AI-Based

Smart Grid Headlights

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Adaptive headlight system using Computer Vision

Problem Addressed :-

Night driving is often made dangerous by glare from oncoming vehicles' headlights. Traditional car headlights provide uniform illumination and cannot adapt to dynamic road conditions, which can temporarily blind drivers and increase the risk of accidents. There is a need for an intelligent headlight system that can **detect vehicles in real time** and **adjust the light distribution dynamically**, reducing glare for other drivers while maintaining optimal road visibility.

Solution :-

My solution is an AI-powered smart headlight system that adapts to dynamic driving conditions. It uses real-time vehicle detection to identify oncoming traffic and divides the headlight into a grid for precise light control. Sections corresponding to detected vehicles are dimmed to reduce glare, while other areas remain illuminated for optimal visibility..

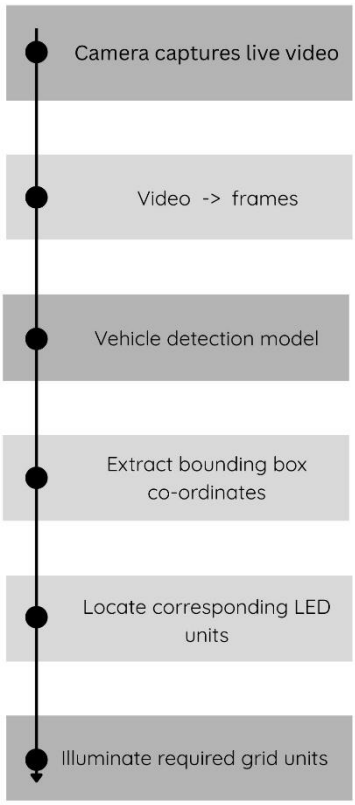
Problem Statement:-

Night driving is risky due to glare from oncoming vehicles' headlights, which can **temporarily blind drivers** and reduce their ability to judge distances or see obstacles. Static, traditional headlights cannot adjust to traffic, causing **eye strain, fatigue, and slower reaction times**, especially on highways or poorly lit roads. Excessive glare not only endangers the driver but also **affects other road users**, increasing the likelihood of accidents. There is a clear need for an intelligent system that **adapts headlight intensity dynamically** to ensure safety for everyone on the road.

Solution:

- AI-powered smart headlights that **adapt dynamically** to traffic conditions.
- Uses **YOLOv8 vehicle detection** to identify oncoming vehicles in real time.
- Headlights divided into a **16×12 grid of controllable units** for precise light modulation.
- Sections corresponding to detected vehicles are **dimmed**, while other areas remain bright.
- **Smooth fading transitions** ensure gradual changes in brightness for comfort and safety.
- Software simulation allows testing with **images and videos** before hardware implementation.

Workflow Diagram :-



Output (Software Simulation) :-

Brief :-

The headlight is divided into m x n grid of units. The Machine learning model returns bounding box within which car is detected. The corresponding co-ordinates of grid units are dimmed in fading manner as shown above.

ML Model :

In this prototype, Yolov8n (~3.2M parameters) trained on coco dataset is the model used to detect vehicles at night. With availability of desired dataset we could build custom model by using Transfer learning vis models like lighter versions of MobileNet, yolo, etc.