested in pattern recognition and learning from data. Artificial Neural Networks (ANNs) are a class of machine learning algorithms that learn from data and specialize in pattern recognition, inspired by the structure and function of the brain.

As we'll find out, deep learning belongs to the family of ANN algorithms, and in most cases, the two terms can be used interchangeably. In fact, you may be surprised to learn that the deeplearning field has been around for over 60 years, going by different names and incarnations based on research trends, available hardware and datasets, and popular options of prominent researchers at the time.

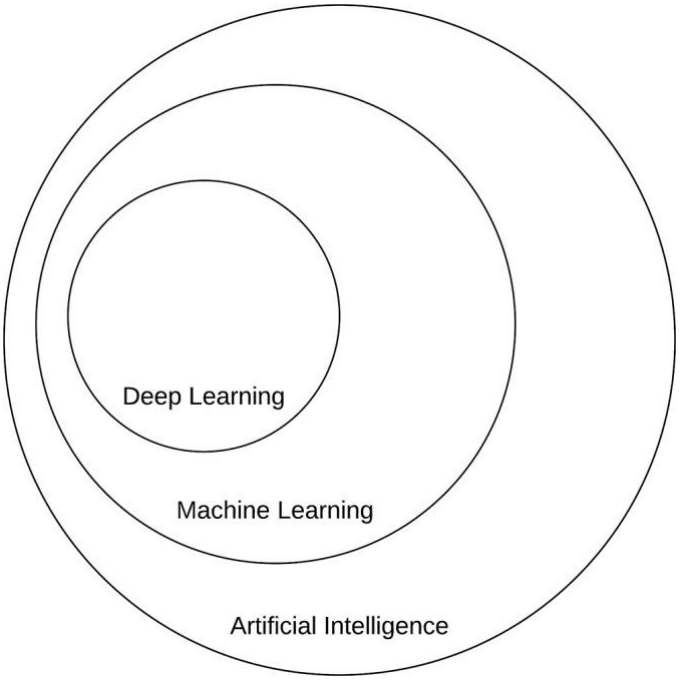

Fig 1.4.1: A Venn diagram describing deep learning as a subfield of machine learning which a subfield ofartificial intelligence is in turn.

1.5 Convolutional Neural Network

A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While inprimitive methods filters are hand-engineered, with enough training, ConvNets can learn these filters/characteristics.

The architecture of a ConvNet is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex. Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field. A collection of such fields overlaps to cover the entire visual area.

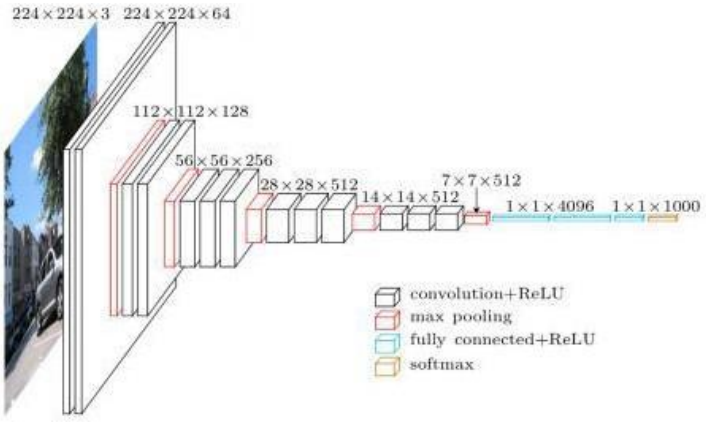

Fig 1.5.1: A visualization of the VGG Architecture

Each layer in a CNN applies a different set of filters, typically hundreds or thousands of them, and combines the results, feeding the output into the next layer in the network. Duringtraining, a CNN automatically learns the values for these filters.
In the context of image classification, CNN may learn to:

- Detect edges from raw pixel data in the first layer.
- Use these edges to detect shapes (i.e., "blobs") in the second layer.
- Use these shapes to detect higher-level features such as facial structures, parts of a car,etc.in the highest layers of the network.

The last layer in a CNN uses these higher-level features to make predictions regarding the contents of the image.

Layer 1: Convolutional

The role of the convnet is to reduce the images into a form which is easier to process, without losing features which are critical for getting a good prediction. Example regarding this is shown in **Fig 1.5.2**

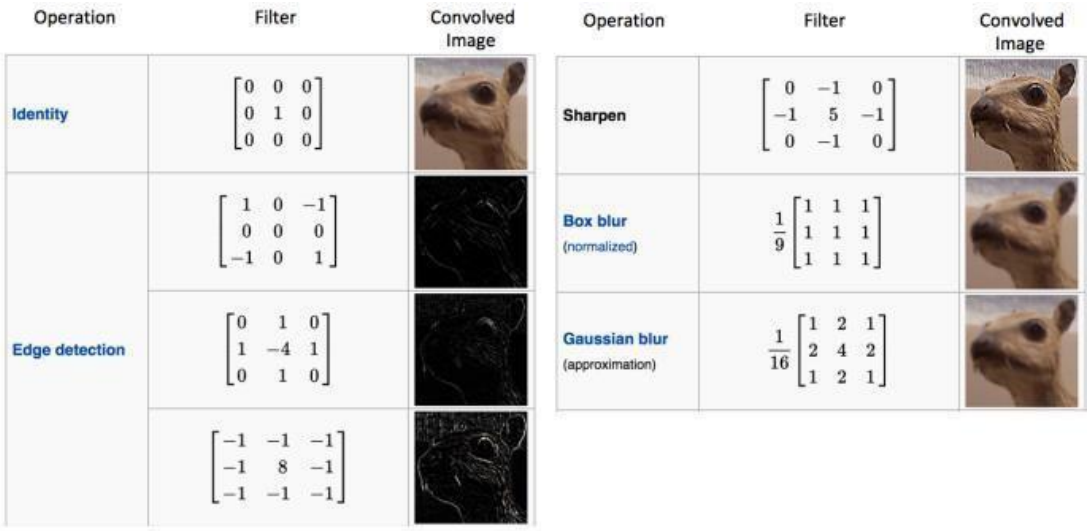

Fig 1.5.2: Example for Convolutional Layer

Layer 2: Pooling Layer

The pooling layer is responsible for reducing the spatial size of the convolved feature. This is to decrease the computational power required to process the data through dimensionality reduction.

Layer 3 & 4: Fully Connected Output Layer And Softmax

Neurons in FC layers are fully connected to all activations in the previous layer, as is the standard for feedforward neural networks. FC layers are always placed at the end of the network(i.e., we don't apply a CONV layer, then an FC layer, followed by another CONV) layer. It's common to use one or two FC layers prior to applying the softmax classifier, as the following(simplified) architecture demonstrates:

INPUT => CONV => RELU => POOL => CONV => RELU => POOL => FC => FC

Here we apply two fully connected layers before our (implied) softmax classifier which will compute our final output probabilities for each class.

Gives the final probabilities for each label. We have an activation function such as softmax orsigmoid to classify the outputs as cat, dog, car, truck etc.

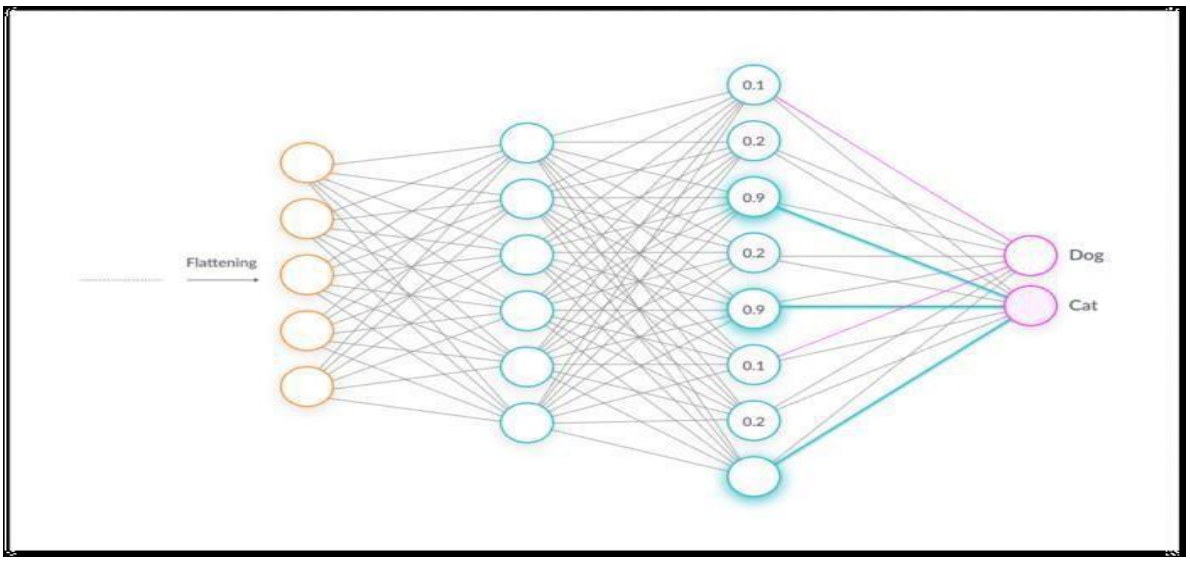

Fig 1.5.3: Fully Connected Output Layer

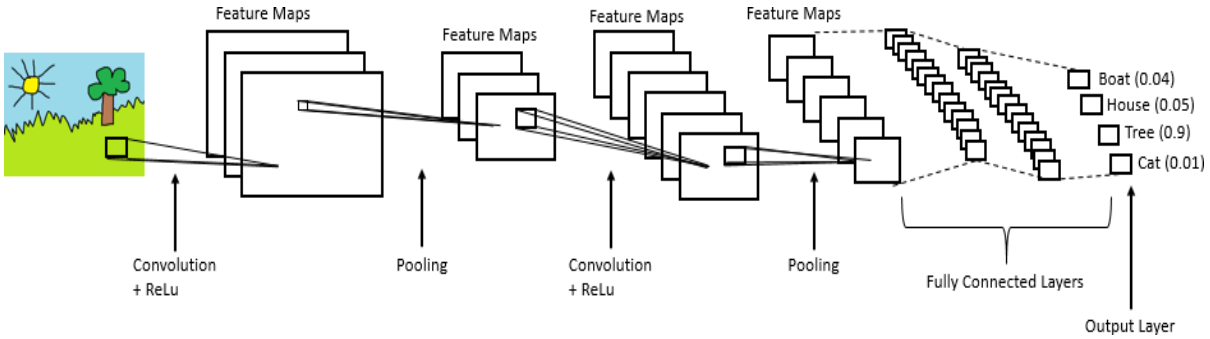

Fig 1.5.4: Complete CNN Architecture

1.6 Internet of Things

The Internet of things (IoT) describes physical objects (or groups of such objects) with sensors, processing ability, software, and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks. Internet of things has been considered a misnomer because devices do not need to be connected to the public internet, they only need to be connected to a network and be individually addressable.

The field has evolved due to the convergence of multiple technologies, including ubiquitous computing, commodity sensors, increasingly powerful embedded systems, and machine learning. Traditional fields of embedded systems, wireless sensor networks, control systems, automation, independently and collectively enable the Internet of things. In the

consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", including devices and appliances that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smartphones and smart speakers. IoT is also used in healthcare systems.

1.6.1 Application of IoT

- **Healthcare -** Healthcare industry has been utilizing the possibilities of Internet of Things for life saving applications. Starting from collecting vital data from bed side devices, real- time diagnosing process, accessing medical records and patient Information across multiple departments, the entire system of patient care can be improved with IoT implementation.
- **Smart Home and Office -** Smart home applications with the use of smart sensors are becoming popular now. Any smart device can be configured and connected to the internet and control using simple mobile application.
- **Agriculture and Smart Farming -** There are lot of challenges in the agriculture and farming industry to produce more crops and vegetable to feed increasing human population. Internet of Things can assist farmers and researchers in this area to find more optimized and cost-effective ways to increase production.
- **Autonomous Driving -** Autonomous driving has been evolving with the use of artificial intelligence and smart sensor technology in Internet of Things. Earlier generation of autonomous vehicle (partial automation) will assist drivers to drive safely, avoid collisions and warn about the conditions of the road and vehicle.

1.7 Arduino UNO

Fig 1.7.1: Arduino UNO

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

CHAPTER 2

DETAILED LITERATURE SURVEY

A detailed survey of 16 papers was carried out which are listed below. The main objectives of the paper, the problem statement and the author's approach was studied which helped us to extract the information required for our project and hence come up with our own problem statement and objectives.

1. **[2020] Drowsiness Detection of a Driver using Conventional Computer Vision Application,** Hitendra Garg.

   The developments in technology over the years bring the support to drivers using smart vehicle systems. In past few years, there has been substantial increase in road accidents in India and worldwide as well. The most significant reasons for the same are drowsiness and fatigue. Therefore, driver drowsiness and fatigue detection is major possible area to prevent a large number of sleep induced road accidents. Considering this problem, this article proposes a Real-Time Drowsiness Detection System (RT-DDS) applicable in motor vehicles with the help of conventional Computer Vision applications. The system employed various Computer Vision applications using blink rate, eye closure, yawning to effectively and quickly identify the drowsiness of a driver during driving the vehicle and alter the driver accordingly. The proposed work tried to contribute in reducing the increased number of road accidents while keeping the methodologies simple and intact.

2. **[2021] Monitoring Driver Drowsiness status at Night based on Computer Vision,** Vidhu Valsan A , Paul P Mathai and Ierin Babu.

   Drivers drowsiness and fatigue decreases the vehicle management skills of a driver. The operator driving vehicle in night has become a significant downside today. Driver in a drowsiness state is the one among the important reason of increasing amount of road accidents and death. Hence the drowsiness detection of driver is considering as most active research field. Many ways are created recently to detect the drowsiness of driver. Existing methods can be classified in three categories based on physiological measures, performance measures of vehicles and ocular measures. Few ways are intrusive and distract the driver from comfortable driving. Some of the methods need expensive sensors for information handling. drowsiness is developed in this paper. In this proposed system, real time video of driver records using a digital camera. Using some image processing techniques, face of the driver is detected in each localized using one shape

predictor and calculating eye aspect ratio, mouth opening ratio, yawning frequency subsequently. Drowsiness is detected based on the values of these parameters. Adaptive thresholding method is used to set the thresholds. Machine learning algorithms were also implemented in an offline manner. Proposed system tested on the Face Dataset and also tested in real-time. The experimental results shows that the system is accurate and robust.

3. **[2020] An Efficient Convolutional Neural Network Approach for Facial Recognition,** Aayushi Mangal ,Himanshu Malik and Garima Aggarwal.

   Data security being the main concern now a days, has faced a lot of threat in terms of breaching of information which requires immediate attention. Biometrics have served a long-run for this purpose which is a part of Deep Learning. In the recent past, face recognition has become a very important tool for safety and security purposes. This paper presents the application of face recognition technique, making use of Convolutional Neural Network (CNN) with Python and a comparison is drawn between the other techniques such as Principal Component Analysis (PCA), Local Binary Pattern (LBP) and K Nearest Neighbour (KNN). Unlike conventional methods, the proposed scheme uses four Convolutional layers with ReLu layers, four pooling layers, a fully connected layer and a Softmax Loss Layer to normalize the probability distribution. The dataset consists of 1500 images with different facial expressions and the model is trained and tested in order to acquire an accuracy using CNN method.

4. **[2020] Emotion Recognition Based on Facial Expressions Using Convolutional Neural Network (CNN),**Sabrina Begaj , Ali Osman Topal and Maaruf Ali**.**

   Over the last few years, there has been an increasing number of studies about facial emotion recognition because of the importance and the impact that it has in the interaction of humans with computers. With the growing number of challenging datasets, the application of deep learning techniques have all become necessary. In this paper, we study the challenges of Emotion Recognition Datasets and we also try different parameters and architectures of the Conventional Neural Networks (CNNs) in order to detect the seven emotions in human faces, such as: anger, fear, disgust, contempt, happiness, sadness and surprise. We have chosen iCV MEFED (Multi-Emotion Facial Expression Dataset) as the main dataset for our study, which is relatively new, interesting and very challenging.

5. **[2019] Driver Drowsiness Detection by Yawn Identification Based on Depth Information and Active Contour Model**, Mina Zohoorian Jafari Yazdi and Mohsen Soryani

   Increasing road accidents, caused by sleepy drivers is an important transportation problem now a day. A high percentage of road accidents are caused by drivers' lack of awareness caused by fatigue. Hence, the development of an automated system that determines the driver's drowsiness and issues a warning as soon as the driver loses attention on the road is a necessary step to prevent road accidents. This system must also function under illumination variations that have previously been a complication in similar works. Specific postures of the body and face may be regarded as indications of driver's fatigue. These include yawning and eye closure which determine whether or not the driver is in an adequate condition for driving. In this paper, in order to detect a driver's yawning, her nose tip is first identified in the depth image of the face and then the lower area of the face is separated. In the resulting image, the approximate area of the mouth is found and using depth information and the active contour model, an open mouth is identified.

6. **[2020] Driver Drowsiness Detection System based on LBP and Haar Algorithm**, Yuvraj Suryawanshi and Sushma Agrawal**.**

   Drowsiness is one of the main reasons for road accidents in the last few years. With the improvement in technology, various accident prevention technologies are evolving. The primary objective of avoidance of road accidents can be achieved through real-time drowsiness detection of a driver using video capturing with face detection. After capturing and detecting the drowsiness by using a camera, the alarm will buzz. The position of head and blinking of eyes are used as the features to detect whether the driver is drowsy or not. The camera captures the real-time drowsiness by using Local Binary Pattern to detect the face and Haar cascade to detect the eyes. A custom eye blinking file has been developed for eye blinking detection and AdaBoost is used to focus on eye movements at the same instant of time.

7. **[2020] Evaluation of Driver Drowsiness based on Real-Time Face Analysis**, Anway Giovanni Salzillo, Student Member, IEEE, Ciro Natale and Giovanni B. Fioccola, Enrico Landolfi.

   Driving a car is a complex and potentially risky activity in people's everyday life, and it requires the full involvement of physiological and cognitive resources. Any loss of these resources can cause traffic accidents. For example, drowsy driving affects the ability to adapt, predict and react to unexpected events. A solution to this problem is the adoption of Advanced Driver Assistance Systems (ADAS), which can warn the driver if sleepiness is detected. Thus, they should include a Driver Monitoring System (DMS) to understand, measure and monitor human behaviour in different scenarios. This article is focused on detecting driver drowsiness by using non-intrusive measures such as the behavioural approach, as it is the most promising solution to use in real vehicles. The developed framework allows the extraction of drowsiness-related measures by analysing the driver's face with a standard camera. First, a face detection stage identifies the driver face in a video frame. Then, a set of facial landmarks locations are identified. These landmark points are used to estimate the head orientation and to detect when a blink occurs. By monitoring properly defined ocular variables, the degree of driver drowsiness is detected through a Fuzzy Inference System (FIS).

8. **[2020] Development of an intelligent drowsiness detection system for drivers using image processing technique**, Amin Azizi Suhiman , Zazilah May and Noor A' in A.Rahman.

   Drowsy driving highly contributes to a number of road accidents throughout the years. Car crashes or any unwanted incidents can be avoided by implementing a system with alarm output to alert drowsy drivers to focus on the road. An intelligent system is developed to detect driver drowsiness and trigger alarm to alert drivers as one way to prevent accidents, save money and reduce losses and sufferings. However, due to high variability of surrounding parameters, current techniques have several limitations. Bad lightings may affect camera ability to accurately measure the face and the eye of the driver. This will affect the analysis using image processing technique due to late detection or no detection hence decrease the accuracy and efficiency of the technique. Several techniques have been studied and analyzed to conclude the best technique with the highest accuracy to detect driver drowsiness. In this work, a real-time system that

utilizes computerized camera to automatically track and process driver's eye using Python, dlib and OpenCV is proposed. The eye region of the driver is measured and calculated continuously to determine the drowsiness of the driver before triggering an output alarm to alert the driver.

9. **[2021] Drowsiness Detection System Using Deep Learning**, Avigyan Sinha, Aneesh RP, Sarada K Gopal.
   Drivers drowsiness is the major problem that causes road accidents. Unlike normal facial expression, drowsiness is defined to be a condition of exhaustion, where the expression of the face is different from usual. The important steps in detecting drowsiness are face detection and expression detection. Many algorithms are being developed to detect face and expressions. But these algorithms give poor performance due to the extrinsic parameters of the environment. Light and position of the camera are the major problems. In this paper, different architectures were used to analyse the performance of face and drowsiness detection. Also we have proposed new detection methods using deep learning techniques. To estimate the drivers' state we use facial regions corresponding to the entire face. The algorithms employed for face detection are i) Viola Jones ii) DLib iii) Yolo V3. For the Classification, The CNN (Convolutional Neural Network) architecture employed in the drowsiness detection is modified LeNet.

10. **[2020] All In One Network For Driver Attention Monitoring**, Dawei Yang , Xinlei Li ,Xiaotian Dai , Rui Zhang , Lizhe Qi , Wenqiang Zhang , Zhe Jiang.
    Nowadays, driver drowsiness and driver distraction is considered as a major risk for fatal road accidents around the world. As a result, driver monitoring identifying is emerging as an essential function of automotive safety systems. Its basic features include head pose, gaze direction, yawning and eye state analysis. However, existing work has investigated algorithms to detect these tasks separately and was usually conducted under laboratory environments. To address this problem, we propose a multi-task learning CNN framework which simultaneously solve these tasks. The network is implemented by sharing common features and parameters of highly related tasks. Moreover, we propose Dual-Loss Block to decompose the pose estimation task into pose classification and coarse-to-fine regression and Objectcentric Aware Block to reduce orientation estimation errors. Thus, with such novel designs, our model not only achieves SOA results but also reduces the complexity ofintegrating into automotive safety systems. It runs at 10 fps on

vehicle embedded systems which marks a momentous step for this field. More importantly, to facilitate other researchers, we publish our dataset FDUDrivers which contains 20000 images of 100 different drivers and covers various real driving environments. FDUDrivers might be the first comprehensive dataset regarding driver attention monitoring.

11. **[2020] Driver Drowsiness Detection Using Convolutional Neural Networks**, Zuzana Képešiová and Ján Cigánek, Štefan Kozák.

    The presented paper deals with automatic detection of driver drowsiness. Detecting the driver's drowsiness behind the steering wheel and then alerting him may reduce road accidents. Drowsiness in this case is captured using an autocamera, whereby, based on the captured image, the neural network recognizes whether the driver is awake or tired. The convolutional neural network (CNN) technology has been used as a component of a neural network, where each frame is evaluated separately and the average of the last 20 frames is evaluated, which corresponds to approximately one second in the training and test dataset. First, we analyze methods of image segmentation, and develop a model based on convolutional neural networks. Using an annotated dataset of more than 2000 image slices we train and test the segmentation network to extract the driver emotional status from the images.

12. **[2020] Real-Time Drowsiness Identification based on Eye State Analysis**, Nageshwar Nath Pandey, Naresh Babu Muppalaneni.

    As per the previous year’s report concerning to road crashes indicates that the principal cause of such a fatal road accidents is because of negligence behavior as well as drowsiness of driver. This problem reveals the requirement of such a system that can recognize drowsiness state of driver and gives alert signal to the driver before the occurrence of any accidents. Therefore, this proposed work has established drowsy detection as well as accident avoidance system based on the eye blink duration. Here, first the open and close state of eye are detected based on the eye aspect ratio (EAR). Further, the blink duration or count during the changes of eye state from open to close are analyzed. Then, it identifies the state of drowsiness, when blink duration becomes more than a certain limits and sends the alert message to the driver through the alarm. Our developed system has shown the accuracy of 92.5 % approx on yawning dataset (YawDD).

13. **[2020] Arduino based Real Time Drowsiness and Fatigue Detection for Bikers usingHelmet,** M.Oviyaa, P.Renvitha and Ms.R.Swathika.

    Vehicle accidents are rapidly increasing in many countries. Among many other factors, drowsiness and fatigue are playing a major role in these accidents and systems which can monitor it are currently being developed. Among them, Electroencephalography (EEG) proved to be very reliable. The conventional vehicle and the vision based detection for drowsiness is very much essential only when the driver is about to sleep and every so often very late in preventing fatalities on road. This paper is specially developed to improve the safety of the bikers. The proposed system has EEG-sensors which are implemented within the helmet to detect the drowsy state of the driver. The biomedical signal from the driver's brain is sensed by a Brain-wave sensor. This system provides real-time drowsiness and fatigue detection for the bikers by making a helmet to play a vital part with warning platform as a miniaturized sensor and to provide mind machine interface (MMI) to address the challenges like drowsiness and fatigue. When the biker is detected to be in drowse state the system alerts the biker by an alarm and motor gets slow down and stopped.

14. **[2020] Neural Network Based Driver Warning System,** Ishan jain, Hrishita Singh. According to reports, an astounding 69% of adult drivers report driving while drowsy at least once a month in the previous year according to The National Sleep Foundation. In today's fast-moving world people are usually stressed and sleep-deprived due to their demanding career. As a result of this such people fall asleep behind the wheel. Visual fatigue and drowsiness cause many accidents due to which many deaths and injuries are taking place around the world. To increase vehicle security, we propose an advanced driver assistance system (ADAS). This system aims to locate and estimate the driver's eye condition and head position using a camera that will be an indication of his drowsiness level. We also propose a speed control system to detect signboards on the way and instruct the driver either to continue with the same speed or to decelerate the vehicle based on machine learning. This system also calculates the distance between two vehicles, based on the distance it instructs the driver either to continue with the same speed or to slow down. With the system on board of multiple vehicles the safety of the travel increases and the rate of accidents caused due to driver negligence will be reduced.

15. **[2020] Early driver drowsiness detection using electroencephalography signals,** Sazali Yaacob, Pranesh Krishnan and Amir Rasyadan.

    This study aims to provide a solution in determining the drowsiness state among drivers at the early stage. The revolving issue nowadays is the increasing number of traffic crashes due to drowsiness are considerably at an alarming stage. Drowsiness is a state of sleepiness, which leads to the lapse of attention and focuses. Numerous factors caused drowsiness, which can be determined through the biosignals of an individual. A thorough analysis of the bio-signals of drivers, which is the electroencephalogram (EEG), is applied as one of the solutions in handling drowsiness. EEG is significant in measuring drowsiness levels as it shows the electrical activity of the brain. This study analyzes driver behaviour by measuring the brain wave pattern to detect drowsiness. In this study, the brain signals from the subjects were collected using an EEG headset interfaced with the OpenBCI software. The subjective approach, namely, the Karolinska Sleepiness Scale (KSS), is performed to validate the data. This study involves signal processing in examining brain wave patterns by using MATLAB. An alpha frequency band is extracted from the estimation of power spectral density (PSD) using the periodogram method. Classification of all the extracted features by using a decision tree showed high accuracy ranges from 77.1%-97.20% for each of the subjects.

16. **[2020] Detecting Human Driver Inattentive and Aggressive Driving Behavior UsingDeep Learning**, Monagi H. Alkinani, Wazir Zada Khan .

    Drowsy driving contributes more than 20% of road fatalities, especially to countries like America which relies heavily on road transportation. With significant physical injuries to passengers and significant economic losses, it becomes a vital task to detect driver drowsiness and relieve their fatigue. In this research, we developed an integrated facility to help resolve this task, which contains a polymorphic detection model, based on deep learning, and a music recommender system, aiming to release drivers' fatigue. The detection model contains two parts. The first utilized human keypoints detection model to monitor driver's expression and detect drowsiness while the other used real time heart rate to detect. To ease the pressure of data collection and make the whole system a integrated product, a wearable device is made by ourselves. Besides these, a novel personalized music recommender system is built up to help adjust the status of driver. With the combination of two detection model, we achieved 96.82% accuracy and built up a finetuned deep learning model.

2.1 LITERATURE SURVEY SUMMARY TABLE

The table 2.1 represents the summary of our Literature Survey review which consists of the paper referred to, the problems that have been encountered in the particular paper, the author's approach in solving the problem and finally the results that were obtained.

SL. NO	Title of the Paper	Problem Addressed	Authors Approach/ Method	Results
1	Drowsiness Detection of a Driver using Conventional Computer Vision Application IEEE 2020	In the proposed work, method from computer vision features for facial landmark detectionis implemented to identify the state of drowsiness and fatigue.	This paper proposed an method called Histogram of Oriented Gradients (HOG) with Linear Support Vector Machine (SVM) detectors to localize the driver's face in a frame is implemented.	Using Histogram of Oriented Gradients (HOG) It aims for a good facial recognition rate.
2	Monitoring Driver Drowsiness status atNight based on Computer Vision IEEE 2021	In the proposed work, computer image processing implemented to identify the state of drowsiness and fatigue for better results.	They proposed a method called Contrast Limited Adaptive Histogram Equalization (CLAHE) method is used to improve the contrast of images.	This method is used to detect the drowsiness in low lightening condition as well as at night.
3	An Efficient Convolutional Neural Network Approach for FacialRecognition IEEE 2020	In the project, the concept of Deep Learning is appliedto recognition the face in an image.	This paper proposed a method using Deep Learning's CNN for detecting the the face by applying pretrained Dataset.	This method is used obtain the best results thanevery existing method for facial Recognition.

4	Emotion Recognition Based on Facial Expressions Using Convolutional Neural Network (CNN) IEEE 2020	In the project, the convolutional neural network of Deep learning is used for Facial Emotion Expressions (FER).	This paper proposed a method of CNN which uses 4 layer and a pre-trained VGG16 model was appliedto our dataset for detecting the face from giving Images.	The Results are these emotions are overpredicted: angry, disgust, fear and surprised, and these emotions are underpredicted :contempt and sadness.
5	Development of an intelligent drowsiness detection system fordrivers using imageprocessing technique. IEEE 2020	Electroencephalogr am(EEG),Electroc ardiogram (ECG), respiration measurement and other techniques to detect the drowsiness have many drawback.	The proposed method makes use of a real time system that utilizes computerized camera to automatically track and process driver's eye using Python, dlib and OpenCV.	Due to Bad lighting condition during the night, the accuracy of this system is around 80%.
6	Driver Drowsiness Detection by Yawn Identification Basedon Depth info and Active Contour Model. IEEE 2019	Many times accidents occur due to the driver's drowsiness, Yawning also comes under drowsiness. So detecting this is important.	The proposed method make use of Depth Information and Active Contour Model to detect weather the driver is yawning or not.	Using the depth image, an open or closed mouth was detected with an accuracy of 86%. And it is light insensitive.
7	Driver Drowsiness Detection System based on LBP andHaar Algorithm. IEEE 2020	In the proposed system behavioral-based approach is used with the monitoring of eye, eye blinking, and head position.	This uses Local Binary Pattern to detect the face and Haar cascade to detect the eyes. AdaBoost is used to focus on eye movements at the same instant of time.	This gives us an analysis of drowsiness detection in real time during daylight with efficient brightness towards the face.

8	Evaluation of Driver Drowsiness based on Real-TimeFace Analysis. IEEE 2020	Development of an algorithm to createa system based on the direct observation of the driver, rather than the vehicle state, using methods thatdo not require intrusive data acquisition systems, thus allowing its adoption in a real world application.	This uses of an algorithm that has been implemented in Python by using libraries: dlib, skfuzzy and OpenCV. Fuzzy Inference System (FIS) is used to detect the degree of driver drowsiness.	The performance analysis showed that the proposed blink detector gives satisfactory results: Precision equals 93%, Recall equals 90% and FI Score equals 91%.
9	Drowsiness Detection SystemUsing Deep Learning IEEE 2021	Compared to many algorithms these algorithms give poor performance due to the extrinsic parameters of the environment. Light and position of the camera are the major problems.	Three different algorithms implemented Viola Jones algorithm, Dlib based MC KCF algorithm , Performance of MC – KCF algorithm is used to detect the driver drowsiness.	Apart from other research works, Face detection from the low light images is the first objective of this work
10	All In One NetworkFor Driver Attention Monitoring IEEE 2020	However, existing work has investigated algorithms to detect these tasks separately and was Usually conducted under laboratory environments. To address this problem, we propose a multi- task learning CNN framework which simultaneously solve these tasks	The proposed method is implemented by a multi-task learning CNN framework , DANet, With proposed DBL and OAB.	In this paper, we propose a multi-task learning CNN framework DANet, which can Simultaneously identify face landmark, head pose and gaze direction.

11	Driver Drowsiness Detection Using Convolutional Neural Networks IEEE 2020	Drowsiness in this case is captured using an autocamera, whereby, based on the captured image, the neural network recognizes whether the driver is awake or tired.	This paper proposed a method using Deep Learning's CNN for detecting the the face by applying pretrained Dataset.	We decided to create an application that could help drivers with detecting their mental state of drowsiness and we achieved
12	Real-Time Drowsiness Identification basedon Eye State Analysis IEEE 2021	This problem reveals the requirement of such a system that can recognize drowsiness state of driver and gives alert signal to the driver before the occurrence of any accidents.	first the open and close state of eye are detected based on the eye aspect ratio (EAR)	this proposed work has established drowsy detection as well as accident avoidance system based on the eye blink duration
13	Arduino based RealTime Drowsiness and Fatigue Detection for Bikers using Helmet IEEE 2020	This system provides real-time drowsiness and fatigue detection for the bikers by making a helmet with warning platform as a miniaturized sensor and to provide mind machine interface (MMI) to address the challenges like drowsiness and fatigue.	The proposed system has EEG (Electroencephalography)-sensors which are implemented within the helmet to detect the drowsy state of the driver.	This system delivers the most efficient and embedded drowsy driver detection system for bike riders using helmet.

14	Neural Network Based Driver Warning System IEEE 2020	We have focused on the drive alertness system to monitor the concentration of a car driver and accordingly, we will provide data on lanes and car distances and safe length for other car safety systems to act pre-emptively and provide better safety.	The proposed method Advanced Driver Assistance System (ADAS). This system aims to locate and estimate the driver's eye condition and head position using a camera that will be an indication of his drowsinesslevel.	After the algorithm was implemented and tested it was observed that when enough amount of light is falling on the person, the face and eyes are successfully detected.
15	Early driver drowsiness detection using electroencephalography signals IEEE 2020	A thorough analysis of the bio-signals of drivers which is the electroencephalogram (EEG), is applied as one of the solutions in handling drowsiness.	This proposed method EEG (electroencephalogram) is significant in measuring drowsiness levels as it shows the electrical activity of the brain.The brain	The relative alpha power for each Alert Driving and Drowsy Driving were being averaged by calculating the mean.
16	Integrated Intelligent Drowsiness Detection System Based on Deep Learning IEEE 2020	The detection model contains two parts. The first utilized human keypoints detection model to monitor driver's expression and detect drowsiness while the other used real time heart rate to detect.	This proposed method developed an integrated facility to help resolve this task which contains a polymorphic detection model based on deep learning and a music recommender system aiming to release drivers' fatigue	The proposed integrated drowsiness detection system which can use multiple approaches to detect drowsiness during long-time driving and give moderate feedback to boost the spirit of the driver.

Table 2.1: Summary of Literature Survey describing the problems addressed, author's approach and the results of the survey.

CHAPTER 3

PROBLEM STATEMENT & OBJECTIVES

3.1 Problem Statements

- In general, nearly 20% of road accidents all over the world are caused due to the driver fatigue. But all the existing system have an unacceptable accuracy, which in this field is highly dangers.
- Some existing system comes with good accuracy but the time it takes to process and alert the driver is bit slow. Again, this is too dangers in this filed.
- And other systems have an acceptable accuracy but the cost is too expensive.

3.2 Objectives

The objectives of Proposed system are:

1) To design a system in such a way that, it aids in the prevention of accidents of passenger and commercial vehicles by detecting the early symptoms of drowsiness before the driver has fully lost all the attentiveness and warn the driver that they are no longer capable of operating the vehicle safely.
2) To design a system which will alert the driver by means of buzzer and speaker (also speaker can have a user defined/desired input) whenever the driver is drowsy.
3) And this proposed system has an hazard light which will glow when the system detect the driver's drowsiness. This will help in alerting the vehicle which are behind this vehicle.
4) The main objective is to have a low-cost, real-time drowsiness detection system with better accuracy.

CHAPTER 4

SYSTEM ANALYSIS

4.1 Functional Analysis

The functions of software systems are defined in functional Analysis and the behavior of the system is evaluated when presented with specific inputs or conditions which may include calculations, data manipulation and processing and other specific functionality.

- Our system should be able to read the real time image.
- It should be able to recognize the face in the image.
- It should be able to mark the facial landmarks in the recognized face.
- It should be able to recognize that the driver is drowsy or not with Eye Aspect ratio.
- It should be able to alert the driver if the driver is drowsy.

4.2 Non-Functional Analysis

Nonfunctional needs describe however a system should behave and establish constraints of its practicality. This type of needs is additionally called the system's quality attributes. Attributes such as performance, security, usability, compatibility are not the feature of the system, they are a required characteristic. They are "developing" properties that emerge from the whole arrangement and hence we can't compose a particular line of code to execute them. Any attributes required by the customer are described by the specification. We must include only those requirements that are appropriate for our project.

Some Non-Functional Requirements are as follows:

- Reliability
- Maintainability
- Performance
- Portability
- Flexibility

4.3 Hardware Requirements:

- Processor: Pentium IV 2.4GHz
- Hard Disk: 250 GB
- RAM: 4GB
- Monitor: 15 VGA Color
- Arduino UNO
- APR Chip
- Speaker
- Buzzer
- 2 LED Light (Hazard Light)
- Connecting cables and wires.

4.4 Software Requirements:

- Operating System: Windows XP Professional, Windows 7/10
- Arduino IDE
- Python IDE

CHAPTER 5

DESIGN

5.1 High Level Design: System Architecture

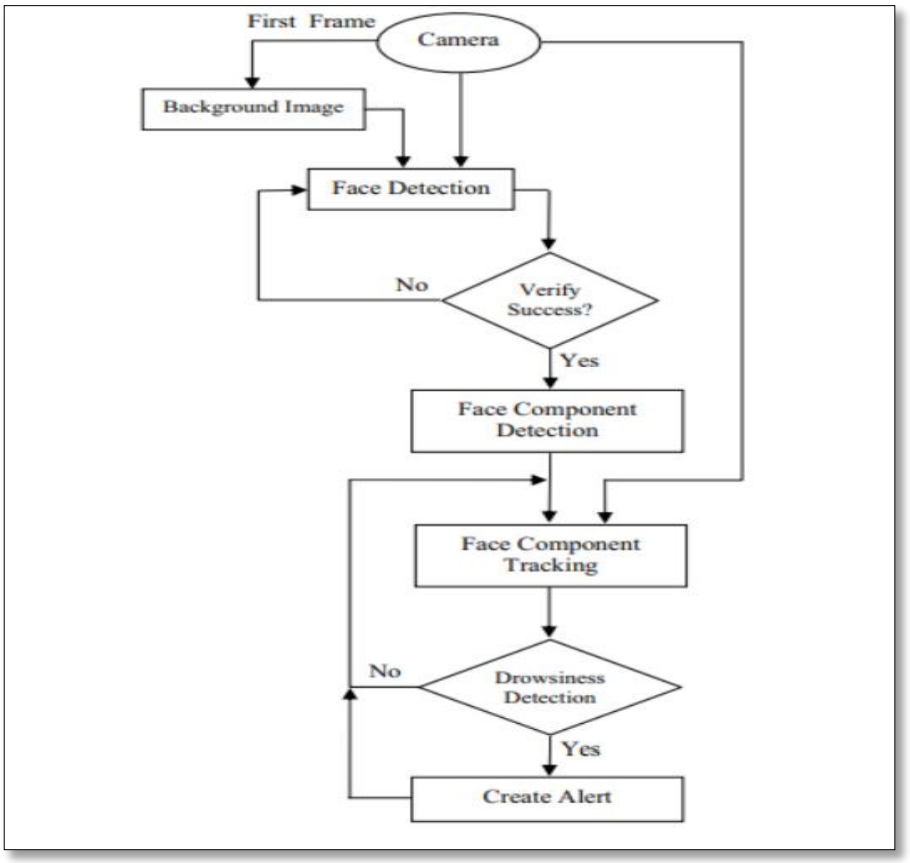

Fig 5.1: System Architecture

Besides eye and head movements, another visual cue that can potentially capture one's level of drowsiness is his/her eyes and faces detection analysis. Making a real time application with computer vision is very effective and efficient challenging task that needs processing powerful system. OpenCV is open source software, which is used for creating computer vision. OpenCV is available in C, C++, and Python and Java programming languages extension. It can be over clocked maximum 1500MHz PC with OPEN CV can work with windows operating system, windows OS is loaded with programming software and OpenCV. In case of driver is in sleepy or finding fatigue, the message will be sent by using speaker and buzzer will be turned on. Haar Feature based Cascade Classifier technique, it is a machine learning based approach where a cascade function is trained from a lot of positive andnegative images, and this positive image is used for detecting face region and eye region the update of region. Open CV is packed with a trainer as well as detector. This used for creating user defined object classifier.

The object classifier that has been created is stored in.xml file extension classifier can be used in the later stages of programming.Also in this paper we use canny operator edge detection for recognize exact coordinate of eyes region.

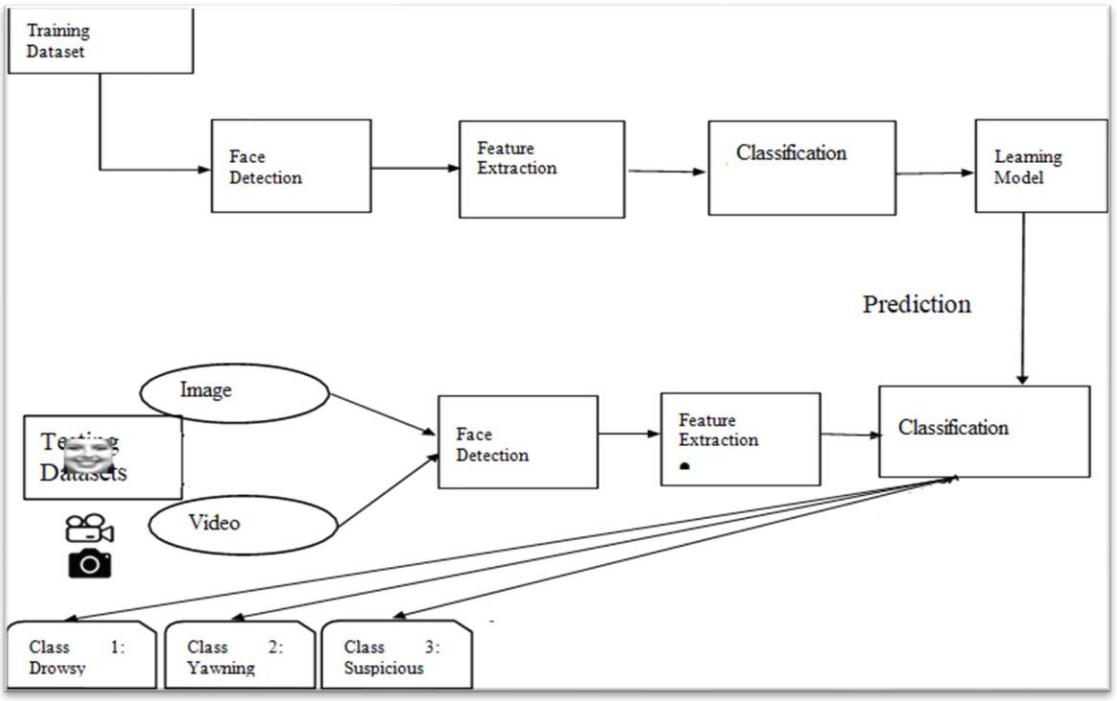

Fig 5.2: Block Diagram

It is widely used for modeling software systems and is increasingly used for high designing non-software systems and organizations. It is a process of planning a new business system or replacing an existing system by defining its components or modules to satisfy the specific requirements. Before planning, you need to understand the old system thoroughly and determine how computers can best be used in order to operate efficiently. System Design focuses on how to accomplish the objective of the system.

5.2 Low Level Design

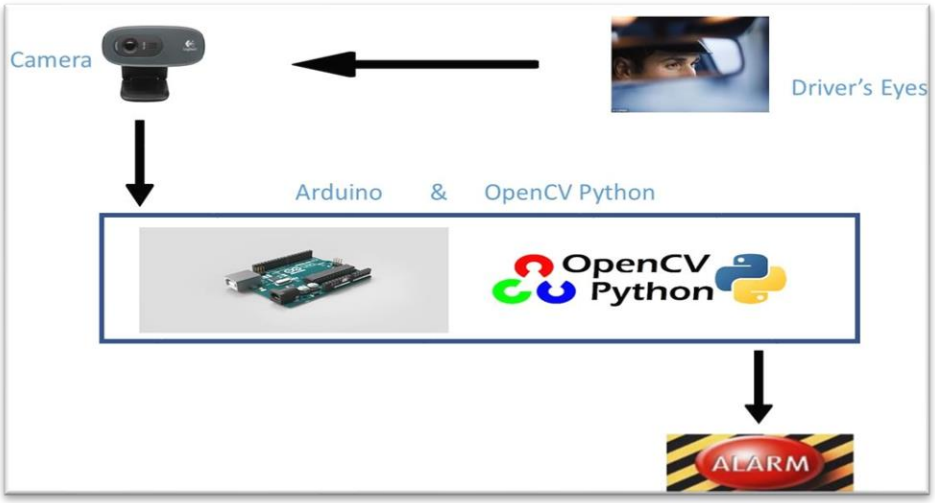

Fig 5.3: Low Level Design

The system comprises of 3 phases:

1. Capturing –The image of the driver is captured using logitech camera, which is known for its clarity and cost effective. This camera creates a video clip and concentrates on single frame containing driver's eye blink. The captured video is then divided into frames for analaysing.
2. Detection – This phase first involves the detection of face of the driver. Face detection is done using facial landmark which results in locating the face in a frame. Only facial related structures or features are detected and all other types of objects like buildings, trees, bodies are ignored. In our method eye is the decision parameter for finding the state of the driver. Eye Aspect Ratio(EAR) is the ratio of number of eye blinks to the width of the eye.
3. Correction – The actual state of the eye is found, if it is closed or open or semi closed or semi open. The identification of eye status is most important requirement. A warning message is channelized if obtained eyes are in close or semi close state to a particular threshold value. If the systems detects that the eyes are open then it is repeated again and again until closed eyes are found.

CHAPTER 6
IMPLEMENTATION

An implementation is a realization of a technical specification or algorithm as a program, software component, or other computer system through computer programming and deployment. Many implementations may exist for a given specification or standard. For example, web browsers contain implementations of World Wide Web Consortium-recommended specifications, and software development tools contain implementations of programming languages.

A special case occurs in object-oriented programming, when a concrete class implements an interface; in this case the concrete class is an implementation of the interface and it includes methods which are implementations of those methods specified by the interface.

In the information technology industry, implementation refers to post-sales process of guiding a client from purchase to use of the software or hardware that was purchased. This includes requirements analysis, scope analysis, customizations, systems integrations, user policies, user training and delivery. These steps are often overseen by a project manager using project management methodologies. Software Implementations involve several professionals that are relatively new to the knowledge based economy such as business analysts, technical analysts, solutions architects, and project managers.

To implement a system successfully, a large number of inter-related tasks need to be carried out in an appropriate sequence. Utilising a well-proven implementation methodology and enlisting professional advice can help but often it is the number of tasks, poor planning and inadequate resourcing that causes problems with an implementation project, rather than any of the tasks being particularly difficult. Similarly with the cultural issues it is often the lack of adequate consultation and two-way communication that inhibits achievement of the desired results.

Developing safety measures to prevent drunk and drowsy driving is a major challenge for the car industry. Here are some of the ideas on how to prevent drowsiness and drunk driving while driving. When a driver enters a car, starts the ignition at first, he would be told to provide breath sample, by using an alcohol sensor, it would be detected whether the driver is in drunk state or not. If yes, then the ignition would turn off. If driver not drunk, then next step would be face capture. Face capture would be done by a web camera that would be placed in front of the driver near dashboard.

The camera would capture the face of driver along with eye and mouth tracking. Eye tracking is done to detect whether the driver eyes are open or closed to measure drowsiness level and mouth capture done to check for yawning while driving. After detection and tracking of face, eyes and mouth capture while driving, the system continuously keeps checking for any variations in above parameters. By using Visual Studio 2013 and OpenCV with Emgu tracking and detection of facial features is being done.

OpenCV using Emgu being open library contains all XML files for eye closeness detection and yawn detection would be carried out using template matching where picture already stored will be compared to find whether the driver is in a drowsy state or not. If any one of the parameters gets checked that is if driver found drunk while driving or in drowsy state then an alarm would go off and seats would vibrate, thus making the driver alert again. If the alarm goes off again and again within a certain time interval, then the system would turn off the ignition and turn on the indicator lights to warn vehicles coming from behind to avoid crashing of vehicles.

Hardware Implementation

- **PC with OpenCV:** OpenCV (Open Source Computer Vision Library) is released under a BSD license and hence it‘s free for both academic and commercial use. It has C++, Python and Java interfaces and supports Windows, Linux, Mac OS, and Android. OpenCV was designed for computational efficiency and with a strong focus on real- time applications. Written in optimized C/C++, the library can take advantage of multi- core processing. Enabled with OpenCV, it can take advantage of the hardware acceleration of the underlying heterogeneous compute platform.

Software Implementation

- **Python:** Python is a great and friendly language to use and learn. It fun, and can be adapted to both small and large projects. Python will cut your development time greatly and overall, its much faster to write Python than other languages. This course will be a quick way to understand all the major concepts of Python programming. Python is a high-level, interpreted and general-purpose dynamic programming language that focuses on code readability. The syntax in Python helps the programmers to do coding in fewer steps as compared to Java or C++. The language founded in the year 1991 by the developer Guido Van Rossum has the programming easy and fun to do. They usually involve imperative and object-oriented functional programming.

- **OpenCV:** OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was later supported by Willow Garage then Itseez (which was later acquired by Intel). The library is cross-platform and free for use under the open-source BSD license. OpenCV supports the deep learning frameworks TensorFlow, Torch/PyTorch and Caffe.

- **Qt editor:** Qt Creator is a cross-platform C++, JavaScript and QML integrated development environment which is part of the SDK for the Qt GUI application development framework. It includes a visual debugger and an integrated GUI layout and forms designer. The editor's features include syntax highlighting and autocompletion. Qt Creator uses the C++ compiler from the GNU Compiler Collection on Linux and FreeBSD. On Windows it can use MinGW or MSVC with the default install and can also use Microsoft Console Debugger when compiled from source code. Clang is also supported.

- **Arduino:** Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

CHAPTER 7

TESTING AND RESULTS

7.1 Test Cases

Test Case ID	Test Case Description	Expected Output	Actual Output	Remarks
1	Image or video capture.	Should Capture input image.	Image Captured Successful.	Pass
2	Eye Detection.	Eye Should detected as facial Landmark.	Facial Landmark is detected.	Pass
3	Eye Blink Detection.	Blink State detected.	Same as Expected.	Pass
4	Voice Intimation.	Voice Output for different blinks.	Same as Expected.	Pass
5	Hazard Light	Light should glow when drowsiness is detected.	Same as Expected.	Pass
6	Head Tilt	Should detect when head bend.	Same as Expected	Pass
7	Image Capture and automated Facial Landmark Detection.	Face and Eye Detection.	Functioned Properly.	Pass
8	Eye Blink Detection and Voice output.	Voice output For No Blink or Drowsy State.	Functioned Properly.	Pass
9	Yawn Detection	Should detect when driver Yawn.	Same as Expected.	Pass

		Taker and Vehicle should Stop.		
10	System testing	Blinks detection and Voice Output and Intimation to Care taker.	Same as Expected.	Pass

Table 7.1: Test Cases

7.2 Results

The paper described an improved drowsiness detection system based on CNN-based Machine Learning. The main objective is to render a system that is lightweight to be implemented in embedded systems while maintaining and achieving high performance. The system was able to detect facial landmarks from images captured on a mobile device and pass it to a CNN-based trained Deep Learning model to detect drowsy driving behaviour. The achievement here was the production of a deep learning model that is small in size but relatively high in accuracy. The model that is presented here has achieved an average of 83.33% of accuracy for all categories where the maximum size of the model did not exceed 75KB. This system can be integrated easily into dashboards in the next generation of cars to support advanced driver-assistance programs or even a mobile device to provide intervention when drivers are sleepy. There are limitations to this technology, such as obstructing the view of facial features by wearing sunglasses and bad lighting conditions. However, given the current state, there is still room for performance improvement and better facial feature detection even in bad lighting conditions.

CHAPTER 8

SNAPSHOTS

The following snapshot contains the Drowsiness Detection process.

Fig 8.1: Drowsiness Detection

The following snapshot contains the Yawning Detection.

Fig 8.2: Yawning Detection

The following snapshot contains the Hardware Setup.

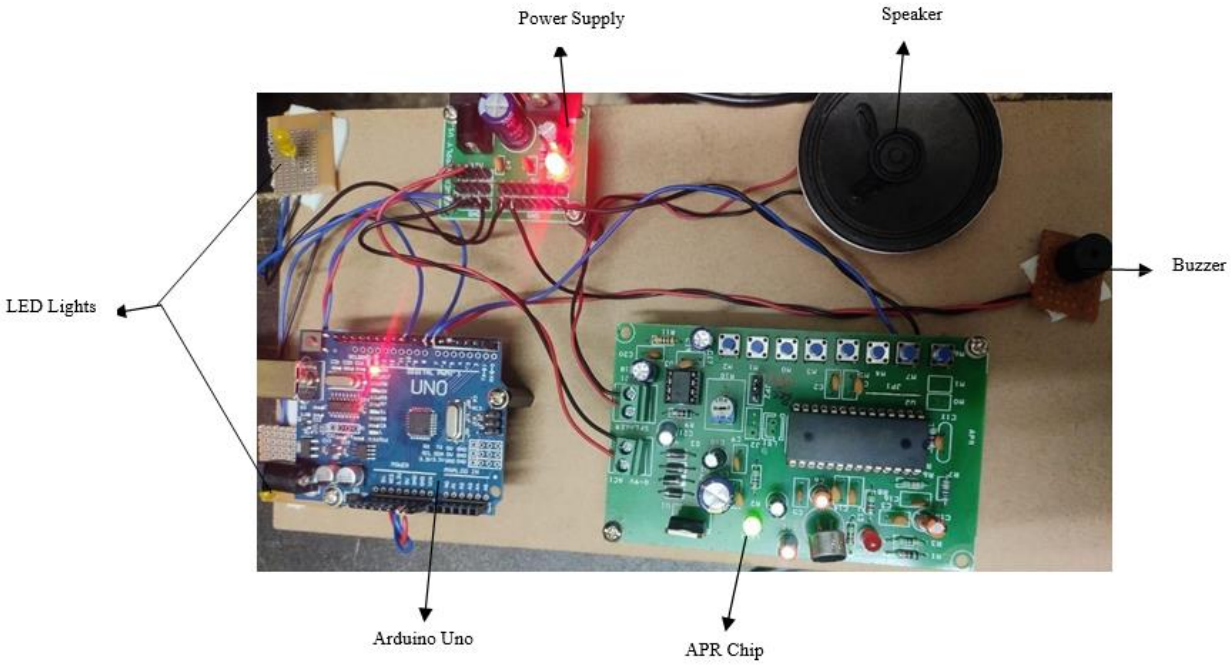

Fig 8.3: Hardware Setup

CHAPTER 9

APPLICATIONS

- This system can be used in Factories to alert the workers.
- This system can also be used for Railway drivers and Pilots.
- This system can be used in all Commercial and Personal vehicles.

CONCLUSION AND FUTURE ENHANCEMENT

Conclusions

A driver alertness detection system was proposed based on fatigue detection in real-time. The proposed method easily detects the eye blink and the drowsiness. Information about the eyes position was obtained through image processing algorithms. Image processing offers a noninvasive approach to detect drowsiness without any annoyance and interference. An algorithm for performing face recognition was used. It was found that with this algorithm, a good measurement of the blink rate was obtained. The proposed algorithm was able to detect the eyes at medium and high illumination and independent of gender and age, but for optimal detection the camera had to be positioned as front as possible. In order to prevent the effects of poor detection due to insufficient light, night vision camera was implemented so that better results, unaffected by lack of brightness, will be obtained. Safe driving will be ensured by indicating the driver using a buzzer indicator.

Future Enhancement

The cell phone detection enhanced by the hybrid system solution was possible with machine learning for Movement Detection and new features from Optical Flow as: horizontal movement, the area of connected components, and the dimensions of region movement detected. The increase of the frame per second processing and the image resolution.

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