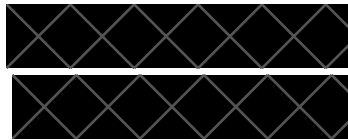


Homes.Design System Requirements

Inf 43 -- Homework 1

February 9, 2023



Introduction

Homes.Design is a web domain created to get rid of the human interior designers and automate the entire process of selecting a good interior design for your space.

Homes company, a company that specializes in interior designing, wants to automate the entire process of interior designing by asking an AI to take the place of human interior designers, to eliminate the risk of security by letting another (possibly unknown) person into your house. The AI first analyzes the design of your space and then provides you with a rendering of your desired designs and specifications (or an “average” rendering if you do not know what you want). The use of AI also helps reduce costs for the Homes corporation and therefore, this AI-driven web domain can help increase profits. This AI also helps eliminate the risk of being judged by another person, a very real risk that exists when you let a human interior designer into your house.

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Other requirements	Describes additional requirements and contains the Glossary
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Priorities/Implementation Phase	Lists the functionality of the system in the order of priority (or how it should be implemented)
Future Directions and Expected Changes	Lists any future ideas that can be implemented

Overview/Executive Summary

The goal of Homes.Design is to ensure that it can reduce spending on human interior designers and automate the entire process of designing while adding to the users' comfort of not being judged.



Homes.Design is a web domain and can be accessed on any device as long as the device has an access to/supports a web browser. The website is free to use, but the users will have to create an account if they want to save their designs (and access them later).

The website opens up to a blank text box (after creating an account/logging in). The user will then need to provide a floor plan, specify the camera angle, and specify the dimensions so that the AI can understand the needs better (if they are specifying a new design; if they want to continue on an old design, they can just open that up instead of taking photos again). After all of this, the user will specify their needs in the text box. Then, the AI will render an image of the new design based on the specifications and availability. The user can then determine whether they want to see another design or purchase the elements of the design that they like.

Initially, the website will crawl through Amazon's shopping webpage and will gather the furniture item photos and dimensions from there to populate the website, so Amazon's shopping webpage would be used to train the AI (and possibly attract new vendors). The payment will be done through a built-in interface within the website itself so PayPal and other payment options would not be necessary.

Homes.Design will help reduce costs for Homes corporation while ensuring that users have a secure and judgment-free environment to play with designs and add comfort and personalization to their space!

Application Context/Environment Constraints

Homes.Design is a website that can run on any device, whether it be mobile phones, laptops, or tablets, provided that these devices have access to a web browser that supports image rendering. The first few versions, with the 'fake' (real designers acting as AI until the AI gets trained) and real AI, would work on web browsers that support image rendering, but for future versions with a video walkthrough, browsers with 3D rendering would be needed. Eventually, there is a plan to move to a VR version of this project. If that happens, a device supporting stereoscopic vision would be necessary for the best experience (Note: the image rendering version of the website would still work even when newer versions come out).

This website can be run in an office if the office needs to be redesigned (or designed from scratch). The website can also be used at home for personal use where a user can decide to remodel their space. In both cases, the user (personal or office) needs to create a free account so that their designs are saved.

The furniture and designs shown on the website would come from companies such as AWS and Asher, while the initially empty website will be populated by designs from Amazon's shopping webpage.

The UI for this website would be captivating and attention-grabbing because Homes corp. wants users to feel like they have to create an account and join them for the best designs. They want



to hook their customers to their website so that the customers keep coming back to the website for their furniture and design needs. The website's UI would be designed in such a way that the website's most attractive furniture would be placed on the homepage so that users want to continue and look at more designs.

Functional Requirements

There are two types of users on this website- the customer (buyer) and the vendor (seller). Both types of users have to create a free account to continue working on the website. In the first version of the website, the AI (or the system) will be human interior designers who would work on training the AI. In the subsequent versions, a real AI-based system would replace these human designers. Image 1 below shows the use case diagram for Homes.Design.

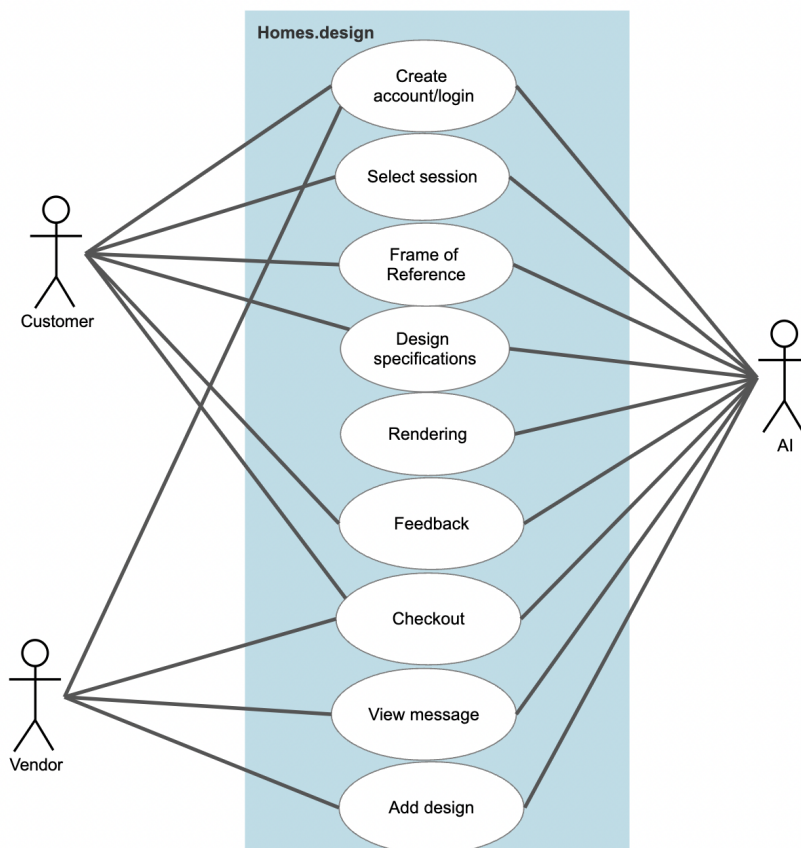


Image 1: Homes.Design use case diagram

Customer Interface and role of AI

- **Create account/login**

When the customers first go to the website, they will be prompted to first select whether they are a customer or a vendor. Then (assuming they select the customer option), they will be prompted to either create an account if they are a new customer or log in if they are a returning customer. When an old customer tries to log in, the AI will have the job of verifying the credentials of the customer and making sure that these credentials are



correct before letting this user access their content. When a new customer creates an account, the AI has the job of storing the information of the new customer in its customer database to make sure that it can verify credentials and retrieve other information when needed. All customers need to create an account or log in to an existing account to access the contents of the website, but account creation is free.

- **Select session**

After logging in, an existing customer has an option of resuming any old session if they want to continue on their work from a previous time, or if they want to remodel the same space, with the same frame of reference, from a previous session. The customer also has an option of creating an entirely new session if they wish to start from scratch on an old space, with a new frame of reference, or want to start designing a completely new space. When the customers are creating a new session, they have the option to name the session or leave it as “untitled” depending on what they want. When the customers select the option of opening a pre-existing session, the AI has the job of finding that session in the customer system database, opening it, and setting it up for the customers to continue working on it. When the customers select the option of opening a new session though, the AI has the job of storing that session with the particular account information on the Homes.Design customer database. Existing customers can also delete a session if they want to do so, and the AI has the job of finding that session on the customer database with the corresponding account information, and deleting that session from the customer database corresponding to the particular account. New customers do not have an option to select an old session because there is no session information for them; they will have to start with a new session the first time.

- **Frame of Reference**

When the customers start a new session, they will have to enter a set of information before they can start the design process. First, all customers will have to upload a floor plan of the space that they want to redesign. In addition to this floor plan, they will need to specify at least one dimension on the floor plan. The customers can add more dimensions if they want because there is no limit on the number of dimensions that can be added, but one dimension is the minimum. When customers provide some dimensions (at least one), the AI can use the principle of extrapolation to figure out the other dimensions by itself and can get an approximate idea of the space which needs to be redesigned. If the user provides more than one dimension, the AI can be more accurate in its approximation of the space and the customers can have an even more accurate idea of how their space would look when they are done. The AI will not move ahead until the user has provided the floor plan and at least one dimension for the floor plan. After uploading the floor plan and the dimensions, the users will be prompted to upload photos of the space that they want to redesign. At least one photo is necessary, but more than one photo is allowed to let the AI get a better idea of the space. With each photo provided, the user will also have to specify the camera angle that was used to take the photo, and will also have to mark the bounds of the photo. In addition to the bounds, the customers will have to specify two points on each photo, say A and B, and also specify where those two points are on the floor plan that the user has just provided. The user can provide multiple photos with different camera angles to get the most accurate



results for one space, and the users can also select multiple spaces that may exist on the same floor plan. For example, if the user wants to redesign two rooms that exist on the same floor plan, they have the option to do so and they can provide multiple photos (at least one per room) of the same. The AI cannot continue without at least one photo that the user provides, in addition to the information regarding the camera angle of that photo, its bounds, and the two points on the photo and on the floor plan, because the AI needs to have some information about the space before it can come up with designs that fit the space. If an existing customer wants to continue with a previous design, they can just open a previous session and select the images (and camera angles, bounds, and points on the floor plan) that they want from there and re-upload them instead. After uploading (or re-uploading) these photos, the camera angles, bounds, and the points on the floor plan, the user will get a congratulatory message saying that the session is now ready to go, letting the user know that they have completed the setup and can start with the design process.

- **Design specifications**

After the congratulatory message, customers will see a text field that says “Ask me Anything,” along with their selected image (or images if they selected multiple images for their frame of reference) at the bottom of the text field. In this text field, customers have the option of letting the AI know if they are looking for something specific, ranging from color, style, price, etc. The customers do not have to use any technical jargon, regular English works just fine for this input field. For example, if a customer wants a blue couch under \$100, this will be the space to specify that requirement. On the other hand, if customers are unsure about what they want, they can just say something as simple as “redesign,” and that will work too. The customers can provide any furniture-related queries inside this text box, but any query that goes outside that scope will provide an error. For example, if a user says “give me another window,” the AI will give an error and the user will have to re-enter something related to furniture. The AI will take note of these inputs and will work on the rendering depending on the text entered by the customer.

- **Rendering**

Here, the user has no part to play. This is a completely AI-driven step where the AI will analyze the user inputs provided in the “design specifications” and will render an image accordingly. If the user has provided a specific input such as “blue couch under \$100,” the AI will search the inventory to find all blue couches under \$100 and will display the most chosen one out of all of the available ones. If a customer provides inputs such as “redesign,” then the AI will display the most commonly chosen designs for the space provided, based on past user experiences and training. Before the AI renders an image based on the design specifications, it needs to analyze the frame of reference provided by the user. It needs to be smart enough to take into account pre-existing furniture that has to be removed and/or replaced (for example an existing couch that needs replacement), and also has to be smart enough to distinguish between what is furniture and what is just decoration (such as a vase on the table, or a painting on the wall). In addition to understanding pre-existing furniture, the AI needs to understand the floor plan provided and the photos, camera angles, and dimensions provided with the floor plan. The AI should be able to take in all of this information and form an approximation of what



the space looks like (such as where the windows are, where the doorways are, etc) before it can render an image (and later video). After it analyzes the frame of reference and the design specifications, the AI finally renders an image. The images (and later videos) rendered by the AI are only an approximation of the actual design and are not rendered to scale; the AI is only to give the user an idea about how their design would look and is not a 100% accurate image of the space.

- **Feedback**

The customer can view the rendered image and provide feedback. For example, if the customer does not like what is presented by the AI, they can ask the AI to retry. The AI will note this as a failure on its part and will try the rendering process again hoping to give a better result on the next attempt. This process of trial and error can continue until the customer finds something that they like. If the user finds something they like, they can add it to a “purchasing list” by giving an add command in the text field (AI adds the item to the list). When the user gives the add command, the AI will check the inventory for the item, and if it is not found, the AI will let the user know that the item is out of stock and that the user cannot purchase the item as of now. Therefore, the item will not be added to the purchasing list of the user. If the customer does not want to purchase the item(s) yet- they just want to save their designs- they can do that by naming their session (if not done already) and then giving the save command to the AI (the AI will save the session along with the purchasing list for the session). The users can also just exit their current design and the AI will auto-save their design and its specifications as an untitled session (unless the users named the session earlier). If the customer wants to purchase the item (or items) then they can let the AI know that they want to proceed to checkout and any item in their purchasing list will be considered a part of their cart.

- **Checkout**

The customer can take a look at the item(s) in their purchasing list and can remove any items that they do not want from the list (AI carries out the removal process). When they have finalized their choice, they can enter their payment information into the website’s payment interface and the AI will work on verifying their details. The customers will have the option of saving their information onto their account and if they agree to do so, the AI will store their information securely corresponding to their account. Once that step is complete, their payment will go through to the vendors and their order would be complete. The users will receive the contact information of the vendors as soon as their purchase is successful. New users have to enter their payment information when they purchase something for the first time from the website, but existing users, if they have any saved payment information, can use their saved payment information from their last transaction to carry out the payment (the AI will retrieve this information). If the users have any concerns about their product(s), they can directly contact the vendor through the contact information provided at the time of a successful order. The AI will ensure that the customer’s message reaches the vendor successfully.

Vendor Interface and the role of AI

- **Create account and login**



When the vendors first go to the website, they will be prompted to first select whether they are a vendor or a customer. Then (assuming they select the vendor option), they will be prompted to either create an account if they are a new vendor or log in if they already have an account. When a pre-existing vendor tries to log in, the AI will have the job of verifying the credentials of the vendor and making sure that these credentials are correct before letting this user access their content. When a new vendor creates an account, the AI has the job of storing the information of the new vendor in its vendor database to make sure that it can verify credentials and retrieve other information when needed. All vendors need to create an account or log in to an existing account to access the contents of the website, but account creation is free. When the vendors create an account, they will also automatically have an additional new “wallet” that will be assigned to them on the website (speculation of a wallet based on speculation that vendors will want to see their balance in addition to adding their products).

- **Checkout**

The vendor checkout interface is different from the user checkout interface. When the vendor accesses their checkout section, they will be able to view their “wallet” which contains their balance. The vendors will not get the full price for their designs; a small percentage of their income will be taken by Homes.Design. When a purchase is successful, the AI will implement the small percentage cut and will deposit the remainder of the amount in the vendor’s wallet.

- **View Message**

The vendor will have a message section for customer concerns and grievances. The vendor can click on the view message section and can respond to these messages and the responses will be received directly by the customer. The AI will be responsible for the successful transfer of the message from the vendor to the customer.

- **Add Design**

The vendor can choose to add new products to the website if they want to do so. They will have to upload at least one image of their product in addition to dimensions and price (and any other relevant information such as disclosure of damage, delivery date, and so on). When the vendor uploads a product on the website, the AI will add the product to the inventory of Homes.Design (along with its image and other relevant information), so that customers can access this new design as well.

Software Qualities and Non-functional Requirements

- Usability- Users should find the system to be fun and creative to use, without any bugs.
- Security- Security is not as important in most aspects of the website but users must be able to carry out their payments securely. There should be some encryption to protect user payment information.
- Portability- The website has to run on all devices that support a web browser with image rendering (and later 3D rendering), therefore it is inferred that the website has to be portable enough to run on all these web browsers.
- Speed- The website does not have to be very fast. Response time to a query can have a maximum time of 20 seconds.



- Maintainability- The website has to be maintainable, because it will have several versions, starting from the human-based AI to possible VR-based implementation. So, it needs to be modifiable with ease.
- Robustness- The AI can encounter errors such as when the customer says something like “I want another window” in their input, which is outside the scope of this website, or when the inventory has run out of a product that a particular customer wants. The website should not break in these situations and the AI should be able to give an error message and continue without crashing the entire website.

Other Requirements

Timeline:

- Requirements document is needed by February 9th, 2023.
- The initial non-functional prototype without any AI rendering but with some UI implemented, such as the customer/vendor interface (to see how it would work in the actual version), is expected by March 26th, 2023.
- The initial functioning, human-assisted version (human designers instead of AI) will be needed by January 26, 2024. This version should also support image rendering (by human designers instead of AI). So, this will be the first fully functioning version of the website.
- A fully automatic version, where human designers are replaced by AI, is due by January 26, 2025. This version should also support video walkthroughs, in addition to the image rendering from the previous version.

Budget:

The first fully functioning version (with human-assisted “fake” AI and image rendering) will have a budget of \$1 million, and the next version with video walkthroughs and AI replacing human designers would have a budget of another \$ 1 million as well.

Subscriptions and Advertisements:

The website is free to use, but advertisements will be implemented within the website. These advertisements are a source of income for the Homes corporation.

User Agreement:

The website should implement a user agreement that would be presented to the customers at the time of account creation; the users cannot proceed further into the website without signing this agreement. This agreement ensures that the users cannot hold Homes corporation responsible for any safety or legal issues.

AI training:

The AI should be trained not only by learning what the human designers do in the fake AI version (first version), but also through outside interior designers, magazines, publications, and so on. This will allow for the AI to provide the best possible results to a query by the customer. The AI will also learn by leveraging other sites such as Amazon’s shopping site to try and replicate Amazon’s system of earning profits on products sold from the website.



Appearance:

The website should be creative and attractive for the users. They should be hooked to the website just by looking at the homepage (the user interface should be attractive) and should want to continue onto subsequent pages of the website.

Algorithm for product display:

The algorithm for displaying products when rendering images should be implemented such that whenever possible, items that give the most profits to Homes corporation are displayed first. For example, if a customer wants a blue couch and multiple blue couches are available, and there is no “average” blue couch (this happens when customer choices have varied, or no customers have asked for a blue couch yet), then the blue couch that gives Homes corporation the maximum revenue would be displayed first. In addition to displaying products based on profits, the AI should be smart enough to understand the likes and dislikes of the customer during a particular session and should display similar products. If a new session begins, then the AI starts all over again and does not need to remember what happened in the previous session.

Language and Country:

- This website aims to support only English in its first few versions. So, all inputs provided by the user and all of the messages outputted by the system have to be in English.
- Currently, the website is targeting the US audience, with plans of expanding to other markets. The US is a test market and depending on the response received, plans to expand to outside markets may be implemented.

Glossary of terms

UI	Also known as User Interface. It is an interaction field where humans interact with the system; it is the side of the system visible to humans. Includes things such as display screens (the pages visible to the user when they enter Homes.Design is an example as well).
space	Space, as used in this document, pertains to any area that can be redesigned, for example, a room, an office, an entire floor, etc.
prototype	Prototype is an initial version, implemented by developers, that does not have all the functionality, but shows some basic functionality (such as UI) so that the client has an idea of what the final product would look like.



bounds	A bound can be thought of as a box that is required to enclose your item; the bounds represent the boundaries of an item (for example the endpoints of a photo are its bounds)
query	Query, as used in this document, pertains to customer input- it can be a question asked or a statement made to the AI to request more information (textual input provided by the customer).

Assumptions and Risks

Assumptions:

- The AI is not perfect and will make mistakes. The assumption is that the AI will get smarter over time with its training and learning from the human designers doing their job in the first version of the website.

Risks:

- If the website accidentally changes some aspects outside the website's scope, then there may be legal issues. For example, if the user provides a floor plan that does not have all the walls of a particular room, and the AI designs something in place of the missing walls, then there can be legal issues because the AI has changed the floor plan. The implementation of the user agreement can help solve this issue.
- The budget for both versions is \$1 million each. The money may not be sufficient because of the complexity of the software implemented and the increasing cost of experienced software engineers. The project may end up overrunning its budget.
- The timeline for each version of the project is one year. This timeline may not be sufficient because implementing an AI with image rendering (or video rendering) is very new and complex; there is a risk of not meeting the deadlines for this project.
- The hardware used by Homes Corporation is purchased from companies like Asher and AWS. This hardware may not be feasible economically because purchasing hardware can get computationally expensive with an increase in the amount of hardware purchased.
- The AI generation model used by this website is very new and complex. The ability of the AI to take someone's floor plans and carry out the redesigning operations it does is very new. The model might not be feasible to implement, and there is a risk of this idea not being feasible to implement as an AI.
- The human-supported version of this website (the first version with image rendering) may be slow because the human designers may not be able to meet the maximum response time of 20 seconds for various reasons such as the designers being busy with other customers and so on.

Priorities/Implementation Phase



Mr. Homes, the owner of the Homes Corporation, wants to see a prototype of the design by the end of March 2023, therefore, he wants developers to focus on starting the prototyping of the design as soon as possible. He wants to know what everything would look like, without all the functionality, but with some basic UI, so, he would like the developers to consider prototyping a top priority.

The AI rendering used in this project is “cutting-edge” technology. It is extremely new and complex, therefore, Mr. Jones would like the developers to start working on the research and development phase for the AI alongside prototyping the system with UI for customers. Mr. Homes wants to make sure that the AI requirements given by him are feasible, therefore he wants developers to start on some research and development for this part of the project at the same time as the prototype development (thereby making both research and development for the AI and prototyping the top priorities).

After the prototype is complete, Mr. Homes wants the developers to start working on the actual functionality of the project. He wants developers to start working on the rendering of still images from a given perspective; the first version of the website.

In addition to supporting the image rendering version of the project, Mr. Homes believes that it would not be a bad idea to have human designers instead of AI in the first version of the project. He believes these humans can serve as fake AI until the second version of the project with a fully functional AI is developed.

After the first version comes out with human designers and image rendering; Mr. Homes wants the second version of the project to have the 3D rendering and video walkthroughs, along with a fully functional AI. He wants to give the users a more immersive experience in the second version of this project. So, after the first version is complete, Mr. Homes would want developers to start working on this version of the project, which is expected one year after the first version.

Future Directions and Expected Changes

Listed below are some features that the Homes Corporation would like to add to the website in the future.

- Homes Corporation wants to implement a marketplace into the website for people to buy and sell products. They want this marketplace to be modeled off of existing platforms such as Amazon or eBay.
- Mr. Homes expects to make this design available in countries outside of the US if it is successful in the US.
- The Corporation may also want to support other languages since they plan to expand outside of the US.
- The second version of the AI has video rendering, but Mr. Homes wants users to have an even greater immersive experience by implementing a VR version of the website.
- Mr. Homes may also want to try out an AR version instead of a VR version and would give more specific directions if and when that is to be implemented.



- Currently, there are no requirements for the input provided by a customer. The customer can provide a low-resolution photo or take a photo in a dimly lit room, and the AI will try its best to render an image. This image may be completely different from what the user wanted but, there is no way to fix it except for the customer either re-uploading an image or using the process of trial and error to arrive at their desired result. Mr. Homes wants to change this in the future by implementing a warning that will tell the users if their photo is not clear enough.
- In the future, Mr. Homes expects to set up partnerships with other furniture design companies (in addition to individual companies) and also wants to set up sponsorships for the website. Since these arrangements would be contract based, he expects to also support product returns directly on the website (this is currently not supported).

