INTELLIGENT WEARABLE FOR SCREEN-DRIVEN EYE STRAIN MANAGEMENT

Analog System Design and Introduction to NN, CNN AND GNN

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Objective:

The project aims to detect and manage fatigue using an IR blink sensor, a Convolutional Neural Network (CNN), and a vibration sensor. The system is designed to enhance safety and productivity by providing real-time fatigue alerts.

1. **IR Blink Sensor:** Detects eye blinks to monitor the frequency and duration of blinks, which are key indicators of fatigue.
2. **CNN with Webcam Integration:** Analyzes facial expressions and features (e.g., drooping eyelids, yawning) using real-time webcam feeds to detect fatigue.
3. **Vibration Sensor:** Delivers immediate tactile feedback when signs of fatigue are identified, alerting the user to take corrective action

Workflow:

1. **Data Collection**

- Blink data from the IR sensor.
- Facial features through the webcam.

2. **Preprocessing**

- Filtering and normalizing blink and image data.
- Segmenting blink intervals and facial regions.

3. **Feature Extraction**

- Blink patterns (frequency and duration).
- Facial features indicating fatigue (eye closure percentage, yawning detection).

4. **Model Training and Integration**

- Train a CNN for fatigue detection based on facial datasets.
- Combine blink data with facial fatigue indicators for enhanced accuracy.

5. **Alert System**

- Trigger the vibration sensor when fatigue thresholds are crossed.

6. **Output**

- Display fatigue level on a dashboard or mobile application for monitoring

Hardware Components:

1. IR Blink Sensor

2. Webcam

3. Vibration Motor

4. Arduino Board

5. 9V Battery with USB Power Supply

6. Resistors

7. Capacitors

8. Transistors

9. Diodes

10. Breadboard

11. Jumper Wires

Research Paper Analysis:

1. Driver Fatigue Detection Based on Convolutional Neural Networks Using EM-CNN:

This research proposes a driver fatigue detection system using a novel Eye-Mouth Convolutional Neural Network (EM-CNN) to analyze facial features. It combines eye and mouth data to enhance the accuracy of detecting fatigue. The system uses a **Multitask Cascaded Convolutional Network (MTCNN)** for precise face detection and localization of key facial landmarks. From the identified facial regions, the EM-CNN model analyzes parameters such as:

- **PERCLOS (Percentage of Eyelid Closure Over Time):** A key metric for evaluating fatigue based on eye closure patterns.
- **POM (Percentage of Mouth Opening):** Used to identify yawning, a common indicator of drowsiness.

The system demonstrated a high level of performance, achieving approximately **93.6% accuracy** and sensitivity, making it a robust tool for real-world applications in driver safety.

Relevance to our Project:
This paper is highly relevant as it emphasizes CNN-based fatigue detection using real-time eye and mouth data. Similarly, your project integrates an IR blink sensor and CNNs for fatigue analysis, which shares the same goal of monitoring eye-related features to detect fatigue. The use of PERCLOS as a parameter is something that could be incorporated.

2. *Eye Blink Detection Using CNN to Detect Drowsiness Level in Drivers for Road Safety:*

This study explores a system that detects driver drowsiness levels using CNNs to analyze blink patterns. The system leverages **image processing techniques** and real-time data from a webcam to monitor changes in eye blink rates and durations, which are strong indicators of fatigue.

Key features of the system include:

- **Individual Adaptation:** The model accounts for differences in baseline blink rates among users, ensuring personalized detection thresholds.
- **Real-Time Alerts:** Once drowsiness is detected, the system provides immediate feedback to alert the driver.

This approach demonstrated a reliable performance, effectively identifying drowsy states in drivers during testing.

Relevance to our Project:
This research aligns closely with our project's objective of using IR blink sensors for fatigue detection. Both projects emphasize the significance of monitoring eye blink patterns to assess drowsiness. The concept of providing **real-time alerts**, as in vibration-based feedback system, strengthens the connection between our work and this paper.

References:

1. Integration of electroencephalogram (EEG) for objective measure of attention-deficit hyperactivity disorder (MAHD) in pre-schoolers
   Cite as: Rev. Sci. Instrum. 93, 054101 (2022); doi: 10.1063/5.0088044
2. Clinical Utility of EEG in Attention-Deficit/Hyperactivity Disorder: A Research Update, Loo SK, Makeig S. Clinical utility of EEG in attention-deficit/hyperactivity disorder: a research update. Neurotherapeutics. 2012 Jul;9(3):569-87. doi: 10.1007/s13311-012-0131-z. PMID: 22814935; PMCID: PMC3441927.
3. AttentioNet: Monitoring Student Attention Type in Learning with EEG-Based Measurement System: This study introduces "AttentioNet," a Convolutional Neural Network-based approach that utilizes EEG data to classify attention into five distinct states. The model achieved an average accuracy of 92.3%, demonstrating its potential for real-world applications in monitoring student attention.