Department of Electronic Engineering
EL-401 Final Year Design Project
Proposal for the Final Year Design Project

Title	**A Multiple Lane Detection Network for Intelligent Transportation System**

Domain	Domain 1 Embedded System	Domain 2 Intelligent Transportation	Domain 3 Neural Network	Domain 4 Computer Vision

1. Nature of Project [Tick all that applicable]

☑ New Project OR ☐ Extension of Existing Project	☐ Industrial Collaboration	☐ Funded
☐ Other Department Collaboration (If yes) Department Name_________________	☐ Other Academic Institution Collaboration (If yes) Institution Name________________	

2. Brief Outline (*Problem Identification and Significance*)

Advance Driver-Assistance System (ADAS) plays a vital role in upgrading the safety of driving by assisting drivers with defensive driving. ADAS secures the services of automated technology, including sensors and cameras, to detect nearby obstacles and respond adequately. These systems are significant in minimizing human errors, which are the predominant cause of road accidents. By automating, and enhancing vehicle technology, ADAS crucially provides to reducing road fatal accidents minimizing the probability of collisions[1].

Fig. 1. (a) Original Multiple Lanes

Fig. 1. (b) Detected Multiple Lanes

Advanced Driver-Assistance Systems (ADAS) offer a range of innovative features that enhance vehicle safety, convenience, and driving experience. These features include Collision avoidance Lane Departure Warning and Assist, Adaptive Cruise Control, Automatic Emergency Braking, Blind Spot Monitoring, Rear Cross Traffic Alert, and Forward Collision Warning. Additionally, features like Traffic Sign Recognition, Driver Attention Monitoring, and Semi-Autonomous Parking Assist. Some systems also offer 360-Degree Camera Views, Night Vision, and Adaptive Headlights. Furthermore, ADAS can include advanced features like Highway Assist, Lane Centering, and Traffic Jam Assist, which enable semi-autonomous driving capabilities. These features work together to create a safer, more convenient, and more enjoyable driving experience [2].

A lane is a key part of the traffic system that separates different sections of a road, helping cars to drive safely and efficiently. Lane detection is the process of automatically identifying these road markers to keep vehicles within their lanes and avoid accidents with cars in other lanes. This technology is especially important in self-driving cars, as it helps the vehicle make decisions about its position and ensures safe driving. However, creating lane detection algorithms is challenging due to the variety of lane markings, changing road and weather conditions, and the narrow size of lanes[3].

Low light during early morning and evening, along with poor visibility in bad weather, can make lane detection less accurate. The appearance of the road can change due to construction materials, tire marks, or shadows from vehicles and trees, increasing the chance of detection errors. Informative road markings can also lead to incorrect classifications. Moreover, vehicles blocking lane markings often complicate the task of determining lane boundaries [4]. In the context of different features of ADAS, we are concentrating on the development and implementation of a Multi lane detection model.

Multi-lane detection is a principal part of Advanced Driver Assistance Systems. It facilitates vehicles to identify and supervise multiple lanes concurrently, supporting functions such as lane departure warning (LDW), and Lane Keeping Assist (LKA). This innovation makes sure that vehicle make diplomatic decisions by tracking lane positions, Mainly in extreme environments like highway roads. Multi-lane detection is crucial for restricting lane discipline and minimizing collision risks by safely keeping vehicles properly lined up within their lane. It strengthens safety and driving smoothness, particularly in complicated environments[5] The World Health Organization awares about the number of road accidents, as there's a lack of effective registry system for road traffic deaths[6].

3. Objectives

1. Design a real time neural network system for multi-lane detection that accurately identifies and separates multiple lanes, even in complex driving conditions.
2. Design pre-processing block to prepare dataset according to neural network requirements.
3. Develop hardware prototype for multi-lane detection system.

4. Scope

Autonomous driving system can enhance road safety, or enable autonomous vehicles to navigate multi-lane roadways. Improve data processing to reduce delays, enabling the system to work in real-time while maintaining accuracy. Algorithm development and training are involved in detection of multi-lane roadways. The challenges might impact the project’s success include:

- Complexity of lane markings.
- Integration challenges

5. Proposed Methodology

We plan to develop a system that can detect multiple lanes on the road using images obtained from dataset. The process involves several steps, starting with collecting data to make it easier to analyze. We will then use advanced techniques to identify the lanes, followed by refining the results to ensure accuracy. The given block diagram Fig. 2. below explains this process step by step, highlighting each stage involved in creating a reliable system for detecting lanes in various driving conditions.

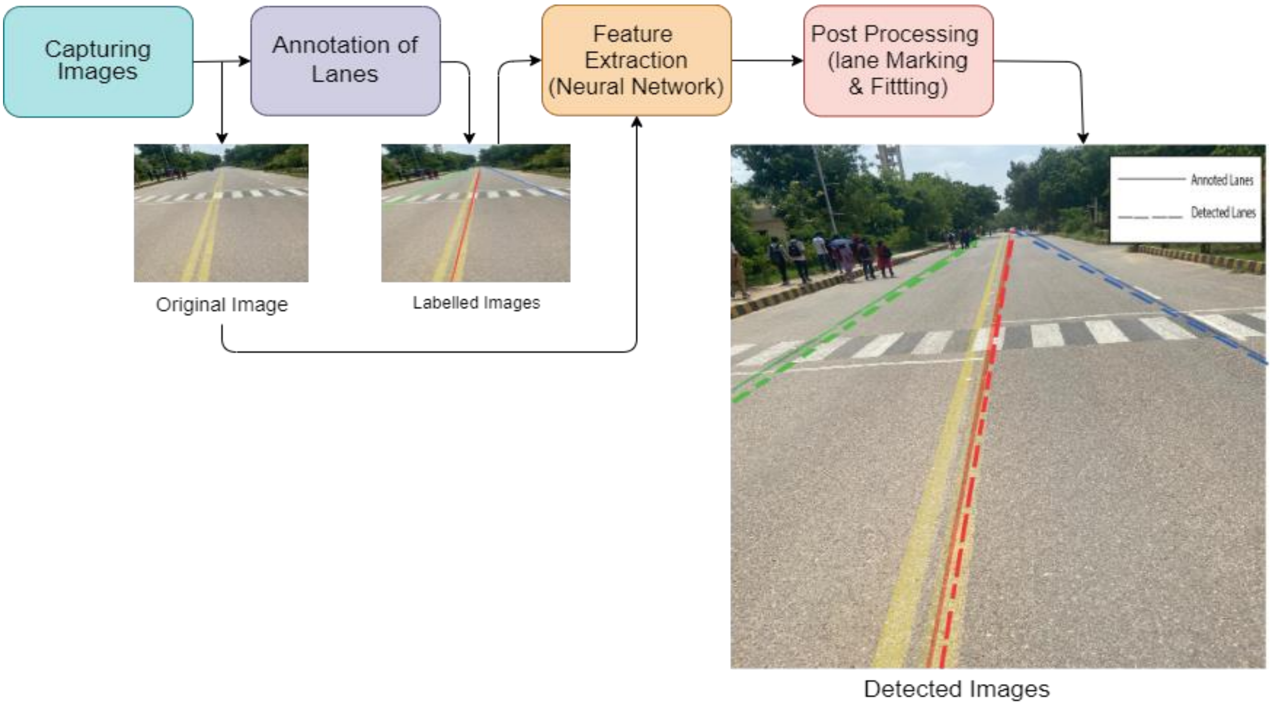

Fig. 2. Block Diagram for Multilane Detection

In this block diagram, Firstly, images are captured. These images are referred to as original images in the process. Next, these original images go through an annotation step where relevant parts of the image are labeled or marked for further analysis. This produces a labeled image. After that, the labeled image proceeds to the feature extraction phase, where important features or characteristics of the image are identified and extracted for further use. Subsequently, the features are utilized to detect objects or patterns, producing detected images. Finally, the detected images undergo post processing to refine or improve the output, completing the process. We will prepare a dataset by combining the images with their labels, in which we take an image as input and separate the labels from it. Input images should be prepared and separated, which will help us train our model.

In the pre-processing stage, data cleaning involves shuffling to ensure diversity, noise removal to improve quality, and data augmentation to increase volume for better model training. Data pre-processing for multi-lane detection focuses on resizing images to ensure uniformity, adjusting brightness and contrast for varying lighting, and using edge detection techniques to highlight lane boundaries. Post-processing involves clustering lane segments after detection, which adds complexity and slows down the process. This step is required to group detected lane points into meaningful lane instances, especially when the number of lanes is variable[7].

Additionally, the focus is narrowed to expected lane areas, and multiple image versions are created to enhance system learning and improve detection accuracy[8]

Feature is extracted by obtaining low-level details from images to assist in lane and road detection. This process starts with image acquisition where image of roads is collected. In lane detection, the process focuses on gathering evidence of lane markings. Algorithms such as CNN, FCN, SCNN and YOLO are popular for lane detection. These algorithms work by mapping pixel values to specific classes, where each class represents either a particular lane or the background by automatically identifying features within images. A Convolutional Neural Network (CNN) is at the core of these algorithms. CNNs are used for image recognition and processing features within images. Recent advances in lane detection based on deep neural networks have enhanced the detection performance of intelligent vehicles under different traffic scenes. However, it's still difficult for existing lane detection algorithms to robustly extract lane instances and adapt to varying lane numbers simultaneously[9].

For single-lane detection, algorithms like Deep Lanes utilize CNNs to accurately detect and follow a single lane. When it comes to multi-lane detection, algorithms like SCNN (Spatial CNN) and an advanced version of Lane-Net are applied[10].

Post-processing in lane detection focuses on enhancing the initial detection results. It involves eliminating unnecessary elements through noise removal, making lane lines smoother for a more continuous appearance, and applying curve fitting methods to accurately represent curved lanes. The Hough Transform is effective for finding straight lane segments, while B-splines refine and fit the curves. By combining these techniques, lane detection becomes more accurate and reliable for both straight and curved lanes[10].

The flowchart provided below in Fig. 3. clearly explains the process of developing a deep learning model. The flowchart effectively details each step, providing a comprehensive visual guide that outlines the workflow from start to finish, making it easier to understand the entire development process.

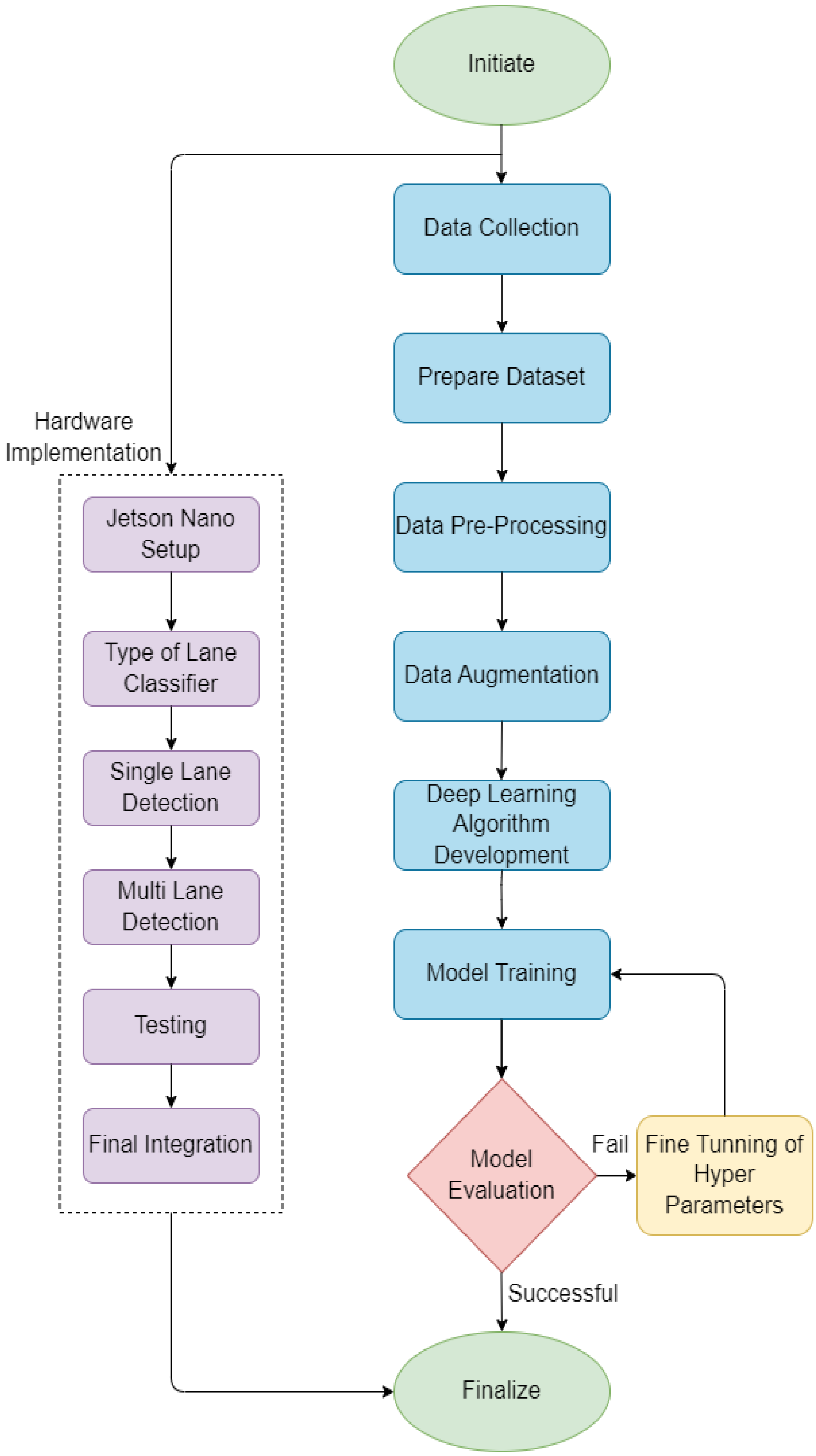

Fig. 1. Flowchart for Multilane detection

Firstly, we begin the process by collecting the necessary data. This includes gathering input images or other relevant data types. Secondly, we move on to prepare dataset. After this, the collected data undergoes pre-processing to clean and prepare the data for further analysis. Next, we develop the deep learning algorithm using the pre-processed data. Then, we train the model with the developed algorithm. After the training phase, we evaluate the model to determine its performance if the model fails we adjust the algorithm, modify the training data, or perform curve fitting, and then retrain the model. Furthermore, if the model is successful we move on to integrating the model into the hardware system.

Jetson Nano is a small, powerful computer for embedded applications that execute multiple neural network. The hand-sized edge AI full system, depicted in Fig.4 is built with 64 quad-core ARM Cortex-A57 CPU. Its running speed is 1.43 GHz and running on a Type C 5V/3A power supply. Talking about processing memory, it has 4GB of 64-bit LPDDR4 RAM on-board and 16GB of eMMC storage and runs Linux for Tegra. Setting of the Jetson Nano starts with the implementation of hardware. This shows the configuration of Jetson Nano by using neural network.

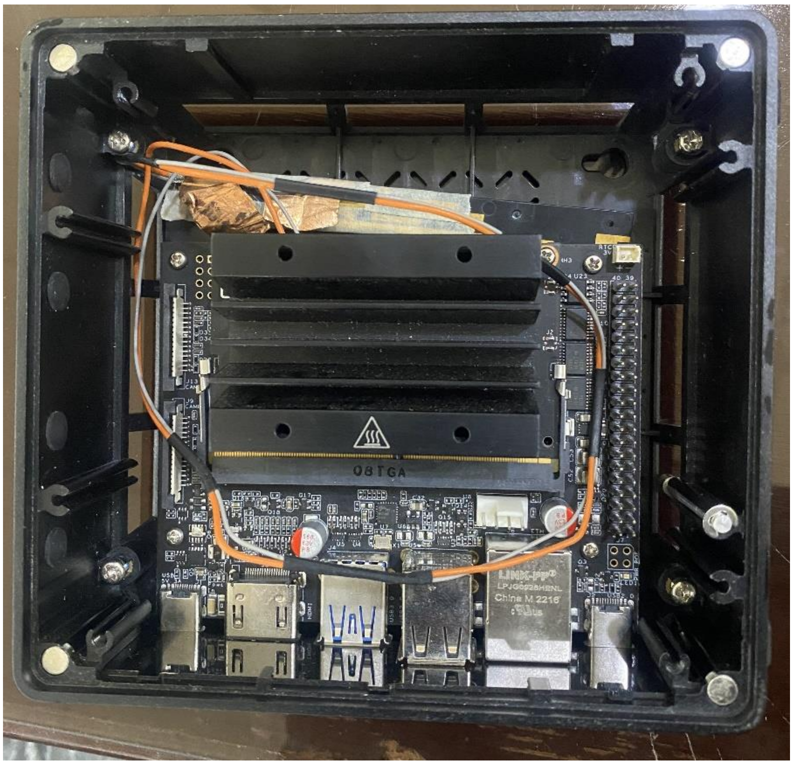

Fig. 4. NVIDIA Jetson Nano Developer Kit

Secondly in the model conversion step the deep learning model is converted into a format that can easily run on Jetson Nano. In the next step, detection of single lane is tested. After the successfully completion of previous step, moving towards the multilane detection. In this step detection of multilane is also tested. Then, the model is integrated in a real world environment. Finally, we conclude the process by finalizing the system.

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6. Resources Involved

- Google Collab
- Jetson Nano

7. Description of Industrial Support (If any)

None

8. SDGs (If Applicable)

☐ No Poverty	☐ Zero Hunger
☐ Good Health and Well-Being	☐Quality Education
☐ Gender Equality	☐ Clean water and Sanitation
☐ Affordable and Clean Energy	☑ Decent Work and Economic growth
☑ Industry, Innovations and Infrastructure	☐ Reduced Inequalities
☑ Sustainable Cities and Communities	☐ Responsible Consumption and Production
☐ Climate action	☐ Life Below Water
☐ Life on Land	☐ Peace, Justice and Strong Institutions

☐ Partnerships	

9. Gantt Chart

Year	2024 to 2025										
Months	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June
Literature Review											
Proposal Writing and Project proposal submission											
Mid-Year Evaluation Preparation											
Final integration											
Report Drafting											
Final evaluation and presentation											
Software Implementation											
Dataset gathering, searching for software tools, learning python, neural network											
Designing algorithm for detection and implementation designing of database and algorithm											
Training, Testing, Optimizing Lane Detection Model											
Hardware Implementation											
Explore Jetson Nano, Relevant Libraries, and Tools											
Single Lane Detection Prototype Implementation and Testing											
Multi-Lane Detection Prototype Implementation and Testing											
Final integration											
Report Drafting											
Final evaluation and presentation											

10. Details of Project Team

i. Students

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ii. Supervisors / Advisors

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Industrial Advisor (If any)				

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Project Serial No.: ___________ Dated: ______________________	Signature Convener Steering Committee	Signature FYP Coordinator

☐ Proposal Approved	☐ Not Approved	☐ Returned for Clarification / Modification
Comments: (if any)		

(Signature of Chairperson)

Date: ______________________