AI and smart vision for house management
Project Plan

V0.2

Prepared by :

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REVISION HISTORY

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0.1	24/05/2024	First Draft
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1 Executive Summary

NTT e-MOI JSC, a subsidiary of NTT East Japan, is at the forefront of digital transformation, offering innovative solutions in Managed Service Provider (MSP), IT Outsourcing (ITO), and global human resources training. Their new venture aims to revolutionize property management through the implementation of an advanced AI and Smart Vision system. This initiative responds to the growing inadequacies of the company's current manual property inspection processes, which are both time-consuming and error-prone. The proposed system seeks to replace these outdated methods with a highly efficient, automated solution that will offer significant improvements in accuracy and operational efficiency.

The project's primary goal is to develop a cutting-edge, highly available online housing management system that will provide detailed and accurate analyses of housing changes over time. This system will utilize the latest in image analysis technology to compare current satellite images with historical data, enabling quick identification of structural changes. The resultant data will be stored securely and made accessible through a sophisticated web application, ensuring high confidentiality and ease of access for verified users.

The expected benefits of this solution are manifold. In the short term, the system will drastically reduce inspection times and operational costs while increasing monitoring reliability. In the long term, the adoption of this technology will position NTT e-MOI as a leader in innovative property management solutions, enhancing customer satisfaction and competitive advantage.

The application will focus initially on urban areas, particularly Hanoi City, employing state-of-the-art computer vision techniques to analyze high-resolution satellite and drone images. The user interface will feature an interactive 2D map displaying extensive property details, which will be accessible on any device with internet connectivity.

However, the project is not without risks, including potential delays, technology failures, and budget constraints. Furthermore, the scope of the project currently excludes rural and mountainous areas, which may be considered in future enhancements.

In summary, this project represents a significant technological leap forward for NTT e-MOI, offering both immediate and long-term benefits while also improving the company's market position through advanced digital solutions.

2 Background

2.1 Client/Company Background Description

NTT e-MOI JSC, a subsidiary of NTT East Japan, specialises in leveraging cutting-edge technology to drive business development and digital transformation for their clients. They offer various services including Managed Service Provider (MSP), IT Outsourcing (ITO), and global human resources training. In software development, they excel in using leading low-code platforms to deliver high-quality software products with shorter development times compared to traditional methods. NTT e-MOI strongly emphasises building long-term partnerships with customers by aligning with their business goals and fostering a collaborative, growth-oriented environment both internally and externally. (NTTe-MOI, 2020)

2.2 Organisation's Current Situation

NTT e-MOI JSC has developed a property management solution that currently provides basic monitoring features. This system requires the business team to perform manual inspections and updates to track house changes. This approach, while functional, is becoming increasingly insufficient as the client base grows and the need for more efficient, accurate, and scalable solutions becomes apparent.

Manual inspections are time-consuming and prone to human error, leading to inefficiencies and inconsistencies in property monitoring. The lack of an automated system means that inspectors must physically visit each property to check for any changes or violations, resulting in delays and increased operational costs. These inefficiencies can have serious implications for property owners and regulatory bodies, as significant changes or potential violations might be missed or detected too late.

2.3 Business Problems/Opportunities

Problems

- **Short-Term**: The current manual inspection process is inefficient and prone to errors, leading to delays and increased operational costs. Inspectors face challenges in covering all properties comprehensively, resulting in missed detections and inconsistencies in reporting.
- **Long-Term**: The lack of an automated system limits scalability and the ability to respond quickly to changes, affecting customer satisfaction and regulatory compliance. The organisation risks falling behind competitors who adopt advanced technologies for property management.

Opportunities

- **Short-Term**: Implementing an AI and Smart Vision system for house management can significantly reduce inspection time and increase accuracy (Monna et al., 2021). This will streamline operations and improve the reliability of property monitoring, providing immediate cost savings and operational efficiency.
- **Long-Term**: By adopting advanced technologies such as GPS data, satellite imagery, computer vision, and spatial data processing (Pan et al., 2020), NTT e-MOI can establish itself as a leader in innovative property management solutions. This will enhance the company's competitive edge, attract new clients, and open up opportunities for expanding their service offerings. Additionally, the automated system will enable better data-driven decision-making, leading to improved customer satisfaction and long-term partnerships.

3 Objectives

3.1 Goals

Given the situation of the client with the current inefficient, highly time and money-consuming process, the goal of this project is to create a highly efficient, highly available, online housing management system that not only provides accurate, detailed and useful analysis, but can also be accessed anywhere with an internet connection, at any time needed, while still maintaining high confidentiality, with a strict access control that only allows verified, trusted individuals to access the system.

3.2 Objectives

The objective for this project can be divided into 2 parts. First, the image analysis model. This model will take in the current (most recent) satellite image (image taken from above) of the metro area and use that as a base. Other images of the same area but from the previous year(s) will then be inputted, and the model will compare the base images with its predecessors to find differences in terms of housing, land structure, landscape,... These data after being extracted will be transformed and moved to a storage medium - a database, for storage and further usage by the second part, the user interface application. This will be how the end users, our stakeholders will view the data generated by the analysis model (part 1). This will come in the form of a web application - accessed through the web. This ensures the application’s availability, being able to be accessed from any device with a web browser and an Internet connection. This web application will use the data generated in part 1, and display it in both numerical and on image, to give the user the most possible insights into the data, in a highly descriptive, but also easy to understand format. This website will also employ user authentication to ensure that only verified individuals with the correct credentials can access the application.

3.3 Expected benefits

This solution aims to give the stakeholder a more efficient, simpler, less expensive but also highly accurate and descriptive way to view changes in a metro area throughout the years. Compared to the existing process, which requires a lot of man hours, manual labour and work, which is not only expensive, inefficient, but also highly error-prone, this new solution aims to improve it on all fronts, providing a highly accurate, insightful yet efficient and easy, convenient way to view these previous manually generated data, from anywhere, anytime. This solution will not only quicken up the process, but also make it less error prone, highly scalable, available and more secure.

4 Scope

4.1 Analysing Housing Images from Urban Areas

The app will implement advanced computer vision techniques to analyse housing images from urban environments, prioritising Hanoi City. This process will involve:

- **Data Acquisition**: Collecting high-resolution images of houses from urban areas using various sources such as satellite images and drones from open sources like Kaggle and Google Earth.
- **Preprocessing**: The gathered data should be cleaned and preprocessed to guarantee quality and eliminate duplication.
- **Object Detection and Segmentation**: Identifying and isolating houses and other man-made architectural structures within the images. The steps might involve using convolutional neural networks (CNNs) and other deep learning models trained on the dataset we collected from the data acquisition step.
- **Change Detection**: Comparing new images with historical data to detect housing changes, such as new construction, renovations, and demolitions. This will help authorities identify and cross-check whether the construction is approved and licensed.

4.2 Implementing Smart Vision Algorithms Using AI Models

The app will incorporate advanced AI models to enhance the accuracy and performance of its vision algorithms. Key aspects will include:

- **Machine Learning Models**: Utilising trained models and fine-tuning them with specific datasets to improve performance on ML tasks like object detection, image classification, and segmentation.
- **Deep Learning Frameworks**: Implementing frameworks like TensorFlow, PyTorch, or Keras to build and deploy the AI models. These existing frameworks are essential to create neural networks that can process and analyse large volumes of image data.
- **Continuous Learning**: As more images are analysed, the AI model will update and refine its understanding, aiming for higher accuracy over time.

4.3 User Interface with 2D Map Displaying House Properties

Users will be able to visualise housing data with the informative and user-friendly design of the interface. Important features will include:

- **Interactive 2D Map**: A user-friendly map that displays the distribution of houses in selected urban areas. Users can zoom in and out, pan across different neighbourhoods, and click on the house pin for more details.
- **Property Information**: Each house on the map will be annotated with key properties like:
    - Address
    - Latitude and Longitude
    - Area
    - House Owner
    - Yearly Changes in the Area
- **Search and Filter Options**: Tools that let users narrow down their results by size, ownership, or historical changes or search for particular properties. As a result, users will find the information they need more quickly.
- **Data Export**: The user can export property data and map visuals for download and sharing with standard formats like CSV, PDF, or image files.

5 Out of Scope

5.1 Out of Scope

- **2D mapping instead of 3D**: The map visualisation in the app will be in two dimensions to guarantee performance, simplicity, and clarity. A 2D map offers a user-friendly interface, fast load times, and wide device compatibility. With this option, users can quickly interact with the map, view comprehensive property details, and make use of features like annotation and zooming without having to deal with the complex details of 3D visuals.

5.2 Future Work

- **Managing Houses Outside Urban Areas**: Because of the greater density of properties and improved data availability in urban regions, the software now concentrates on evaluating images of houses. Future upgrades will address the particular difficulties rural and mountainous areas face, including scarce housing distribution, diverse geography, and limited data.
- **Feature Extraction**: Other house features will be considered, including dimensions, roof types, building materials, and other architectural details. Those characteristics can be added to further detail each property profile.
- **Integration with Other Data Sources**: Although it is outside the current scope, combining the results of image analysis with information from other sources—such as property records, urban planning databases, and geographic information systems (GIS)—to produce a thorough overview of each property will be studied in the future.

- **User Interaction**: Encouraging an environment of collaboration for keeping accurate data by allowing users to post comments, report errors, or recommend improvements to property information is currently outside of the scope of this project, but it will be taken into consideration for future enhancements.

6 Risks

SEVERITY →

LIKELIHOOD ↓	1	2	3
1	LOW Regulatory and Compliance Issues Inadequate Stakeholder Engagement	LOW Team's skill gaps	MEDIUM Budget Constraints
2	LOW	MEDIUM Insufficient Training Data	HIGH Unexpected obstacles
3	MEDIUM	HIGH Resource Availability	HIGH Scope changes

Timeline: Unexpected obstacles could cause delays, pushing back deadlines and milestones. These unforeseen challenges, such as technical issues or unanticipated dependencies, can disrupt the planned schedule, making it difficult to meet deadlines and achieve project milestones on time.

Team's Skill Gaps: Team members might lack the specific skills or experience required for certain tasks. This skill gap can hinder progress, as team members may struggle with complex or specialised aspects of the project, leading to inefficiencies and potential delays in task completion.

Change of Project Scope: New requirements may emerge during the development phase. These evolving requirements, driven by factors such as client demands for more detailed property analysis, the need to incorporate real-time data processing, advancements in AI algorithms for more accurate image recognition, improvements in satellite resolution, or internal decisions to expand the system's functionality to include predictive maintenance and energy efficiency analysis, can complicate project management. Adapting to these specific new requirements might necessitate significant changes in system algorithms, data processing techniques, resource allocation, and project timelines to ensure the updated objectives are met.

Resource Availability: Financial constraints may impact the availability of essential tools and resources required for the project. Unexpected costs, such as licensing fees for advanced AI software, subscription fees for high-resolution satellite image datasets, or expenses for cloud computing services, could exceed the initial budget. These financial overruns may necessitate replacing paid tools with less effective alternatives or cutting costs in other areas, potentially affecting productivity, system performance, and the quality of the final deliverables.

Not Enough Training Data: Insufficient training data can hinder the development of accurate and effective models or solutions. Without adequate data, the project might face difficulties in achieving the desired level of performance, leading to suboptimal results and potential rework.

Stakeholder Engagement: Stakeholders might not be as engaged or responsive as needed, leading to misalignment and delays in decision-making. This lack of engagement can result in unclear requirements, insufficient feedback, and delayed approvals, all of which can impede project progress.

Regulatory and Compliance Issues: Changes in laws or regulations might impact the development of a House Management System that uses AI and smart vision to analyze satellite images. Specific regulatory shifts, such as new data privacy laws (e.g., GDPR or CCPA), updated satellite imaging regulations, or stricter AI usage standards, could require adjustments to the system to ensure compliance. For example, implementing new drone operation guidelines, as highlighted in the case study by Tran and Nguyen (2022) on drone management in urban environments, may necessitate enhanced security protocols and restricted operational areas to protect privacy and ensure public safety. These changes can introduce additional tasks, such as implementing enhanced data

protection measures, securing additional permissions for satellite data usage, or modifying AI algorithms to meet new ethical guidelines. Such regulatory shifts can complicate project execution, potentially leading to delays, increased costs, and the need for additional resources to meet the new compliance standards.

7 Deliverables

AI and Smart Vision House Management App

- **Functionality**: Develop an application that uses AI and smart vision technology to track changes in houses using satellite images.
- **Platforms**: Ensure the app is accessible on web platforms for maximum convenience.

Smart Vision System

- **Development**: Develop a Smart vision system specifically designed for detecting changes in properties using satellite imagery. This system could encompass multiple Machine Learning models, which would be handled as part of the deliverables.
- **Performance**: Optimize the system for accuracy and efficiency, ensuring minimal false positives and negatives.

Training Data

- **Data Collection Pipelines**: A comprehensive documentation of data pipelines that were developed to collect, process, and store data used for training the Smart Vision system.

System Design Documentation

- **Architecture Design**: Provide detailed documentation of the system architecture, including the integration of AI components, data sources, and user interfaces.
- **Technical Specifications**: Document the technical specifications, including hardware and software requirements, data flow diagrams, and component interactions.

Code Documentation

- **Source Code**: Deliver the complete source code of the application, including AI models and integration components.
- **Code Comments**: Ensure the code is thoroughly commented to explain the functionality and logic of key sections.
- **API Documentation**: Provide detailed documentation for any APIs developed as part of the project, including usage examples and endpoint descriptions.

User Training and Documentation

- **User Manuals and Guides**: Provide comprehensive documentation, including user manuals and quick-start guides, to assist users in navigating the app.

System Integration and Testing

- **Integration**: Ensure seamless integration of the app with existing NTT e-MOI systems and any third-party tools required by clients.
- **Testing**: Conduct extensive testing, including unit tests, integration tests, and user acceptance testing (UAT), to ensure the app's reliability and accuracy.

8 Project team Structure

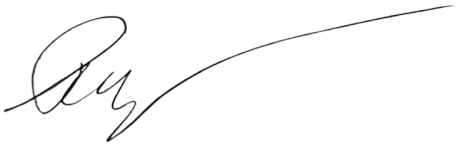
Name	Role	Description	Qualities
Pham Anh Vu	Solution Architect/System Manager	Oversees the overall system architecture, ensures seamless integration of components, and manages technical direction. Maintaining and optimizing a project's infrastructure, ensuring system reliability, security, and performance	Undergraduate student, majoring in System Management 1 YoE in system design
Nguyen Thanh Dat	AI Engineer/Project Manager	Develops and implements machine learning models for change detection, leveraging AI to enhance detection accuracy. Oversees the planning, execution, and completion of technology-based initiatives, ensuring that project goals are met on time, within scope, and within budget.	Undergraduate student in ICT 1 YoE in AI Engineering

Nguyen Minh Nghia	Data Engineer/UIUX Designer	Manages data collection, preprocessing, and storage, ensuring data integrity and availability for analysis and ML models. Creating user-centered designs for digital products, enhancing usability and user satisfaction	Undergraduate student in ICT, specialising in Data Engineering
Luong Trac Duc Anh	Fullstack Engineer/Scrum Master	Designs and develops the user interface, ensuring it is intuitive and user-friendly. Integrates front-end with backend services. Facilitates the Agile Scrum process, ensuring that the team adheres to Scrum practices and principles	Undergraduate ICT Student, junior OutSystems Developer
Tran Tuan Nam	Fullstack Engineer	Develops backend services and APIs, manages databases, and ensures the backend system is robust and scalable.	Undergraduate CS student, majoring in Data Science

9 Project Sign Off

The signatures of the people below document approval of the formal Project Plan. The Project Manager is empowered by this charter to proceed with the project as outlined in this document.

For and on behalf of ***INSERT CLIENT NAME***:



Signed: Date: 02/06/2024
(Xuan Dung Luu)

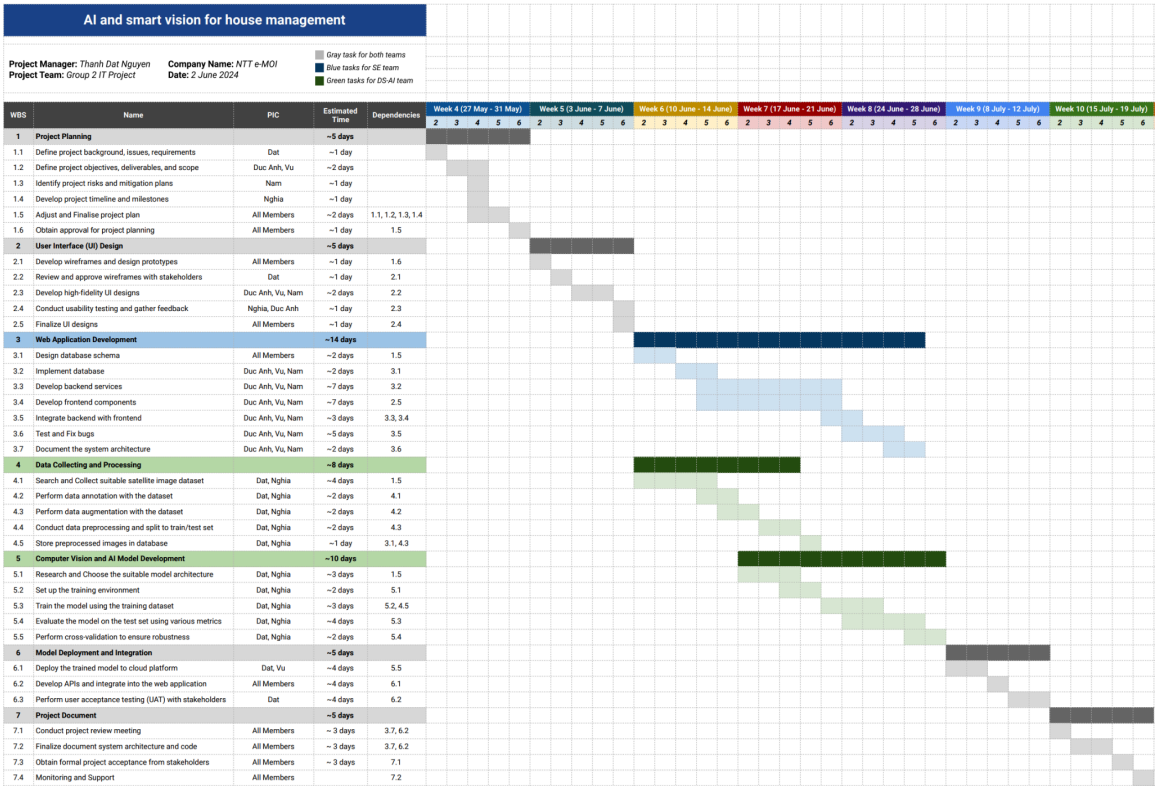
For and on behalf of the Project Team:

Signed: Date:02/06/2024
(Thanh Dat Nguyen, Project Manager)

For and on behalf of Swinburne University of Technology:

Signed: Date:02/06/2024
(Phuong Anh Nguyen, Project Supervisor)

Appendix A – Gantt Chart



WBS	Name	PIC	Estimated Time	Dependencies
1	**Project Planning**		~5 days	
1.1	Define project background, issues, requirements	Dat	~1 day	
1.2	Define project objectives, deliverables, and scope	Duc Anh, Vu	~2 days	
1.3	Identify project risks and mitigation plans	Nam	~1 day	
1.4	Develop project timeline and milestones	Nghia	~1 day	
1.5	Adjust and Finalise project plan	All Members	~2 days	1.1, 1.2, 1.3, 1.4
1.6	Obtain approval for project planning	All Members	~1 day	1.5
2	**User Interface (UI) Design**		~5 days	
2.1	Develop wireframes and design prototypes	All Members	~1 day	1.6
2.2	Review and approve wireframes with stakeholders	Dat	~1 day	2.1
2.3	Develop high-fidelity UI designs	Duc Anh, Vu, Nam	~2 days	2.2
2.4	Conduct usability testing and gather feedback	Nghia, Duc Anh	~1 day	2.3
2.5	Finalize UI designs	All Members	~1 day	2.4
3	**Web Application Development**		~14 days	
3.1	Design database schema	All Members	~2 days	1.5
3.2	Implement database	Duc Anh, Vu, Nam	~2 days	3.1
3.3	Develop backend services	Duc Anh, Vu, Nam	~7 days	3.2
3.4	Develop frontend components	Duc Anh, Vu, Nam	~7 days	2.5
3.5	Integrate backend with frontend	Duc Anh, Vu, Nam	~3 days	3.3, 3.4
3.6	Test and Fix bugs	Duc Anh, Vu, Nam	~5 days	3.5
3.7	Document the system architecture	Duc Anh, Vu, Nam	~2 days	3.6
4	**Data Collecting and Processing**		~8 days	
4.1	Search and Collect suitable satellite image dataset	Dat, Nghia	~4 days	1.5
4.2	Perform data annotation with the dataset	Dat, Nghia	~2 days	4.1
4.3	Perform data augmentation with the dataset	Dat, Nghia	~2 days	4.2
4.4	Conduct data preprocessing and split to train/test set	Dat, Nghia	~2 days	4.3
4.5	Store preprocessed images in database	Dat, Nghia	~1 day	3.1, 4.3
5	**Computer Vision and AI Model Development**		~10 days	
5.1	Research and Choose the suitable model architecture	Dat, Nghia	~3 days	1.5
5.2	Set up the training environment	Dat, Nghia	~2 days	5.1
5.3	Train the model using the training dataset	Dat, Nghia	~3 days	5.2, 4.5
5.4	Evaluate the model on the test set using various metrics	Dat, Nghia	~4 days	5.3
5.5	Perform cross-validation to ensure robustness	Dat, Nghia	~2 days	5.4
6	**Model Deployment and Integration**		~5 days	
6.1	Deploy the trained model to cloud platform	Dat, Vu	~4 days	5.5
6.2	Develop APIs and integrate into the web application	All Members	~4 days	6.1
6.3	Perform user acceptance testing (UAT) with stakeholders	Dat	~4 days	6.2
7	**Project Document**		~5 days	
7.1	Conduct project review meeting	All Members	~ 3 days	3.7, 6.2
7.2	Finalize document system architecture and code	All Members	~ 3 days	3.7, 6.2
7.3	Obtain formal project acceptance from stakeholders	All Members	~ 3 days	7.1
7.4	Monitoring and Support	All Members		7.2

Please refer to the additional uploaded file for a clearer view of the chart

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