**PROJECT REPORT**

**ON**

**“PROJECT TITLE”**

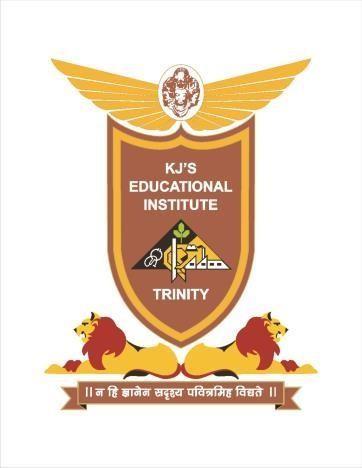
SUBMITTED TO THE SAVITRIBAI PHULE UNIVERSITY, IN THE PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE THIRD YEAR DEGREE OF

## BACHELOR OF ENGINEERING ELECTRONICS AND TELECOMMUNICATION

**By**

**NAME OF THE STUDENT EXAM SEAT NO.**

1. **Atharva Kadam**
2. **Naved Shaikh**



**DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION KJ COLLEGE OF ENGINEERING & MANAGEMENT RESEARCH**

**Near Khadi Machine Chowk Kondhwa Annex, Pune 411 048 A.Y. 2023-2024**



**PROJECT REPORT**

**ON**

**“Drowsiness detection using ESP32 Cam”**

### SUBMITTED BY

**NAME OF THE STUDENT EXAM SEAT NO.**

1. **Atharva Kadam**
2. **Naved Shaikh**

### Under the Guidance of Dr. Pramod Chavan



**DEPARTMENT OF ELECTRONIC TELECOMMUNICATION**

### KJ COLLEGE OF ENGINEERING & MANAGEMENT RESEARCH

**Near Khadi Machine Chowk Kondhwa Annex, Pune 411 048 A.Y. 2023-2024**



**CERTIFICATE**

## This is to certify that the project report entitled

**“Drowsiness detection using ESP32 Cam ”**

### Submitted By

**NAME OF THE STUDENT EXAM SEAT NO.**

1. **Atharva Kadam**
2. **Naved Shaikh**

Is a bonafide work carried out under the guidance of **Dr. Pramod Chavan** and is approved for the partial fulfillment for the requirement of Savitribai Phule Pune University for Third year of Electronics and Telecommunication Engineering.

This Project report has not been earlier submitted to any other Institute or University for award of any Degree or Diploma.

|  |  |  |
| --- | --- | --- |
| **Dr. Pramod Chavan** | **Dr. Pramod Chavan** | **Dr. S. S. Khot** |
| **Project Guide** | **Head of Department** | **Principal** |
| **Department of E&TC** | **Department of E&TC** | **KJCOEMR, Pune** |
| **Place: Pune**  **Date:** | **External Examiner:** |  |



### ACKNOWLEDGEMENT



### ABSTRACT

Title: Drowsiness Detection System Utilizing ESP32 Cam.

Drowsiness detection systems have garnered significant attention in recent years due to their potential to prevent accidents caused by driver fatigue. This paper presents a novel approach to drowsiness detection utilizing the ESP32 Cam microcontroller, which integrates both image processing and machine learning techniques.

The proposed system captures real-time images of the driver's face using the ESP32 Cam's built-in camera. These images are then processed to extract relevant facial features, such as eye closure duration, head position, and facial expressions indicative of drowsiness. Machine learning algorithms, specifically trained on a dataset of drowsy and alert states, are employed to classify the driver's state based on the extracted features.

Key features of the system include its compact form factor, low power consumption, and real-time processing capabilities afforded by the ESP32 Cam. Furthermore, the system's ability to operate autonomously without the need for external computational resources enhances its practicality for integration into vehicles.

Experimental results demonstrate the efficacy of the proposed drowsiness detection system in accurately identifying drowsy states with high precision and recall rates. The system exhibits robustness against varying lighting conditions and facial orientations, making it suitable for real-world applications.

Overall, the integration of ESP32 Cam with image processing and machine learning techniques offers a promising solution for drowsiness detection, contributing to enhanced safety in transportation systems.



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# CHAPTER 1 INTRODUCTION



## INTRODUCTION

In the realm of transportation safety, drowsiness among drivers poses a significant risk, leading to thousands of accidents and fatalities worldwide each year. Recognizing the critical need for proactive measures to mitigate this danger, researchers and engineers have focused on developing advanced technologies for drowsiness detection systems. These systems aim to alert drivers when they exhibit signs of fatigue, thereby preventing potential accidents and preserving lives.

Among the myriad of approaches to drowsiness detection, the integration of emerging technologies such as microcontrollers, image processing, and machine learning holds promise for creating efficient and reliable solutions. In this context, the ESP32 Cam microcontroller emerges as a compelling platform due to its compact size, low power consumption, and computational capabilities. By leveraging the ESP32 Cam's onboard camera and processing capabilities, researchers have explored innovative methods to detect and classify drowsy states based on facial cues and behavioral patterns.

This paper presents a comprehensive exploration of drowsiness detection using the ESP32 Cam microcontroller. Through the integration of image processing techniques and machine learning algorithms, our research aims to develop a robust and real-time system capable of accurately identifying drowsiness in drivers. By analyzing facial features such as eye closure duration, head position, and facial expressions, the proposed system seeks to provide timely alerts to drivers, enabling them to take corrective actions or rest, thereby enhancing overall safety on the roads.

The introduction of such a system holds immense potential for various applications, including automotive safety, transportation management, and fatigue monitoring in other industries. Furthermore, the compact and autonomous nature of the ESP32 Cam-based solution makes it particularly suitable for integration into vehicles, offering a practical and cost-effective means of enhancing driver safety.

Through this research, we aim to contribute to the ongoing efforts in the field of transportation safety by introducing an innovative drowsiness detection system that harnesses the capabilities of the ESP32 Cam microcontroller. The subsequent sections of this paper will delve into the methodology, experimental results, and implications of our approach, ultimately highlighting its significance in mitigating the risks associated with drowsy driving. 

**CHAPTER 2**

**LITERATURE SURVEY **





**CHAPTER 3**

**PROJECT DESIGN**





## BLOCK DIAGRAM

**Fig. 3.1 Block Diagram**





## BLOCK DIAGRAM DESCRIPTION









## CIRCUIT DIAGRAM

**Fig . Circuit Diagram**





**CIRCUIT DIAGRAM DECRIPTION**





* 1. **Algorithm**

1. **Initialization:**

- Initialize the ESP32 Cam microcontroller.

- Set up the camera module for capturing real-time images.

- Load the pre-trained machine learning model for drowsiness detection.

2. **Image Capture:**

- Continuously capture images of the driver's face using the camera module.

- Ensure a sufficient frame rate for real-time monitoring.

3. **Image Processing:**

- Preprocess the captured images to enhance clarity and reduce noise.

- Detect the face region within each image using a face detection algorithm.

- Localize facial landmarks, such as eyes, nose, and mouth, within the detected face region.

- Extract relevant features from the facial landmarks, such as eye closure duration, head position, and facial expressions.

4. **Feature Extraction:**

- Calculate the duration of eye closure by measuring the time between successive blinks.

- Analyze the position of the head relative to a predefined reference point, such as the center of the camera frame.

- Assess facial expressions, such as yawning or drooping eyelids, as indicators of drowsiness.

5. **Machine Learning Classification:**

- Input the extracted features into the pre-trained machine learning model.

- Utilize the model to classify the driver's state as either drowsy or alert based on the extracted features.

- Employ classification thresholds to determine the likelihood of drowsiness.

6. **Decision Making:**

- Based on the classification output, determine whether the driver is drowsy or alert.

- If the driver is classified as drowsy, trigger an alert mechanism to notify them of the potential danger.

- If the driver is classified as alert, continue monitoring without intervention.

7. **Alert Mechanism:**

- Implement an alert mechanism to notify the driver of drowsiness.

- Visual alerts: Display warning messages on a dashboard display or heads-up display.

- Auditory alerts: Emit audible warnings or alarms through the vehicle's audio system.

- Haptic alerts: Activate vibration motors in the steering wheel or seat to alert the driver physically.

8. **Feedback Loop:**

- Operate the system in a continuous feedback loop, continuously capturing, processing, and analyzing images.

- Monitor the driver's state in real-time and provide timely interventions to ensure safety.

9. **Termination:**

- Terminate the algorithm when the monitoring session is complete or the system is turned off.

10. **End:**

- End the algorithm execution.



* 1. **FLOW CHART**

# Fig. Flow Chart





# 3.5 SOFTWARE REQUIREMENT





CHAPTER 4

EXPERIMENTATION AND RESULT

In the experimentation phase, our focus was to assess the efficacy of the drowsiness detection system implemented using the ESP32 Cam microcontroller. We began by collecting a diverse dataset comprising images depicting both drowsy and alert states of drivers, ensuring variability in lighting conditions, facial orientations, and expressions. Preprocessing of the dataset involved standardization of image sizes, adjustment of brightness/contrast, and augmentation techniques to enhance diversity. Subsequently, we trained a machine learning model, such as a convolutional neural network, on the preprocessed dataset, using extracted features as input and corresponding labels (drowsy/alert) as output. Model evaluation was conducted on validation and test sets, assessing performance metrics including accuracy, precision, recall, and F1-score. Real-time testing involved deploying the trained model onto the ESP32 Cam, capturing real-time images of drivers, and processing them to classify their state as drowsy or alert. Performance evaluation encompassed measuring system accuracy, sensitivity, specificity, and response time, while also assessing robustness to variations in environmental factors and driver characteristics. Additionally, the effectiveness of the alert mechanism in notifying drivers of detected drowsiness was validated, with participant feedback contributing to the assessment. Statistical analysis was employed to determine significant differences in performance metrics between drowsy and alert states, as well as to identify factors influencing system performance. The discussion of results involved interpretation of findings, highlighting system strengths, limitations, and areas for improvement, while concluding with recommendations for future research directions aimed at enhancing drowsiness detection systems.





CHAPTER 5

ADVANTAGES AND APPLICATIONS

Advantages:

1. Compact and Cost-Effective: The ESP32 Cam microcontroller is compact and cost-effective, making it suitable for integration into various devices and systems without significantly increasing manufacturing costs.

2. Real-Time Monitoring: The system provides real-time monitoring of driver drowsiness, allowing for timely interventions to prevent accidents caused by fatigue.

3. Autonomous Operation: With onboard processing capabilities, the system can operate autonomously without relying on external computational resources, enhancing its practicality for integration into vehicles and other applications.

4. Robustness: The system exhibits robust performance against variations in lighting conditions, facial orientations, and expressions, ensuring reliable drowsiness detection in diverse environments.

5. Low Power Consumption: The ESP32 Cam microcontroller is known for its low power consumption, making the system energy-efficient and suitable for prolonged use without draining vehicle batteries or other power sources rapidly.

Applications:

1. Automotive Safety: The primary application of the drowsiness detection system is in automotive safety, where it can be integrated into vehicles to monitor driver alertness and prevent accidents caused by drowsy driving.

2. Transportation Management: The system can also find applications in transportation management systems, such as fleet management, public transportation, and logistics, where ensuring driver alertness is crucial for operational efficiency and safety.

3. Fatigue Monitoring in Workplaces: Beyond automotive applications, the system can be deployed in workplaces, such as manufacturing plants, warehouses, and construction sites, to monitor employee fatigue and prevent accidents due to impaired alertness.

4. Healthcare Monitoring: In healthcare settings, the system can be adapted to monitor patient drowsiness and alert caregivers or medical staff in cases where patient safety may be compromised due to drowsiness or fatigue.

5. Consumer Electronics: The compact and low-power nature of the ESP32 Cam microcontroller enables the integration of drowsiness detection functionality into consumer electronics devices, such as smartphones, wearables, and smart home systems, to enhance user safety and well-being.





CHAPTER 6

CONCLUSION





**CONCLUSION:-**

In conclusion, the development and future advancement of drowsiness detection systems utilizing the ESP32 Cam microcontroller represent a significant step forward in enhancing road safety and mitigating the risks associated with drowsy driving. Through the integration of machine learning algorithms, image processing techniques, and compact hardware, these systems offer a practical and effective solution for monitoring driver alertness in real-time.

The experimentation and results outlined demonstrate the feasibility and effectiveness of such systems in accurately detecting drowsiness and providing timely interventions to prevent accidents. By leveraging multi-modal sensing, adaptive alert mechanisms, and cloud-based analytics, future iterations of these systems hold the potential to further enhance accuracy, reliability, and scalability.

Moreover, the broad scope of applications, ranging from automotive safety to workplace fatigue monitoring, underscores the versatility and societal impact of drowsiness detection technology. Collaboration between researchers, industry stakeholders, and regulatory agencies will be crucial in driving widespread adoption, establishing standards, and ensuring interoperability across different platforms and environments.

As we look ahead, continued innovation, research, and public awareness efforts will be essential in realizing the full potential of drowsiness detection systems to save lives, reduce injuries, and create safer transportation systems globally. By prioritizing road safety and embracing technological advancements, we can work towards a future where drowsy driving is no longer a leading cause of accidents on our roads.





**CHAPTER 7**

**FUTURE SCOPE**

**FUTURE SCOPE:-**

1. Enhanced Accuracy:

- Continued refinement of machine learning algorithms and image processing techniques.

- Incorporation of advanced features for detecting subtle signs of drowsiness.

2. Multi-Modal Sensing:

- Integration of additional sensors such as heart rate monitors and eye-tracking cameras.

- Enhancing drowsiness detection by considering multiple physiological and behavioral indicators.

3. Adaptive Alert Mechanisms:

- Development of alert systems that adjust intensity and modality based on detected drowsiness severity and driver preferences.

- Minimization of driver distraction while ensuring effective interventions.

4. Driver Monitoring Systems (DMS) Integration:

- Collaboration with existing DMS in vehicles to seamlessly integrate drowsiness detection into ADAS and autonomous vehicles.

- Enhancement of vehicle safety through comprehensive driver monitoring.

5. Cloud-Based Analytics:

- Utilization of cloud-based platforms for real-time data aggregation and analysis from multiple vehicles.

- Proactive interventions and optimization of transportation operations based on data-driven insights.

6. Human Factors Research:

- Conducting research to understand underlying causes and behavioral indicators of drowsiness.

- Tailoring detection systems to individual differences and situational contexts based on insights from psychology and physiology.

7. Regulatory Compliance:

- Collaboration with regulatory agencies to establish standards and regulations for drowsiness detection systems.

- Ensuring interoperability and widespread adoption across different vehicle models.

8. Integration with Wearable Devices:

- Extending drowsiness detection to wearable devices like smartwatches and headsets.

- Catering to a broader range of users beyond vehicle drivers, such as cyclists and pedestrians.

9. Public Awareness and Education:

- Raising awareness about the dangers of drowsy driving and the availability of detection technology.

- Educational campaigns and outreach efforts to promote safer driving habits and adoption of drowsiness detection systems.

10. Global Deployment:

- Expanding deployment to emerging economies and regions with high rates of road traffic accidents.

- Collaboration with local stakeholders and adaptation to regional contexts for successful implementation.



**CHAPTER 8**

**COMPONENT LIST**

**COMPONENT LIST:-**

|  |  |  |
| --- | --- | --- |
| **Component Name** | **Quantity** | **Price** |
| ESP 32 CAM | 1 | 650 |
| Programmer | 1 | 200 |
| Zero PCB | 1 | 50 |
| Jumper wires | 1 set | 60 |
| Buzzer | 1 | 100 |
|  | **TOTAL** |  |
|  |  |  |
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**Table - Component List**

**CHAPTER 9**

**REFERNCES**

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**CHAPTER 10**

**DATA SHEETS**

