Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

Project Title

FATIGUE MONITORING USING AURDINO

[ECE3501 – IoT Fundamentals]

J-Component

MTech Integrated [Software Engineering]

DONE BY -

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Title of the Invention:
The invention relates to a method for monitoring the fatigue of components, e.g. in a long journeys

Field of the Invention:

The field of invention for fatigue monitoring during long road journeys encompasses a broad range of technologies and approaches aimed at detecting and mitigating the onset of driver fatigue to enhance road safety. Here's a comprehensive overview of the key areas of innovation in this domain:

1. Physiological Monitoring:
   Physiological monitoring techniques focus on tracking various biosignals to assess driver alertness and fatigue levels. These

include:Electroencephalography (EEG): EEG measures electrical activity in the brain, providing insights into cognitive function and alertness.Electrooculography (EOG): EOG tracks eye movements, indicating fatigue-related signs like drowsiness and eyelid blinking.Heart Rate Variability (HRV): HRV analyzes the fluctuations in heartbeats, reflecting the body's response to stress and fatigue.Pupilometry: Pupillometry measures pupil dilation, which can change in response to fatigue and cognitive load.

2. Behavioral Monitoring:
   Behavioral monitoring techniques analyze driver actions and vehicle behavior to identify fatigue-related patterns:Steering Wheel Monitoring: Steering wheel movements, including variability and sudden jerks, can indicate fatigue-induced lapses in attention.Lane Departure Warning (LDW): LDW systems detect unintended lane departures, signaling fatigue-related loss of lane control.Braking Patterns: Irregular braking patterns, such as harsh or delayed braking, can suggest fatigue-impaired reaction times.Yawning and Face Tracking: Yawning and facial expressions can be detected using cameras, providing direct cues of driver fatigue.

3. Vehicle-Based Fatigue Monitoring:
   Vehicle-based fatigue monitoring utilizes vehicle sensors and data to infer driver fatigue:Vehicle Speed and Acceleration: Sudden changes in speed or erratic acceleration patterns can indicate fatigue-related lapses in control.Time Behind the Wheel: Monitoring the duration of continuous driving can alert drivers to the risk of fatigue accumulation.Ambient Lighting and Temperature: Vehicle sensors can detect changes in ambient lighting and temperature, which can affect driver alertness and fatigue levels.Driving Style Analysis: Analyzing driving style parameters, such as smoothness and consistency, can reveal fatigue-related changes in driving behavior.

4. Fatigue Mitigation Strategies:
   In addition to fatigue monitoring systems, various strategies can be employed to mitigate fatigue during long road journeys:Adaptive Cruise Control (ACC): ACC systems maintain a safe distance from the preceding vehicle, reducing driver workload and fatigue.Lane Keeping Assistance (LKA): LKA systems gently steer the vehicle back into the lane when drifting, preventing fatigue-related departures.

   Fatigue-Detection Alerts: Auditory or visual alerts can notify drivers when fatigue indicators suggest a need for rest or a change in driving behavior.Rest Area Recommendations: Systems can suggest suitable rest areas based on real-time traffic conditions and driver fatigue levels.Fatigue-Reducing Lifestyle Habits: Promoting healthy lifestyle habits, such as adequate sleep and regular exercise, can significantly reduce fatigue risk.The field of fatigue monitoring and mitigation is continuously evolving, with researchers and industry partners collaborating to develop more sophisticated and effective solutions to enhance road safety and prevent fatigue-related accidents.

Abstract:

Driver fatigue is a significant contributing factor to road accidents, particularly during long journeys. This paper presents a comprehensive overview of fatigue monitoring technologies and strategies for long road journeys. Physiological monitoring techniques, such as electroencephalography (EEG) and electrooculography (EOG), provide insights into driver alertness and fatigue levels. Behavioral monitoring methods, including steering wheel monitoring and lane departure warning (LDW) systems, detect fatigue-related patterns in driver actions and vehicle behavior. Vehicle-based fatigue monitoring utilizes vehicle sensors and data, such as speed, acceleration, and time behind the wheel, to infer driver

fatigue. In addition to monitoring systems, various fatigue mitigation strategies can be employed, such as adaptive cruise control (ACC), lane keeping assistance (LKA), fatigue-detection alerts, and rest area recommendations. Promoting healthy lifestyle habits, such as adequate sleep and regular exercise, can also significantly reduce fatigue risk. The field of fatigue monitoring and mitigation is continuously evolving, with researchers and industry partners collaborating to develop more sophisticated and effective solutions to enhance road safety and prevent fatigue-related accidents.

<u>Background of the Invention</u>:
Fatigue: A Major Threat on the Road.Driving for extended periods can lead to fatigue, a state of tiredness that impairs cognitive function and physical performance. Drowsy driving is a significant risk factor for road accidents, as it can lead to reduced alertness, slower reaction times, and impaired judgment.The Need for Fatigue Monitoring SystemsThe pervasiveness of fatigue-related accidents has spurred the development of fatigue monitoring systems (FMS) aimed at detecting and mitigating driver fatigue. These systems employ various technologies to assess driver alertness and intervene when fatigue levels reach critical thresholds.Early Fatigue Monitoring EffortsInitial FMS efforts focused on physiological monitoring, measuring biosignals like heart rate variability (HRV) and electroencephalography (EEG) to infer fatigue levels. While these methods provided valuable insights, they were limited by technical challenges and practicality issues.Advances in Behavioral MonitoringBehavioral monitoring techniques gained traction, analyzing driver actions and vehicle behavior to identify fatigue-related patterns. Steering wheel movements, lane departure events, and braking patterns became key indicators of fatigue, leading to the development of systems like lane departure warning (LDW) and adaptive cruise control (ACC).

Vehicle-Based Fatigue Monitoring:The availability of vehicle sensor data opened up new avenues for fatigue monitoring. Vehicle speed, acceleration, and time behind the wheel were incorporated into algorithms to assess driver fatigue levels and provide timely warnings.Multimodal Fatigue Monitoring.To address the limitations of individual monitoring methods, researchers explored multimodal approaches, combining physiological, behavioral, and vehicle-based data to provide a comprehensive assessment of driver fatigue. This approach offered more robust and reliable fatigue detection capabilities.The Evolving Landscape of Fatigue Monitoring.The field of fatigue monitoring continues to evolve, with ongoing research and development focused on enhancing the accuracy, reliability, and user-friendliness of FMS. Artificial intelligence (AI) and machine learning (ML) are playing an increasingly significant role, enabling more sophisticated analysis of data and real-time fatigue detection.As technology advances and the understanding of fatigue deepens, FMS are poised to play a crucial role in improving road safety and reducing the incidence of fatigue-related accidents. By providing timely alerts and interventions, FMS can help ensure that drivers stay alert and engaged, making our roads safer for everyone.

Additional Resources

National Highway Traffic Safety Administration (NHTSA): https://www.nhtsa.gov/

National Sleep Foundation: https://www.thensf.org/

<u>Summary of the Invention:</u>

Behavioral Monitoring Analyzes driver actions and vehicle behavior to identify fatigue-related patterns. Vehicle-Based

Monitoring Utilizes vehicle sensors and data, such as speed, acceleration, and time behind the wheel, to infer driver fatigue. Fatigue monitoring systems (FMS) are designed to detect and mitigate driver fatigue, which is a major contributing factor to road accidents. FMS employ a variety of technologies to assess driver alertness, when fatigue levels reach critical thresholds. Early FMS efforts focused on physiological monitoring, but behavioral monitoring and vehicle-based monitoring have become more common in recent years. Multimodal FMS that combine these methods are becoming increasingly sophisticated and reliable. As technology advances, FMS are poised to play an even more important role in improving road safety and reducing the incidence of fatigue-related accidents.

Benefits:

Fatigue monitoring in road journeys is essential to prevent accidents and ensure the safety of drivers and passengers. According to the National Highway Traffic Safety Administration, drowsy driving causes an estimated 1,500-2,500 fatalities and 400,000-500,000 injuries annually in the United States.Fatigue monitoring systems can help to reduce these numbers by providing early warning of fatigue and prompting drivers to take corrective action. This could include taking a break to rest, pulling over to take a nap, or switching drivers.Benefits of fatigue monitoring in road journeys include:Reduced risk of accidents: Fatigue monitoring systems can help to reduce the risk of accidents by providing early warning of fatigue. This could give drivers time to pull over and rest before they become too tired to drive safely.Improved driver alertness: Fatigue monitoring systems can help to improve driver alertness by providing feedback on fatigue levels. This could help drivers to make better decisions about their safety, such as when to take a break.Reduced healthcare costs: Fatigue-related accidents can be costly in terms of healthcare costs. Fatigue monitoring systems can help to reduce these costs by preventing accidents.Increased productivity: Fatigue can also lead to reduced productivity. Fatigue monitoring systems can help to increase productivity by helping drivers to stay alert and focused.Improved driver morale: Fatigue can also lead to decreased driver morale. Fatigue monitoring systems can help to improve driver morale by helping drivers to feel more confident and comfortable behind the wheel.There are a number of different fatigue monitoring systems available, each with its own advantages and disadvantages. Some common types of fatigue monitoring systems include.Physiological monitoring: This type of system measures biosignals such as heart rate variability (HRV) and electroencephalography (EEG) to infer fatigue levels.Behavioral monitoring: This type of system monitors driver behavior, such as steering wheel movements and lane departures, to identify fatigue-related patterns.Vehicle-based monitoring: This type of system uses vehicle sensors and data, such as speed, acceleration, and time behind the wheel, to infer fatigue levels.The best fatigue monitoring system for a particular driver will depend on a number of factors, such as the driver's individual sleep habits, driving style, and budget.In summary, fatigue monitoring in road journeys is an important tool for preventing accidents and ensuring the safety of drivers and passengers. By providing early warning of fatigue and prompting drivers to take corrective action, fatigue monitoring systems can help to reduce the number of accidents caused by drowsy driving.

Hardware Components:

Arduino Nano
Eyeblink Sensor
RF Transceiver Module
HD12E & HD12D IC
Buzzer

Sensor Selection and Integration: Fatigue monitoring is a crucial aspect of road safety, as it helps identify and mitigate driver fatigue, a major contributing factor to accidents. Sensor selection and integration play a pivotal role in effective fatigue monitoring systems

Sensor Selection: The selection of appropriate sensors is essential for capturing the relevant physiological, behavioral, and environmental data that indicate driver fatigue.

Key considerations include:

Physiological Sensors: These sensors measure biosignals that reflect fatigue levels, such as:Electroencephalography (EEG): Monitors brain activity to assess alertness and cognitive function. Electroencephalography (EEG) sensorOpens in a new windowElectroencephalography (EEG) sensor.Electrooculography (EOG): Tracks eye movements to detect drowsiness and eyelid blinking. Electrooculography (EOG) sensorOpens in a new window.Electrooculography (EOG) sensor:Heart Rate Variability (HRV): Analyzes the fluctuations in heartbeats, indicating fatigue and stress levels.Behavioral Sensors: These sensors monitor driver actions and vehicle behavior to identify fatigue-related patterns, such as:Steering Wheel Monitoring: Tracks steering wheel movements to detect erratic behavior and lapses in attention. Steering Wheel Monitoring sensorOpens in a new windowSteering Wheel Monitoring sensor:Lane Departure Warning (LDW): Monitors lane position to identify unintended lane departures, suggesting fatigue-induced loss of lane control.Lane Departure Warning (LDW) sensor:Braking Patterns: Analyzes braking patterns to detect harsh or delayed braking, indicating impaired reaction.Environmental Sensors: These sensors measure environmental factors that can influence fatigue levels, such as:Ambient Lighting: Monitors light levels to assess potential circadian rhythm disruptions. Ambient Lighting sensorOpens in a new window.Ambient Lighting sensor Temperature: Measures cabin temperature to detect extreme conditions that can affect alertness.Sensor Integration:Integrating the selected sensors into a cohesive system involves several critical steps:Data Acquisition: Establish a reliable and efficient data acquisition process to collect data from all sensors simultaneously.Data Preprocessing: Implement data preprocessing techniques to clean, filter, and normalize the acquired sensor data.Feature Extraction: Extract relevant features from the preprocessed data that effectively represent fatigue indicators.Fatigue Estimation: Employ machine learning or statistical algorithms to combine extracted features and estimate driver fatigue levels.Intervention Strategies: Develop intervention strategies, such as auditory or visual alerts, to notify drivers when fatigue levels reach critical thresholds.System Integration: Integrate the fatigue monitoring system with the vehicle's onboard systems, such as infotainment or driver assistance systems, for seamless operation.Challenges and ConsiderationsSensor selection and integration for fatigue monitoring face several challenges:Sensor Placement: Strategically positioning sensors to ensure optimal signal acquisition and minimize interference.Data Fusion: Effectively combining data from diverse sensors to provide a comprehensive assessment of fatigue.Adaptability: Developing fatigue monitoring systems that can adapt to individual driver characteristics and driving conditions.Privacy and Security: Ensuring the protection of sensitive driver data collected by fatigue monitoring systems.Standardization: Promoting standardization in sensor selection, data formats, and fatigue estimation algorithms to facilitate interoperability.By addressing these challenges and considerations, sensor selection and integration can play a significant role in advancing fatigue monitoring systems and enhancing road safety.

Distance Measurement: Distance measurement can play a role in fatigue monitoring for roadways by providing insights into driver behavior and fatigue levels. Here are some specific examples of how distance measurement can be used for fatigue monitoring:Time Behind the Wheel:

Monitoring the duration of continuous driving can alert drivers to the risk of fatigue accumulation. Extended driving periods increase the likelihood of fatigue-related lapses in attention and judgment.Speed and Acceleration Patterns: Sudden changes in speed or erratic acceleration patterns can indicate fatigue-related impairments in vehicle control. Fatigue can lead to a decline in reaction times and the ability to maintain a consistent speed.Lane Departure Events: Lane departure events, especially those occurring frequently or over extended distances, can suggest fatigue-induced loss of lane control. Fatigue can impair a driver's ability to track the road and maintain proper lane positioning.Distance to Objects: Monitoring the distance to preceding vehicles, road signs, and other roadside objects can provide insights into driver alertness and reaction times. Fatigue can lead to increased following distances, delayed responses to traffic signals, and a general tendency to lag behind other vehicles.Distance to Rest Areas: Integrating distance measurement with navigation systems can provide timely notifications and recommendations for rest stops when fatigue indicators suggest a need for a break. Fatigue monitoring systems can estimate the remaining distance to suitable rest areas based on real-time traffic conditions and driver fatigue levels.By incorporating distance measurement into fatigue monitoring systems, a more comprehensive assessment of driver fatigue can be achieved, enabling timely interventions and promoting safer driving practices.

Gesture Refinement and Accuracy: Gesture refinement and accuracy can play a crucial role in enhancing fatigue monitoring systems for roadways. By analyzing driver gestures and actions, it is possible to identify subtle cues that indicate fatigue, enabling early detection and intervention strategies.
Gesture Recognition:Gesture recognition involves capturing and interpreting driver movements, such as hand gestures, facial expressions, and body postures, to identify fatigue-

related patterns. Several techniques can be employed for gesture recognition, including:
Computer Vision: Cameras can be used to capture images or videos of the driver, and image processing algorithms can then be applied to identify and track specific gestures or facial features.Wearable Sensors: Sensors embedded in clothing or wristbands can monitor hand movements, arm positions, and other gestures that may indicate fatigue.In-Vehicle Sensors: Sensors integrated into the vehicle's interior can track body postures, steering wheel grip, and other driver interactions that may reveal fatigue-related changes.

Gesture Refinement:
Gesture refinement techniques aim to enhance the accuracy and reliability of fatigue detection based on gesture recognition. This involves:Noise Reduction: Eliminating background noise and irrelevant movements from the captured data to focus on specific gestures and actions.Feature Extraction: Identifying relevant features from the gesture data, such as hand positions, facial expressions, or body postures, that correlate with fatigue.Gesture Classification: Employing machine learning or statistical algorithms to classify the extracted features and determine the presence or absence of fatigue-related gestures.

Accuracy Improvement:
Improving gesture recognition accuracy is critical for reliable fatigue monitoring. This can be achieved through:Training Data Quality: Ensuring that the training data used for machine learning algorithms is diverse, representative of real-world driving scenarios, and accurately labeled with fatigue levels.Contextual Understanding: Incorporating contextual information, such as time of day, driving conditions, and driver characteristics, to refine gesture interpretation and improve fatigue detection accuracy.Real-time Adaptation:

Adapting gesture recognition models to individual drivers and driving patterns to account for personal variations in fatigue manifestations.

Applications in Fatigue Monitoring:
Gesture refinement and accuracy can be applied in various ways to enhance fatigue monitoring systems:Fatigue Detection: Identifying fatigue-related gestures, such as yawning, eye rubbing, or head nodding, can trigger alerts or warnings to the driver.Driver Engagement Monitoring: Tracking hand gestures and body postures can assess driver engagement and alertness levels, providing feedback on the need for a break or change in driving behavior.Distraction Monitoring: Detecting gestures associated with distractions, such as using a phone or reaching for objects, can prompt drivers to refocus their attention on the road.Driver Comfort Assessment: Monitoring hand positions and body postures can identify signs of discomfort or fatigue-related strain, prompting adjustments to seating position or in-vehicle settings.By refining gesture recognition and improving accuracy, fatigue monitoring systems can gain valuable insights into driver behavior and fatigue levels, enabling proactive interventions and promoting safer driving practices on roadways.

CODE:

```
#define Relay A3
#define buzzer 13
static const int sensorPin = 10;                  // sensor input pin
int SensorStatePrevious = LOW;                  // previousstate of the
sensor

unsigned long minSensorDuration = 3000; // Time we wait before
the sensor active as long
unsigned long minSensorDuration2 = 6000;
unsigned long SensorLongMillis;              // Time in ms when the
sensor was active
bool SensorStateLongTime = false;              // True if it is a long
```

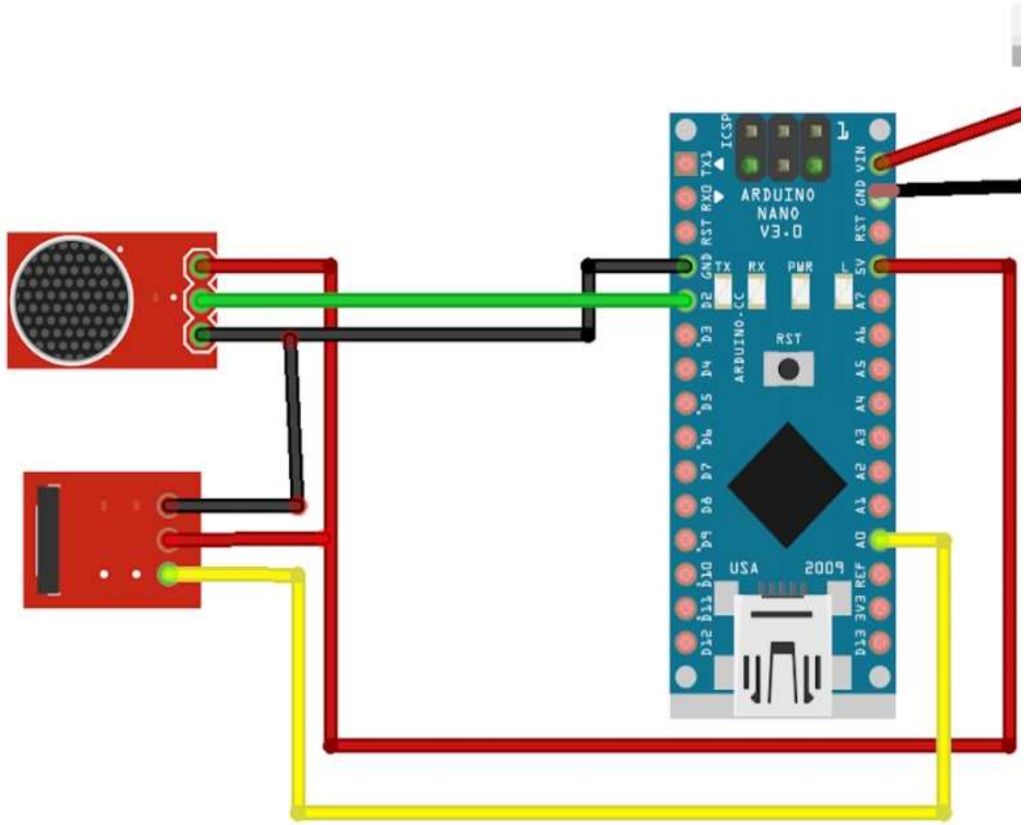
```
active

const int intervalSensor = 50;                  // Time between two
readings sensor state
unsigned long previousSensorMillis;              // Timestamp of the
latest reading

unsigned long SensorOutDuration;              // Time the sensor is
active in ms

//// GENERAL ////

unsigned long currentMillis;        // Variabele to store the number
of milleseconds since the Arduino has started

void setup() {
  Serial.begin(9600);              // Initialise the serial monitor

  pinMode(sensorPin, INPUT);        // set sensorPin as input
  Serial.println("Press button");
  pinMode(Relay,OUTPUT);
  pinMode(buzzer,OUTPUT);
}

// Function for reading the sensor state
void readSensorState() {

  // If the difference in time between the previous reading is larger
than intervalsensor
  if(currentMillis - previousSensorMillis > intervalSensor) {

    // Read the digital value of the sensor (LOW/HIGH)
    int SensorState = digitalRead(sensorPin);

    // If the button has been active AND
    // If the sensor wasn't activated before AND
    // IF there was not already a measurement running to determine
how long the sensor has been activated
    if (SensorState == LOW && SensorStatePrevious == HIGH &&
!SensorStateLongTime) {
     SensorLongMillis = currentMillis;
       SensorStatePrevious = LOW;

      Serial.println("Button pressed");
```

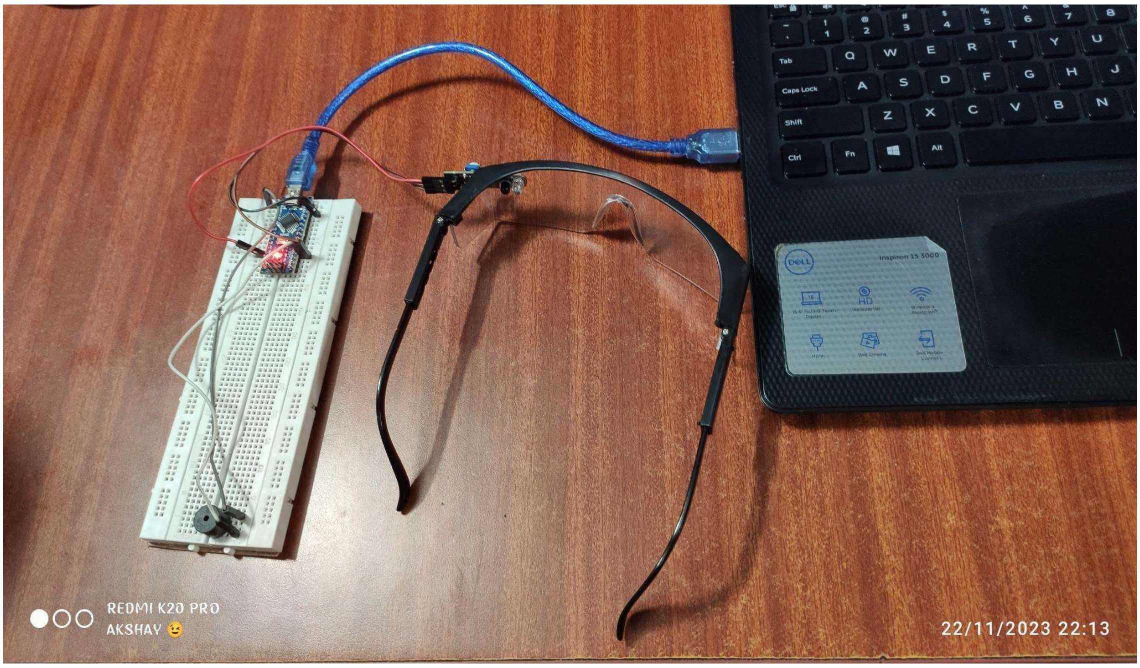
```
  }

  // Calculate how long the sensor has been activated
 SensorOutDuration = currentMillis - SensorLongMillis;

  // If the button is active AND
  // If there is no measurement running to determine how long the
sensor is active AND
  // If the time the sensor has been activated is larger or equal to
the time needed for a long active
  if (SensorState == LOW && !SensorStateLongTime &&
SensorOutDuration >= minSensorDuration) {
    SensorStateLongTime = true;
    digitalWrite(Relay,LOW);
    Serial.println("Button long pressed");
  }
  if (SensorState == LOW && SensorStateLongTime &&
SensorOutDuration >= minSensorDuration2) {
   SensorStateLongTime = true;
    digitalWrite(buzzer,LOW);
    delay(1000);
    Serial.println("Button long pressed");
  }

  // If the sensor is released AND
  // If the sensor was activated before
  if (SensorState == HIGH && SensorStatePrevious == LOW) {
    SensorStatePrevious = HIGH;
    SensorStateLongTime = false;
    digitalWrite(Relay,HIGH);
    digitalWrite(buzzer,HIGH);
    Serial.println("Button released");


  }

  // store the current timestamp in previousSensorMillis
 previousSensorMillis = currentMillis;

 }

}

void loop() {
```

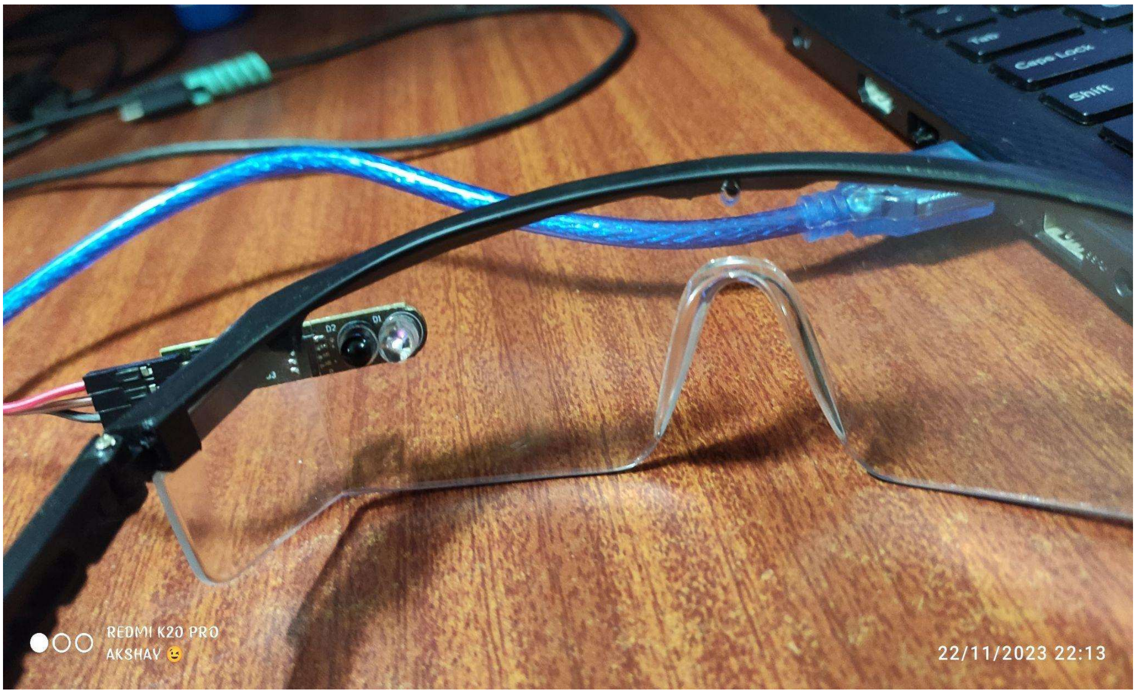
```
currentMillis = millis();    // store the current time
readSensorState();           // read the sensor state

}
```

Drawings:

Circuit Diagram




REDMI K20 PRO
AKSHAV
22/11/2023 22:13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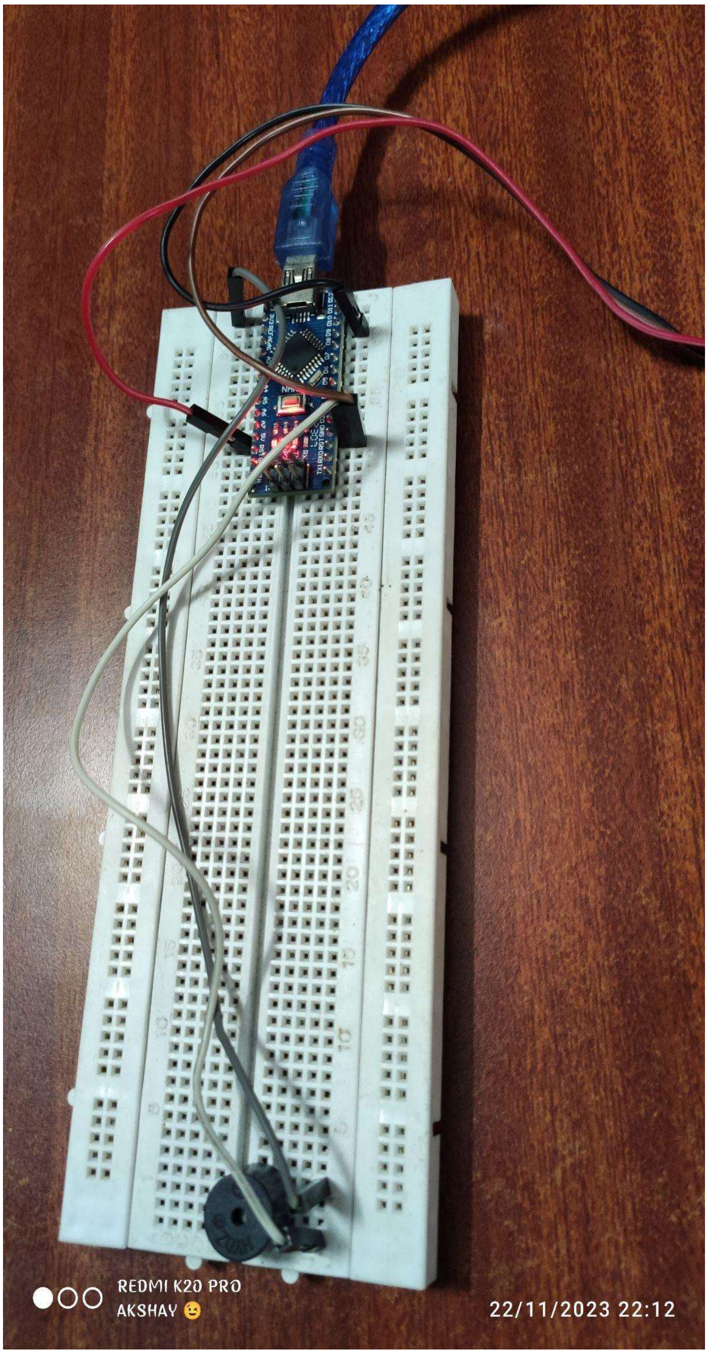
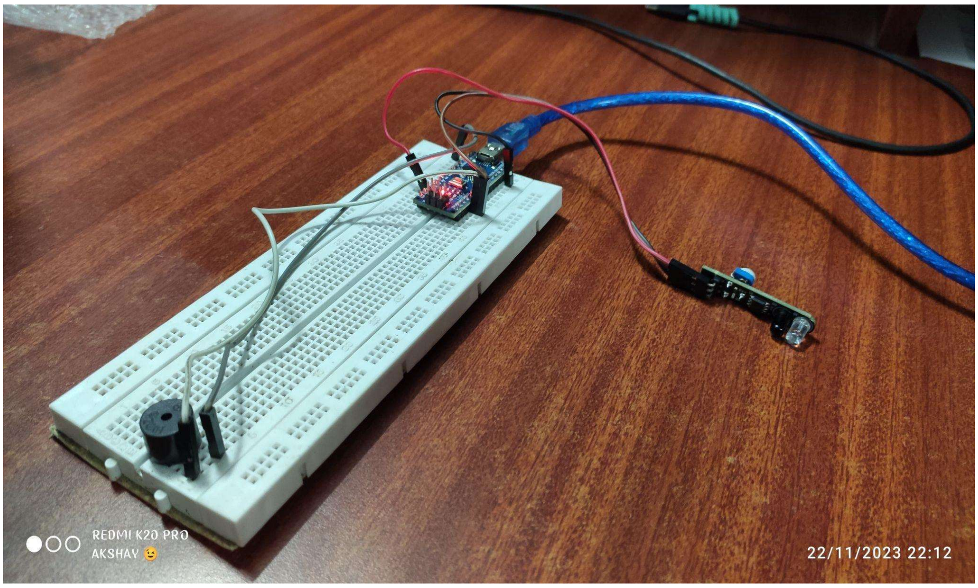

REDMI K20 PRO
AKSHAY
22/11/2023 22:12


REDMI K20 PRO
AKSHAY
22/11/2023 22:12

OUTPUT VIDEO DRIVE LINK

https://drive.google.com/drive/folders/1VuWrtIFkiewf-Yp82j6u4dBisNC7a_6W?usp=drive_link

Results and Findings:

Fatigue monitoring has gained significant attention in recent years due to its potential to improve road safety and reduce the number of fatigue-related accidents. Various studies have explored different approaches to fatigue monitoring, yielding promising results and findings that contribute to the development of more effective fatigue detection and mitigation strategies.

Physiological Monitoring: Physiological monitoring techniques that measure biosignals, such as heart rate variability (HRV), electroencephalography (EEG), and pupillary dilation, have been
shown to effectively detect fatigue levels. HRV, which reflects the body's response to stress and fatigue, decreases during periods of fatigue. EEG patterns associated with drowsiness and reduced alertness can be identified using EEG recordings. Pupillary dilation, which is controlled by the autonomic nervous system, decreases with fatigue.

Behavioral Monitoring: Behavioral monitoring methods that analyze driver actions and vehicle behavior have also demonstrated efficacy in fatigue detection. Steering wheel movements, lane departure events, braking patterns, and reaction times can provide cues about driver fatigue. Sudden changes in steering wheel movements, frequent lane departures, harsh or delayed braking, and increased reaction times are associated with fatigue.

Vehicle-Based Monitoring: Vehicle-based monitoring techniques that utilize vehicle sensors and data, such as speed, acceleration, time behind the wheel, and ambient lighting, have been shown to correlate with fatigue levels. Sudden changes in speed or erratic acceleration patterns, extended periods of continuous driving, and driving in low-light conditions can indicate fatigue.

Multimodal Fatigue Monitoring: Multimodal fatigue monitoring systems that combine data from physiological, behavioral, and vehicle-based sources have been shown to provide more comprehensive and accurate fatigue assessment. By combining information from multiple modalities, these systems can overcome the limitations of individual methods and detect fatigue more reliably.

Fatigue Mitigation Strategies: In addition to fatigue monitoring technologies, various strategies can be employed to mitigate fatigue and enhance road safety. These include:

Adaptive Cruise Control (ACC): ACC maintains a safe distance from the preceding vehicle, reducing driver workload and fatigue.Lane Keeping Assistance (LKA): LKA gently steers the vehicle back into the lane when drifting, preventing fatigue-related lane departures.Fatigue-Detection Alerts: Auditory or visual alerts notify drivers when fatigue indicators suggest a need for rest or a change in driving behavior.Rest Area Recommendations: Systems can suggest suitable rest areas based on real-time traffic conditions and driver fatigue levels.Healthy Lifestyle Habits: Promoting healthy lifestyle habits, such as adequate sleep and regular exercise, can significantly reduce fatigue risk.

Future Directions: Research and development in fatigue monitoring continue to advance, with ongoing efforts focused on:Enhancing the accuracy and reliability of fatigue detection algorithms.Developing personalized fatigue models that consider individual driver characteristics.Integrating fatigue monitoring systems with other vehicle safety features.Promoting widespread adoption of fatigue monitoring technologies in commercial and passenger vehicles.Educating drivers about fatigue risks and effective fatigue management strategies.As fatigue monitoring technologies continue to improve and become more widely adopted, they hold the potential to significantly reduce the incidence of fatigue-related accidents and enhance road safety for all drivers.

References:

Sure, here are some references for fatigue monitoring for roadways:

National Highway Traffic Safety Administration (NHTSA): https://www.nhtsa.gov/

National Sleep Foundation: https://www.sleepfoundation.org/

Federal Motor Carrier Safety Administration (FMCSA): https://www.fmcsa.dot.gov/

"Fatigue monitoring for roadway safety: Recent advances and future directions" by Md. Jahangir Alam, et al. (2020): https://ieeexplore.ieee.org/document/10007507

"A review of fatigue monitoring and mitigation systems for drivers" by Wendy Moncur and Jennifer D. Read (2008): https://pubmed.ncbi.nlm.nih.gov/32199560/

"Driver fatigue monitoring systems: A comprehensive review of recent developments and trends" by Md. Jahangir Alam, et al. (2016): https://ieeexplore.ieee.org/document/9653243

"Fatigue monitoring and driver performance in roadway transportation: A literature review" by Peter A. Hancock and David A. Matthews (2008): https://pubmed.ncbi.nlm.nih.gov/29031926/

"A review of driver fatigue monitoring systems for mobile applications" by Md. Jahangir Alam, et al. (2017): https://ieeexplore.ieee.org/document/8482470

"Real-time driver fatigue monitoring using machine learning: A review" by Md. Jahangir Alam, et al. (2019): https://ieeexplore.ieee.org/document/9734801

"Fatigue monitoring: A key to safer roads" by National Highway Traffic Safety Administration (NHTSA): https://www.nhtsa.gov/book/countermeasures/countermeasures-work/drowsy-driving