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1. Project Title

**AI-Powered Accident Prevention and Driver Monitoring**

1. Research Question

This project focuses on developing an AI-powered road safety system to reduce the risk of road accidents by employing real-time monitoring and analysis of both the environment and driver behaviour. The system utilizes computer vision and deep learning to detect potential road hazards, including vehicles, pedestrians, and obstacles, and to assess driver alertness by tracking signs of drowsiness or distraction. The primary question this project aims to answer is:

**How can AI be used to improve road safety by identifying and addressing environmental hazards and driver fatigue in real time?**

1. Proposed Project Artefact/Deliverables

The project will deliver a web-based accident prevention system developed using Python and Flask for the web interface. The key features will include:

* Real-time video feed analysis from dashboard cameras for object detection using models like YOLO.
* Distance and speed estimation using stereo vision or monocular distance estimation methods.
* Driver behaviour monitoring using facial recognition and Convolutional Neural Networks (CNNs) to detect signs of drowsiness or distraction.
* A customizable real-time alert system for issuing warnings via audio, visual or Alert System.
* A web dashboard for live monitoring of the vehicle and driver status, accessible remotely from any device.

1. Rationale for Project Choice

This project aligns with my interest in AI and road safety technology, which is a crucial area of development in the modern transportation industry. The rise of accidents due to distracted and drowsy driving is a significant concern, making this system potentially life-saving. It integrates my knowledge of computer vision, deep learning, and web-based application development, making it an ideal choice for applying and extending my technical skills.

1. Background Research

To shape this project, I researched multiple datasets and technologies. The primary datasets used for training include:

* [Road Vehicle Images Dataset on Kaggle](https://www.kaggle.com/datasets/ashfakyeafi/road-vehicle-images-dataset/data)
* [Driver Drowsiness Dataset on Kaggle](https://www.kaggle.com/datasets/ismailnasri20/driver-drowsiness-dataset-ddd/data)
* [KITTI Vision Benchmark Suite](https://www.cvlibs.net/datasets/kitti/eval_object.php?obj_benchmark=2d) The review of similar products, such as Tesla's Autopilot and Mobileye, guided my understanding of how current technologies handle accident prevention and where this project can offer improvements. There is significant demand for systems that ensure safety, both in personal vehicles and in fleet management, which highlights the market potential.

1. Areas for Investigation

Key areas for investigation include:

* Computer vision techniques for object detection (YOLO)
* Driver fatigue detection using CNN and facial landmark detection
* Real-time alert systems and integration with audio and visual feedback mechanisms
* Web development frameworks (Flask) for live monitoring
* Distance and speed estimation through vision-based approaches

1. Research Ethics

This project aligns with my interest in AI and road safety technology, a critical area of development in the modern transportation industry. The rise of accidents due to distracted and drowsy driving is a significant concern, and the system developed in this project has the potential to be life-saving. By utilizing computer vision, deep learning, and real-time monitoring, the system aims to prevent accidents and improve driver safety, while ensuring that data is handled ethically.

To maintain high ethical standards, this project will ensure that all video feeds and driver monitoring data are used strictly for research and safety purposes.

Additionally, the next step in this project is to obtain **ethical approval** from the appropriate review board before commencing any practical work. This step will ensure that all methodologies and data usage comply with ethical guidelines, particularly in relation to the collection and processing of sensitive data such as facial recognition and driver behaviour monitoring. No data will be used or stored without prior informed consent from participants, ensuring the privacy and rights of individuals are respected at all stages of the project.

1. Review of Reference Materials

* **Books:**

[1] I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. MIT Press, 2016.  
A comprehensive resource for understanding deep learning models used in the project.

[2] S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*. Prentice Hall, 2010.  
Provides a foundation in AI concepts relevant to road safety applications.

* **Academic Papers:**

[3] R. Fasila and K. Raseela, "Accident Prevention System using AI for Autonomous Vehicles," *IEEE Transactions on Intelligent Transportation Systems*, 2022.  
A seminal paper on AI-based accident prevention.

[4] Y. Jo and K. Lee, "Real-time Detection of Driver Drowsiness using Deep Learning," *Springer Neural Computing and Applications*, 2019.  
This paper discusses facial recognition models for drowsiness detection.

1. Methodology

This project will follow an iterative development methodology. The stages include:

1. **Research and Requirements Gathering:** Understand user requirements and identify key system components for accident prevention and driver monitoring.
2. **Data Collection:** Utilize publicly available datasets Kaggle, KITTI, etc. to train deep learning models.
3. **Development:**
   * **Object Detection**: Implement YOLO models to identify road hazards in real-time.
   * **Driver Monitoring**: Use CNNs for drowsiness and distraction detection based on facial expressions.
4. **Alert System Integration:** Develop and test real-time alerts triggered by detected hazards.
5. **Web Application:** Build the Flask-based dashboard for live monitoring and alerts.
6. **Testing and Evaluation:** Perform extensive testing in simulated environments, collecting both quantitative and qualitative data to measure performance.
7. Project Plan

The project will be broken down into the following phases:

**Phase 1:** Research and Requirements Gathering (**2 weeks**)

**Phase 2:** Data Collection and Preprocessing (**2 weeks**)

**Phase 3:** Model Development (**6 weeks**)

**Phase 4:** Flask Application Development (**4 weeks**)

**Phase 5:** Testing, Optimization, and Evaluation (**6 weeks**)

**Phase 6:** Final Documentation and Presentation (**4 weeks**)

1. References

[1] J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, “You Only Look Once: Unified, Real-Time Object Detection,” *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2016, pp. 779-788.

[2] H. Fan, Z. Jiang, and H. Liu, "Real-Time Driver Drowsiness Detection System Using Deep Learning," *IEEE Transactions on Cognitive and Developmental Systems*, vol. 12, no. 3, pp. 760-771, 2020.

[3] Y. Jo, K. Lee, "Real-time Detection of Driver Drowsiness using Deep Learning," *Neural Computing and Applications*, vol. 31, no. 1, pp. 121-134, 2019.

[4] C. Wang, W. Han, and J. Zhao, "Accident Prevention System Based on Computer Vision and AI for Autonomous Vehicles," *IEEE Transactions on Intelligent Transportation Systems*, vol. 22, no. 4, pp. 2987-2998, 2021.

[5] Y. Zhang, X. Liu, and H. Wu, "Stereo Vision-Based Distance Estimation for Autonomous Driving Systems," *IEEE Access*, vol. 8, pp. 76591-76600, 2020.

[6] H. Chen, P. Zhao, and F. Liu, "Vision-Based Speed Estimation and Obstacle Detection in Autonomous Driving," *Sensors*, vol. 21, no. 5, 2021.

[7] R. Fasila, and K. Raseela, "Accident Prevention System using AI for Autonomous Vehicles," *IEEE Transactions on Intelligent Transportation Systems*, vol. 23, no. 5, pp. 478-490, 2022.

[8] A. Dosovitskiy, L. Beyer, and A. Kolesnikov, "An Image is Worth 16x16 Words: Transformers for Image Recognition at Scale," *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2021, pp. 6810-6821.

[9] X. Fan, M. Zhang, and H. Wang, "Real-Time Driver Fatigue Detection and Warning System Using AI and Computer Vision," *IEEE Access*, vol. 9, pp. 78550-78563, 2021.

[10] P. Viola, and M. Jones, "Robust Real-time Object Detection," *International Journal of Computer Vision*, vol. 57, no. 2, pp. 137-154, 2019.