Final Year Project

**InspectAI**

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# **Project Vision**

"We envision a future where the inspection process is revolutionized, making use of cutting-edge technology to empower professionals in various industries. Inspect AI is our answer to this vision, combining the power of smart spectacles and artificial intelligence to enhance the way objects are inspected, defects are identified, and measurements are taken. Our project's vision is to create a world-class inspection system that improves accuracy, efficiency, and user experience while opening new possibilities for industries that rely on precision and quality.

Inspect AI is designed to transform traditional inspection methods into a more intelligent and intuitive process. With real-time 3D model generation, precise object detection, and seamless data integration, our system enables inspectors to:

Inspect and analyze objects in real time, resulting in quicker decision-making and reduced downtime.

Detects anomalies and defects with unprecedented accuracy, reducing human error and improving the quality of inspections.

Measure and analyze objects with precision, providing valuable data for quality control and process improvement.

Collaborate seamlessly with other team members through the integration of inspection data into existing systems.

Enhance user experiences with an intuitive interface, augmented reality overlays, and comprehensive reporting.

We aim to empower professionals in manufacturing, construction, healthcare, and various other fields with a solution that not only streamlines their workflows but also elevates the quality of their work. Inspect AI will set a new standard for inspection systems, contributing to safer, more efficient, and more accurate operations.

By delivering a solution that seamlessly combines the capabilities of smart spectacles and advanced artificial intelligence, we aspire to foster innovation, reduce operational costs, and ultimately improve the quality of products and services across different industries. Our vision is to be at the forefront of the digital transformation of inspections, driving progress through intelligent, user-centric technology.

We are committed to realizing this vision by assembling a dedicated team of experts, continuously enhancing our system, and collaborating closely with industry professionals to ensure our solution meets the ever-evolving needs of our users. Together, we will bring about a future where inspections are smarter, more efficient, and more precise."

# **Problem Statement:**

Challenges in Modern Inspection Processes and the Need for Inspect AI

## **Background:**

In various industries, the need for accurate and efficient inspection processes is paramount. Inspection tasks play a crucial role in ensuring product quality, safety, and compliance with industry standards. However, traditional inspection methods often suffer from inefficiencies, inaccuracies, and limited capabilities.

## **Challenges:**

Limited Real-time Insights: Traditional inspection methods often rely on manual inspection, which can be slow and prone to human error. Inspectors may lack real-time insights into objects being examined.

Anomaly Detection Challenges: Identifying defects or anomalies in inspected objects requires expertise and may not always result in consistent and accurate outcomes. Current practices may overlook subtle defects.

Dimension Measurement Complexity: Measuring the dimensions of objects accurately can be cumbersome and may require additional tools, resulting in time-consuming processes.

Data Management and Collaboration: The management of inspection data, annotations, and reports is often fragmented, making it challenging for inspectors to collaborate effectively and integrate inspection results into other systems.

Privacy and Compliance: Handling sensitive inspection data while adhering to privacy regulations and industry-specific compliance standards can be complex and require robust security measures.

## **The Solution: Inspect AI**

The Inspect AI project aims to address these challenges by introducing a revolutionary solution that combines smart spectacles and artificial intelligence. This innovative system will enable inspectors to perform inspections with precision and efficiency, transforming the way inspections are conducted across various industries.

## **Scope of the Project:**

Inspect AI will provide real-time video analysis, 3D model generation, object detection, anomaly recognition, and dimension measurement, all integrated into a user-friendly interface. The system will also facilitate data management, reporting, and integration with external systems. It will incorporate strong security measures to ensure data privacy and regulatory compliance.

## **The Impact:**

The successful implementation of Inspect AI will significantly improve inspection processes in industries such as manufacturing, construction, healthcare, and many others. This project seeks to:

## **Increase Efficiency:**

By offering real-time insights, precise measurements, and anomaly detection, inspections will become faster and more accurate.

## **Enhance Quality:**

Accurate defect identification and precise measurements will result in higher-quality products and services.

## **Facilitate Collaboration:**

Inspectors will have the tools to collaborate effectively and integrate inspection data into existing systems.

## **Improve Safety:**

Better inspections contribute to safer work environments and higher safety standards.

## **Drive Innovation:**

Inspect AI sets a new standard for inspection systems, fostering innovation and pushing the boundaries of technology.

The Inspect AI project aims to transform the landscape of inspection processes, improving not only the efficiency and accuracy of inspections but also the overall quality and safety across industries.

# **Business Opportunity: Revolutionizing Inspection with Inspect AI**

## **Introduction:**

The business opportunity presented by Inspect AI is one of innovation and transformation. It revolves around the integration of cutting-edge technology into traditional inspection processes, promising substantial benefits to various industries. Here's a comprehensive overview of the business opportunity:

## **Market Overview:**

Inspection processes are fundamental to numerous industries, including manufacturing, construction, healthcare, aerospace, automotive, and many more. The global inspection market is substantial, driven by the need for quality control, safety, and compliance with regulatory standards.

## **Key Business Opportunities:**

### ***Market Expansion:***

The adoption of Inspect AI presents an opportunity to penetrate and expand within existing markets. Industries that rely on inspections for quality control and safety, such as manufacturing, construction, and healthcare, can benefit immensely.

### ***Product Customization:***

Tailoring the system to cater to specific industry needs presents a business opportunity. Customization could involve the development of specialized detection models, measurement tools, and industry-specific reporting templates.

### ***Data Analytics and Insights:***

Leveraging the data collected from inspections can lead to the creation of analytics and insights services. Providing customers with deeper analysis of their inspection data can add significant value.

### ***Integration Services:***

As companies increasingly seek to integrate inspection data into their broader operations, there is a business opportunity in offering integration services that bridge Inspect AI with other systems, such as enterprise resource planning (ERP) and quality management systems (QMS).

### ***Hardware Sales:***

Smart spectacles are an essential component of the system. Collaborating with smart spectacle manufacturers or offering these hardware devices can be a lucrative avenue.

### ***Training and Support Services:***

The successful implementation of Inspect AI relies on well-trained users. Providing training and ongoing technical support services can be a sustainable revenue stream.

### ***Global Expansion:***

As the system proves its value, opportunities for global expansion and market diversification emerge. International markets with industries requiring robust inspection solutions are potential growth areas.

### ***Competitive Advantage:***

The Inspect AI project has a distinct competitive advantage due to its innovative combination of smart spectacles and advanced AI. This technological advantage positions the system as a frontrunner in the market, attracting early adopters and establishing a strong brand presence.

## Conclusion:

The business opportunity presented by Inspect AI is not only aligned with market needs but also represents a chance to revolutionize and improve inspection processes across industries. By leveraging technology to address long-standing challenges, this project opens doors to various revenue streams, customization possibilities, and global expansion. Moreover, it contributes to enhanced product quality, safety, and innovation within the inspection industry.

# **Project Objectives: Inspect AI**

The objectives of the Inspect AI project are outlined to provide a clear and measurable focus for the development and implementation of the system. These objectives are designed to guide the team and stakeholders toward the successful realization of the project's vision.

## **Deliver Precision and Efficiency:**

### ***Objective:***

To enhance the accuracy and efficiency of inspection processes in various industries.

### ***Key Results:***

Achieve a minimum of 95% accuracy in anomaly detection and reduce inspection time by at least 30%.

Real-time Insights:

### ***Objective:***

Provide inspectors with real-time insights into inspected objects during the inspection process.

### ***Key Results*:**

Ensure that inspectors receive instant feedback on detected objects and anomalies.

## **Accurate Anomaly Detection:**

### ***Objective:***

Develop algorithms for accurate and consistent detection of defects and anomalies.

### ***Key Results:***

Achieve a false-positive rate of less than 5% and a true-positive rate of over 95% in anomaly detection.

## **Precise Dimension Measurement:**

### ***Objective:***

Enable inspectors to measure object dimensions with high precision.

### ***Key Results:***

Provide measurement tools with an error margin of less than 1% for all standard measurements.

## **User-Friendly Interface:**

### ***Objective:***

Create an intuitive and user-friendly interface for inspectors.

### ***Key Results:***

Ensure that 95% of users can confidently use the system after minimal training.

## **Effective Data Management:**

### ***Objective:***

Streamline data management and reporting for inspections.

### ***Key Results:***

Generate comprehensive inspection reports with a 95% reduction in report creation time.

## **Secure Data Handling:**

### ***Objective:***

Implement strong security measures to protect inspection data.

### ***Key Results:***

Maintain compliance with industry-specific data security regulations and zero data breaches.

## **Integration and Collaboration:**

### ***Objective:***

Enable the integration of inspection data with external systems and facilitate collaboration among inspectors.

### ***Key Results:***

Achieve seamless integration with at least three common external systems used in the target industries.

## **Highly Reliable System:**

### ***Objective:***

Develop a highly reliable system with minimal downtime.

### ***Key Results:***

Ensure system uptime of at least 99.9% during business hours.

## **Market Penetration and Growth:**

### ***Objective:***

Establish Inspect AI as a market leader in the inspection technology industry.

### ***Key Results:***

Achieve a 20% market share within three years of product launch.

## **Customer Satisfaction:**

### ***Objective:***

Ensure high levels of customer satisfaction among system users.

### ***Key Results:***

Maintain a customer satisfaction rating of at least 90% based on user feedback and surveys.

## **Innovation and Expansion:**

### ***Objective:***

Drive innovation within the inspection industry and explore opportunities for global expansion.

### ***Key Results:***

Identify and implement at least two major innovations within the first year and enter at least one new international market within three years.

These objectives serve as a roadmap for the Inspect AI project, focusing on the core goals of accuracy, efficiency, user experience, security, and growth. They provide a framework for measuring the project's success and impact on various industries that rely on inspection processes.

# **Project Scope:**

The project scope for Inspect AI defines the boundaries, objectives, deliverables, and constraints of the project. It serves as a guideline for project stakeholders, including the project team, sponsors, and users, ensuring a clear understanding of what the project will encompass.

## **Scope Statement:**

Inspect AI is a comprehensive system designed to enhance the efficiency and accuracy of inspection processes across various industries. The project scope includes the development, implementation, and deployment of the system, with the following key components:

### ***1. System Components***:

User Interface: A user-friendly interface that displays live video feeds, 3D models, and inspection results. It includes tools for annotation and interaction.

Video Processing: Algorithms and modules for real-time video stream capture, 3D model generation, object detection, and anomaly recognition.

Measurement Tools: Tools for precise dimension measurement and analysis within the 3D model.

Data Management: A database system for storing inspection data, annotations, and generated reports.

Integration Services: Mechanisms to enable integration with external systems and data sharing.

Security Measures: Data encryption, user authentication, and authorization for data protection.

Hardware Integration: Custom software for smart spectacles, allowing control and data transfer.

### ***2. Functionality:***

The system will provide real-time insights during inspections, including object detection, anomaly recognition, and dimension measurement.

It will facilitate user collaboration, data sharing, and integration with external systems.

The system will offer an intuitive user interface with augmented reality overlays and comprehensive reporting capabilities.

### ***3. Performance and Scalability:***

The system will be optimized for real-time processing, with a goal of minimal latency.

It should be capable of handling multiple simultaneous inspections and users.

Performance enhancements may include GPU acceleration for computationally intensive tasks.

### ***4. Security and Compliance:***

The project will adhere to data security and privacy regulations, ensuring that sensitive inspection data is protected.

The system will comply with industry-specific standards and regulations where applicable.

### ***5. Training and Support:***

The project will provide training materials and support services to ensure users can effectively operate the system.

Out of Scope:

Hardware production: The project will not manufacture or sell smart spectacles; instead, it will focus on software integration with existing hardware.

External systems development: While integration is within scope, the development of third-party systems that Inspect AI will connect to is not part of this project.

Data archival: Long-term storage and archival of inspection data beyond a defined period are out of scope.

Constraints:

The project is subject to budget and resource constraints.

Development is constrained by the capabilities and limitations of existing smart spectacle hardware.

Regulatory constraints must be adhered to, depending on the industries in which the system will be used.

Project Deliverables:

A fully functional Inspect AI system.

User documentation and training materials.

Implementation of data security measures and regulatory compliance.

A successful deployment plan for the system's use in specific industries.

The Inspect AI project scope encompasses the development of an innovative system aimed at revolutionizing inspection processes, focusing on efficiency, accuracy, user experience, and security. The project is expected to deliver a comprehensive solution that meets the defined objectives and requirements.

# **Project Constraints**

Project constraints are factors that limit the project's scope, resources, or execution in various ways. Identifying and managing constraints is crucial for the successful completion of the Inspect AI project. Here are the key project constraints with the "skilled personnel and developer" constraint removed:

## **Budget Constraints:**

The project is subject to budget limitations that may impact the scope of development, hardware acquisitions, and other resource allocations.

## **Hardware Constraints:**

The project relies on the capabilities and limitations of existing smart spectacle hardware, which may have constraints in terms of processing power, storage, and connectivity.

## **Regulatory Compliance:**

Compliance with industry-specific regulations and standards, as well as data privacy laws, can be a constraint that affects system design and data handling.

Integration Challenges:

Integrating Inspect AI with external systems or databases may pose technical challenges, especially when dealing with legacy systems.

## **Data Storage Limitations:**

Storage constraints can affect the amount of inspection data that can be stored, archived, and retrieved efficiently.

## **GPU Limitations:**

Utilizing GPU acceleration may be subject to limitations based on the available hardware, which can impact the performance and real-time processing capabilities of the system.

## **Development Timelines:**

There may be fixed deadlines or launch dates that need to be adhered to, potentially constraining the time available for development, testing, and refinement.

## **User Training and Acceptance:**

Inspectors' ability to adapt to and accept the system may be constrained by the learning curve and their familiarity with new technology.

## **Scalability Challenges:**

The system's ability to scale and accommodate a growing number of users, concurrent inspections, and expanding data volumes may be constrained.

## **External Factors:**

External factors, such as unforeseen industry changes or economic conditions, can introduce constraints that need to be considered during project execution.

## **Hardware Compatibility:**

Compatibility with various models and brands of smart spectacles can be a constraint, as each may have different hardware capabilities and software requirements.

## **User Accessibility:**

Users' physical and sensory abilities may impose constraints on the usability of the system.

# **Stakeholders Description**

Stakeholders in the Inspect AI project are individuals, groups, or entities that have a vested interest in the project's success. Identifying and understanding the various stakeholders and their roles is crucial for effective project management. Here are descriptions of some key stakeholders in this project:

## **1. End Users (Inspectors):**

- Description: The primary users of the Inspect AI system are inspectors in various industries, including manufacturing, construction, healthcare, and more. They use the system for real-time inspections, object detection, and data management.

## **2. Project Team:**

- Description: The project team includes developers, designers, domain experts, and project managers responsible for the system's design, development, testing, and deployment. They work together to bring the project to fruition.

## **3. Project Managers:**

- Description: Project managers are responsible for planning, coordinating, and ensuring the successful execution of the project. They oversee timelines, budgets, and resource allocation.

## **4. Smart Spectacle Manufacturers:**

- Description: Manufacturers of smart spectacles are crucial stakeholders, as the project depends on the integration of the system with these devices. Collaboration with manufacturers is necessary to ensure compatibility and functionality.

## **5. Regulatory Authorities:**

- Description: Regulatory bodies and authorities relevant to the industries using Inspect AI are stakeholders. Compliance with industry-specific regulations and data privacy laws is vital.

## **6. Data Security Experts:**

- Description: Experts in data security and privacy play a role in ensuring that the project complies with relevant regulations. They contribute to securing inspection data and protecting user privacy.

## **7. Industry Representatives:**

- Description: Representatives from industries such as manufacturing, construction, and healthcare provide domain-specific insights, requirements, and feedback to tailor the system to their needs.

## **8. Technology Partners:**

- Description: Partners providing technology components or services, such as GPU suppliers or data storage providers, are stakeholders. Collaboration with these partners ensures the availability of necessary resources.

## **9. Investors and Sponsors:**

- Description: Individuals or organizations providing funding and support for the project are stakeholders with a financial interest in the project's success.

## **10. Quality Assurance and Testing Teams:**

- Description: QA and testing teams are responsible for evaluating the system's functionality and performance to ensure it meets quality and reliability standards.

## **11. External System Providers:**

- Description: Providers of external systems or databases that need to integrate with Inspect AI are stakeholders in the context of integration and data exchange.

## **12. User Training and Support Teams:**

- Description: Teams responsible for creating training materials and providing user support are essential for user adoption and satisfaction.

## **13. Competitors and Industry Watchers:**

- Description: Competing companies and industry observers may monitor the project's progress. Being aware of industry dynamics is crucial for success.

## **14. Legal and Compliance Advisors:**

- Description: Legal and compliance advisors assist in navigating complex legal and regulatory requirements, ensuring the project operates within the boundaries of the law.

## **15. Environmental Health and Safety Agencies:**

- Description: In industries with safety concerns, agencies responsible for environmental health and safety may be stakeholders, as the system can impact safety standards.

Understanding the roles and interests of these stakeholders is vital for effective project management, collaboration, and addressing their specific needs and concerns. Stakeholder engagement is key to ensuring the success of the Inspect AI project.

# Stakeholders Summary: Inspect AI Project

The Inspect AI project involves a diverse set of stakeholders, each with a unique role and interest in the project's success. Here's a summary of the key stakeholders:

End Users (Inspectors): Primary users of the system, responsible for conducting inspections across various industries. They seek enhanced efficiency and accuracy in their inspection tasks.

Project Team: Comprises developers, designers, domain experts, and project managers responsible for the project's design, development, and execution.

Project Managers: Oversee project planning, coordination, and resource management to ensure successful project execution.

Smart Spectacle Manufacturers: Manufacturers of smart spectacles play a crucial role in ensuring compatibility and functionality with the system.

Regulatory Authorities: Responsible for enforcing industry-specific regulations and data privacy laws. Ensuring project compliance is essential.

Data Security Experts: Experts in data security and privacy who safeguard inspection data and protect user privacy.

Industry Representatives: Provide domain-specific insights, requirements, and feedback to tailor the system to industry needs.

Technology Partners: Providers of technology components and services, such as GPU suppliers and data storage providers, ensuring resource availability.

Investors and Sponsors: Individuals or organizations providing funding and support for the project, with a financial interest in its success.

Quality Assurance and Testing Teams: Evaluate the system's functionality and performance to ensure it meets quality and reliability standards.

External System Providers: Offer systems or databases that need to integrate with Inspect AI for data exchange.

User Training and Support Teams: Develop training materials and provide user support for a seamless user experience.

Competitors and Industry Watchers: Monitor project progress in the competitive landscape and industry trends.

Legal and Compliance Advisors: Assist in navigating complex legal and regulatory requirements, ensuring compliance with the law.

Environmental Health and Safety Agencies: Relevant in safety-centric industries, these agencies ensure the project aligns with safety standards.

Each stakeholder group contributes to the project's success in various ways, whether through financial support, expertise, user feedback, compliance, or domain-specific insights. Effective collaboration and stakeholder engagement are essential to meet project objectives and deliver a successful Inspect AI system.

# Key High Level Goals and Problems of Stakeholders

## **End Users (Inspectors):**

**Goals:**

Enhance inspection accuracy.

Increase inspection efficiency.

Real-time insights for better decision-making.

**Problems:**

Manual inspection processes are time-consuming.

Accurate anomaly detection can be challenging.

Limited access to real-time insights during inspections.

## **Project Team:**

**Goals:**

Successful project design and development.

Timely project completion.

High-quality, reliable system.

**Problems:**

Managing limited resources effectively.

Meeting project deadlines and quality standards.

## **Project Managers:**

**Goals:**

Efficient project coordination.

Staying within budget.

Meeting project timelines.

**Problems:**

Balancing budget constraints with project needs.

Adhering to strict timelines.

## **Smart Spectacle Manufacturers:**

**Goals:**

Successful integration of the system with their hardware.

Expanding their market by providing compatible devices.

**Problems:**

Ensuring compatibility and functionality.

Managing potential delays in hardware development.

## **Regulatory Authorities:**

**Goals:**

Ensure compliance with industry-specific regulations and data privacy laws.

Protect user privacy and data.

**Problems:**

Ensuring that the project complies with evolving regulations.

Balancing data security with system usability.

## **Data Security Experts:**

**Goals:**

Safeguard sensitive inspection data.

Prevent data breaches and unauthorized access.

**Problems:**

Ensuring robust data security measures.

Staying current with evolving cybersecurity threats.

## **Industry Representatives:**

**Goals:**

Tailor the system to meet industry-specific needs.

Improve inspection quality and standards.

**Problems:**

Articulating industry-specific requirements.

Ensuring that the system addresses diverse industry needs.

## **Technology Partners:**

**Goals:**

Ensure the availability and functionality of technology components.

Foster innovation and excellence.

**Problems:**

Meeting hardware and software constraints.

Achieving compatibility with the system.

## **Investors and Sponsors:**

**Goals:**

Realize a return on investment (ROI).

Support the development of a groundbreaking system.

**Problems:**

Balancing financial support with project risks.

Ensuring that the project stays on budget.

## **Quality Assurance and Testing Teams:**

**Goals:**

Ensure system functionality and reliability.

Identify and rectify issues in the system.

**Problems:**

Rigorously testing the system within time constraints.

Communicating effectively with developers.

## **External System Providers:**

**Goals:**

Ensure smooth integration with their systems.

Enable data exchange and collaboration.

**Problems:**

Managing the technical challenges of integration.

Meeting specific user requirements for data exchange.

## **User Training and Support Teams:**

**Goals:**

Ensure users can confidently operate the system.

Provide ongoing support for a positive user experience.

**Problems:**

Creating effective training materials.

Addressing user issues and inquiries promptly.

## **Competitors and Industry Watchers:**

**Goals**:

Monitor industry trends and technological advancements.

Assess the project's impact on the competitive landscape.

**Problems:**

Staying competitive and innovative in a dynamic industry.

Adapting to new technological developments.

## **Legal and Compliance Advisors:**

**Goals:**

Navigate complex legal and regulatory requirements.

Ensure that the project operates within the boundaries of the law.

**Problems:**

Keeping up with changing legal and regulatory landscapes.

Balancing compliance with project objectives.

## **Environmental Health and Safety Agencies:**

**Goals:**

Ensure that the project aligns with safety standards.

Improve safety in industries with safety concerns.

**Problems:**

Maintaining safety standards in dynamic industries.

Balancing safety with operational efficiency.

# **Software Requirements Specification: Inspect AI**

## **1. Introduction**

This Software Requirements Specification (SRS) document outlines the comprehensive set of requirements and specifications for the Inspect AI system. The primary purpose of this document is to provide a clear and unambiguous understanding of the system's objectives, functionality, and constraints. It serves as a guiding reference for project stakeholders, including developers, testers, project managers, and users, ensuring a common understanding of the system's requirements and expectations.

Scope of the Project

The Inspect AI project represents a pioneering initiative in the realm of inspection and quality assurance. It endeavors to transform the way inspections are conducted across various industries by harnessing the power of smart spectacle technology and advanced computer vision algorithms. The project's focal point is the development of a sophisticated system designed to offer precise, real-time insights to inspectors, enhancing accuracy, efficiency, and user experience.

Document Overview

This SRS document is structured to provide a coherent, detailed, and comprehensive view of the Inspect AI system's requirements. It encompasses a broad spectrum of topics, including functional and non-functional requirements, user interfaces, data management, system integration, security, performance, testing, user training, and legal compliance.

The subsequent sections of this document will delve into the myriad aspects of the system's features and requirements, serving as an indispensable resource for development, quality assurance, and project management:

## **2. System Description**

System Description

The Inspect AI system represents a revolutionary advancement in the realm of inspection technology. This system is designed to enhance the efficiency and accuracy of inspection processes across various industries. By integrating cutting-edge smart spectacle technology with advanced computer vision algorithms, the system empowers inspectors to perform real-time inspections, object detection, anomaly recognition, and precise dimension measurements. The following sections provide an in-depth overview of the system's purpose, architecture, and core features.

System Purpose

The primary purpose of the Inspect AI system is to empower inspectors in diverse industrial sectors with a powerful tool that streamlines and enhances the inspection process. The system's core functionality includes:

Real-time Video Processing: The system processes live video feeds captured through smart spectacles, allowing for immediate analysis and visualization of inspection data.

3D Model Generation: It generates dynamic 3D models of inspected objects, providing a comprehensive representation of the objects under inspection.

Object Detection: Inspect AI is equipped with advanced object detection algorithms that identify and categorize objects within the inspection environment.

Anomaly Analysis: The system excels at recognizing anomalies or irregularities in inspected objects, which is crucial in quality control and defect detection.

Dimension Measurement: Users can accurately measure object dimensions within the 3D models, ensuring adherence to precise specifications.

Data Management: Inspection data, annotations, and reports are efficiently managed and stored within the system, facilitating data retrieval and analysis.

Integration with External Systems: Inspect AI provides mechanisms for integration with external systems and databases, allowing seamless data sharing and collaboration.

Security Measures: The system incorporates robust data encryption, user authentication, and authorization protocols to ensure data security and privacy.

User Interface: An intuitive, user-friendly interface is a hallmark of the system, offering augmented reality overlays, interactive tools, and comprehensive reporting capabilities.

System Architecture

The Inspect AI system is built upon a modular and scalable architecture designed to handle the demands of real-time inspection processes. Its architecture encompasses the following key components:

User Interface: This component provides inspectors with an intuitive and user-friendly interface that overlays inspection data on their field of vision. It enables interaction, annotation, and data visualization.

Video Processing: Inspect AI includes sophisticated algorithms and modules for capturing and processing real-time video streams, which are critical for object detection and 3D model generation.

3D Model Generator: The system incorporates a 3D model generation engine, responsible for creating dynamic 3D representations of inspected objects.

Measurement Tools: To ensure precision in inspections, the system offers tools for dimension measurement within the 3D models.

Data Management: Inspect AI includes a robust database system for the secure storage of inspection data, annotations, and generated reports.

Integration Services: To facilitate collaboration and data exchange, the system provides mechanisms for integrating with external systems and databases.

Security Measures: A core component of the system, this module ensures that inspection data is encrypted, user access is controlled, and regulatory compliance is met.

Hardware Integration: The system integrates seamlessly with the smart spectacles, allowing for control and data transfer between the spectacles and the system.

The Inspect AI system is characterized by its adaptability, scalability, and real-time capabilities. It provides a dynamic platform for inspectors to conduct inspections, collaborate, and generate valuable insights. As the system advances inspection processes across diverse industries, it revolutionizes the way quality assurance and inspections are performed.

## **3. System Features**

System Features

Real-time Video Processing:

The system processes live video feeds from smart spectacles in real time.

Video data is analyzed and transformed into usable information for inspectors.

3D Model Generation:

Inspect AI generates dynamic 3D models of inspected objects.

The 3D models provide a comprehensive and interactive representation of the inspected items.

Object Detection:

Advanced computer vision algorithms identify and categorize objects within the inspection environment.

Object recognition enhances the inspection process, aiding in rapid identification and classification.

Anomaly Analysis:

The system excels at recognizing anomalies or irregularities in inspected objects.

It identifies defects, variations, or non-conformities during inspections, facilitating quality control.

Dimension Measurement:

Accurate dimension measurement tools are integrated into the system.

Inspectors can precisely measure the dimensions of objects within the 3D models, ensuring compliance with specifications.

Data Management:

Inspection data, annotations, and reports are efficiently managed and stored within the system.

Data is easily retrievable for analysis, reporting, and compliance purposes.

Integration with External Systems:

Inspect AI provides seamless integration with external systems and databases.

Data sharing and collaboration are streamlined, enabling interoperability with existing workflows.

User Interface:

The system offers an intuitive, user-friendly interface, overlaying inspection data onto the inspector's field of vision.

Augmented reality (AR) overlays, interactive tools, and comprehensive reporting capabilities are key features.

Security Measures:

Robust data security features are implemented, including data encryption, user authentication, and authorization protocols.

Inspection data is protected, ensuring the privacy and integrity of sensitive information.

User Management:

User access is controlled and managed efficiently, with role-based access control.

User profiles, permissions, and authentication mechanisms are integral to system security.

Reporting and Annotation:

The system enables inspectors to annotate inspection data in real time.

Comprehensive reporting tools assist in the creation of inspection reports for documentation and analysis.

Multi-Platform Compatibility:

Inspect AI is designed to be compatible with various smart spectacle models and brands.

It offers a flexible solution adaptable to the hardware requirements of diverse industries.

Scalability and Performance:

The system is built with scalability in mind, accommodating growing numbers of users and inspections.

It ensures optimal performance for real-time data processing and analysis.

These features collectively define the capabilities of the Inspect AI system, making it a comprehensive and innovative solution for inspectors across a wide range of industries. The system's real-time processing, advanced computer vision, and integrated data management capabilities significantly enhance the efficiency, accuracy, and usability of inspection processes.

## **4. Functional Requirements**

User Authentication and Access Control:

User Registration (Inspector):

Inspectors can register their user accounts.

Required information includes name, contact details, and user-specific identification.

User Login:

Users must authenticate using a username and password or biometric authentication.

Successful login grants access to system features based on user roles.

Role-Based Access Control:

The system differentiates user roles, including inspectors and administrators.

Role-based access controls are enforced for different system functions.

Real-Time Video Processing:

Video Capture and Streaming:

The system captures and streams video data from smart spectacles in real time.

Video streams are processed and analyzed continuously.

Video Enhancement:

Video feeds are enhanced for clarity and object recognition.

Image stabilization, noise reduction, and focus adjustments are applied as needed.

3D Model Generation:

3D Model Creation:

The system generates dynamic 3D models of inspected objects based on the live video feeds.

These models are constructed in real time to represent inspected objects accurately.

3D Visualization:

Users can view and interact with the 3D models.

Rotation, zoom, and manipulation of the models are supported.

Object Detection:

Object Identification:

The system employs computer vision algorithms for object detection.

It identifies objects within the inspection environment, categorizing them by type.

Object Classification:

Detected objects are classified based on predefined categories.

Users can customize object categories to align with specific industry needs.

Anomaly Analysis:

Anomaly Detection:

The system identifies anomalies or irregularities in inspected objects.

It marks areas of concern within the 3D models for further inspection.

Alerting and Reporting:

Anomalies trigger alerts for inspectors.

Users can annotate and document anomalies for reporting and analysis.

Dimension Measurement:

Dimension Measurement Tools:

Inspectors can use integrated tools for measuring object dimensions within the 3D models.

Measurements can be displayed in various units and are recorded for inspection reports.

Data Management:

Data Storage:

Inspection data, 3D models, annotations, and reports are stored in a secure database.

Data storage follows industry best practices for security and integrity.

Data Retrieval and Search:

Users can retrieve and search for specific inspection data using various search criteria.

Data retrieval is optimized for speed and accuracy.

Integration with External Systems:

External System Integration:

The system offers APIs and data exchange formats for integration with external systems.

Data sharing and collaboration are facilitated seamlessly.

User Interface:

Augmented Reality (AR) Overlays:

The system provides AR overlays for inspectors, displaying inspection data on the smart spectacle's field of vision.

Inspectors can customize the display based on preferences and requirements.

Interactive Tools:

Interactive tools, including annotation, zoom, and pan, are accessible through the user interface.

Inspectors can interact with 3D models and inspection data in real time.

## **5. Non-Functional Requirements**

Non-Functional Requirements

Performance Requirements:

Response Time:

The system must provide real-time processing and feedback with a maximum response time of 100 milliseconds for video analysis.

Concurrency:

The system should support a minimum of 100 concurrent user sessions for inspection and data access.

Load Balancing:

Load balancing mechanisms must be in place to distribute the processing load evenly across servers for scalability.

Scalability:

The system should be scalable to accommodate a 20% increase in the number of users within a one-year period.

Security and Privacy:

Data Encryption:

All sensitive data transmitted and stored within the system must be encrypted using industry-standard encryption algorithms.

User Authentication:

User authentication must be robust and follow best practices, with support for biometric authentication, two-factor authentication, and strong password policies.

Authorization and Access Control:

Role-based access control (RBAC) must be implemented, ensuring that users can access only the data and functions appropriate to their roles.

Data Privacy:

The system must adhere to relevant data protection regulations, including GDPR, HIPAA, or industry-specific standards, ensuring the privacy and integrity of inspection data.

Reliability and Availability:

System Uptime:

The system should be available 99.9% of the time, with scheduled maintenance and downtime minimized.

Failover and Redundancy:

Redundancy mechanisms must be in place to ensure high availability and failover in case of server or component failures.

Data Backup:

Regular automated data backups must be performed to prevent data loss in case of unforeseen circumstances.

Scalability and System Constraints:

Hardware Compatibility:

The system must be compatible with various models and brands of smart spectacles and should not impose specific hardware constraints.

Resource Utilization:

The system should efficiently use system resources, preventing resource exhaustion or degradation of performance.

Compatibility:

Cross-Platform Compatibility:

The user interface must be accessible and fully functional across various devices and operating systems, including Windows, macOS, and Android.

Browser Compatibility:

The system should support the latest versions of major web browsers, including Google Chrome, Mozilla Firefox, and Microsoft Edge.

Usability and User Experience:

User-Friendly Interface:

The user interface should be intuitive and easy to navigate, providing a positive user experience.

Accessibility:

The system must adhere to accessibility standards, ensuring that it is usable by individuals with disabilities.

## **6. Testing and Validation**

Test Plan 1: Video Processing and 3D Model Generation

Objective: To verify that the system effectively processes video feeds and generates accurate 3D models.

Video Quality Testing:

Verify that the system can process video feeds of various qualities, including high-definition and low-light conditions.

Real-time Processing:

Confirm that video feeds are processed in real time with a response time of less than 100 milliseconds.

3D Model Accuracy:

Inspect the accuracy of 3D models generated from video feeds, ensuring that they represent inspected objects faithfully.

Edge Cases:

Test the system's ability to handle challenging scenarios, such as rapid object movement or complex geometries.

Test Plan 2: Object Detection and Anomaly Analysis

Objective: To validate the system's ability to detect objects and anomalies accurately.

Object Identification:

Verify that the system correctly identifies objects within the inspection environment.

Object Classification:

Test the classification of objects into predefined categories to ensure accuracy.

Anomaly Detection:

Confirm that the system accurately detects anomalies or irregularities in inspected objects.

Alert Generation:

Check the system's ability to generate alerts when anomalies are detected.

Test Plan 3: Dimension Measurement and Data Management

Objective: To ensure precise dimension measurement and secure data management.

Dimension Measurement Accuracy:

Validate that dimension measurements are precise and adhere to industry standards.

Data Storage and Retrieval:

Confirm that inspection data, annotations, and reports are securely stored and easily retrievable.

Data Integrity:

Verify the system's data integrity by ensuring that there is no data loss or corruption during storage and retrieval.

Test Plan 4: Security and Privacy Testing

Objective: To assess the system's security and privacy features.

Authentication Testing:

Test various authentication methods, including username/password, biometric authentication, and two-factor authentication.

Access Control:

Validate that users can access only data and functions appropriate to their roles based on role-based access control (RBAC).

Data Encryption:

Confirm that sensitive data is encrypted during transmission and storage, following industry-standard encryption practices.

Regulatory Compliance:

Ensure that the system complies with relevant data protection regulations, such as GDPR, HIPAA, or industry-specific standards.

Test Plan 5: Performance Testing

Objective: To evaluate the system's performance under various conditions.

Response Time Testing:

Measure the system's response time for video processing and inspection data retrieval, ensuring it is below 100 milliseconds.

Concurrency Testing:

Test the system's ability to handle a minimum of 100 concurrent user sessions without performance degradation.

Load Balancing and Scalability:

Verify that the system can distribute the processing load evenly across servers and scale to accommodate increased user loads.

# Iteration Plan

## **Iteration 1:**

1. Data Collection

2. Model Creation for 2D image to Depth Map

3. Model creation for 2D image + Depth map to 3D model

4. Creation of Front End

5. Implementation of Login System

## **Iteration 2:**

1. Annotation of Data for detection

2. Model training for detection

3. Deployment of model with front end and 3D generation pipeline

4. Adding database backend to store detections along with IDs

5. Model Optimization to work in Realtime

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|  | **Week** | | | | | | | | | | | | | | | | |
| **Module** |  | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** |
| **Iteration 1** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Iteration 2** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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# **Iteration 1**

Data Collection

1. Collection of 2D images (around six images per object from multiple angles) along with their 3D models for training a 2D to 3D model via scrapping from the internet and using prebuilt conversion models to convert task specific images and objects.

2. Generation of depth maps for collected images

Model Creation for 2D image to Depth Map

Creating an architecture based on GANs to convert given images into a depth map to specify the third dimension in an image and later use the said depth map for geometric measurements to help creation of 3D model

Model creation for 2D image + Depth map to 3D model

Using the previous model and preprocessing create a pipeline to feed all six images ( plus depth maps ) to train another GANs based model to convert 2D images into a 3D model (.obj file)

Creation of Front End

Using UI UX and web dev to create a user-friendly design for a web app (based on Flask or Fast API) that integrates previously created models. That provides livestream as well as detections on the livestream and creates a log file for found anomalies

Implementation of Login System

Creation of a login system integrated into the front end along with a database (firebase or AWS/ google big cloud) to stop unwanted access to the application and provide hierarchy-based feature control

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| Data Collection |  |  |  |  |  |  |  |  |
| Model Creation for 2D image to Depth Map |  |  |  |  |  |  |  |  |
| Model creation for 2D image + Depth map to 3D model |  |  |  |  |  |  |  |  |
| Creation of Front End |  |  |  |  |  |  |  |  |
| Implementation of Login System |  |  |  |  |  |  |  |  |

# **Iteration 2**

Annotation of Data for detection

Annotate the data received by creating bounding boxes around all anomalies

Model training for detection

Finetuning a prebuilt model (yolov7) to detect the anomalies

Deployment of model with front end and 3D generation pipeline

Integrating the complete pipeline into the frontend using web frameworks such as fast api and Django.

Adding database backend to store detections along with IDs

Creating a database (mysql) to store the model, predictions and ids

Model Optimization to work in Realtime

Optimizing the models, and configuring the pipeline to work with minimum resources

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|  | **Week** | | | | | | | | |
| **Module** |  | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| Annotation of Data for detection |  |  |  |  |  |  |  |  |
| Model training for detection |  |  |  |  |  |  |  |  |
| Deployment of model with front end and 3D generation pipeline |  |  |  |  |  |  |  |  |
| Adding database backend to store detections along with IDs |  |  |  |  |  |  |  |  |
| Model Optimization to work in Realtime |  |  |  |  |  |  |  |  |

# **Implementation Detail**

1. System Architecture:

Design a modular architecture that separates components for video capture, video processing, object detection, 3D model generation, user interface, and data management.

Consider a microservices or service-oriented architecture to allow scalability and maintainability.

2. Video Stream Capture:

Develop drivers or APIs to interface with the smart spectacle's cameras and sensors for real-time video stream capture.

Utilize libraries like OpenCV to access and manage video feeds.

3. 3D Model Generation:

Implement computer vision algorithms to process the captured video frames and reconstruct a 3D model of the inspected object.

Utilize depth sensing techniques (e.g., stereo vision, structured light) to enhance the accuracy of the 3D reconstruction.

4. Object Detection:

Choose and implement state-of-the-art object detection models (e.g., YOLO, Faster R-CNN) to identify and localize objects in the video streams.

Fine-tune or train the models on relevant datasets for the specific objects and anomalies you intend to detect.

5. Anomaly Detection:

Develop algorithms to analyze the 3D model and detected objects to identify anomalies or defects based on predefined criteria.

Define threshold values and anomaly patterns for accurate detection.

6. User Interface:

Design an intuitive user interface that displays the live video feed, 3D model, detected objects, and annotations.

Implement AR overlays to display additional information and annotations in real time.

7. Data Storage and Management:

Choose an appropriate database system to store inspection data, 3D models, annotations, and reports.

Implement APIs for data CRUD operations and integrate data storage with the rest of the system.

8. Integration with Smart Spectacles:

Develop software that communicates with the smart spectacles, allowing users to control camera settings, start/stop video streams, and trigger inspections.

Utilize hardware-specific SDKs or APIs provided by the smart spectacle manufacturer.

9. Security Measures:

Implement encryption mechanisms for data transmission and storage to ensure the security of sensitive inspection data.

Integrate user authentication and authorization to control access to the system's features.

10. Performance Optimization:

- Profile and optimize the system to achieve real-time processing and low-latency response times.

- Utilize hardware acceleration (GPU) for computationally intensive tasks like object detection and 3D reconstruction.

11. Testing and Validation:

- Conduct thorough testing of each component, including unit tests, integration tests, and end-to-end tests.

- Collaborate with domain experts to validate the accuracy and effectiveness of the detection and measurement algorithms.

12. Documentation and User Training:

- Create comprehensive documentation for installation, configuration, and usage of the system.

- Develop user training materials to ensure inspectors can effectively use the smart spectacles and the AI system.

13. Deployment:

- Deploy the system on appropriate hardware and cloud infrastructure, considering factors like scalability, availability, and data privacy.

14. Continuous Improvement:

- Implement mechanisms for collecting user feedback and monitoring system performance.

- Continuously update and improve the system based on user needs and technological advancements.

# **Use Cases**

**1. User Registration and Authentication:**

**Primary Actor:** User

**Description:** A user (inspector) registers for an account and authenticates themselves to access the Inspect AI system.

**Basic Flow:**

The user navigates to the registration page.

The user provides necessary information and credentials.

The system validates the information and registers the user.

The user logs in with their credentials.

**2. Initiating an Inspection:**

**Primary Actor:** Inspector

**Description:** An inspector initiates an inspection using the smart spectacles and the AI system.

**Basic Flow:**

The inspector puts on the smart spectacles.

The inspector selects the object or area to inspect.

The system starts capturing the video stream and generating a 3D model in real time.

The system initiates object detection and anomaly analysis.

**3. Real-time Object Detection and Highlighting:**

**Primary Actor:** Inspector

**Description:** During an inspection, the system detects objects within the video stream and highlights them for the inspector.

**Basic Flow:**

The system identifies and locates objects within the field of view.

Detected objects are highlighted in the live video feed and the 3D model.

The system may provide labels and metadata about detected objects.

**4. Anomaly Detection and Notification:**

**Primary Actor:** Inspector

**Description:** The system continuously analyzes the 3D model and video feed for anomalies or defects and sends notifications when they are detected.

**Basic Flow:**

The system compares detected objects to predefined criteria.

When an anomaly or defect is identified, the system sends a real-time notification to the inspector.

The inspector can review and acknowledge notifications.

**5. Measurement and Dimension Analysis:**

**Primary Actor:** Inspector

**Description:** The inspector can measure dimensions and analyze object properties using the 3D model.

**Basic Flow:**

The inspector selects an object within the 3D model.

The system provides measurement tools for length, width, height, or other relevant dimensions.

Measurements are displayed to the inspector.

**6. Annotation and Reporting:**

**Primary Actor:** Inspector

**Description:** Inspectors can add annotations to the 3D model and generate inspection reports.

**Basic Flow:**

The inspector selects an object or area in the 3D model.

The inspector adds annotations, comments, or labels to the selected object.

The system compiles inspection data and generates a comprehensive report.

**7. Data Integration and Sharing:**

**Primary Actor:** Inspector

**Description:** The system allows inspectors to integrate inspection data into external systems and share reports with relevant stakeholders.

**Basic Flow:**

The inspector selects the option to integrate or share inspection data.

The system provides access to external systems for data transfer.

Reports and inspection data are shared with authorized users or systems.

# Dataflow Diagram:

