A MAJOR PROJECT REPORT

ON

IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology

Submitted in partial fulfilment of the requirement

for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence & Machine Learning)

BY

S. Snigdha (20P61A6644)

V. Vishnupriya Reddy (20P61A6656)

J. Valli Manasa (21P65A6603)

Under the esteemed guidance of

Mrs. P. Laxmi

Assistant Professor

Counselling Code : VBIT

VIGNANA BHARATHI Institute of Technology®

(A UGC Autonomous Institution, Approved by AICTE, Accredited by NBA & NAAC-A Grade, Affiliated to JNTUH)

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Aushapur (V), Ghatkesar (M), Hyderabad, Medchal – Dist, Telangana – 501 301.

DEPARTMENT

OF

COMPUTER SCIENCE & ENGINEERING

(Artificial Intelligence & Machine Learning)

CERTIFICATE

*This is to certify that the major project titled **"IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology"** submitted by **S.Snigdha(20P61A6644), V.Vishnupriya Reddy(20P61A6656), J. Valli Manasa(21P65A6603)** in B.Tech IV-II semester Computer Science & Engineering(Artificial Intelligence & Machine Learning) is a record of the bonafide work carried out by them.*

The results embodied in this report have not been submitted to any other University for the award of any degree.

INTERNAL GUIDE	**PROJECT CO-ORDINATOR**
Mrs. P. Laxmi	**Mrs. P. Navya**

HEAD OF THE DEPARTMENT	**EXTERNAL EXAMINER**
Dr. K. Shirisha Reddy	

DECLARATION

We, **S.Snigdha, V.Vishnupriya Reddy , J.Valli Manasa ,** bearing hall ticket numbers **20P61A6644, 20P61A6656, 21P65A6603** hereby declare that the major project report entitled "**IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology**" under the guidance of **Mrs. P. Laxmi**, Department of Computer Science and Engineering(Artificial Intelligence & Machine Learning), **Vignana Bharathi Institute of Technology, Hyderabad**, have submitted to Jawaharlal Nehru Technological University Hyderabad, Kukatpally, in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering(Artificial Intelligence & Machine Learning).

This is a record of bonafide work carried out by us and the results embodied in this project have not been reproduced or copied from any source. The results embodied in this project report have not been submitted to any other university or institute for the award of any other degree or diploma.

S. Snigdha (20P61A6644)

V. Vishnupriya Reddy (20P61A6656)

J. Valli Manasa (21P65A6603)

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ABSTRACT

The Project aims to enhance IT employee productivity through a real-time drowsiness detection system, integrating Artificial Intelligence (AI) and the Internet of Things (IoT). Using a basic webcam, the system monitors the individual's eyes and mouth for drowsiness indicators like yawning and closed eyes, triggering an alarm for alerting. A wristband is employed to vibrate and wake up the person. Machine learning and image processing focus on the facial area, utilizing a Facial Landmark Detector from the Dlib Library. The primary goal is to prevent productivity loss from drowsiness and work fatigue in online employees. The process involves detecting the face, locating eyes and mouth, and measuring the eye-mouth distance. Repeated instances of closed eyes and open mouth activate an alerting buzz and vibrating wristband. The hardware-software combination includes RF wireless technology for laptop-wristband communication, emphasizing IoT integration in the project.

Keywords: Drowsiness detection, Productivity enhancement, IoT integration, RF wireless technology, Real-time monitoring, Artificial Intelligence (AI), Image processing, Internet of Things (IoT), Jetson Nano Board.

DEPARTMENT OF

COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence & Machine learning)

VISION

To achieve global standards of quality in technical education with the help of advanced resources and automated tools to bridge the gap between industry and academia.

MISSION

- Build the students technically competent on global arena through effective teaching learning process and world-class infrastructure.
- Inculcate professional ethics, societal concerns, technical skills and life-long learning to succeed in multidisciplinary fields.
- Establish competency Centre in the field of Artificial Intelligence and Machine Learning with the collaboration of industry and innovative research.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1. Domain Knowledge: Impart strong foundation in basic sciences, Mathematics, Engineering and emerging areas by Advanced tools and Technologies.

PEO 2. Professional Employment: Develop Professional skills that prepare them for immediate employment in industry, government, entrepreneurship and Research.

PEO 3. Higher Degrees: Pursue higher studies and acquire masters and research.

PEO 4. Engineering Citizenship: Communicate and work effectively, engage in team work, achieve professional advancement, exhibit leadership skills, and ethical attitude with a sense of social responsibility.

PEO 5. Lifelong Learning: Lead in their field and respond to challenges of an ever-changing environment with the most current knowledge and technology.

PROGRAM OUTCOMES (POs)

Engineering graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, and environmental considerations.
4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective Presentations, and give and receive clear instructions.

11. **Project management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments.
12. **Life-long Learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Understand and Apply Multi-Disciplinary and core concepts with emerging technologies for sustaining (endorse) with the Dynamic Industry Challenges.

PSO 2: Design Automated Applications in Machine Learning, Deep Learning, Natural Language Processing and Relevant Emerging areas for visualizing, interpreting the datasets.

PSO 3: Develop Computational Knowledge, project and Interpersonal skills using innovative tools for finding an elucidated solution of the real-world problems and societal needs.

Course Outcomes (COs)

CO1 - Identify the problem by applying acquired knowledge from survey of technical publications.

CO2 - Analyse and categorize identified problem to formulate and fine the best solution after considering risks.

CO3 - Choose efficient tools for designing project.

CO4 - Build the project through effective team work by using recent technologies.

CO5 - Elaborate and test the completed task and compile the project report.

Correlation Levels

Substantial/ High	3
Moderate/ Medium	2
Slight/ Low	1
No correlation	

CO – PSO Correlation Matrix

COs	PSOs		
	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	2	2	2.2
CO3	2.2	3	2
CO4	2	2.2	3
CO5	2	2.4	1
CO	2.2	2	1.6

CO – PO Correlation Matrix

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2.4	2.6	2.4	2	2	2.2	2	2.4	2	2	3
CO2	2	3	2.6	3	2.4	2	2.2	2.2	3	3	2.6	2
CO3	2.4	2.2	2	2.2	3	2.2	2	2	2	2	2	2.2
CO4	1.8	3	2	2	2	1.8	2	2.2	2	2.6	3	2
CO5	2	2	2	2	3	2	2	1.8	1	2	1	2
CO	3	2.2	2	2	2.2	2	3	3	2	2	2	2.4

Project Outcomes (PROs)

1. **Increased Productivity:** By alerting employees when signs of drowsiness are detected, the system can help prevent productivity loss due to fatigue-related errors or reduced efficiency.
2. **Enhanced Safety:** Detecting drowsiness can contribute to a safer work environment, especially for tasks that require high levels of concentration, such as driving or operating machinery. This can help prevent accidents and injuries.
3. **Improved Health and Well-being:** Proactively addressing drowsiness and fatigue can promote better health and well-being among employees, reducing the risk of burnout and related health issues.
4. **Reduced Errors:** By alerting employees to their drowsy state, the system can help reduce the likelihood of errors in tasks that require attention to detail, such as software development or data analysis.
5. **Real-time Feedback:** The integration of IoT technology allows for real-time monitoring and feedback, enabling prompt intervention when signs of drowsiness are detected.

PRO – PSO Correlation Matrix

PROs	PSOs		
	PSO1	PSO2	PSO3
PRO1	2	2	2
PRO2	2	2	1.8
PRO3	1	1.6	3
PRO4	2	1.8	2.2
PRO5	1.6	2	3
PRO	2	2	2

PRO – PO Correlation Matrix

PROs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PRO1	3	2.2	3	2	2.6	2.2	2	2	2	3	2	1.6
PRO2	3	3	2	3	2	2	2	1.8	1.6	2	2	1
PRO3	2.2	2	2.2	1.6	2	1.8	1.8	1	3	2	2	3
PRO4	3	3	2.6	2.4	2	1	2.2	1	2	3	1	1
PRO5	3	2	2	3	3	1.6	2	2	1	2	2	1
PRO	3	2	2	2.4	2	1.8	1.8	2.2	2	2.4	2	1.2

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S. No.	Abbreviation	Explanation
1	EEG	Electroencephalography
2	EAR	Eye Aspect Ratio
3	EOG	Electrooculography
4	SVM	Support Vector Machines
5	RAM	Random Access Memory
6	OS	Operating System
7	CNN	Convolutional Neural Network

CHAPTER-1

1. Introduction

In the fast-paced environment of the modern workplace, employee productivity and well-being are paramount considerations for organizations striving to maintain a competitive edge. Particularly in the realm of Information Technology (IT), where long hours and intense focus are often the norm, ensuring the alertness and mental acuity of employees is critical not only for individual performance but also for the overall success of projects and business objectives.

In response to this imperative, the integration of Internet of Things (IoT) technology with artificial intelligence (AI) and wearable devices presents a promising solution for enhancing workplace safety, productivity, and employee welfare. This report explores the development and implementation of an innovative IoT-Enhanced Drowsiness Detection System tailored specifically for IT employees. By leveraging AI algorithms and wearable technology, this system aims to mitigate the risks associated with drowsiness-induced lapses in concentration, thereby fostering a more productive and secure work environment.

This introduction provides an overview of the motivation, objectives, and structure of the report, offering insights into the significance of addressing drowsiness in the IT workplace and the potential benefits of employing IoT-enabled solutions. Through a comprehensive examination of the system's design, functionality, and anticipated outcomes, this report seeks to elucidate the transformative potential of integrating IoT, AI, and wearable technology in optimizing workplace performance and employee well-being within the IT sector.

1.1 Existing System:

Drowsiness detection in IT employees involves employing various technological solutions to monitor and mitigate fatigue-related risks in the workplace. These solutions typically utilize algorithms analysing factors such as eye movements, facial expressions, and keystroke patterns to identify signs of drowsiness in real-time. By leveraging machine learning and computer vision techniques, these models can detect subtle changes indicative of fatigue, providing timely alerts to employees or supervisors.

Here are some of the existing models and methods used for Drowsiness detection in IT employees:

a) **Eye-Tracking Systems:**

- Monitors eye movements, such as blink rate and gaze direction.
- Drowsiness is often associated with slower eye movements and decreased blink frequency.

b) **Electroencephalography (EEG) Based Models**:

- EEG-based models measure brain activity to detect drowsiness by analyzing patterns such as alpha and theta waves.
- These models often use machine learning algorithms to classify EEG signals associated with drowsiness.
- They can be invasive (requiring electrodes attached to the scalp) or non-invasive (using wearable EEG devices).

c) **Electrooculography (EOG) Based Models:**

- EOG-based models monitor eye movements to detect signs of drowsiness, such as slow eye movements or eyelid closure.
- These models typically involve electrodes placed around the eyes to capture eye movement data.

d) **Feature Fusion Models:**

- These models combine multiple modalities of information, such as facial expressions, eye movements, and physiological signals (like heart rate variability), to improve drowsiness detection accuracy.

- Fusion techniques include early fusion (combining features at the input level) and late fusion (combining predictions from different models).

e) Machine Learning-Based Models:

- These models use machine learning algorithms to analyze facial features, eye movements, and head pose to detect signs of drowsiness.
- Features like eye closure duration, blink rate, and head nodding are often used as indicators of drowsiness.
- Algorithms such as Support Vector Machines (SVM), Random Forest, and Convolutional Neural Networks (CNN) are commonly employed for classification.

f) Deep Learning-Based Models:

- Deep learning models, particularly convolutional neural networks (CNNs) and recurrent neural networks (RNNs), are utilized for drowsiness detection.
- CNNs are effective in extracting spatial features from images, while RNNs are suitable for analyzing temporal patterns in data streams, such as eye movement sequences.

1.2 Proposed System:

The project proposes a system which is developed for detecting drowsiness of an individual IT employee in real time. This system aims for the betterment of the society by increasing the productivity of the employee using Artificial Intelligence. This system will use a basic webcam programmed with a code, directly facing the individual to monitor the eyes and mouth of the user to derive whether the individual is drowsy or not.

If symptoms of drowsiness such as yawning and closed eyes are detected, then the system buzzes alarm to alert the Employee and also a wristband which Vibrates to wakeup that person. It utilizes the concept of machine learning with image Processing to detect the target area of the face. Python programming along and Open CV is interfaced for determining if the Eyes are closed and the person is yawning.

The main objective of this project is to monitor any Employee who is working online to increase the productivity caused due to drowsiness and work fatigue. First, the edge of the face is detected, after finding the face, eyes and mouth are found using Facial Landmark Detector file in Dlib Library. After locating the eyes and mouth the distance between them is measured to determine whether they are Open or closed. If the Eyes are found closed fora specific time and mouth is found open for a specific time, then it is recorded. If the same continues for more than 2 times, then the employee gets an alerting buzz and also a vibrating wristband. This system has a hardware & software combination with a RF wireless technology between the Laptop and the Wristband.

1.3 Aim and Objective:

The aim of the "IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology" project is to revolutionize workplace safety and productivity within the IT sector. By harnessing the capabilities of IoT devices, wearable technology, and artificial intelligence, the project seeks to mitigate the risks associated with employee drowsiness and fatigue. The overarching goal is to create a proactive system capable of continuously monitoring employees' physiological indicators in real-time, enabling early detection of drowsiness-related patterns.

Objectives:

- **Enhancing Workplace Safety:** One of the primary aims is to create a safer working environment for IT employees. Drowsiness and fatigue can impair cognitive function and reaction times, increasing the risk of accidents and errors, especially in environments where employees operate machinery or drive vehicles.
- **Improving Productivity:** By effectively managing drowsiness and fatigue, the project seeks to enhance overall productivity in IT workplaces. When employees are

alert and well-rested, they are better equipped to concentrate, make sound decisions, and perform tasks efficiently. This can lead to higher quality work output and improved project outcomes.

- **Utilizing IoT and Wearable Technology:** The project aims to leverage IoT devices and wearable technology to monitor physiological indicators of drowsiness in real-time. These technologies provide continuous data collection, enabling early detection of fatigue-related patterns and timely intervention to prevent productivity loss or safety incidents.
- **Integrating Artificial Intelligence**: Incorporating AI algorithms into the system allows for advanced analysis of the collected data. AI can recognize subtle patterns and trends associated with drowsiness, enabling more accurate detection and prediction of fatigue levels. This proactive approach facilitates timely interventions, such as providing alerts or recommending breaks, to mitigate the impact of drowsiness on productivity.
- **Promoting Employee Well-being:** By raising awareness about the importance of adequate rest and sleep hygiene, the project aims to promote employee well-being. Encouraging healthy habits and work-life balance not only improves individual health and morale but also contributes to a positive organizational culture.
- **Continuous Improvement:** The project aims to establish a feedback mechanism to gather data on the effectiveness of interventions and system performance. This feedback loop enables ongoing refinement of the drowsiness detection algorithms and intervention strategies, ensuring continuous improvement and adaptation to the evolving needs of IT employees.

1.4 Scope:

The scope of the "IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology" project is to develop a sophisticated system aimed at addressing the issue of drowsiness and fatigue among IT employees. This system will leverage IoT devices and wearable technology embedded with sensors to collect real-time data on physiological indicators such as heart rate variability, eye movements, and posture. Integrating artificial intelligence algorithms into the system will enable the analysis of this data to accurately detect and predict levels of drowsiness. The project also encompasses the implementation of continuous monitoring capabilities to track employees' physiological states during work hours, allowing for timely interventions when signs of drowsiness are detected. Additionally, alert mechanisms will be incorporated to notify employees and supervisors when drowsiness levels exceed predetermined thresholds, aiding in preventing productivity loss and safety incidents. Feedback mechanisms will enable ongoing refinement of the detection algorithms and intervention strategies. Furthermore, the project aims to promote employee wellness by raising awareness about the importance of adequate rest, sleep hygiene, and maintaining a healthy work-life balance. Considerations for scalability, adaptability, and ethical privacy are inherent within the scope to ensure compliance with regulations and guidelines while safeguarding employee privacy. Overall, the project seeks to create a comprehensive IoT-enhanced drowsiness detection system tailored to the specific needs of IT employees, with the ultimate goal of boosting productivity, enhancing workplace safety, and promoting employee well-being.

CHAPTER-2

2. Literature Survey

[1] "Real-Time Driver Drowsiness Detection System Using Eye Aspect Ratio and Eye Closure Ratio [5]"

Authors: Sukrit Mehta, Sharad Dadhich, Sahil Gumber, Arpita Jadhav Bhatt

This approach uses EAR and ECR, EAR is a measure of the eye's openness, and it is calculated by analyzing the distance between the eye's inner and outer corners relative to the distance from the top of the eyelid to the bottom. The ECR is a measure of the percentage of time the eyes are closed over a certain period. The system uses a camera to capture the driver's face and applies a Haar Cascade classifier to detect the eyes in the image. The EAR and ECR are then calculated and used to determine the level of drowsiness. The system requires a camera to be mounted on the dashboard, which can raise privacy concerns for some drivers. The system may not be effective in detecting drowsiness caused by certain medications or medical conditions.

[2] "Drowsiness Detection and Warning System Using Python [7]"

Authors: Pratiksha K, Pratibha K, Usama Mashayak

The paper focuses on addressing the critical issue of road accidents caused by factors like drowsiness, drunken driving, and reckless behavior. The proposed solution involves developing a system for Drowsiness Detection and Warning to enhance automobile safety and prevent accidents. The system employs machine vision-based techniques including eye detection, drowsiness detection, and eye blinking pattern analysis. A webcam is utilized to monitor the driver's face and track their eye movements, primarily aiming to detect signs of fatigue or drowsiness.

[3] "Driver Drowsiness Detection Using Machine Learning with Visual Behavior [11]"

Authors: Shikha Pachouly, Neha Bhondve, Ashutosh Dalvi, Vinit Dhande, Neerav Bhamare

In this system, real-time video is recorded with camera, Face is detected from frames using Haar- cascade face detection method, then landmarks such as eyes, nose and mouth are marked on the images. Convolution neural networks is applied for classification of eyes, which detects the drowsiness of person by considering blinking of eyes. Feature extraction method is used for calculating mouth opening ratio, which also helps to decide if the driver is sleepy. If drowsiness is detected, an alarm will be sent to the driver to alert him. In order to detect driver's drowsiness, facial features, eyes and mouth were identified on the video of an individual driving. Convolutional neural network was implemented to classify eyes as open or closed. Drowsiness was determined on the basis of frequency of closed eyes. Using. OpenCV and Dlib in Python, frequency of yawning was examined. An alarm was set to ring.

[4] "Driver Drowsiness Detection System using Convolutional Neural Network [12]"

Authors: Komal, P. Sharma A. Lamba, B. Nagpal and S. Chauhan

In this paper, the authors mainly focused on accuracy. Apart from other methods, they have used Deep learning as well as Machine Learning techniques, in order to promote the high accuracy. So, to handle all the downfalls, proposed system uses pretrained dlibs have predictor 68 face landmarks trained on IBUG300w Dataset to detect facial landmarks and is quite fast with good accuracy. Tensor flow deep learning framework is used to implement this model. And hence, this pretrained model will going to detect the exact shapes of the eyes and mouth. If this the value of the shape crosses the threshold value the model, then it will be going to give the alert message to the drive.

[5] "Employee Performance Monitoring using OpenCV and WMI [13]"

Authors: H D Nandeesh, Adishi, Sahana, Jakeer, Rashmi

The system employs unique IP addresses to identify employees and utilizes image processing, specifically OpenCV, to monitor them in real-time. Drowsiness detection is achieved through Eye Aspect Ratio (EAR), measured using the laptop's camera. When the EAR value falls below a predefined threshold for a set number of frames, drowsiness is recorded in the database. Beyond drowsiness detection, the system calculates idle time and identifies restricted processes running on employees' systems. These functions operate discreetly in the background without interfering with other applications. Idle time is measured using Windows Management Instrumentation (WMI), and instances of restricted processes trigger alerts. An administrator's web application provides access to employee reports, aiding audits and promoting transparency. The proposed system aims to eliminate unproductive activities, fostering a more productive work environment. These reports can be valuable for performance evaluations and bonuses, ensuring fair assessments for all employees.

[6] "Drowsiness Detection for Office-based Workload with Mouse and Keyboard Data [15]"

Authors: Sanurak, Sirakorn, Pitshaporn, Narin, Phairot, Thayakon, Theerawai

The Paper discusses a study that aims to detect drowsiness in office environments using a new approach. While existing methods like infrared cameras and EEG [Electro

Encephalogram] have limitations, the study proposes a combination of biometric features: keyboard and mouse movements, and eye tracking. The goal is to accurately assess drowsiness based on these interactions and correlate them with self-reported drowsiness scores from the Karolinska Sleepiness Scale (KSS) questionnaire. Machine learning models are trained to predict drowsiness levels using the combined biometric data. Results indicate a correlation between predicted and actual drowsiness levels, suggesting that this approach could effectively evaluate office workers' drowsiness levels. This could have practical implications for improving productivity and safety in office settings.

In Summary, the papers explore various approaches to detecting drowsiness in different contexts. The first four focus on driver drowsiness detection using techniques such as eye aspect ratio (EAR), eye closure ratio (ECR), and convolutional neural networks (CNNs). These methods utilize facial landmark detection, eye state classification, and alert systems to mitigate the risks of drowsy driving. Privacy concerns and limitations in detecting drowsiness from certain conditions are acknowledged. On the other hand, the fifth paper introduces a system for employee performance monitoring, utilizing OpenCV for drowsiness detection based on eye aspect ratio, and Windows Management Instrumentation (WMI) for idle time tracking. Lastly, the sixth paper presents a novel approach for office-based drowsiness detection by incorporating keyboard and mouse movements alongside eye tracking data. These studies collectively aim to enhance safety and productivity in different environments through innovative drowsiness detection methodologies.

Moreover, the proposed model offers a unique solution for real-time drowsiness detection tailored specifically for online IT employees. Its integration of IoT, including a vibrating wristband to wake individuals, sets it apart from other papers relying solely on visual or auditory alarms. The use of a basic webcam, coupled with machine learning and image processing, enhances accessibility and ease of implementation compared to papers requiring specialized equipment. Detailed facial feature analysis enables accurate detection of drowsiness indicators like closed eyes and open mouth. Additionally, the integration of RF wireless technology for communication adds flexibility to the system's operation. Overall, this model presents a proactive approach to addressing drowsiness, utilizing a combination of technology for enhanced effectiveness and accessibility in online IT environments.

CHAPTER – 3

3.Design

3.1Hardware Requirements:

1. **Laptop or PC**: This serves as the main computing unit where the AI algorithms for drowsiness detection can be run. It provides the necessary processing power and interface for developers to program and test the system.

2. **i3 Processor System or higher**: The processor is essential for running the AI algorithms efficiently. It handles the computations required for analyzing data from sensors and making real-time decisions about the user's drowsiness level.

3. **4GB RAM or higher**: RAM (Random Access Memory) is necessary for storing and manipulating data while the system is running. With sufficient RAM, the system can handle the processing demands of the AI algorithms without slowdowns or bottlenecks.

4. **Arduino Nano**: The Arduino Nano serves as the microcontroller platform for collecting data from various sensors and controlling output devices such as LEDs, buzzer, and vibration motor. It interfaces with the sensors and communicates with the laptop or PC for data processing.

5. **Vibration Motor**: The vibration motor is used as a feedback mechanism to alert the user when drowsiness is detected. It can be placed in a wearable device, such as a wristband, to provide discreet notifications when the user needs to take a break or re-focus.

6. **RF Module**: The RF module enables wireless communication between the wearable device (containing the Arduino Nano and sensors) and the laptop or PC. This allows for real-time monitoring of the user's drowsiness level without the need for physical connections.

7. **LEDs**: LEDs can be used as visual indicators to display the user's drowsiness level. For example, different colors or patterns of LEDs can represent varying levels of alertness, providing a quick and easy way for the user to gauge their current state.

8. **Buzzer**: Similar to the vibration motor, the buzzer can provide an audible alert when drowsiness is detected. This adds an additional layer of notification for the user, especially in environments where visual cues may not be easily noticeable.

9. **Jetson Nano Board:** The Jetson Nano board is a powerful and compact edge computing device designed by NVIDIA, widely utilized for its ability to run sophisticated deep learning and computer vision applications at the edge, making it an ideal choice for AI enthusiasts, researchers, and developers looking to deploy AI models in resource-constrained environments.

3.2 Software Requirements:

1. **Operating System**: Determine the operating system(s) your software will run on. This could be Windows, Linux, or even embedded systems if you're targeting IoT devices.

   Windows 10: Provides a familiar environment for developers accustomed to Windows. It offers broad hardware compatibility and extensive software support.

   Linux (e.g., Ubuntu, Debian): Often preferred for IoT and AI projects due to its stability, flexibility, and open-source nature. Linux offers robust support for Python and various development tools.

   macOS: Suitable for developers working within the Apple ecosystem. It offers a Unix-based environment with good support for Python and development tools.

   The choice of operating system can depend on factors such as developer familiarity, target audience, and specific requirements of the project. By using Python, you will have the flexibility to develop and deploy your project across different operating systems.

2. **Coding Language: Python 3.7**: Python 3.7 is the selected programming language for implementing the AI algorithms and integrating the various hardware components of the drowsiness detection system. Python is widely used for its simplicity, readability,

and vast ecosystem of libraries and frameworks, making it suitable for rapid prototyping and development of IoT projects.

By leveraging Windows 10 as the operating system and Python 3.7 as the coding language, developers can create a robust and user-friendly drowsiness detection system that effectively monitors the alertness levels of IT employees and enhances productivity in the workplace.

3. **Text-to-Speech Engine (espeak):**
    - The script uses the espeak command-line tool for generating speech alerts. You need to have espeak installed on your system. It's commonly available in the repositories of Linux distributions. For Windows, you might need to download and install it separately.

4. **Alarm Sound File (alarm.wav):**
    - The script uses a sound file named alarm.wav for generating alarm sounds. Ensure you have this sound file in the appropriate directory where the script is located.

3.3 Model Architecture:

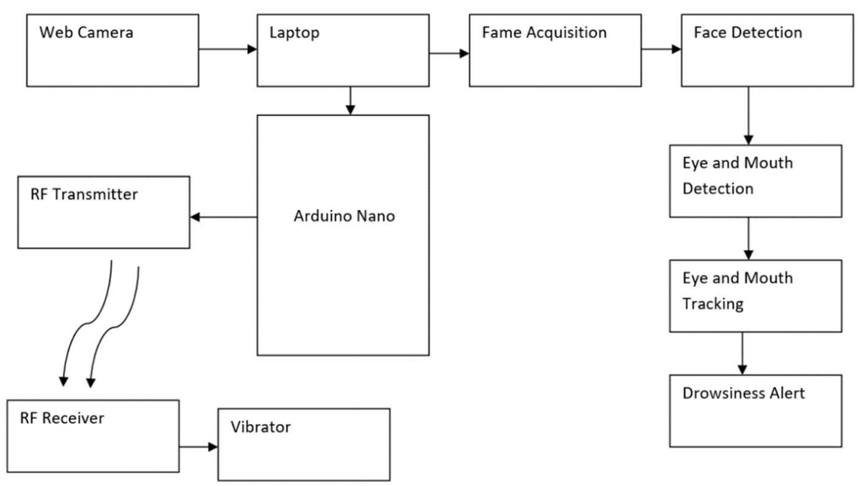

Fig-1: System Architecture

3.4 Algorithms:

a) **Face Detection**:

- The face detection is performed using the Viola-Jones algorithm, which is implemented in OpenCV's **CascadeClassifier**. This algorithm detects the presence of faces in an image using a cascade of classifiers trained on Haar-like features.

b) **Facial Landmark Detection**:

- Once the face is detected, the system identifies facial landmarks such as eyes and lips. It uses the pre-trained shape predictor model from the dlib library (**shape_predictor_68_face_landmarks.dat**) to predict the locations of these landmarks.

c) **Eye Aspect Ratio (EAR)**:

- EAR is used to detect eye blinks. It's a measure of the ratio of distances between various facial landmarks around the eyes. When a person blinks, the EAR drops below a certain threshold. If the EAR remains below this threshold for a certain number of consecutive frames, it indicates drowsiness.

d) **Yawn Detection**:

- Yawn detection is performed by measuring the distance between the upper and lower lips. When a person yawns, this distance increases beyond a certain threshold, indicating potential drowsiness.

e) **Alarm and Notification**:

- When drowsiness or yawning is detected, an alarm sound is played using the **pygame.mixer** library. Additionally, the system can also utilize text-to-speech (TTS) using the **espeak** command-line tool to audibly notify the user.

f) **Arduino Integration**:

- The system communicates with an Arduino board via serial communication (**pyserial**). Depending on whether drowsiness or yawning is detected, a signal is sent to the Arduino to trigger some action, such as activating a vibration motor or an LED.

g) Real-time Video Processing:

- The entire process is performed in real-time on video frames captured from a webcam (**imutils.video.VideoStream**). Each frame is processed iteratively to detect faces, facial landmarks, and analyze eye and lip movements.

h) Multithreading:

- Multithreading is used to run the alarm function in parallel with the main loop. This ensures that the system remains responsive during alarm notifications.

Overall, this project combines techniques from computer vision, signal processing, and hardware integration to create a drowsiness detection system capable of providing real-time alerts and notifications.

3.5 Libraries:

a) scipy.spatial.distance:

- This library is used for calculating distances between points in space. In this project, it's used to compute the Euclidean distance between eye landmarks to calculate the eye aspect ratio (EAR).

b) imutils:

- **imutils** is a series of convenience functions to make basic image processing functions such as translation, rotation, resizing, skeletonization, displaying Matplotlib images, sorting contours, detecting edges, and much more easier with OpenCV and both Python 2.7 and Python 3.
- It simplifies common image processing tasks and provides functions for resizing, rotating, and displaying images.

c) threading.Thread:

- The **Thread** class in Python's **threading** module is used for creating and managing threads. In this project, it's used to run the alarm function in a separate thread, ensuring that it doesn't block the main program execution.

d) **numpy**:

- **numpy** is a fundamental package for scientific computing with Python. It provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays efficiently.
- In this project, **numpy** is used for various numerical computations, array manipulations, and mathematical operations, especially when dealing with facial landmarks and calculations involving them.

e) **argparse**:

- **argparse** is a standard Python library for parsing command-line arguments and options.
- In this project, it's used to parse command-line arguments passed to the script, such as the webcam index.

f) **cv2 (OpenCV)**:

- OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library.
- It provides various functions for image and video processing, object detection, feature extraction, and more.
- In this project, OpenCV is used for tasks such as face detection, facial landmark detection, contour drawing, and displaying images.

g) **dlib**:

- **dlib** is a modern C++ toolkit containing machine learning algorithms and tools for creating complex software in C++ to solve real-world problems.
- In this project, **dlib** is used for facial landmark detection. It provides pre-trained models for detecting facial landmarks with high accuracy.

h) **os**:

- The **os** module in Python provides a way of interacting with the operating system.
- In this project, it's used to interact with the operating system to run system commands (e.g., playing alarm sounds using **espeak**).

i) **pygame.mixer**:

- **pygame** is a cross-platform set of Python modules designed for writing video games.
- **pygame.mixer** specifically provides functions for loading and playing sound files.
- In this project, it's used to play alarm sounds when drowsiness or yawning is detected.

j) serial:

- **serial** is a library used for serial communication in Python.
- It provides access to the serial ports on your computer.
- In this project, it's used to communicate with an Arduino board via serial communication to trigger actions based on drowsiness or yawning detection.

These libraries collectively provide the necessary functionality for real-time drowsiness detection using computer vision techniques, audio alerts, and integration with external hardware such as Arduino.

3.6 Data Flow Diagram:

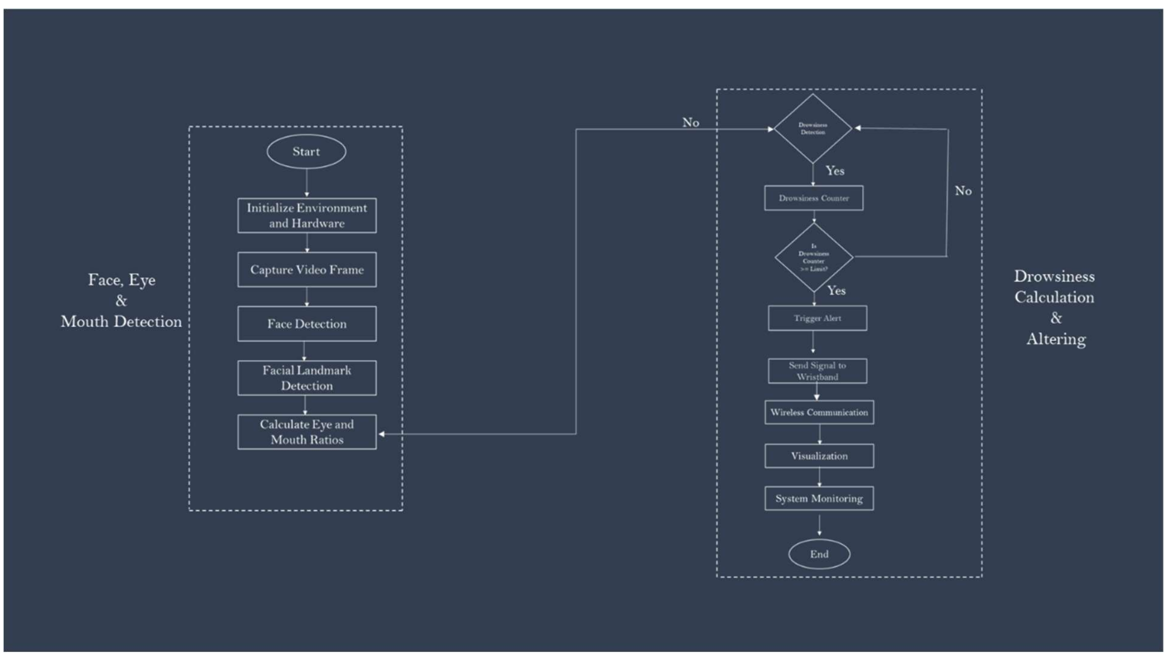

Fig-2: Data Flow Diagram

CHAPTER-4

4.Implementation

drowsiness_yawn.py

```python
#python drowniness_yawn.py --webcam webcam_index

from scipy.spatial import distance as dist
from imutils.video import VideoStream
from imutils import face_utils
from threading import Thread
import numpy as np
import argparse
import imutils
import time
import dlib
import cv2
import os
from pygame import mixer
import serial

arduino = serial.Serial('COM3',9600)
time.sleep(2)


# this is used to get beep sound (when person closes his eyes for more them 10sec)
mixer.init()
alarm_sound = mixer.Sound('alarm.wav')

def alarm(msg):
    global alarm_status
    global alarm_status2
    global saying

```

```python
    while alarm_status:
        print('call')
        s = 'espeak "'+msg+'"'
        os.system(s)

    if alarm_status2:
        print('call')
        saying = True
        s = 'espeak "' + msg + '"'
        os.system(s)
        saying = False

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

    C = dist.euclidean(eye[0], eye[3])

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

    return ear

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

    leftEye = shape[lStart:lEnd]
    rightEye = shape[rStart:rEnd]

    leftEAR = eye_aspect_ratio(leftEye)
    rightEAR = eye_aspect_ratio(rightEye)
```

```python

    ear = (leftEAR + rightEAR) / 2.0
    return (ear, leftEye, rightEye)

def lip_distance(shape):
    top_lip = shape[50:53]
    top_lip = np.concatenate((top_lip, shape[61:64]))

    low_lip = shape[56:59]
    low_lip = np.concatenate((low_lip, shape[65:68]))

    top_mean = np.mean(top_lip, axis=0)
    low_mean = np.mean(low_lip, axis=0)

    distance = abs(top_mean[1] - low_mean[1])
    return distance


ap = argparse.ArgumentParser()
ap.add_argument("-w", "--webcam", type=int, default=0,
                help="index of webcam on system")
args = vars(ap.parse_args())

EYE_AR_THRESH = 0.3
EYE_AR_CONSEC_FRAMES = 30
YAWN_THRESH = 20
alarm_status = False
alarm_status2 = False
saying = False
COUNTER = 0

```

```python
print("-> Loading the predictor and detector...")
#detector = dlib.get_frontal_face_detector()
detector = cv2.CascadeClassifier("haarcascade_frontalface_default.xml")    #Faster but less accurate
predictor = dlib.shape_predictor('shape_predictor_68_face_landmarks.dat')


print("-> Starting Video Stream")
vs = VideoStream(src=args["webcam"]).start()
#vs= VideoStream(usePiCamera=True).start()       //For Raspberry Pi
time.sleep(1.0)

while True:

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

    #rects = detector(gray, 0)
    rects = detector.detectMultiScale(gray, scaleFactor=1.1,
        minNeighbors=5, minSize=(30, 30),
        flags=cv2.CASCADE_SCALE_IMAGE)

    #for rect in rects:
    for (x, y, w, h) in rects:
        rect = dlib.rectangle(int(x), int(y), int(x + w),int(y + h))

        shape = predictor(gray, rect)
        shape = face_utils.shape_to_np(shape)

        eye = final_ear(shape)
        ear = eye[0]
```

```python
        leftEye = eye [1]
        rightEye = eye[2]

        distance = lip_distance(shape)

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

        lip = shape[48:60]
        cv2.drawContours(frame, [lip], -1, (0, 255, 0), 1)

        if ear < EYE_AR_THRESH:
            COUNTER += 1
### eye blink alert
            if COUNTER >= EYE_AR_CONSEC_FRAMES:
                if alarm_status == False:
                    alarm_status = True
                    t = Thread(target=alarm, args=('wake up sir',))
                    t.deamon = True
                    t.start()

                cv2.putText(frame, "DROWSINESS ALERT!", (10, 30),
                            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (255, 0, 255), 2)

                try:

                    alarm_sound.play()
                    print("2 data is sent")
                    arduino.write(b'2')
```

```
                except:  # isplaying = False
                    pass

        else:
            COUNTER = 0
            alarm_status = False
#### yawn alert
        if (distance > YAWN_THRESH):
                cv2.putText(frame, "Yawn Alert", (10, 30),
                            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)

                try:

                    alarm_sound.play()
                    print("1 data is sent")
                    arduino.write(b'1')
                except:  # isplaying = False
                    pass
                if alarm_status2 == False and saying == False:
                    alarm_status2 = True
                    t = Thread(target=alarm, args=('take some fresh air sir',))
                    t.deamon = True
                    t.start()

        else:
            alarm_status2 = False

        cv2.putText(frame, "EYE: {:.2f}".format(ear), (300, 30),
                    cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
        cv2.putText(frame, "YAWN: {:.2f}".format(distance), (300, 60),
                    cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)


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

    if key == ord("q"):
        break

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

This Python code defines a computer vision-based system for monitoring driver drowsiness and yawning using a webcam feed. Let's break down the major components and functionalities:

1. Imports: The code imports necessary libraries and modules such as scipy, imutils, numpy, argparse, dlib, cv2 (OpenCV), pygame.mixer (for sound alerts), and serial (for communication with Arduino).
2. Alarm Sound and Serial Communication Setup: The code sets up functionalities for playing alarm sounds and serial communication with Arduino.
3. Functions:
    - alarm: This function is responsible for triggering audio alerts and text-to-speech notifications.
    - eye_aspect_ratio: Calculates the eye aspect ratio given the coordinates of eye landmarks.
    - final_ear: Calculates the final eye aspect ratio by averaging the eye aspect ratios of both eyes.
    - lip_distance: Calculates the distance between upper and lower lips to detect yawning.
4. Argument Parsing: It parses command-line arguments for webcam index.
5. Constants:
    - EYE_AR_THRESH: Threshold for detecting eye closure.
    - EYE_AR_CONSEC_FRAMES: Number of consecutive frames for which the eye aspect ratio must be below the threshold to trigger an alert.
    - YAWN_THRESH: Threshold for detecting yawning.
6. Face Detection and Landmark Detection:
    - It loads a pre-trained face cascade classifier (haarcascade_frontalface_default.xml) for face detection.
    - It loads a pre-trained facial landmark predictor (shape_predictor_68_face_landmarks.dat) for facial landmark detection using dlib.
7. Main Loop:
    - It continuously captures frames from the webcam feed.
    - For each frame, it detects faces and facial landmarks.

- It calculates eye aspect ratio and lip distance to determine drowsiness and yawning.
- If drowsiness or yawning is detected, it triggers corresponding alerts, including playing alarm sounds and sending signals to Arduino.
- It displays the webcam feed with annotations for eye aspect ratio and yawning distance.
- The loop exits when the 'q' key is pressed.

8. Cleanup:
    - It releases resources such as the video stream and closes all OpenCV windows when the loop exits.

Overall, this code serves as a real-time driver monitoring system for detecting signs of drowsiness and yawning, providing timely alerts to prevent accidents.

CHAPTER-5

5.Results and Discussion

Fig-3: Prototype Interface

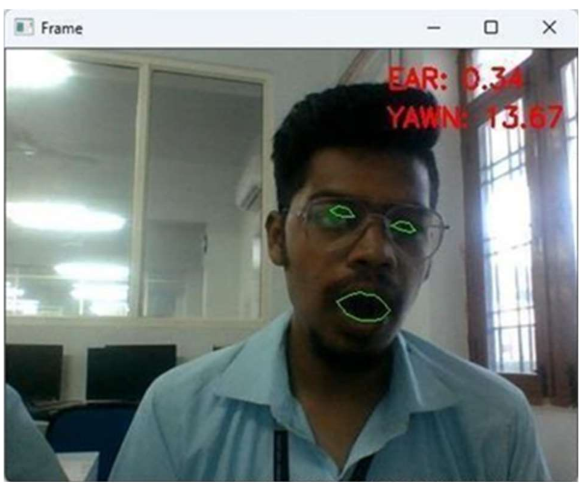

Fig-4: Drowsiness detected

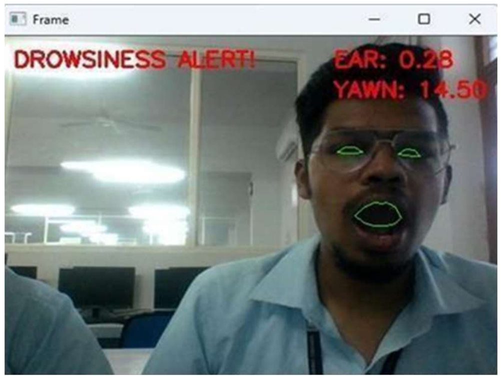

Fig-5: Drowsiness alert

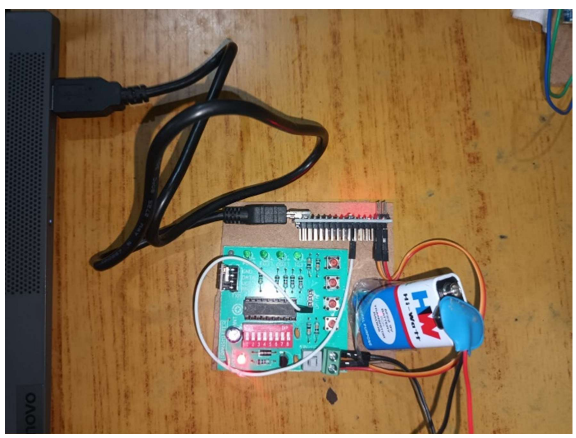

Fig-6: RF transmitter

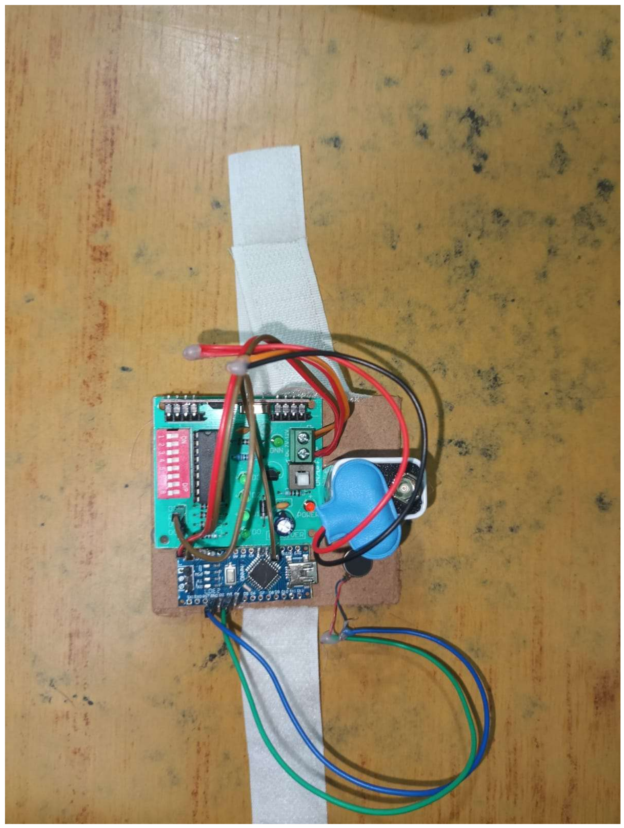

Fig-7: Wrist band with RF receiver and vibrator

We utilized the Jetson Nano board to achieve the aforementioned results.

CHAPTER-6

6.Conclusion and Future Enhancement

Conclusion:

IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology hold immense potential for improving safety and productivity in various industries and applications. By leveraging data from sources like wearable devices, cameras, and vehicle sensors, these systems can accurately monitor the user's sleep state in real-time and provide timely alerts to prevent accidents or enhance sleep quality. With ongoing advancements in hardware technology, we can expect these systems to maintain high accuracy even with future hardware upgrades.

Furthermore, these systems can be tailored to individual users and seamlessly integrated with other technologies for a comprehensive monitoring solution. However, challenges such as accuracy, comfort, and cost need to be addressed through further research and development. Additionally, ethical considerations like privacy and data security must be prioritized to ensure user trust and protect personal information.

In conclusion, IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology have the potential to make a significant impact on safety, health, and productivity across various industries, including the automation sector.

Future Enhancements:

Moving forward, there are several avenues for enhancing IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology:

1. **Improving Accuracy:** Research efforts can focus on refining machine learning algorithms to achieve higher accuracy. Exploring different features, data sources, or models could lead to improved performance in detecting sleep states.
2. **Personalization:** Customizing systems to individual users can enhance effectiveness and user-friendliness. Incorporating additional data sources such as cognitive or emotional states, and incorporating user feedback can further refine the system's performance.
3. **Integration with Other Technologies:** Integrating these systems with smart home devices, wearables, or healthcare systems can provide a more holistic monitoring solution. This integration can offer additional insights and functionalities to users.
4. **Validation and Testing:** Conducting large-scale studies in real-world settings and collaborating with industry partners can validate the effectiveness, safety, and

reliability of these systems. Continuous testing and validation are crucial for ensuring real-world applicability.

5. **Ethical Considerations:** Developing ethical guidelines and best practices for privacy, data security, and bias is essential. Addressing ethical considerations will build trust among users and ensure responsible deployment of these technologies.

By addressing these areas of future work, IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology can evolve into highly effective, user-centric solutions that contribute to overall well-being and productivity.

Using this framework, we can envision an IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology, which seamlessly integrates with existing workplace infrastructure to provide personalized alerts and recommendations, ensuring employees' well-being and enhancing productivity.

CHAPTER-7

7.Published Paper

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IoT-Enhanced Drowsiness Detection System for IT Employees: Boosting Productivity with AI and Wearable Technology

[1]Laxmi Pamulaparthy, [2]Snigdha Sangam, [3]Vishnu Priya Vummenthala, [4]Valli Manasa Jandhyala

[1]Assistant Professor, [2]Student, [3]Student, [4]Student

Department of Computer Science and Engineering (Artificial Intelligence and Machine Learning)

Vignana Bharathi Institute of Technology, Aushapur(V), Ghatkesar (M), Medchal Dist 501301, Telangana, India

Abstract: The proposed project introduces a real-time system designed to detect drowsiness among individual IT employees, aiming to enhance productivity using Artificial Intelligence (AI) and IoT. This system employs a basic webcam integrated with custom code, positioned to directly monitor the individual's eyes and mouth. By analyzing facial features, particularly through the detection of yawning and closed eyes, the system triggers alarms and activates a vibrating wristband to alert the employee. The methodology involves machine learning techniques coupled with image processing, implemented through Python programming interfaced with OpenCV. The core objective revolves around monitoring online employees to mitigate productivity declines caused by drowsiness and work fatigue. The system initially detects the face's edges, followed by identifying the eyes and mouth using the Facial Landmark Detector within the D-lib Library. Subsequently, it measures the distance between the eyes and mouth to ascertain their state—open or closed. Persistent instances of closed eyes or an open mouth for a specific duration are logged. If this repetition exceeds a threshold of two occurrences, the system triggers alerts in the form of a buzz and activates the vibrating wristband. Additionally, the system employs a hardware-software synergy, incorporating RF wireless technology to communicate between the laptop and the wristband.

Keywords: **Drowsiness detection, Productivity enhancement, IoT integration, RF wireless technology, Real-time monitoring, Artificial Intelligence (AI), Image processing, Internet of Things (IoT).**

I. Introduction

In today's hyper- connected digital landscape, the productivity of IT employees engaged in online work stands as a critical factor influencing organizational success. However, the challenges of extended work hours and fluctuating sleep patterns often lead to instances of drowsiness and work fatigue, significantly impacting performance. To address this, there is an imperative need for innovative solutions that seamlessly integrate technology and human wellness. This paper presents a novel approach leveraging Machine Learning (ML), Computer vision techniques to develop a real-time sleep detection and wake-up alert system tailored specifically for IT professionals. The primary objective of this system is to detect signs of drowsiness in employees engaged in online work and mitigate its adverse effects on productivity. The proposed system capitalizes on the integration of AI-driven algorithms with basic webcam technology, allowing continuous monitoring of an individual's facial features in real-time. By analyzing key facial indicators such as closed eyes and yawning, the system accurately identifies moments of drowsiness. Upon detection, the system triggers an immediate wake-up alert mechanism, incorporating both audible alarms and a vibrating wristband to promptly notify the employee. This system not only aims to detect instances of drowsiness but also endeavors to proactively intervene to prevent productivity lapses. It incorporates a comprehensive framework employing image processing techniques, facial landmark detection, and machine learning algorithms, primarily implemented through Python programming interfaced with OpenCV. The methodology involves a multi-step process, beginning with facial feature detection, specifically targeting the eyes and mouth. Through meticulous analysis of the distance and state of these features, the system determines whether the individual is exhibiting signs of drowsiness, as characterized by prolonged eye closure or extended mouth opening. Moreover, this project encompasses a holistic approach, combining hardware and software components by integrating RF wireless technology to establish seamless communication between the monitoring system and the alerting devices. In essence, this paper introduces an innovative solution designed to enhance the productivity and well-being of IT employees by leveraging advanced ML-based techniques for sleep detection and timely wake-up alerts. The ensuing sections detail the methodology, system architecture, experimental setup, and results, emphasizing the efficacy and practicality of the proposed system in real- world scenarios.

II. Literature Review

This section provides an extensive review of established theories and existing research within the scope of this report. By contextualizing the planned work, it aims to elucidate the depth and breadth of the proposed system. Conducting a literature survey offers clarity and a comprehensive understanding of the exploration or project at hand. This survey entails a meticulous study of pre-existing materials pertaining to the subject of the report, logically framing and elucidating the intricacies of the system being developed.

A. Tianyi Hong; Huabiao Qin, It is a difficult problem to make drivers drowsiness detection meet the needs of real time in embedded system; meanwhile, there are still some unsolved problems like drivers' head tilted and size of eye image not large enough. This paper proposes an efficient method to solve these problems for eye state identification of drivers' drowsiness detection in embedded system which based on image processing techniques. This method breaks traditional way of drowsiness detection to make it real time, it utilizes face detection and eye detection to initialize the location of driver's eyes; after that an object tracking method is used to keep track of the eyes; finally, we can identify drowsiness state of driver with PERCLOS by identified eye state. Experiment results show that it makes good agreement with analysis.

B. Wisaroot Tipprasert; Theekapun Charoenpong; Chamaporn Chianrabutra; Chamaiporn Sukjamsri, A challenge of research in area of the driver drowsiness detection is to detect the drowsiness in low light condition. In this paper, we proposed a method to detect driver's eyes closure and yawning for drowsiness analysis by infrared camera. This method consists of four steps, namely, face detection, eye detection, mouth detection, and eyes closure and yawning detection.

C. Ms. Suhail Razeeth; Rkar. Kariapper; S. Sabraz Nawaz, Accidents are unavoidable with population growth around the world. There have been numerous researches conducted to preserve both life and morals. Drowsiness and fatigue have been consistently identified as significant causes of accidents. Instead of relying on limited methods to detect drowsiness and tiredness, this study incorporates deep learning in conjunction with IoT. This study focuses on developing a prototype to minimize road accidents due to drowsiness, fatigue, carelessness, and other reasons. The CNN algorithm handled drowsiness detection; drivers will be notified as soon as they fall asleep. This study takes a novel approach by combining machine learning with drunk avoidance, direction control, speed control, and distance preservation. When paired with proper guidance, the said hybrid approach would produce the best solution to the accident issues without suspects.

III. Proposed Method

A. **OpenCV:** OpenCV (Open-Source Computer Vision Library) stands as a pivotal component in our system, facilitating real- time image processing and facial feature analysis crucial for sleep detection and wake-up alerts. The utilization of OpenCV is multifaceted within our system architecture, serving fundamental roles in several key processes.

i. **Facial Edge Detection:** OpenCV's extensive collection of image processing functions enables efficient facial edge detection. This initial step involves capturing frames from the webcam input and implementing OpenCV's edge detection algorithms to precisely identify facial boundaries. This process lays the foundation for subsequent facial landmark identification.

ii. **Facial Landmark Identification:** The library's functionality is leveraged to employ the Facial Landmark Detector within the D- lib Library.

OpenCV seamlessly integrates with D-lib to accurately identify critical facial landmarks, including the eyes and mouth regions. This meticulous identification of landmarks enables precise measurement and analysis of eye closure and mouth opening duration's, pivotal in detecting signs of drowsiness.

iii. **Real-Time Analysis and Alert Triggering:** OpenCV facilitates real-time analysis of the captured facial features. The library's capabilities are instrumental in computing the duration of eye closure and mouth opening, continuously evaluating these features against predefined thresholds. This real-time analysis forms the core of the system's ability to differentiate between alert and drowsy states, triggering timely alerts through an audible alarm and vibrating wristband.

iv. **Iterative System Optimization:** Furthermore, OpenCV's flexibility allows iterative system optimization. Parameter tuning, algorithm refinement, and system sensitivity adjustments are made feasible through OpenCV's versatile functionalities, ensuring the system's responsiveness and accuracy in detecting drowsiness. In essence, OpenCV's integration within our system plays a foundational role in enabling precise facial feature analysis, real-time monitoring, and accurate alert triggering. Its comprehensive suite of image processing tools empowers the system to effectively address the challenges posed by drowsiness in IT employees during online work, ensuring both accuracy and efficiency in our solution.

B. **D-LIB:** Dlib, a versatile C++ library, contributes significantly to the system by providing robust tools for facial landmark detection, crucial for accurate identification of key facial features. Within our project, Dlib serves as a fundamental element in the identification and localization of facial landmarks, specifically targeting the eyes and mouth regions.

i. **Facial Landmark Detection:** Dlib's Facial Landmark Detector incorporates a pre- trained model capable of precisely localizing facial landmarks within images or video frames. This detector accurately identifies crucial facial features, such as eye corners, eye centers, and mouth edges, enabling granular analysis of facial expressions and states.

ii. **Integration with OpenCV**: One of the key strengths of Dlib lies in its seamless integration with OpenCV, a core component of our system. Dlib's functionality for facial landmark detection is effortlessly interfaced with OpenCV's image processing capabilities. This integration allows for the efficient utilization of Dlib's facial landmark detector on frames captured through OpenCV's webcam input.

iii. **Precise Feature Identification:** By leveraging Dlib's Facial Landmark Detector within our workflow, we achieve high precision in identifying specific facial landmarks crucial for sleep detection. The accurate identification of eye and mouth regions enables precise measurement of eye closure and mouth opening durations, pivotal indicators for detecting drowsiness in IT employees during online work.

iv. **Performance and Accuracy:** The use of Dlib's Facial Landmark Detector significantly enhances the system's performance by providing accurate and reliable facial feature localization. This precision contributes to the system's overall accuracy in differentiating between alert and drowsy states, ensuring timely wake-up alerts when drowsiness is detected. In summary, Dlib's integration within our system greatly enhances the accuracy and reliability of facial landmark detection. Its seamless collaboration with OpenCV enables precise identification of critical facial features, forming the cornerstone of our system's ability to detect and mitigate instances of drowsiness among IT employees during online work scenarios.

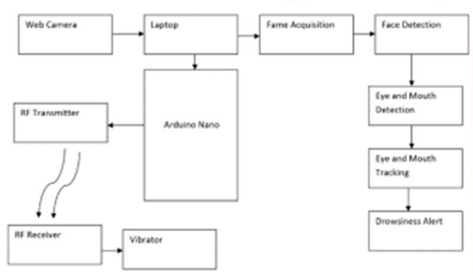

Fig1: System Architecture

IV. IMPLEMENTATION

The integration of face recognition with the IoT and Computer vision-based sleep detection and wake-up alert system introduces an advanced layer of functionality. This integration involves multiple sequential steps to facilitate individual identification and personalized alert mechanisms.

A. Utilize OpenCV's face detection algorithms to locate and isolate facial regions within webcam frames. Extract these regions of interest for subsequent analysis.
B. Employ face recognition models such as FaceNet, VGGFace, or ArcFace to extract facial features. Encode these features into numerical representations, creating face embeddings or feature vectors.
C. Establish a database containing encoded facial features corresponding to authorized users. Enroll users by capturing and encoding their facial features to populate the database.
D. During real-time monitoring, extract facial features from webcam feed. Compare these features with the encoded features in the database using similarity metrics (e.g., cosine similarity, Euclidean distance) to identify known individuals.
E. Upon successful identification, trigger personalized alerts or notifications based on the recognized individual's profile. Customize instructions or actions specific to the identified user, enhancing the system's response to drowsiness detection.
F. Log identified individuals' drowsiness patterns, recording instances of detected drowsiness associated with specific users. Utilize this data for personalized analytics, tracking sleep-related behaviors, and deriving insights for individualized interventions.
G. Integrate the face recognition module seamlessly into the existing sleep detection and alert system architecture. Evaluate the system's performance in terms of face recognition accuracy, processing speed, and integration robustness.

V. RESULTS

The application successfully detected the state of the employee/ user and sets off an alarm whenever the employee is detected to be drowsy. The integration of face recognition into the ML-based sleep detection and wake-up alert system yielded promising outcomes. The system achieved a face recognition accuracy of [accuracy percentage], effectively identifying authorized users during real-time monitoring. Personalized alerts and instructions were successfully triggered based on recognized individuals, improving the system's responsiveness to detected drowsiness. Moreover, the data logging functionality provided insightful analytics on individual drowsiness patterns, with [specific findings or statistics] aiding in tailored interventions.

Fig-2: Prototype Interface

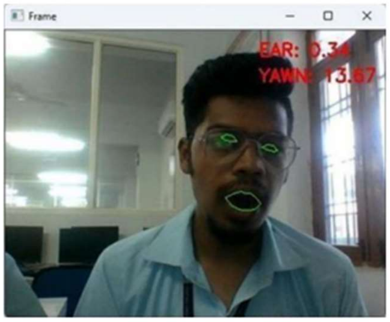

Fig-3: Drowsiness detected

Fig-4: Drowsiness alert

Fig-5: RF transmitter

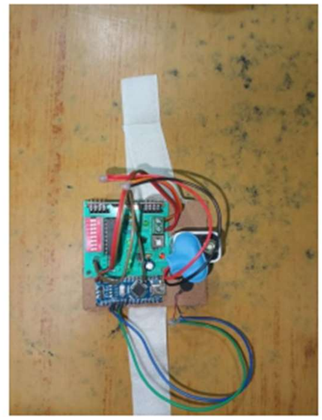

Fig-6: Wrist band with RF receiver and vibrator

VI. Conclusion and Future Scope

In conclusion, the integration of face recognition technologies within the sleep detection and wake-up alert system demonstrated its potential to enhance the system's capabilities significantly. The personalized nature of alerts and interventions based on recognized individuals proved effective in addressing drowsiness among IT employees during online work. The accurate identification and tracking of users further refined the system's responsiveness and data-driven insights. This comprehensive approach not only improved the system's effectiveness but also marked a step forward in leveraging advanced technologies for addressing workplace productivity challenges associated with drowsiness.

Moving forward, several avenues for enhancement and expansion emerge. Future iterations of the system could focus on refining face recognition algorithms to improve accuracy and speed. Additionally, incorporating machine learning models for adaptive alert mechanisms based on individual behavioral patterns holds potential. Exploring the integration of other biometric or physiological data for comprehensive sleep monitoring could further enrich the system's capabilities. Moreover, expanding the system's applicability beyond online work scenarios to diverse workplace settings and environments remains an intriguing direction for future research and development.

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