Homes.Design System Requirements
Inf 43 – Homework 1

Feb 9, 2023

Introduction

This document is the Requirements Document for the web-based interior design software, Homes.Design.

Homes Corp. is an interior design company whose designers recommend design ideas to their customers, and they make additional money by directing customers to purchase furniture from certain suppliers. The company's founder and president, Henry Homes, wants to cut costs in paying human designers. Therefore, Homes is commissioning the INF43 Software Engineering group to create a system that uses artificial intelligence (AI) that takes input from users in the form of text and photos, and it outputs interior design recommendation renderings that contain real products users can buy.

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Overview / Executive Summary

The Homes.Design system's goal is to use AI to generate renderings of users' rooms that contains recommendations for how the interior design of the rooms could be. The user is to supply a floor plan, an image of a room, and a description of how they want the room to look like in the form of text. When the AI generates the rendering, the user can refine what they want even further in order to create more renderings that will better suit their tastes.

The use of the system itself will be free, and Homes Corp. will make money from affiliate / partnership links to real products shown in the AI-generated renderings. Every product shown in the renderings will be real, purchasable items, and the links to purchase them will be provided by the system when the renderings are presented to the users.

The system will be accessible through a website of the same name (Homes.Design), which implies that both desktops and mobile devices will be able to access it.

The main obstacle is developing and training the AI that will generate the room renderings, so while the AI is being developed and trained, the initial version of the system will be human-driven. After the completion of the AI, the system will transition to using the AI only. In addition, the ability to take in users' videos of the rooms and

generating three-dimensional (3D) walkthroughs of the renderings will be implemented a year after the launch of the initial version.

The implementation of a marketplace system (Homes Marketplace) in which users can put up items for sale and buy other people's items is planned for the future. Homes Corp. will take a percentage of the sales to generate revenue from the purchases.

Application Context / Environmental Constraints

The Homes.Design system is web-based. When it comes to generating static images, the system will be accessible from any device that has a modern browser capable of submitting queries, rendering images, and rendering Hypertext Markup Language 5 (HTML5) files. This implies support for both computers and mobile devices.

As for the future feature in which 3D walkthroughs are generated, the browser must support 3D rendering. Additionally, for the future version that supports virtual reality (VR), the platform must support VR to utilize that feature.

While it was not explicitly stated to be used within homes alone, the examples of the system being used in the interview were of people using the system to design the insides of their homes for various rooms.

Not many details about the user interface (UI) were specified, but the interface users see when entering the Homes.Design site is to be inviting and include a prompt to create an account.

It was specified that when the users describe what they would like the interior design to look like, the users will be presented with the image of the space to be renovated and a blank text field below or above it that tells the user a phrase along the lines of "Ask me anything and I'll do my best." It will simply be a text field without any form of a sidebar that contains modifiers / options for the renderings. There will also be a menu button included in the interface that allows the user to choose to close the session, switch to another session, or switch between photos.

As for handling accessibility for the visually impaired, given that the system is about generating visual renderings, accessibility in that regard will not be implemented.

Since the generation of the renderings is computationally expensive, companies like Amazon Web Services (AWS) or Azure will be used.

Functional Requirements

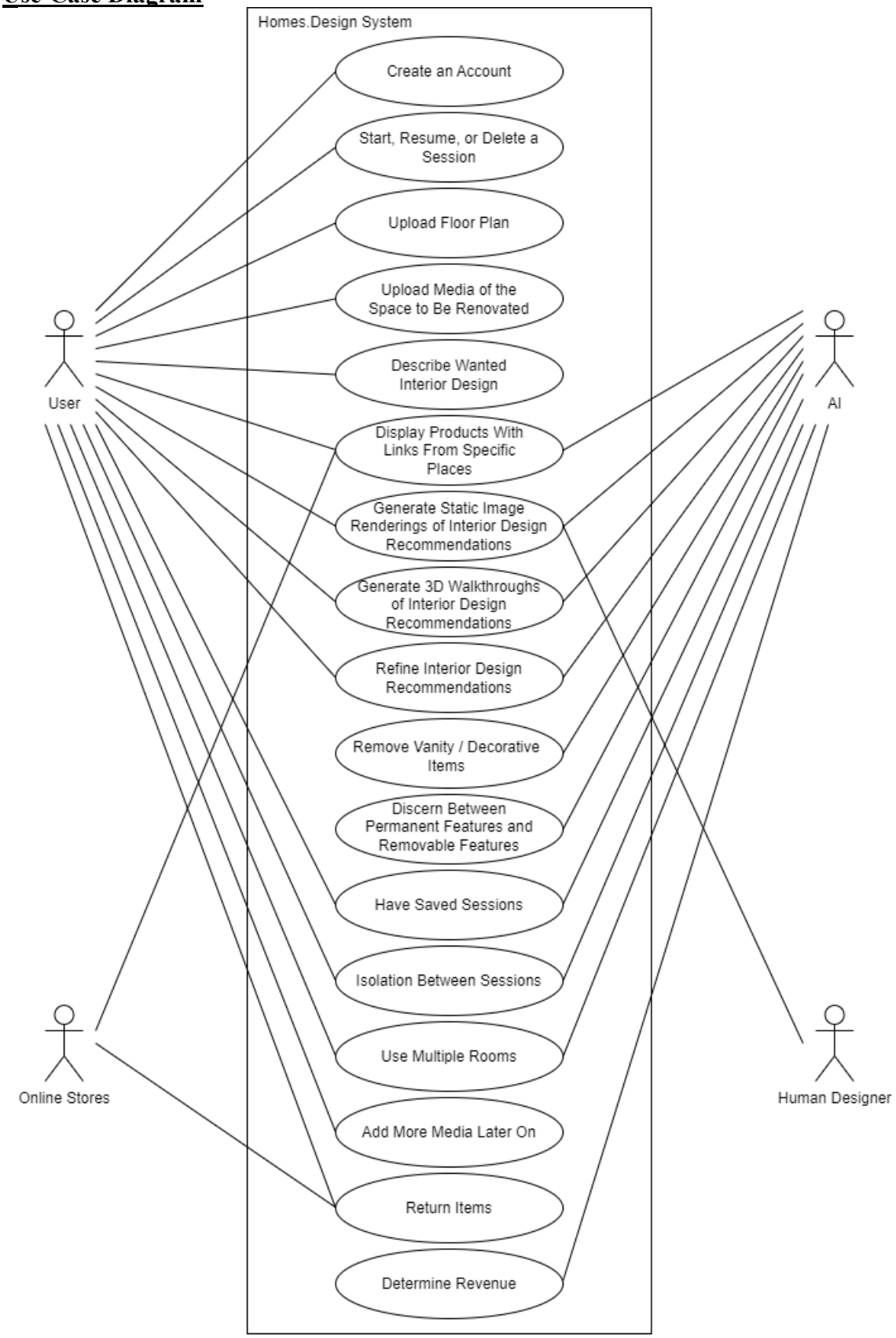
Introduction

This section describes the features of the Homes.Design system, the actors that interact with the system, and the behavior of the system when interacting with the actors.

The actors are the users, the AI, human designers from Homes Corp., and the online stores / companies whose products will be shown in the renderings.

The page that follows contains a use-case diagram of the system, and after that, descriptions of the features are provided.

Use-Case Diagram



Features

- **Create an account**
  An account system is present. Upon entering the website, the user is prompted to create an account. An account is required for users to utilize the system.

- **Start, resume, or delete a session**
  After logging into their accounts, users can choose to begin a new session with the AI, resume a previously saved session, or delete a session.

- **Upload floor plan**
  Upon starting a new session, the users are to upload a floor plan of the area to be redesigned. The floor plan must have a top-down view of the space. The floor plan will note where features like windows and doorways are. At least one dimension of the floor plan must be specified for the system (the rest of the dimensions not specified can be calculated by the system from the given dimensions).

- **Upload media of the space to be renovated**
  After uploading a floor plan, users are prompted to upload media of the area(s) they want renderings generated for. For the generation of static images, the users must upload at least one photo of the space. For each photo, the user must specify on the floor plan where the camera was positioned in the photo for calibration. Additionally, the user must specify two points on each photo and match them to two points on the floor plan. For the generation of a 3D walkthrough, multiple photos with several angles and / or a video of walking through the space will need to be provided by the users. There is no requirement for the quality of the photographic inputs (the AI will work with what it is given). After providing the needed media, the user is given a congratulations message letting them know that the session is ready to proceed.

- **Describe wanted interior design**
  After uploading the media for the space that the user wants to have interior design suggestions generated for, the user will describe how they want the interior design of the space to be like through text (such as describing design style and budget). If the user uploaded multiple photos, they may choose which photo they want to use for the rendering. The user may type anything in their textual description, and the AI will try its best to work off the description. The user may not upload photos of specific items and ask the system to find other items that look similar to them. There will be no form of presets of colors and styles for the user to choose from.

- **Display products with links from specific places**
  The renderings produced will contain products (such as paint colors, furniture, and decorations) from a "catalogue" of products in which Homes.Design can earn money from users purchasing the items (such as items being purchased through Amazon affiliate links). Only links to purchase the displayed items in the renderings will be provided to the user through the user selecting the items. The

user would have to further interact with the AI to have other products and their links shown to them. The user can purchase the items through interacting with the links.

- **Generate static image renderings of interior design recommendations**
  Based on the floor plan and media inputted by the user, the AI will generate interior design recommendations that best fits the user's descriptions. The suggestions are to be more about decoration rather than remodeling suggestions (for example, suggestions about furniture can be made, but not about stoves). Initially, this will be performed by human designers as the AI is being trained, but this will transition to being fully carried out by the AI. The furniture and decorations included in the renderings are real, purchasable items. The AI will not consider proximity to power outlets when making suggestions. Cameras have distortion associated with them that lead to skew being present in images; this skew from the input images will be present in the renderings. If the specification given by the user is not descriptive, the AI will produce a generic rendering that incorporates common design choices. If the user's specification requests interior design features that the AI cannot generate (such as the furniture description not matching any real item), the AI will generate a rendering that is as close to the description it can manage. However, it is possible that the AI will fail in producing a rendering and will inform the user of the failure. If the user specified for the room to be emptied, the AI will try to generate a rendering of the room with white walls and without any items. The generated renderings are then displayed to the user.

- **Generate 3D walkthroughs of interior design recommendations**
  For the version in which 3D walkthroughs are supported, the AI will use the media / video input from the user to generate a 3D walkthrough of the space containing interior design recommendations including purchasable items based on the description given by the user. The walkthroughs are then shown to the user.

- **Refine interior design recommendations**
  After seeing the renderings of the interior design recommendations, the user may refine how they want the recommendations to be like by inputting more descriptions (such as by specifying what about the renderings they like, specifying different colors wanted, and specifying budget constraints). The AI will use this additional input to generate more renderings. The user may continue to describe what they want more, and the AI will remember the user's preferences throughout the session. Alternatively, the user may simply tell the AI to show them another rendering, and the AI will generate a new rendering.

- **Remove vanity / decorative items**
  Vanity items in the input media that are not permanent features of the space will be removed by the AI when generating renderings and the AI will try to render what is behind them. If the AI does not properly remove them, the user will have

to make adjustments, such as removing them physically or taking photos from different angles.

- **Discern between permanent features and removable features**
  The AI will be able to discern which features / objects shown in the media inputs are permanent features of the space that cannot be removed (such as windows).

- **Have saved sessions**
  Sessions will be saved automatically for the user, and the user may resume sessions with the AI remembering their preferences when generating suggestions. Saved sessions can be given a label by the user. If items from previously saved sessions were purchased and no longer available, they will still be present in the renderings, but if the user tries to purchase them, the system will inform the user about the lack of availability.

- **Isolation between sessions**
  The AI's memory of the user's preferences will remain isolated in individual sessions; the preferences of the user will not carry over from one session to another session. Whenever a new session is started, the user will be treated by the AI as if they were a new person; the user's other sessions will not influence the AI's recommendations.

- **Use multiple rooms**
  The user can have separate rooms in different sessions, or the user can have multiple rooms included in a single session with the AI.

- **Add more media later on**
  The user may upload additional media to existing sessions. Additional rooms to redesign may be added if the initial floor plan uploaded for those sessions included those rooms. A new session is needed for rooms that are not included in the initial floor plan.

- **Return Items**
  In the initial version in which users purchase items from the vendors themselves through links provided by the system, users who would like to return purchased items would be referred to go through the vendors of the products.

- **Determine revenue**
  The AI is able to determine how much money Homes Corp. will earn from users purchasing items suggested to them by the system.

Software Qualities and Non-functional Requirements

Software qualities of Homes.Design are fun, creative, engaging, profitable, not very slow, and secure.

Fun, Creative, and Engaging: From the perspective of the user, the experience of using the system should feel fun and creative. The use of the system should feel less intimidating to the user when compared to hiring a human interior designer. The interaction between the AI and the user should lead to a result that is pleasing to the user.

Not very slow: The generation of the renderings may be relatively slow, but not in a way that is inhibitive (a maximum time of approximately 20 seconds). It does not need to be extremely fast. The 20-second maximum does not apply to the human-assisted version (the task is expected to take hours to complete for this version).

Profitable: From a business perspective, the system should earn Homes Corp. money and profits.

Secure: The payment processing must be secure. The data of both the companies and the users must be secure (at least to the extent of keeping their data involving money secure). There is no significant concern in keeping the users' design data secure.

Other Requirements

AI Training Specification

When the AI is being trained, its training model will include various paintings, decorations, furniture, and paints seen online. The training model should allow the AI to have the ability to calculate the amount of money Homes Corp. will earn through users purchasing the suggested products.

Interior design magazines, publications, and websites will be part of the AI's training, and the AI will learn the colors and styles of furniture that fit different interior design styles.

Additionally, data gathered from the period in which the system is human-driven will be used for training the AI.

Cost to Users and How Homes Corp. Earns Money

The service of having design recommendations rendered will be free to the users in order to maximize adoption of the system. Homes Corp. will earn money through the sale of items (users purchasing items through affiliate links and products from partnered businesses) and potentially advertisements.

Initially, the AI will scrape Amazon for products that Home Corp. can make money from when purchased by users.

Initial Region and Language Support
Business will first be conducted to buyers in the United States.

The initial version will have support for the English language.

Lack of Tutorial
A tutorial for how to use the system will not be provided to the user. Most users are expected to learn how to use the system through their interactions with it.

Level of Realism
The renderings need not be completely photorealistic as they are meant to serve mainly as inspiration for users.

Use of Third Parties
Potentially using tools from third parties that give parts of needed functionality (such as payment processing) will be investigated. The amount of money the third parties take is a factor in deciding whether to use their tools.

Budget:
- The initial version that generates static images will have a budget of $1,000,000.
- The version that generates 3D walkthroughs and has VR support will have an additional budget of $1,000,000.

Glossary of Terms	
Actor	People, outside systems, and other units that are not part of the system itself that have interactions with the system
Amazon Web Services (AWS) and Azure	Cloud computing services owned by Amazon and Microsoft, respectively
Artificial Intelligence (AI)	Software / technology that has the capacity to seemingly learn and carry out tasks that typically need to be completed by humans
Augmented Reality (AR)	Technology that places digital graphics into the display of the real world that the user sees
Hypertext Markup Language 5 (HTML5)	The markup language that is typically used for web pages and describes the structural makeup of the pages
User Interface (UI)	The view of the system presented to the user and is the part of the system where the user and system make interactions with each other
Virtual Reality (VR)	A three-dimensional environment simulated to and experienced by the user

Assumptions / Risks

A developmental risk is developing the AI to work as specified. The feasibility of the goals of how the AI should work must be assessed. Human designers temporarily assisting in completing tasks the AI is meant to do will aid in dealing with this risk. The use of third-party tools may reduce this risk, too.

A safety and legal risk is the suggestions depicted by renderings potentially violating fire codes and other safety regulations. The users will have to agree not to hold Homes Corp. accountable for such instances if they occur.

Henry Homes mentioned that the buyers and sellers of items in the marketplace could communicate with each other and make purchase agreements in a way that cuts out Homes Corp. This prevents the company from earning money from these purchases. This can be seen as a business risk.

Another business risk is the costs exceeding the revenue. The profits not being high enough would mean that the business is not feasible from an economic standpoint.

Priorities / Implementation Phases

Time Schedule

- Non-functional/UI protype: This version contains no AI rendering or payment handling, but it puts out fake results as if it works. This is meant to give an idea of how the UI will look like. This is scheduled to be ready on March 26, 2023.
- Human-assisted version: This version has humans assisting in the generation of the renderings and has support for the static image rendering. This is scheduled to be released on January 26, 2024.
- Full AI version: This version generates the renderings using solely the AI, and it includes generating 3D walkthroughs while still maintaining the feature of generating static images. This is scheduled to be released on January 26, 2025.

Priorities

The first major priority is creating mockups / prototypes of how the UI will look like before the other technology is implemented. These prototypes will also give an idea of how the experience of using the system is.

Afterwards, the next priority is developing / training the AI to be properly functioning as specified. This is due to the AI generation being the part of the project that is very innovative, whereas the other parts of the project (such as payment handling, having a business earn money mainly through affiliate sales, and having 3D rendering performed in websites) are known to be able to be carried out. Implementing the generation of static images is prioritized first before implementing 3D walkthroughs.

Implementing the Homes Marketplace is a future priority that is to be handled after the priorities listed above.

Future Directions and Expected Changes

Virtual Reality Support

For platforms that support the use of VR, the ability to use VR equipment when users view the 3D walkthroughs is planned for the future.

Augmented Reality Support

Support for using augmented reality (AR) with the system is a potential future feature. AR has benefits to it, such as allowing the AI to have better measurements of the space.

Partnerships

Homes Corp. will aim to get sponsorships / form contracts with companies to have their products shown in the renders for users of the system to purchase. When this happens, contracts would have to be formed regarding the handling of returns.

An interface will need to be created for these suppliers of furniture, paint, etc.

Refunds

As for handling refunds, the INF43 Corp. will research how companies like eBay handle such issues before gaining approval from Homes.

Region and Language Expansion

There are plans to expand the conducting of business to countries other than the United States in the indeterminate future.

Support for more languages other than English is planned, and which languages will be supported depends on the market in the future.

Suggestion Algorithm Bias

The algorithm for suggesting products to users in the renderings may include a bias that favors suggesting products that will earn Homes Corp. relatively higher amounts of money when purchased by users.

Media Quality Warning

While there are no requirements for the photos and videos that users upload for generating renderings, if users uploading low-quality media that leads to low-quality renderings becomes a significant issue, the system may start giving warnings when it is given media that is low-quality or too dark.

Homes Marketplace

The Homes Marketplace will allow users to add items to its inventory, and users can purchase items from it. Homes Corp. will take a percentage of the money exchanged during the sales. While the implementation of the Homes Marketplace is a future concern, specifications describing the marketplace were given.

- **Add item to marketplace**
  The user can add an item they own to the marketplace's inventory. The user must specify the dimensions of the item (like height, width, depth) and upload photos of the item from different perspectives.

- **Purchase marketplace item**
  The user can purchase items from the marketplace's inventory. When purchased, Homes Corp. will take a percentage of the money used.

- **Lack of price negotiation**
  The price of items sellers put up for sale cannot be negotiated. The buyer must pay the price listed for the items.

- **Handle payments**
  A payment processor will be implemented into the system to handle payments from the user. Payment processing may be handled by pre-existing companies, and this will be looked into. Early in the interview, it was stated that payments may be handled through Stripe or Venmo.

- **Exchange of contact information**
  After the payment of a marketplace item is handled, the buyer and seller will receive each other's contact information.

- **Have a populated space**
  Even before customers and vendors are present to populate the marketplace with items, the marketplace will be populated with products from websites like Amazon and Ikea through the use of a web crawler that takes in data such as product pictures and dimensions.

Homes Marketplace Interface

There will be interfaces for the Homes Marketplace when it is implemented. It will have interfaces for the buying and selling of products by users, making it similar to other marketplaces like Facebook Marketplace and Craigslist.

When payments are made through the website, they will go through the system's interfaces, but not many details were given about that.

Marketplace Dispute Settling

The handling of disputes between buyers and sellers in the Homes Marketplace (such as in the event of the seller falsely advertising the item) will need to be investigated.