UNIVERSIDAD DE GUADALAJARA

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Maestría en Ingeniería de Software

Software Configuration Management Project

BaseLine Virtual Assistant for Recognizing Dangerous Roads.

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1. Introduction

In the field of technological innovation, the "Virtual Assistant for the Recognition of Dangerous Roads" project emerges as a visionary company with significant implications in improving road safety. This project aims to develop an advanced virtual assistant, capable of using pattern recognition and deep learning algorithms to detect and alert about dangerous conditions in real time on our roads.

Prior to the deployment of this initiative, it is imperative to establish a solid Baseline. This reference point will not only define the fundamental elements of the project, but will also act as the cornerstone for the management, evaluation and continued success of the development. From the technical specification of the modules to the rigorous definition of functional and non-functional requirements, this Baseline will be the compass that will guide each iteration of the project towards its completion.

2 Abstract

Any car owner will be able to access the assistant; all they need to do is activate it to begin its operation. This means that the assistant will be able to visualize the user's route in real-time, check for optimal speed, and monitor the time it takes for the journey. It will utilize artificial intelligence to analyze the type of route taken, road conditions, and incline. Additionally, it will have the capability to send alerts to other users as well as emergency services in the event of an accident, utilizing geolocation within at least a 10km radius.

To implement this, machine learning techniques will be employed along with speed sensors, gyroscopes, accelerometers, and cameras. These will be used to gather information, which will then be stored in a database for processing. This will enable the assistant to generate visual or auditory alerts, as well as provide alternate route recommendations.

3 Project baseline description

3.1 **General Objective**:

The overarching aim of this innovative project is to enhance road safety through the development and implementation of an advanced Virtual Assistant tailored for the recognition of hazardous conditions on roads. By leveraging cutting-edge technologies, including pattern recognition and artificial intelligence, the project seeks to create a robust system capable of identifying and alerting users to potential dangers in real-time.

3.2 **Objective**

- Develop a sophisticated algorithm for the real-time recognition of hazardous road conditions.

- Implement a user-friendly interface for seamless interaction with the Virtual Assistant.
- Integrate machine learning capabilities to enhance the system's ability to adapt and improve hazard recognition over time.
- Establish a scalable and modular architecture to accommodate future updates and expansions.

3.3 Project Scope:

The project's scope encompasses the following key modules and features:

- Data Acquisition
- Data Processing
- Alert generation
- Monitoring and maintenance
- Administration Interface
- Vehicle integration
- Notifications to authorities and emergency services
- Historical Data Analysis and Report Generation

The features are described in the following point.

3.4 Requirements

Functional and Non-Functional Requirements play an essential role in charting the path towards creating effective technological solutions. Functional Requirements outline the specific capabilities and functions that the software must meet, while Non-Functional Requirements define the characteristics that affect its performance, security, and user experience.

Having these requirements clearly defined from the beginning is like mapping out a journey before embarking on it. Functional Requirements act as specific targets to be achieved, setting expectations for what the software must achieve to satisfy the user's needs. On the other hand, Non-Functional Requirements are the conditions that guarantee that this trip is smooth, efficient and safe.

3.4.1 Functional Requirements

Module 1	Data Acquisition	RF-01	The system must be capable of collecting data from multiple sources, such as traffic cameras, vehicle sensors, and real-time weather data.
		RF-02	The system must efficiently store and manage large volumes of data.
		RF-03	It should be able to sync and merge data from various sources to gain a comprehensive view of road conditions.
Module 2	Data Processing	RF-04	The system must apply computer vision and machine learning algorithms to identify dangerous roads.

		RF-05	It should analyze traffic speed, weather conditions, and other relevant factors.
		RF-06	It should generate alerts when hazardous conditions are detected.
Module 3	Alert Generation	RF-07	The system must send alerts to drivers through a user-friendly interface.
		RF-08	It should provide specific recommendations for safe driving.
		RF-09	It should be able to communicate with navigation systems and voice assistants.
Module 4	Monitoring and Maintenance	RF-10	The system must monitor the operational status of key components like cameras and sensors.
		RF-11	It should generate performance and preventive maintenance reports.
Module 5	Administration Interface	RF-12	It should provide an administration interface for configuring and customizing the system
		RF-13	It should allow access to historical data and trend analysis.
		RF-14	It must be secure and require authentication for access.
Module 6	Vehicle Integration	RF-15	The system must integrate with vehicle information and entertainment systems.
		RF-16	It should provide real-time feedback to drivers through the vehicle's interface
		RF-17	It must allow bidirectional communication to receive vehicle telemetry data.
Module 7	Notifications to Authorities and Emergency Services	RF-18	The system must be capable of sending automatic notifications to traffic authorities and emergency services when extremely hazardous conditions are detected.
		RF-19	It should include detailed information about the location and nature of the danger
Module 8	Historical Data Analysis and Report Generation	RF-20	The system must be capable of storing and analyzing historical data regarding hazardous road conditions.

		RF-21	. It should generate periodic reports and trend analysis to enhance long-term road safety.

3.4.2 Non-Functional Requirements

RNF-01	The system must ensure the security and privacy of collected data.
RNF-02	System performance must be scalable to handle increases in data volume.
RNF-03	Data processing latency must be low to enable real-time responses
RNF-04	Detection accuracy of dangerous roads must be high.
RNF-05	The system should be adaptable to various weather and lighting conditions.
RNF-06	Alerts must be clear and understandable.
RNF-07	The system should have redundancy to ensure critical alerts are delivered.
RNF-08	The speed of alert delivery must be minimal.
RNF-09	The system must be capable of performing remote software updates.
RNF-10	The administration interface should be intuitive and user-friendly.
RNF-11	It should be compatible with multiple browsers and devices.
RNF-12	Vehicle integration should be compatible with a variety of makes and models.
RNF-13	Latency in communication with the vehicle should be minimal for a real-time driving experience
RNF-14	Notifications to authorities must be reliable and delivered in real-time
RNF-15	The system must comply with regulations and standards for communication with authorities and emergency services.
RNF-16	The system must be efficient in processing historical data
RNF-17	Report generation should be configurable and customizable to meet user needs.
RNF-18	It must ensure the security and privacy of historical data

3.5 System Architecture:

The architecture of the Virtual Assistant for Hazardous Road Recognition is designed to be robust, scalable, and adaptable to various environments. The system is divided into key components that seamlessly work together to ensure efficient hazard detection and user interaction.

Image Recognition Module	Utilizes advanced image processing algorithms to analyze real-time data from road-facing cameras.
	Employs computer vision techniques to identify and categorize potential hazards, such as potholes, construction zones, and adverse weather conditions.
Sensor Integration:	Integrates data from a variety of sensors, including GPS for location tracking and weather sensors for real-time weather conditions.
	Enables the system to correlate sensor data, providing a comprehensive view of the road environment.
Machine Learning Engine:	Implements machine learning models to continuously improve hazard recognition accuracy.
	Adapts and refines hazard detection based on historical data, user feedback, and evolving road conditions.
User Interface (UI):	Offers an intuitive and responsive UI accessible via both mobile applications and in-vehicle displays.
	Provides real-time hazard alerts with visual indicators and audible warnings.
	Includes features for user feedback on hazard accuracy and system performance.

Backend Infrastructure:	Establishes a robust backend infrastructure to handle data processing, storage, and retrieval.
	Implements cloud-based solutions for scalability, ensuring optimal performance during peak usage.

3.5.1 Specification of Technologies and Tools:

Programming Languages:	Python for backend development and algorithm implementation.
	JavaScript and HTML/CSS for front-end development.
Frameworks and Libraries	OpenCV for computer vision and image processing.
	TensorFlow or PyTorch for machine learning model development.
	Flask or Django for backend web framework.
Database	MongoDB or PostgreSQL for efficient data storage and retrieval.
Cloud Services	Integration with cloud services such as AWS or Azure for scalable infrastructure.
User Interface Development	ReactJS or Angular for building responsive and interactive user interfaces.
Communication Protocols	RESTful APIs for seamless communication between frontend and backend components.
Version Control	Git for version control, ensuring collaborative and organized development.

3.6 Work Breakdown and Schedule

Name	Time	Start Time	Finish Time
Collect process information.	30 days	18/08/2023	19/09/2023
Specification of requirements.	60 days	18/08/2023	19/10/2023
Technology selection	30 days	18/08/2023	19/09/2023
Development of the workspace	60 days	18/08/2023	19/10/2023
Vehicle Integration	90 days	08/10/2023	08/01/2024
Create interface	90 days	09/09/2023	09/12/2023
Create alert	60 days	09/09/2023	09/11/2023
Create database	90 days	09/10/2023	09/01/2024
Create intercommunication	90 days	09/09/2023	09/12/2023
Development notification and alert	90 days	09/09/2023	09/12/2023
Development processing data	90 days	01/01/2024	01/04/2024
Generate Manuals and maintenance	60 days	01/04/2024	01/06/2024
Report result	30 days	01/06/2024	01/07/2024
Error corrections	60 days	01/07/2024	01/09/2024

3.7 Risk management:

- Identification of Potential Risks:

Name	Risk	Mitigation Strategy	Contingency plan
Algorithmic Accuracy	Inaccuracies in hazard detection algorithms may lead to false positives or negatives.	Conduct rigorous testing with diverse datasets and road conditions to enhance algorithm accuracy.	Implement a user feedback mechanism to quickly identify and correct algorithmic errors.
Data Security and Privacy	Potential breaches of data security and privacy concerns related to user information.	Implement robust encryption protocols and comply with data protection regulations.	Establish a response plan for immediate action in case of a security incident, including user notification and system updates.
Integration Challenges	Difficulties in integrating the Virtual Assistant with various vehicle systems and platforms.	Collaborate closely with automotive manufacturers and ensure compatibility during development.	Develop adaptors or APIs for seamless integration with different vehicle models, minimizing potential disruptions.
User Adoption	Users may be resistant to adopting the Virtual Assistant, impacting its effectiveness.	Implement an extensive user education and onboarding process, highlighting the benefits and ease of use.	Gather user feedback continuously and adjust the user interface or educational materials based on user insights.
Regulatory Compliance	Changes in road safety regulations may impact the legality of the Virtual Assistant's operation.	Stay informed about and proactively adhere to regulatory requirements throughout development.	Establish a legal team to monitor and address changes in regulations, ensuring ongoing compliance

3.7.1 Mitigation Strategies and Contingency Plans:

Name	Mitigation strategy	Contingency plan
Continuous Testing and Validation	Implement an extensive testing protocol, including simulated and real-world scenarios, to identify and rectify algorithmic inaccuracies.	Establish a rapid-response team to address emerging issues promptly, providing over-the-air updates to users.
Security Measures:	Employ encryption technologies, secure data transmission protocols, and regular security audits.	Activate a response team to isolate and address security breaches, inform affected users, and implement corrective measures.
Adaptive Integration Framework	Develop a flexible integration framework to accommodate varying vehicle systems and platforms.	Maintain an ongoing collaboration with manufacturers, ensuring swift adaptations to changes in vehicle technology.
User Engagement and Education	Implement a comprehensive user engagement plan, including tutorials, FAQs, and responsive customer support.	Monitor user adoption rates and feedback, adjusting educational materials and support systems as needed.
Regulatory Monitoring	Establish a dedicated team to monitor and interpret changes in road safety regulations.	Develop a rapid-response plan to adapt the Virtual Assistant to meet new legal requirements and maintain its legal operation.

3.8 Criteria of acceptance:

Conditions that Must be Met for the Project to be Considered Successful:

Name	Condition	Rationale
Hazard Detection Accuracy:	The Virtual Assistant must achieve a minimum accuracy rate of 95% in identifying and alerting users to hazardous road conditions.	Ensuring a high level of accuracy is critical for the reliability and effectiveness of the system.
Real-time Responsiveness	The system must provide real-time hazard alerts with a latency of no more than two seconds from the detection of a hazard.	Timely alerts are crucial for enabling users to react promptly to potential dangers.
User Adoption Rate	The Virtual Assistant must achieve a user adoption rate of at least 80% within the first six months of deployment	User adoption is indicative of the system's perceived value and ease of use.
Compliance with Data Privacy Regulations	The system must adhere to all relevant data privacy regulations and standards, ensuring the secure handling of user data.	Protecting user privacy is a fundamental aspect of the project's success and ethical considerations.
Integration with Vehicle Systems:	The Virtual Assistant must seamlessly integrate with a minimum of 90% of commonly used vehicle systems and platforms.	Compatibility with diverse vehicle models enhances the system's applicability and market reach.

3.8.1 Quality Criteria and Tests:

- Algorithmic Precision and Recall:
  - Test: Conduct precision and recall tests using diverse datasets to evaluate the algorithm's accuracy in identifying hazards without generating false positives.
- Latency Testing:
  - Test: Simulate various road conditions and scenarios to assess the system's real-time responsiveness, ensuring it meets the specified latency criteria.
- Usability Testing:
  - Test: Engage a representative sample of users in usability testing to evaluate the clarity, intuitiveness, and overall user experience of the interface.
- Security Audits:
  - Test: Conduct regular security audits to identify and address potential vulnerabilities, ensuring the system complies with data privacy and security regulations.
- Integration Compatibility Testing:
  - Test: Verify the Virtual Assistant's compatibility with a range of vehicle systems through integration tests, ensuring seamless communication and functionality.
- User Feedback Analysis:
  - Test: Analyze user feedback regarding hazard accuracy and system performance to identify areas for improvement and refinement.
- Regulatory Compliance Checks:
  - Test: Regularly review and update the system to ensure compliance with evolving road safety regulations and legal requirements.

3.9 Human resources

List of Roles and Responsibilities:

Rol	Responsibilities
Project Manager	Oversee the overall planning, execution, and delivery of the Virtual Assistant project.
	Define project scope, goals, and deliverables
	Coordinate with stakeholders, ensuring alignment with project objectives.
	Monitor and report project progress, risks, and resource utilization.

Lead Developer:	Lead the software development team in implementing algorithms and system functionalities.
	Oversee code quality, ensuring adherence to coding standards and best practices.
	Collaborate with other teams to integrate software components seamlessly.
User Interface (UI) Designer:	Design intuitive and visually appealing user interfaces for both mobile and in-vehicle applications.
	Ensure the UI enhances user experience and aligns with usability principles.
	Collaborate with developers to implement UI designs effectively.
Machine Learning Engineer:	Develop and implement machine learning models for hazard detection and system adaptation.
	Continuously improve algorithms based on user feedback and evolving road conditions.
	Collaborate with the development team to integrate machine learning components.
Backend Developer	Design and implement the backend infrastructure for data processing, storage, and retrieval
	Develop APIs for seamless communication between frontend and backend components.
	Ensure the scalability and efficiency of the backend architecture.
Data Security Specialist	Implement and maintain robust data security measures to protect user information.
	Conduct regular security audits and address potential vulnerabilities.
	Ensure compliance with data privacy regulations.

User Engagement Specialist:	Develop and execute user engagement strategies, including tutorials and onboarding materials
	Gather user feedback and insights to enhance user experience.
	Provide responsive customer support to address user queries and concerns.

Name	Rol	Cost
Rodrigo Resendiz	Project manager	$4000
Kevin Alvarez	Lead Developer	$3000
Omar Bravo	UI Designer	$2500
Peter Anguila	Backend Developer	$1200
Benny Urdaneta	Backend Developer	$1200
Matew Ramirez	Machine Learning Engineer	$2000
Jaime Resses	User Engagement specialist	$2000
Andres Lopez	Data Security specialist	$2000
Claudia Galvez	UI Designer	$2000
Andrea Doriga	Backend Developer	$2000

3.10 Budget

Detail of Estimated Costs:

Scales	Rol	Cost
Sr	Project manager	$4000
	Lead Developer	$3000
	UI Designer	$2500
	Backend Developer	$2000
Jr	Backend Developer	$1200
Sr	Machine Learning Engineer	$2000
	User Engagement specialist	$2000
	Data Security specialist	$2000
Development Tools and Licenses		$1000
Testing Team Salaries		$4000
Testing Tools and Licenses		$1000
Simulation and Test Environments		$2000
Infrastructure and Cloud Services:	Backend Infrastructure	$3000
	Cloud Services (AWS/Azure):	$1500
Personnel Training and Development:	Training Programs	$1500
	Skill Enhancement Workshops	$500
Regulatory Compliance and Certification:	Legal Consultation for Compliance	$1500
	Certification Fees	$800
User Engagement and Support	User Feedback Analysis Tools	$1200
	Customer Support Platform	$1200
Contingency and Unforeseen Expenses	Contingency Fund (10% of Total Budget)	10% of total budget