IoT-based Automatic Driver Distraction Detection

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1 Introduction

1.1 Background and Context

Every day, thousands of people die from road accidents around the world. Many car accidents are caused by human or driver errors. According to WHO (2023), the number of deaths caused by road accidents is nearly 1.19 million each year. In Vietnam, in 2023 alone, traffic accidents claimed approximately 11,628 lives.

According to Statista (2023), traffic-related deaths in 2022 exceeded 11,000 in Vietnam. While there had been a decline from 2013 to 2021, 2022 saw a dramatic increase—more than doubling the number of deaths in 2021.

Most accidents are linked to abnormal driver behavior such as eating, drinking, using the phone, or talking to passengers. Detecting and minimizing these distractions is essential to prevent avoidable accidents.

1.2 Research Questions

1. How can machine learning algorithms detect driver distraction using real-time visual inputs?
2. What specific facial features (e.g., eye aspect ratio, blink rate) most accurately indicate distraction?
3. How can landmark-based models be integrated into a lightweight system with IoT hardware?
4. What challenges are involved in real-time landmark tracking in various lighting and movement conditions?

1.3 Relevance and Importance of the Research

This research proposes an IoT-based detection system relying on facial landmark tracking to identify distracted driver behavior. The model is implemented using classical computer vision and machine learning, avoiding complex deep learning and dataset training, making it lightweight and practical for deployment with basic hardware.

2 Literature Review

2.1 Summary

Past studies have primarily focused on deep learning models with large datasets for driver behavior recognition. However, such systems are resource-intensive and require significant computational power. Our approach avoids these by using rule-based and traditional machine learning methods with facial landmarks.

2.2 Key Concept

This system uses pre-trained shape predictors like `shape_predictor_70_face_landmarks.dat` and applies traditional methods such as Eye Aspect Ratio (EAR) and blink detection to assess driver alertness. Rather than training neural networks, it uses thresholding logic and lightweight classification.

3 Research Design and Methods

3.1 Research Design

This study follows an experimental, real-time implementation approach using pre-defined facial landmark models and classic machine learning techniques. It avoids dataset training and deep learning, instead employing statistical methods and heuristics to classify distracted behavior.

3.2 Methods and Sources

3.2.1 Tools & Technologies

- **Computer Vision Libraries:** OpenCV, Dlib
- **Machine Learning:** Scikit-learn (for basic statistical modeling)
- **IoT Hardware:**
  - Arduino Uno R3 (buzzer control)
  - Rapoo C200 Webcam (video input)
  - Buzzer (audio alert)
  - Laptop (processing and communication)

3.2.2 Procedures

1. **Landmark Detection:** Use Dlib's 70-point shape predictor to detect eyes, nose, and facial orientation.
2. **Eye Detection:** Calculate Eye Aspect Ratio (EAR) to monitor blinking or drowsiness.
3. **Behavior Classification:** Use threshold-based rules or simple classifiers to identify distraction.
4. **Arduino Communication:** If distraction is detected, trigger an alert via buzzer using Arduino Uno.
5. **Evaluation:** Evaluate system response latency and reliability under various real-world scenarios.

3.2.3 Practical Considerations

- **Hardware Constraints:** Computation is performed on the laptop, not embedded devices.
- **Environmental Variables:** Tests will be conducted in varying light and head position scenarios.
- **Ethical Concerns:** No personal data will be stored; participant consent will be acquired for testing.

4 Implications and Contributions to Knowledge

This project contributes to real-time safety technologies by demonstrating that lightweight computer vision techniques can detect distraction without the overhead of deep learning. It also shows how classical ML can still be effective for embedded and resource-constrained environments.

4.1 Practical Implications

The system can potentially be adopted in commercial driver-monitoring systems, offering a cost-effective and scalable solution for in-vehicle distraction alerts. Insurance companies and fleet operators may use the results to assess driver performance and safety compliance.

4.2 Theoretical Implications

This research supports the notion that classical methods—enhanced by modern tools like Dlib—are still viable in real-world applications. It provides a framework for further development in human-centered IoT and behavior-aware systems without reliance on cloud computing or large-scale models.

5 References

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6 Research Group

Name	**Work**
Doan Le Gia Bao	Leader, machine learning design, and final implementation
Luu Duc Duy	System integration, hardware integration and Arduino interface
Hoang Hai Long	Preparation for two weeks presentation, documentation

Nguyen Van Cong	Preparation for final presentation, documentation, lists of hardware needed