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Design Home with AI

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Abstract— The Designed Home with AI project is about designing homes using AI, ML and Computer Vision technologies. It normally takes quite some time, skills and financial resources to design homes. Furthermore, it can be difficult for users to design a particular house on their plot of land with their preferences in mind before construction. The system designed will help people in overcoming these problems. Users will be able to upload pictures of their land and specify dimensions and their requirements through the platform. We will use computer vision algorithms such as image pre-processing and edge detection in order to analyze the land that they have. Then AI will help us create suitable layouts and maximize space. The system will also offer customized recommendations for interior and exterior finishes for them to choose and customize. House Designs will be available in 3D model as well as Virtual Reality walkthrough experience using Unity3D which would allow users to visualize their dream build before it's constructed. We plan to combine Android App development, Backend services, AI and 3D visualization into a seamless product that can be used for designing homes. We aim to reduce manual work, improve productivity and simplify the process of designing for our users, architects and designers. We are focusing on residential buildings plans but would like to incorporate AR, VR, sustainable designs and cost estimation in the coming years.Keywords--Artificial Intelligence, Machine Learning, Computer Vision, Home Design, Land Image Analysis, Boundary Detection, Floor Plan Generation, Space Optimization, Interior and Exterior Design, 3D Visualization, Unity 3D.

I. INTRODUCTION

Designing a home should be done meticulously, efficiently utilize the given space, and meet all requirements of the people living in it. House plans should offer livability, utility, and aesthetic appeal to the eyes. However, people with little to no prior knowledge of building or access to architects and designers may find it hard to plan their dream home. Traditional approaches are often manual and iterative in nature which makes it time-consuming and expensive to plan out home layouts. The advancements in technologies like Artificial Intelligence (AI), Machine Learning (ML), Computer Vision have paved the way for new solutions that can help people plan their home efficiently. These technologies could help extract plot details from the image of the land, understand the user's requirements and recommend house layouts that can fit into the given plot of land considering the user's preferences. While there are home designing applications available that offer floor plan sketching tools and home interior visualization options, sketching rooms manually on a floor plan or having separate tools for land analysis, home design recommendation and 3D visualization could be time-consuming for users. Designed Home with AI is a system that provides land analysis from images, AI-based assistance for home layout plans, personalized recommendations for interior and exterior designing, and 3-dimensional visualization. Users can upload images of the land, input the plot size, and enter their requirements and preferences. Image Processing and Computer Vision can aid in analyzing the input while the AI-based recommendation system can help suggest potential houses that can be built on the plot. Users can edit the recommended designs as per their preferences and visualize their house using the 3D modeling features using Unity 3D. Users can take a virtual walk through their house to see the design output provided by the system. By combining an android application, backend, APIs for AI and other processes, and a 3D simulator, Designed Home with AI hopes to reduce human effort required for initial stages of home planning, increase the quality of visualizing home design alternatives, and make personalized home designing recommendations easier. This system is geared towards residential planning at its early stages and does not substitute professional help needed for analyzing structural integrity, approvals, validating building plans, or architecture.

II. LITERATURE SURVEY

Advances in artificial intelligence, computer vision, and computer-aided design now allow us to envision new ways of streamlining and democratizing the home-planning process. With traditional approaches to house planning, clients and architects will typically go back and forth discussing potential arrangements, draw floor plans by hand, and go through several iterations until a desirable layout is achieved. While architectural workflows offer careful planning and professional expertise, beginning homeowners who may not know how to describe their needs using architectural tools can find the design process daunting. Tools such as Planner 5D, Floor planner, and SketchUp offer users the ability to create floor plans, organize rooms, design home interiors, and visualize spaces in 3 dimensions. These programs show how visualization tools can aid homeowners in developing an understanding of different space configurations. However, current tools require a significant amount of manual work and separate processes for analyzing plots of land, planning layouts, and visualizing these plans in 2D and 3D. Furthermore, automation in generating floor plans has been studied in programs that computationally generate room layouts based on provided spatial constraints and design preferences. These methods illustrate the promise of AI in automating aspects of the planning process to minimize repetitive tasks and provide homeowners with alternate layouts to consider. However, the utility of an automatically generated floor plan will always be contingent on how well it accommodates metrics such as room size, circulation,

personal preferences, and restrictions of the plot. Another key component of intelligent planning is the ability for software to understand and analyze a user's plot of land. Computer Vision can provide this functionality through image processing methods. Object recognition can be applied to images in order to identify plot boundaries and extract features from plot images. Image segmentation and contour detection are two Computer Vision methods which could be used to analyze plot images. However, depending on image quality, the angle of photography, shadows on the land, grass, and fence lines, identifying where a plot starts and ends may be unreliable. As such, Computer Vision should only be used to analyze the plot in conjunction with dimensions provided by the user and the ability to correct the VR boundary. Recommender systems provide another tool that can be used to personalize the home-planning process. Recommender systems can use AI to provide suggestions for interior designs, colour schemes, furniture placement, and exterior home styles. If homeowners are provided recommendations along with being able to plan out their floor layout, they can further explore designs that fit their personal preferences instead of choosing from premade templates. Visualization in three dimensions is another useful tool that can enhance the home-planning process. Users should be able to visualize their proposed floor plan by seeing it modeled in 3 dimensions. This will allow users to view their planned home from various angles and have a better understanding of how rooms and spaces relate to one another. Using Game Engines such as Unity 3D, we can create an interactive model of the user's planned home as well as a First Person Controller to allow users to take a virtual walkthrough of their home. While many of these technologies have been developed independently, there is still a gap in designing software that can take in information about a users' plot of land and identify intelligently generated home plans and designs based on their needs. Designed Home with AI seeks to bridge this gap by presenting a Android software that allows users to input their land images, plot dimensions, and requirements. Uses would include image-processing methods for assessing properties, machine learning algorithms to create design proposals, and Unity 3D to render design proposals. Our contribution will merge these aspects together to provide an interactive planning experience to allow potential homeowners to better explore design options. However, machine-created design drafts should only be considered a draft as one would still need to consider zoning laws, structural integrity, topography, and architects.

III. PROPOSED DESIGN

Designed Home with AI is proposed system assists users with the process of finding home designs that they may like. It generates house designs based on user inputs like plot image, plot dimension and what the user is looking for. Developed with technologies like mobile app development, computer vision, AI-based building plan assistance system and home plan 3D visualization. The system can help users with home planning stage before consulting architects and professionals. The modules of the system include plot image processing module, boundary detection module, building plan generation AI module, interior design suggestions, exterior design suggestion and 3D house visualization module. Designed home with AI Android app built with Kotlin programming language in Android studio, and the system can include python based image processing backend built using FastAPI or Flask to handle connections and communications between different modules. OpenCV and Numpy libraries can be used for plot image preprocessing and extracting boundary information. Deep learning and machine learning methods can be researched and implemented for floor plan generation based on user input and suggesting building designs to users. User can provide images of their plot along with expected building dimensions, number of floors and their preferences. Once provided with plot image and information, system will use those to assist user with possible layouts that can be generated in that area. Interior and exterior designing can be suggested to users which they can browse through and customize as they like. Users can save their designs and come back to it later to continue planning their work. Finalized design can be seen in 3D house model and users can do a walkthrough of the house model to get an understanding of how the building plan looks like. System can use database such as SQLite or Firebase to store information about users, projects, preferences, and saved plans. System Architecture is designed with modular approach. Plot image processing and analysis, building plan generation with AI, interior exterior design suggestions, visualization and database are separate modules. Admin module can be added to manage system users and projects. Designed Home with AI will help users browse through house designs using a plot they have as a base. System will allow users to visualise houses in 3D before they are built.



Fig.1 Start Design Page

IV. IMPLEMENTATION

Designed Home with AI: Let users create and visualize home designs using AI assisted technologies and 3D visualization. User flows: The project can be split between frontend-dev (mobile App(Android Studio, Kotlin)), image processing, AI-Assisted designing, Processing of user inputs and displaying 3d visualization and database Frontend: The android app is developed using Android Studio and the Programming language used is Kotlin. The Android app takes in plot dimensions and an image of the plot from the users along with their requirements for designing. Then the image gets transferred to Open CV and image gets processed using python scripts. This flow allows us to preprocess the plot image and find the boundaries of the plot. After we receive dimensions from user and process image, our system will provide floor-plan models that fit into the dimension and meet customers' requirements. Our system will also suggest interior designing and exterior designing of the home that user can choose. The system will use a python based backend (using FastAPI(Flask) to allow communications between mobile app and processing of customer inputs (images, dimensions etc.)) . After the customer is satisfied with the floor plan and design, they can push the design layout to Unity. In Unity, we can create a 3D model of the house along with a walkthrough of the house to help them better visualize the house. We can use SQLite or Firebase to store details about the customer, projects they launch, dimensions of each project and the designs they save.The modules in our system are divided based on functions: User based Interactions, Image processing and editing, AI-Designing assistant, Displaying the 3d model and Customer Project Management. This greatly reduces the complexity of the system. Designed Home with AI allows user to do preliminary planning for their home and visualize it using 3D technologies. The design schematics our system provides need to be evaluated by a professional before actual construction. Our system does not replace structural engineers and building-code verification.

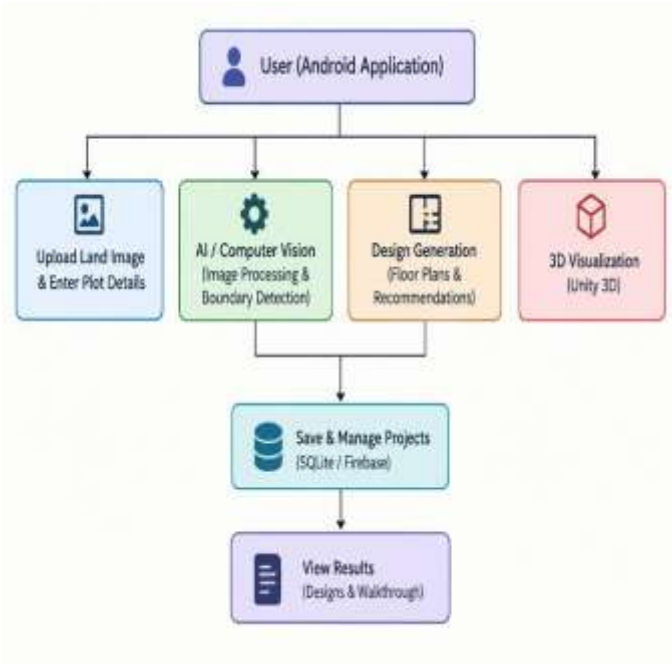


Fig.2 *Strcuture for project on Design Home With AI*

User Input and Plot Details Module

This module lets users input the info needed for an initial home design. Using the Android app, you can upload a picture of your land and fill in details like plot dimensions, how many floors you want, and your own design preferences. This information helps the system get a better idea of what you're looking for, so it can suggest appropriate floor plans and designs. Once you submit the details, they get sent to the backend for further processing.

AI and Computer Vision Module

This module takes care of processing the uploaded plot image and figuring out its boundaries. We use OpenCV and NumPy for image preprocessing and analysis, which helps get the input ready for the next design steps. The system looks at the boundaries it detects along with the dimensions the user has entered. It's worth mentioning that factors like image quality, perspective distortions, shadows, and unclear edges can impact the analysis. So, it's a good idea for users to verify the results before moving on to the design phase.

Design Generation and Recommendation Module

This module helps users create initial floor plans and design ideas by taking into account their plot details and personal preferences. By using AI and machine learning, including plans for TensorFlow, it can suggest various room layouts and arrangements. Plus, the system offers design tips for both the inside and outside of the space based on what users choose. Users can dive into the different options and tweak the proposed designs to better fit their needs. Essentially, this module aims to assist users in comparing various planning possibilities before they settle on a design for visualization..

3D Visualization Module

This module gives users the chance to check out their chosen home design in a 3D environment. Using Unity 3D alongside C#, it brings the proposed house to life as a detailed model, allowing for a virtual walkthrough. This visualization makes it much easier for users to grasp the spatial arrangement, the layout of the rooms, and how the whole house is going to look. They can move around the design from various angles, which really helps in visualizing what the layout will be like in three dimensions. Just keep in mind that while the 3D model is great for visualization, it doesn't replace the need for professional architectural drawings.

Project Storage and Management Module

This module takes care of storing and retrieving users' home design projects. You can use either SQLite or Firebase to keep track of user info, plot details, design preferences, layouts that have been generated, and any project data that's been saved. With this setup, users can easily look back at their past designs and pick up right where they left off on their planning projects. By organizing everything by project, it keeps the connection between the original plot details and the design outcomes clear and easy to follow.

Result Viewing and Customization Module

This module lets users check out the generated floor plans, design ideas, and 3D visualizations. You can look through the

different options, pick your favorite design, and tweak it to fit your needs. Once you've chosen a design, you can take a stroll through it using the Unity 3D walkthrough, which really helps you grasp what the home will look like before you dive into more planning. Just keep in mind, this system is all about kicking off the design process, so it's crucial to have qualified professionals review any layouts before you start building.

Backend and System Coordination Module

The backend plays a vital role in managing how the Android app talks to various components, like the image processing tools, design generation features, and project storage. You can build it using Python along with frameworks like FastAPI or Flask. When users send in their plot details and preferences, the backend jumps into action, handling the request and managing all the necessary operations. After that, it sends back the available design information so the app can show it to users. This modular setup not only keeps the main functions of the system separate but also makes it easier to maintain and expand the app down the line..

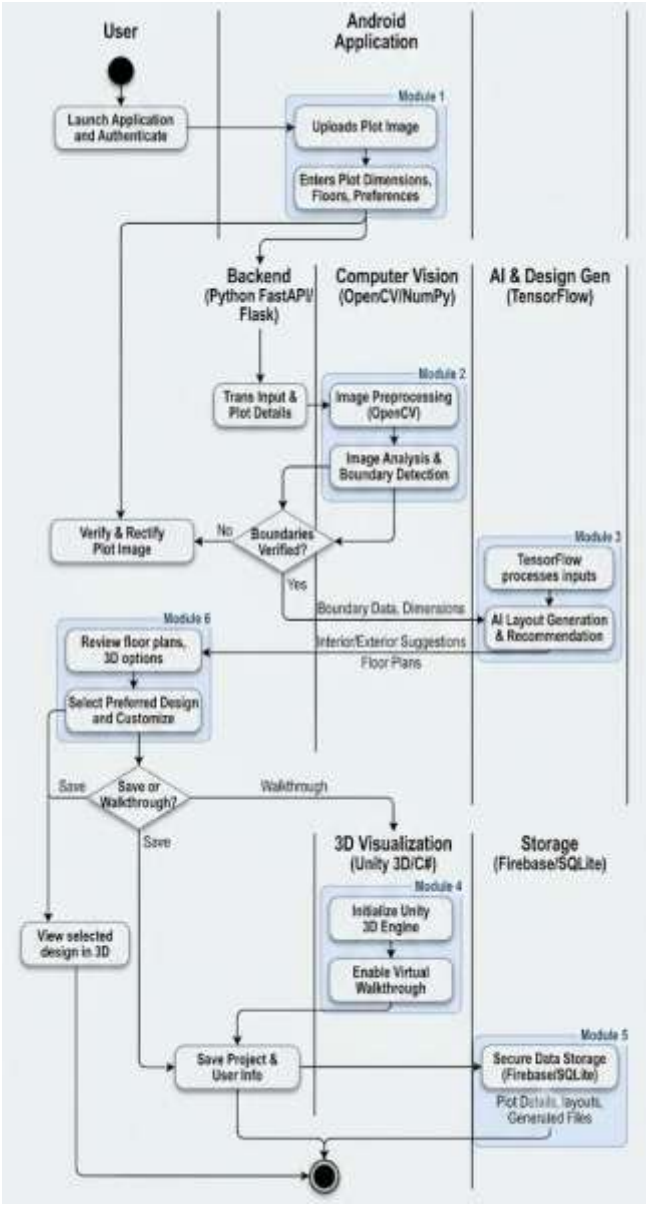


Fig.3 *Activity Diagram For Design Home With AI*

V. RESULTS AND CONCLUSION

The Designed Home with AI system offers a fresh, AI-driven take on the early stages of home planning by combining plot image processing, design generation, and 3D visualization. Using an Android app, users can easily upload an image of their land, input plot dimensions, and share their design preferences. They can add details like the number of floors, bedrooms, bathrooms, and their budget, which helps the system tailor its design suggestions more closely to their needs.

With this information, the system analyzes plot boundaries, creates potential floor plans, and suggests both interior and exterior design ideas. Users have the flexibility to explore these designs and tweak them to fit their tastes and the available space. Thanks to Unity 3D, chosen layouts can be visualized as detailed three-dimensional models, letting users take a virtual tour to see how the rooms are arranged and how the overall design looks. To help users keep track of everything, the system uses SQLite or Firebase for saving and retrieving project details, user preferences, plot measurements, and generated designs. This way, users can easily access their saved projects whenever they need to review their options. The goal here is to streamline the initial home design process by merging multiple planning tasks into one cohesive platform. Instead of just relying on traditional drawings or trying to picture the final result in their heads, users can compare various layouts and visualize their concepts in 3D before diving into more detailed planning. This solution also aims to help users clarify their needs when working with architects and designers, pinpoint their preferred room configurations, and make smarter choices during the early design phase. The system's modular design means that components like the application, image processing, AI-driven design help, database, and 3D visualization can all be developed and enhanced separately. This opens the door for future upgrades, such as better plot boundary detection, smarter room placements, energy-efficient design suggestions, improved budget recommendations, support for different architectural styles, and more interactive 3D customization. Future iterations might even take into account local building regulations, analyze ventilation and natural light, and provide climate and location-specific recommendations. All in all, Designed Home with AI aims to make the preliminary home planning process more accessible, interactive, and user-friendly by blending mobile tech, computer vision, AI suggestions, and 3D visualization. Yet, it's crucial to evaluate the system's performance, accuracy, and usability through real-world implementation and testing. Remember, the layouts and visualizations created are meant for initial planning and should always be vetted by qualified architects and structural engineers before any actual construction begins.

OUR APPLICATION INTERFACE IS BELOW

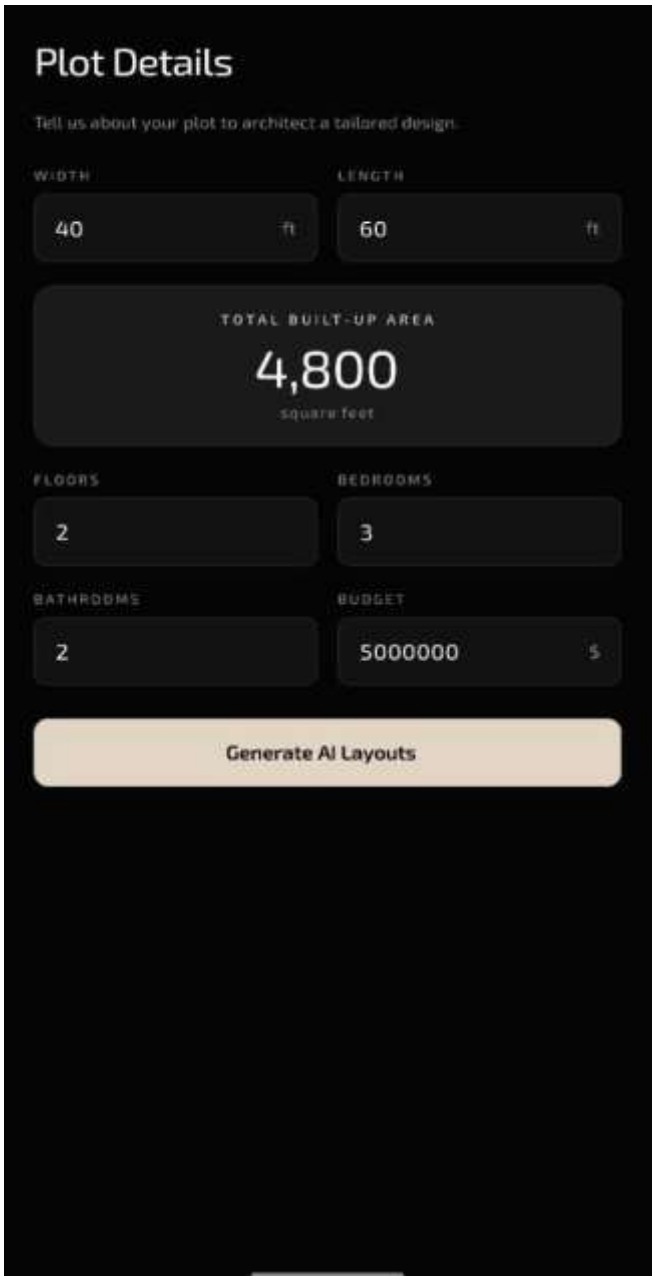


fig.4 *Plot Details Page*

Plot Details Page

On the Plot Details page, users can input their plot measurements along with their home requirements to come up with the right house layouts. You can easily specify the width and length of your plot, how many floors you want, the number of bedrooms and bathrooms, and even your budget. Once you've filled that out, the page shows the total built-up area and features a "Generate All Layouts" button to kick off the layout creation. This way, the system can whip up home designs tailored to your plot size and personal preferences.



fig.5 *Layout Details Page*

Layout Details Page

The Choose Your Layout page shows a variety of AI-generated floor plans tailored to your plot size and design needs. Each option features a unique architectural style, like a contemporary open layout, a cozy family villa, or a sleek minimalist design. You can easily compare key details such as total area, number of floors, bedrooms, and bathrooms. If you want a closer look at a particular layout, just hit the "View Full Plan" button. When you find the design that feels right for you, click the "Select" button to choose it. This page is all about making it easier for you to examine different floor plans and pick the one that best fits your tastes and space needs.



Fig.6 Interior Theme Page



fig.7 Exterior Theme Page

Interior Theme Page

The Interior Theme page makes it easy for you to pick an interior design style that suits your taste. You've got four themes to choose from: Luxury, Minimal, Contemporary, and Traditional. Each one comes with a visual example to give you a better idea of how it might look. These choices really help you see how different furniture, lighting, colors, and decor can work together. Once you've settled on a theme you like, you can dive into the "Walk Through in 3D" feature, which lets you explore your future home in a three-dimensional space. This interactive experience really enhances the process of customizing your interior and helps you get a clear sense of your home's vibe before you finalize anything.

Exterior Style Page

On the Exterior Style page, you get to pick how your house will look on the outside based on what you like. There are four design options to choose from: Modern, Villa, Classic, and Minimal. Each one comes with a visual to give you a clear idea of how the exterior will appear. These styles make it easy to compare different architectural elements, like building shapes, windows, entrances, lighting, and exterior finishes. Once you've found a style you love, just hit the "Choose Interior" button to move on to selecting your interior design. This feature really helps you put your personal touch on your home and create a look that fits your architectural style perfectly.

SOCIAL IMPACT & FUTURE

Designed Home with AI could really change the game when it comes to making preliminary home planning easier for everyone. It lets users dive into house designs tailored to their plot size, land photos, and personal tastes. By mixing AI-driven design ideas with 3D visualizations, this system helps folks wrap their heads around different floor plans and share their thoughts with architects more clearly. It's particularly handy for those who aren't too familiar with architectural software, offering a user-friendly way to explore layouts, interior styles, and how the outside of a house will look. Plus, it encourages users to think about how to use their space wisely and weigh different planning options before committing to any decisions. Looking ahead, Designed Home with AI could get even better with more precise plot boundary detection, smarter AI for creating floor plans, extra customization choices, and interactive 3D walkthroughs. Future upgrades might also include advanced furniture placement ideas, the ability to plan multi-floor homes, tips for energy-efficient designs, features that enhance accessibility, and considerations based on local environmental factors. It would be great to add collaboration tools too, so users can easily share their designs with architects and others for input. All of these enhancements could really boost the system's value as a tool for initial home planning and visualization. Of course, any new features would need to be tested once implemented, and it's essential that all proposed layouts get a professional review to ensure they're structurally sound and meet relevant building codes before anything gets built.

Acknowledgment

We are sincerely grateful to our project guide and faculty members for their valuable guidance, continuous support and encouragement during the development of Designed Home with AI. Their feedback, suggestions and constructive observations helped us to understand the project requirements, refine our ideas and improve our approach to AI-assisted home planning, design customization and 3D visualization. We are very grateful to our department and institute for giving us the opportunity, resources and supportive learning environment to complete this project. We would also like to thank our team-mates for their cooperation, dedication and valuable contribution in the different stages of project development such as planning, designing, implementation and documentation. Thanks to the mutual exchange of ideas and joint work we managed to look at different solutions and tackle different challenges that arose in the course of the project. We thank the developers and organizations that provide the technologies and tools we use: Android Studio, Python, computer vision libraries, database technologies, and 3D visualization platforms. We would also like to thank our families and friends for their constant motivation, patience and encouragement throughout this journey. Their support was instrumental in keeping us focused and motivated as we took on the multiple responsibilities of the project. Working on Designed Home with AI has taught us a lot – we've been able to expand our technical knowledge, learn about the real-world applications of artificial intelligence and computer vision, and explore how modern technologies can be used to simplify preliminary home planning. It has also helped us to develop important skills in problem solving, teamwork, time management, research and systematic project development. This experience has opened our minds to software development and inspired us to look into further innovations in AI based design and visualization. Finally, we would like to thank all those who contributed directly or indirectly to the progress of this project and supported us in the successful completion of our work.

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