**RIPHAH INTERNATIONAL UNIVERSITY**

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**Faculty of Computing**

**FINAL YEAR PROJECT PROPOSAL & PLAN**

**AI-Powered Multimodal Vehicle Access System**

**Project Team**

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**Ms. Anum Aleem**

(Lecturer)**AI-Powered Multimodal Vehicle Access System**

**Change Record**

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| --- | --- | --- | --- | --- |
| **Author(s)** | **Version** | **Date** | **Notes** | **Supervisor’s Signature** |
| Munaza Malik  Areeba Sadaqat | 1.0 | 05-09-2025 | Original Draft |  |
| Munaza Malik  Areeba Sadaqat | 2.0 | 09-09-2025 | Changes Based on Feedback From Supervisor |  |
| Munaza Malik  Areeba Sadaqat | 3.0 | 10-09-2025 | Changes Based on Feedback From Faculty |  |
| Munaza Malik  Areeba Sadaqat | 3.0 | 25-09-2025 | Added Project Plan |  |

**Project Proposal**

**Project Title:** AI-Powered Multimodal Vehicle Access System

# Introduction and Background:

The demand for automated and secure vehicle entrance systems is rapidly increasing in today's smart infrastructure. Conventional techniques, including Radio Frequency Identification (RFID) tags and manual checks, frequently result in inefficiencies, long waiting times, and possible security flaws. Unauthorized entry to workplaces, parking lots, residential complexes, universities and colleges can be extremely dangerous for resource management and public safety. With computer vision, pattern recognition, and real-time monitoring, artificial intelligence (AI) has emerged a strong solution for automating and improving security systems.

The ability of license plate recognition (LPR) to automatically identify and validate vehicles without human assistance has drawn interest from all across the world. AI can verify that the driver and the car both belong to a registered entity when combined with facial recognition technology. This multimodal strategy eliminates impersonation risks, human dependency, and allows for real-time alerts for unapproved or suspicious entries. Our proposed project, the AI-Powered Multimodal Vehicle Access System, integrates facial recognition and AI-driven license plate identification to create a more reliable and strong security mechanism. By providing faster, safer, and smarter car entry options, the system aims to lower the faults that come with traditional access methods.

**Literature Review:**

This system aims to provide secure, intelligent access and surveillance for vehicles in parking and institutional environments by combining vehicle and human recognition modalities.

1. **License Plate Recognition (LPR)**Automatic Number Plate Recognition (ANPR) / LPR systems use computer vision, OCR, and machine learning or deep learning models to detect and read the alphanumeric characters on vehicle plates. They are widely used in toll collection, parking lots, traffic monitoring, and law enforcement systems. Recent advances include one-stage detectors and end-to-end networks. For example, Tao et al. propose a real-time deep learning LPR method combining detection and recognition networks to achieve both high accuracy and speed. [1] Zherzdev et al. introduced LPRNet, an end-to-end deep neural network that avoids explicit character segmentation and achieves real-time inference. [2] Laroca et al. presented a layout-independent YOLO-based ALPR system with high recognition accuracy approximately 96.9% across diverse datasets. [3] However, LPR systems by themselves are vulnerable: plates can be forged, altered, or changed, and performance degrades under difficult lighting, occlusion, or nonstandard plate formats. [4]
2. **Face Recognition Algorithms**Models like FaceNet and VGG-Face have become benchmarks in identity verification tasks. In access control contexts, face recognition is used to verify the person entering a facility. Lee et al. implemented a distance face recognition system for standalone access control contexts, showing feasible accuracy and usability in practical setups. [5] But face recognition alone has limitations: it can be fooled by stolen IDs, photo spoofing, or if a person is driving someone else’s car. Also lighting, face occlusion, and pose variation reduce reliability.
3. **RFID and Manual Gatekeeping**Many institutions use RFID (smart cards, proximity cards) or manual gatekeepers for controlling vehicle entry. RFID systems are cost-effective and convenient but suffer from security issues like card cloning, loss, or system tampering. Manual gatekeeping (guards) introduces human error, delays, and lack of consistency, and is not scalable for large institutions.
4. **Multimodal / Fusion Approaches**To overcome limitations of single modalities, some studies propose combining multiple biometric or non-biometric modalities. Safavipour et al. studied a hybrid multimodal biometric system (fingerprint + ECG) and showed improved accuracy versus unimodal systems. [6] Alim et al. demonstrate a method for simultaneous LPR + face detection/recognition at the edge, exploiting optimized AI models to allow concurrent processing in real time. [7] Denys et al. present a multimodal verification framework combining license plate recognition and face recognition for realistic access control. [8]

**Evaluation of LPR, Face, RFID, and Proposed Multimodal System**

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| **FEATURES** | **License Plate Recognition (LPR)** | **Face Recognition Algorithms** | **RFID / Manual Access** | **Proposed System (Multimodal: LPR + Face)** |
| **Plate recognition accuracy** | ✓ | X | X | ✓ |
| **Identity verification** | X | ✓ | X | ✓ |
| **Vulnerability to forgery** | ✓  (plates can be faked) | ✓  (face alone not enough) | ✓  (cards can be cloned) | ✓  (reduces forgery by combining) |
| **Real-time performance** | ✓ | ✓ | X | ✓ |
| **Reliability in practice** | Medium | Medium-High | Low | High |

**Problem Statement:**

## Although License Plate Recognition and Face Recognition systems exist independently, they face certain limitations when deployed individually. License plate systems can be deceived using fake or duplicate number plates, while face recognition systems may fail due to low-light conditions, image quality, or attempts to impersonate an authorized person. Manual verification, on the other hand, is time-consuming, costly, and error-prone. Vulnerabilities arise in high-security locations including residential complexes, business offices, and institutions due to the absence of a unified system. Access by unauthorized vehicles could result in security breaches, abuse of parking resources, and safety hazards. Furthermore, single-mode AI systems are not robust enough for real-time, large-scale deployment where speed and accuracy are crucial.

## This motivates the need for a multimodal solution that integrates both License Plate Recognition and Face Recognition, verified against a centralized database, to ensure that the driver and the vehicle are both authorized. Such a solution would minimize risks, reduce manual workload, and improve security efficiency.

## Proposed Solution and Methodology:

The proposed solution, AI-Powered Multimodal Vehicle Access System, is designed to overcome the limitations of single-mode access systems by integrating Face Recognition (FR) and License Plate Recognition (LPR) into a unified framework.

1. **System Architecture Design:** Develop a detailed system architecture that defines interactions between:
   1. Front-end cameras capturing license plate and driver face.
   2. Backend AI modules for recognition and verification.
   3. Database layer for registered user and vehicle storage.
   4. Gate control system for access authorization.
   5. Web-based admin dashboard enables admins to monitor logs, manage users/vehicles, and generate reports.
   6. User Interface for users to register vehicles, update profiles, and view their access history.
2. **Algorithm Development:** 
   1. **LPR Module:** Extract and recognize alphanumeric characters from the license plate using OCR and CNN.
   2. **FR Module:** Match captured driver face with the database using deep learning.
   3. **Multimodal Verification Layer:** Cross-check both outputs to ensure the plate and driver belong to the same registered person.

User (Register Vehicle + Documents)

Face Camera (Captures User Face)

Plate Camera (Captures License Plate)

License Plate Recognition Module (OCR + ML on Plate)

Face Recognition Module

(Compares with DB Face data)

Send Records

Verify with DB

Multimodal Verification Layer

(Face + Plate Matching)

Logs + Alerts

If Match

If Mismatch/Unregistered

Access Granted

(Gate Opens)

Access Denied

(Gate will not Open)

Admin Dashboard

Update records

University Vehicle Database

(Student Records + Vehicles + Documents

**Scope of the Project:**

The project is divided into the following major modules:

1. **Multimodal Verification Layer:**

Integrates results from both LPR and FR to verify whether the face and vehicle belong to the same registered user.

1. **License Plate Recognition Module (LPR):**

Uses AI-based OCR and machine learning algorithms to detect and recognize vehicle number plates. Handles variations in fonts, lighting conditions, and camera angles.

1. **Face Recognition Module (FR):**

Utilizes deep learning techniques to detect and recognize the driver’s face in real-time. Guarantees flexibility to variations in lighting, partial obstacles, and facial expressions.

1. **Admin Dashboard:**

The admin dashboard will allow to:

* Manage User Records – Add, update, or delete user profiles.
* Register Vehicles & Drivers – Enter and maintain details of new vehicles and their assigned drivers.
* Monitor Live Camera Feeds – Access real-time surveillance to track vehicles and drivers at entry/exit points.
* Generate Reports & Logs – Create detailed activity reports, view past records, and analyze system usage.
* Control Access – Manually override gate control in special cases or emergencies.
* Receive Alerts – Get instant notifications about unauthorized or suspicious activities.an interface for administrators to manage user records, register new vehicles and drivers, monitor live camera feeds, and generate reports/logs.

1. **User Dashboard:**

Provides a dedicated interface for registered users (drivers/vehicle owners). Through this module, users can:

* View their registered vehicle and profile details.
* Track their vehicle’s entry/exit logs.
* Update limited personal details (like contact information).
* Request support or re-registration if their credentials expire.

1. **Gate Control and Alert System:**

Automates gate opening when verification is successful and triggers alerts/logs in case of unauthorized attempts.

**Constraints and Limitations:**

**Environmental Constraints:** Performance may be affected by poor lighting, extreme weather conditions, or low-resolution camera feeds.

**Hardware Limitations:** Requires high-quality cameras and computing resources for real-time processing.

**Database Dependency:** Accuracy depends on the quality and completeness of the registered user database.

**Scalability:** Large-scale deployment may require optimized servers and network resources.

**Assumptions:** Assumes that all authorized vehicles and users are registered in the database.

**List of Faculty Proposed Changes**

**AI-Powered Multimodal Vehicle Access System**

**Supervisor’s Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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| **Proposed Change** | **Proposed By** | **Supervisor’s Decision** |
| Image Recognition feature to be added along with LPR | Dr. Hajra & Dr. Naurin | Approved |
| Work on Scope of Project | Other Faculty Members | Approved |
| Multimodal AI Detection | Dr. Shumaila | Approved |

**Project Plan**

**Work Breakdown Structure:** A work breakdown structure (WBS) is deliverable based decomposition of project scope. The WBS includes 100% of the work defined by the project scope and captures all deliverables -- internal, external, interim – in terms of the work to be completed, including project management.

# Roles & Responsibility Matrix:

The purpose of roles & responsibility matrix is to identify who will do what.

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| **WBS #** | **WBS Deliverable** | **Activity #** | **Activity to Complete the Deliverable** | **Duration**  **(# of Days)** | **Responsible Team Member(s) & Role(s)** |
| 1 | Project Initiation | 1.1 | Supervisor Selection | 1st Week | Both Team Members |
| 2 | Project Topic Finalization | 2.1 | Topic Discussion | 2nd Week | Both Team Members |
| 3 | Literature Review | 3.1 | Conduct Literature Review | 3rd Week | Both Team Members |
| Proposal Preparation | 3.2 | Presented Proposal to Supervisor |
| 4 | Changes according to the Supervisor | 4.1 | Present Proposal to Panel | 4th Week | Both Team Members |
| 5 | Proposal Refinement | 5.1 | Discuss Feedback / Changes | 5th Week | Both Team Members |
|  | 5.2 | Submit Revised Proposal to Supervisor | 5th Week | Both Team Members |
| 6 | Initial Development | 6.1 | Develop 2 Screens | 6th Week | Both Team Members |
|  | 6.2 | Proposal Submission to FYP  In charge | Both Team Members |
| 7 | System Development and Integration | 7.1 | Develop Remaining Screens, Implement AI features, connect database, System Testing & Debugging | 7th – 10th Week | Both Team Members |
| 8 | Submission | 8.1 | Submit Work to Supervisor | 11th Week | Both Team Members |
| 9 | Refinement & Testing | 9.1 | Apply Supervisor’s Suggested Changes | 12th Week | Both Team Members |
| 10 | Open House Preparation | 10.1 | Prepare for Open House | 13th Week | Both Team Members |
| 11 | Final Presentation | 11.1 | Present Project to Faculty/Panel | 14th Week | Both Team Members |

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[1] L. Tao, et al., “A Real-Time License Plate Detection and Recognition,” **Sensors**,

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[4] M. Montazzolli and C. Jung, “Real-Time Brazilian License Plate Detection and

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System,” Sensors, vol. 20, 2020.

[6] M. H. Safavipour et al., “A Hybrid Approach to Multimodal Biometric

Recognition,” Bioengineering, vol. 9, no. 10, pp. 1–18, 2022.

[7] F. Alim, E. Kavakli, S. B. Okcu, E. Dogan, and C. Cigla, “Simultaneous License

Plate Recognition and Face Detection at the Edge,” Proc. Int. Conf. Artificial

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[8] F. Denys, A. Deleforge, and J. Martinez, “Multimodal Verification of Identity for

a Realistic Access Control System,” Proc. IEEE Int. Conf. Biometrics, 2008.

**Approval**

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| **Project Supervisor** | |
| **Comments\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | |
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| **Project Coordinator** | |
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