Project 3

# Designing hands free interactions in Indian household kitchens

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# Declaration

I declare that this written document represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources, which have thus not been properly cited, or from whom proper permission has not been taken when needed.

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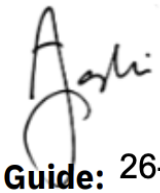
# Project Approval

The project titled “Designing hands free interaction in Indian kitchen” by Sanika Shrikant Deshpande, is approved for partial fulfillment of the requirement for the degree of ‘Master of Design’ in Interaction Design at Industrial Design Centre, IIT Bombay.



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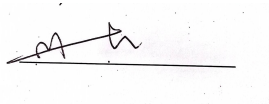
Anirudha Joshi



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# Abstract:

Cooking plays an important and essential role in our lives. Young people who have newly started living independently, though, have not had enough experience with cooking. As a result, they often rely on online recipes or call their parents for guidance.

This project focuses on understanding the problems faced currently in Indian household kitchens and designing a hands free interactive solution for the same. As per the results from primary research three areas were identified which were recipe assistance, assistance on multitasking and cooking assistance where hands-free interaction techniques can help young adults to improve their skills and enjoy cooking even more.

The proposed design utilizes voice-based and visual assistance through a dedicated mobile app installed on the user's device, and assisted by a kitchen-cam, kitchen sensors (such as temperature sensors) and actuators (such as LED lights and beepers on the stove). The system behaves differently in various scenarios, adapting to meet the specific needs of each user. For an absolute beginner, the system offers step-by-step interaction, whereas for the intermediate users, it  plays the role of an assistant, supporting and helping multi-tasking, drawing attention to things that might go wrong. To refine the final design, user evaluation was conducted using the Wizard of Oz technique. Valuable insights and feedback from the evaluation were utilized to modify the design, enhancing its overall effectiveness and user experience.

# 1. Introduction:

Cooking is a pleasurable hobby for many, providing the joy of experimenting with ingredients and recipes. The abundance of online cooking resources poses challenges, as handling written recipes and videos disrupts the cooking process with frequent handwashing. Users prefer hands-free options to avoid smartphone use while cooking. Multitasking during hands-on cooking is difficult, especially for novices, leading to delays in meal preparation. Effective time management is crucial for efficient and stress-free cooking. New cooks may struggle with understanding food status and appropriate actions, resulting in undercooked or overcooked dishes. Keeping track of grocery items is another common issue, leading to missing ingredients during cooking.

The aim of this study is to identify problem areas while cooking and design hands-free interactions that could help users prepare meals according to their expertise. By prioritizing hands-free interactions, the design project aims to simplify and streamline the cooking experience, reducing distractions and enabling users to multitask effectively while maintaining focus on their culinary tasks. The goal is to empower users to navigate through various cooking activities with ease, providing them with greater convenience, efficiency, and overall satisfaction in the kitchen.

The design process for this study encompassed several key steps. It began with an exploration of existing work and conducting primary research to gather relevant information. I conducted contextual user interviews with potential user groups, focusing on understanding their daily routines, cooking environments, habits, and the challenges they encountered in the kitchen while cooking.

To gain further  insights into the introduction of hands-free interactions in cooking, a secondary research and literature review were conducted.The study aimed to explore previous efforts in this area and understand the factors contributing to their success or failure. This involved reading research papers to examine current technologies, usage patterns, and challenges encountered when utilizing voice assistance.

Design guidelines for hands-free interactions were also examined, along with an analysis of the methods and conclusions presented by experts in this field. By extracting the key findings from the literature review and secondary research, valuable insights were obtained to inform future design decisions.

From the research, personas and scenarios were developed, providing a framework for brainstorming and generating design ideas. Various methods were explored for ideating like mind mapping, ideating through recipes, etc. After developing

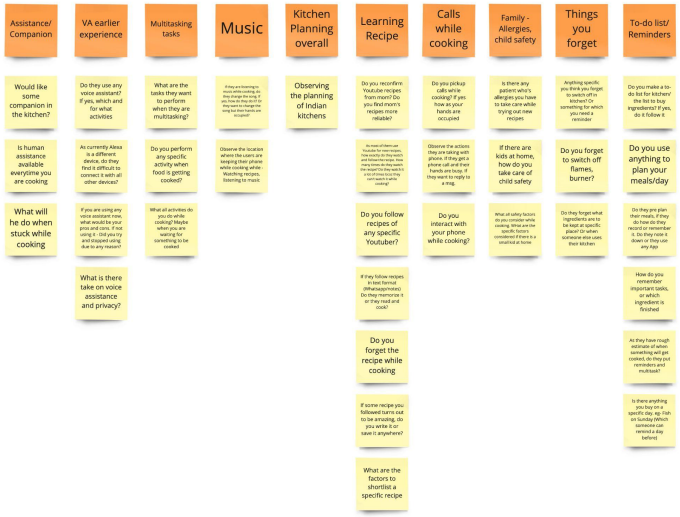
a basic design it was further evaluated with the defined personas. As per the feedback the design was refined.

The study aims to design a system which is an enhancement of current voice and visual based systems to guide the users with specific instructions to ensure that there is minimal requirement of visual cues when the user is expecting a hands free interaction.

# 2. Primary Research

## 2.1. Work Done Earlier

During my initial semester, I collaborated with a group of five individuals for a project centered around qualitative research on "Virtual Assistants (VA) for kitchen appliances" as part of the "User Studies" module. To conduct this study, we utilized the contextual inquiry method and conducted 15 online interviews. The interviews were conducted with diverse user groups, including young adults who had moved away from home, couples with one or two children, and large families with multiple adults. Through the process of affinity mapping, we identified key areas of interest such as multitasking, entertainment, recipe assistance, and reminders/alerts.




The users encountered several challenges while cooking, including interruptions causing irritation, difficulty focusing, forgetfulness, and struggles with operating complex appliances. Their goal was to multitask effectively without compromising efficiency, with features such as hands-free access to recipes and music, improved organization, timely reminders, and assistance without the need for physical interruptions.

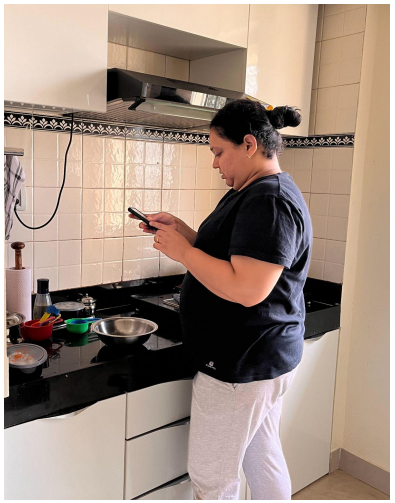
This initial study served as a preliminary exploration to identify the critical areas requiring intervention. Based on the shortcomings identified during this study, the primary research objectives for the current study were determined and finalized.

## 2.2. Study

In the study, we initially conducted a total of 5 interviews involving participants from different age groups and living arrangements. Specifically, 3 elderly individuals with cooking expertise and 2 young adults (between 30-40 years old) from nuclear families were selected. These interviews were conducted in the users' kitchens followed by a semi-structured interview. During the interviews, the participants were instructed to prepare a recipe of their choice, preferably sourced from the internet or their family members. As an assistant, I provided support and assistance as requested by the participants. The participants' cooking

activities and decision-making processes were observed within their natural kitchen environment. Subsequently, the participants were prompted to express their thoughts out loud and recall specific instances or situations related to their cooking experience. This was done through a semi-structured interview format, allowing for a deeper understanding of their perspectives and insights.

Upon analyzing the interviews, it became evident that elderly individuals, who possess extensive cooking experience, are accustomed to their kitchen environments and prefer physical assistance primarily for tasks such as chopping or cooking. However, they do not require assistance in terms of skill sets. On the other hand, young adults with limited cooking experience exhibit a different set of behaviors. They are more inclined to try out new recipes and utilize technology while cooking. They often face challenges such as having to refer to recipes while cooking, forgetting to purchase certain ingredients until they are already in the midst of cooking, struggling to multitask when preparing multiple dishes simultaneously, or juggling cooking with other tasks. When encountering difficulties in cooking, they seek guidance from experienced individuals, such as elderly family members or consult online resources.



Based on the insights derived from these interviews, more users were recruited focusing on user profiles with comparatively less or no experience in cooking.

Total of 5 new participants were recruited. The methodology employed was the contextual inquiry approach used in the pilot study. Participants were given the freedom to choose any recipe they desired, with the option to refer to online sources or cook multiple things as per their wish. The participants encompassed a diverse range of backgrounds, including variations in technological comfort, cooking experience, and gender. Throughout the interviews, audio recordings were made to facilitate further analysis. Additionally, careful attention was paid to the kitchen setup, arrangement, and the placement of phones while cooking. These observations complemented the participants' cooking activities, providing valuable context for the analysis process.

Recorded interviews were transcribed and further coded as User Statements, Observations, Insights, Breakdowns and Design Ideas.

| Sr. No | Comment | Type |
|---|---|---|
| 1 | Finalised this recipe because ingredients are easily available and it is quick | User Statement |
| 2 | Cake is something which everyone likes | User Statement |
| 3 | Focuses of availability and convinience | Insights |
| 4 | She likes to pirotise what her family likes and choose what to cook as per their preference | Observation |
| 5 | VA can help remember her, his family preferences/choices incas she forgets | Design Ideas |
| 6 | Was not really searching for specific recipe but was exploring on instagram and came across this recipe | User Statement |
| 7 | Recipe is from instagram reel | Observation |
| 8 | Generally prefers recipes on Youtube, this recipe is from Insta as she liked it while randomly watching reels | User Statement |
| 9 | When she randomly finds a recipe, saves it to cook later | Observation |
| 10 | I will keep my phone near me as there are specific quantities of ingredients that are to be followed, which I need to refer continuously | User Statement |
| 11 | If hands are bad and can't view recipe, she writes down the recipe - Only quantities of Ingredients also helps. This is only in case of Instagram | Breakdowns |
| 12 | If it is Youtube, it allows to pause and resume the recipe. If hands are dirty I still touch the phone like that only. Cleans the phone screen later after cooking is over | Breakdowns |
| 13 | Doesn't want to take additional effort of washing hands again and again | Insights |
| 14 | Whenever she writes recipes, writes it on paper | Observation |
| 15 | She writes on paper because she can directly keep it on the platform and it's not worried if it gets spoiled | Insights |
| 16 | If she has high priority to cook something, then she will irrespective call for the required ingredients. | Observation |
| 17 | If there is option between two items. Would prefer the one of which she has ingredients available at home | User Statement |
| 18 | Vegetables are filled once a week, Groceries in one-one n hlf month | User Statement |
| 19 | Makes list of ingredients to be bought on phone using Keep App whenever she realises it. Keeps on adding | User Statement |
| 20 | She needs a way to keep a track of the ingredients she needs to buy | Insights |

Through the interpretation of the interviews, key problems were identified and organized into themes using affinity mapping.

## 2.3. Insights

Based on the research study conducted with participants from focused groups, three key areas were identified as focal points for design intervention.

### 2.3.1. Recipe Assistance

A significant number of users relied on YouTube video-based recipes, particularly novice users who followed the instructions step by step. However, the pace of the videos often proved challenging for users to keep up with. Consequently, they frequently had to pause or navigate back and forth, which became cumbersome and inconvenient, especially when their hands were occupied.

Experienced users, on the other hand, typically watched the recipe video once or twice and then relied on their cooking experience to prepare the dish. Novice users, however, had concerns about potentially missing a step from the recipe and felt apprehensive about proceeding without all the necessary information.

Another common issue observed was that many users tended to forget at least one required ingredient while following a specific recipe. Depending on the significance of the ingredient, users either ordered it or asked someone else to get it if it was essential. In cases where the ingredient was considered nonessential, users proceeded with the recipe without it. Novice users, however, were often unsure if they could proceed without a missing ingredient and sought assistance to make that determination.

Furthermore, users who were new to the kitchen faced challenges due to limited utensils, making it difficult for them to discern between measurements such as teaspoon and tablespoon.

Users who relied on recipes from blogs or WhatsApp encountered a lack of visual assistance and struggled to obtain timely feedback on whether their preparation was on the right track.

### 2.3.2. Assistance with Multitasking

Users who possessed a moderate level of cooking experience and cooked meals regularly, around 2-3 times a week, encountered challenges when preparing multiple items simultaneously. One specific difficulty they faced was monitoring the progress of each food item and determining which one required their immediate attention the most.

In addition, these users often struggled to keep track of time, especially when a particular recipe required a specific cooking duration, such as 10 minutes. Instances like boiling milk, making tea, or cooking vegetables would sometimes cause them to forget about the time, leading to potential overcooking or undercooking.

### 2.3.3. Cooking Assistance

Users encountered difficulties when setting the appropriate flame level on their gas burners, resulting in either prolonged cooking times or burnt food items.

When following recipes, users found it challenging to understand measurements specified in terms of teaspoons, tablespoons, and other units.

Certain recipes required special techniques or tricks to achieve optimal results, which users may not have been aware of.

Users often forgot which ingredients they had already added to the recipe, leading them to taste the dish multiple times to ensure all necessary components, such as salt, were included.

In instances where cooking skills were lacking, users experienced difficulties when a step in the recipe went wrong and were unsure how to proceed or rectify the situation.

## 2.4. User Personas

Persona were developed as per the insights gained from primary research

Persona 1 - This persona focused on the users who are new to cooking.

*"Halwa banana halwa nai hota"*

ANURAG, **IT Professional (24)**

Completely **new to cooking**. Trying to **learn cooking** by referring to recipes. Young adults who have shifted from home and are **living alone.**

### Needs

- Wants recipe to be **real-time** and chunked **step-by-step** as per their pace.
- Wants to know **detailed information** about each step they need to perform.
- Needs to know **ingredients and utensils required** for the recipe beforehand.
- Needs **visual assistance** to compare their output with the recipe at multiple stages

### Frustrations

- **Forgets the steps** while they are actually cooking as they have seen recipe before cooking.
- Always wash hands when they have to pause, forward, etc the recipe.
- Don't understand if they are in the right track while cooking certain recipe. They try to relate it with video and **feel stuck** if its not matching.

Persona 2 - This persona focused on the users who knew how to cook but struggled in multitasking.

*"I'm very conscious while cooking"*

## VINEETA, Architect (35)

Cooks on a **daily basis**. Completely used to cooking and kitchen environments.

**Uses technology** for cooking tips, recipes, etc. Open to explore technological advancements which will enhance their cooking abilities.

### Needs

- Needs to **multitask** while cooking
- Wants to **experiment new things**
- Wants to cook things as per their **family preferences** and follow all safety for them
- Wants to be **reminded about ingredients** to be bought beforehand
- Needs **visual assistance** also while referring to some recipes on phone

### Frustrations

- Doesn't like it when is **interrupted** and has to wash hands continuously while cooking
- Doesn't want to **interact with phone** while cooking as hands are not clean
- **Forgets to get few ingredients** and then has to rush to get them
- Faces difficulty to decide what needs **more attention**

## 4.5. Design Implications

1. The design to consider the overall kitchen environment, not limiting it to any specific device.

2. System to have visual assistance along with voice.

3. Conversational assistant would help in cooking.

4. Give users control over the system. Precise instructions to be given by system.

5. Temperature based feedback is more useful in case of novice users as they would need precise assistance.

6. Image recognition and thermal sensing technologies can be explored.

7. System can provide real-time recipe assistance, focusing on minute details such as detailed measurements, required utensils, and step-by-step guidance for process-driven ingredients like ginger garlic paste.

8. The system will subtly notify the user when the gas burner is left on, using both visual and voice assistance. Indicators will be installed to let the user know if the gas burner is on or off.

9. Beyond cooking, the system will support various activities outside the kitchen, allowing users to control calls and create shopping lists, facilitating multitasking.

10. Additionally, video-based cooking assistance will be available to teach and guide the user throughout the cooking process.

# 3. Secondary Research

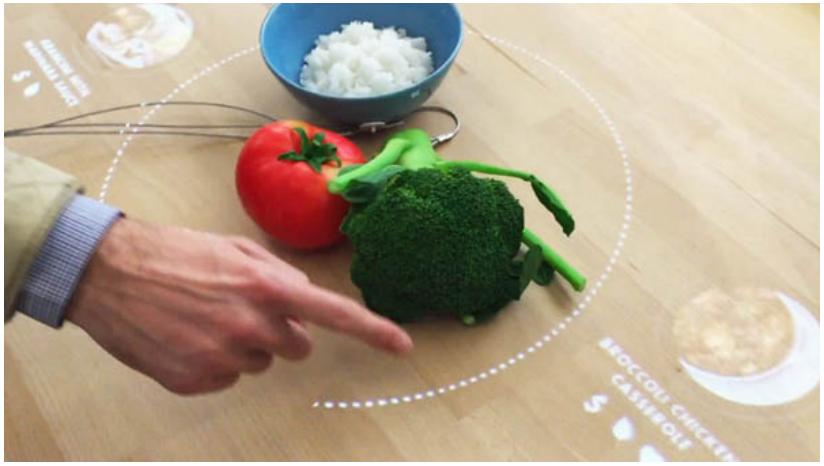
## 3.1. Existing Work

I explored existing work in this domain and found a few products that focused on hands-free interactions using technological advancements. Additionally, I found some works that envisioned future kitchens, which served as inspiration for ideating the design intervention.

**Cooksy - *Smart Cooking Assistant :*** (“How it works – Cooksy”)

"Cooksy - Smart Kitchen Assistant" is an AI-powered countertop appliance designed to simplify and speed up the cooking process. It features a touchscreen display and an integrated camera to identify ingredients and recipes. Users can select a recipe from the Cooksy app or add their own, and the device guides them through each step. Voice recognition allows hands-free operation. Cooksy can adjust cooking durations and temperatures based on the recipe and ingredients, and it offers helpful reminders like when to stir or add ingredients. Besides cooking assistance, it can create shopping lists and set timers.

**Designing the future Kitchen - *Concept by IDEO for IKEA:***
(“Designing the Future Kitchen”) The "Designing the Future Kitchen" concept focuses on using technology to create a warm and inviting kitchen environment, avoiding a robotic and sterile feel. The Concept Kitchen 2025 emphasizes mindfulness and informed decision-making without taking away personal choices. The Table for Living encourages creativity in food preparation and reduces waste by providing recipes and instructions based on leftover ingredients placed on its surface.



**Hello Egg -** ***Voice-powered cooking assistant:*** (“Hello Egg puts a friendly voice-powered cooking assistant in your kitchen”) "Hello Egg" is a voice-activated smart kitchen appliance designed to simplify meal preparation. It combines the functions of a recipe book, timer, and personal assistant in a compact egg-shaped gadget. With access to a vast database of recipes from various sources, users can ask for cooking instructions, ingredient substitutions, and recipe suggestions using voice commands. The device also offers a "My Fridge" feature, suggesting recipes based on the ingredients available to the user. "Hello Egg" can be personalized to cater to dietary requirements, allergies, and individual preferences. Additionally, it learns from the user's interactions to provide tailored recipe recommendations based on their culinary experiences.

**Delish Up -** ***India’s first smart cooking assistant :*** (Dhapola) DelishUp is a smart kitchen gadget designed to support young Indians in cooking more meals at home. It takes the uncertainty out of Indian cooking with precise measurements and automated cooking capabilities. The device connects to a tablet, displaying the required ingredients and exact proportions before starting to cook. It even includes a weighing scale for precise measurements. DelishUp offers a variety of vegetarian and non-vegetarian recipes, providing step-by-step instructional videos and plating tips. Its aim is to make cooking easier and more accessible, especially for those with limited cooking experience. The integration of ChatGPT allows users to customize recipes and receive real-time assistance through the AI-powered UpBot.

## 3.2. Design Implications from Existing Work

1. Previous research primarily targets novice users and recipe assistance, but through the primary research, it became evident that there is also a gap and opportunity for design intervention for intermediate users.

2. The unique aspect of this design is its consideration of all stages of cooking expertise. This area shows promise as there are many conceptual interventions proposed but not fully realized yet, making it an intriguing space for upcoming design initiatives.

3. While many existing approaches concentrate on cooking apps to assist users, this project stands out by prioritizing the creation of a conducive cooking environment.

# 4. Literature Review:

## 4.1. Voice Interaction in cooking environment

(Kendrick et al. 2021) The research paper proposes a multimodal guided cooking experience for a device that combines voice input and output with a touch interface. It found that users prefer voice interaction while multitasking, considering cooking's complex and hands-on nature. The combination of visual and auditory recipe guidance allows the chef to focus on the meal being prepared without needing to look at the visual interface. Therefore, voice interaction can be explored as a hands free interaction technique in case of Indian kitchens.

## 4.2. Current technological solutions

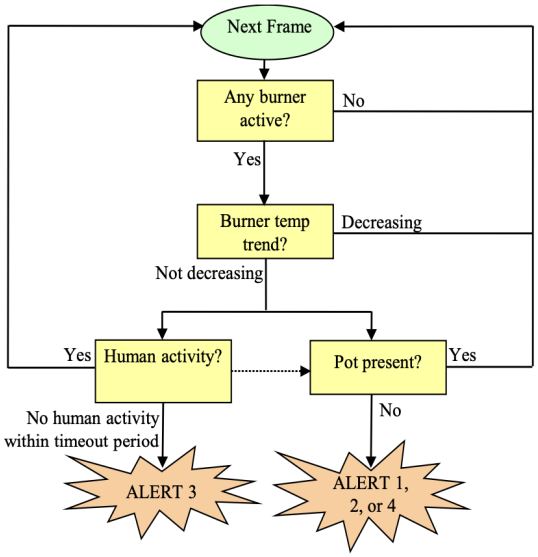
(Kendrick et al. 2021) Existing guided recipe solutions require many sensors and 'smart' accessories to monitor a chef's progress. For example, the Smart Kitchen requires accessories such as radio frequency identification (RFID) tags to identify ingredients, and Shadow Cooking requires a depth camera, projector, and digital scale. KogniChef and Kochbot make use of an entire smart kitchen system to monitor the user's actions and communicate recipe instructions, although the Kochbot may also be used alone as a mobile app providing recipe guidance via voice and screen.

(Yuan et al. 2012) This study develops an automated stove-top monitoring system that could significantly increase kitchen safety. This system uses a thermal camera to detect dangerous situations and behaviors, and alerts the user before a fire occurs. It is hoped that this system will serve to promote independent living among the elderly, leading to increased quality of life and decreased health care costs. The stove-top monitoring system consists of four subsystems: burner status (active/inactive), burner temperature trend, pot presence/absence, and human activity detection.

(Schroth et al. 2022) As per the author, human activity recognition enables technical systems to analyze human behavior in various settings. For example, it can be directly used to support the user in elder care, healthcare or training environments. Nevertheless, human activities are oftentimes highly variable and therefore pose a challenge for any technical system to correctly classify and, even more importantly, generate feedback that is valuable to the user. This paper talks about the process for designing a system that uses machine learning on the sensor node itself in order to improve human activity recognition within a sensor network.

(Yuan et al. 2012) The proposed system in this study is able to meet the following requirements: automatic calibration and identification of all burners for an arbitrary stove top configuration and an arbitrary placement of the camera; detection of burner activity; detection of burner temperature

trend; pot presence/absence detection for initial presence; and identification of human activity at the stove top in order to confirm that the stove is being attended to.  This can be achieved by using a thermal camera to detect dangerous situations and behaviors, and alerts the user before a fire occurs.




Overall, these technologies can help improve the cooking experience for users by increasing efficiency, reducing stress, and providing more guidance. By designing hands-free interactions that address these challenges, users can enjoy cooking even more.

## 4.3. Usage and Difficulties faced while using Voice Assistance

(Pins 2019)The primary use of VAs was playing music, setting timers or reminders (for instance for cooking), controlling smart Home devices and accessing news or weather feeds. Managing shopping lists, asking for information (opening hours, films, persons, recipes etc.) or scheduling appointments. Hands free usage was identified as the main benefit of VAs. Once the users have learnt to talk to VAs, interactions become more fluent.

(Pins 2019) Language commands would need to be as short, clean and accurate as possible with the VA to achieve a high probability of successful understanding. Acquiring complex information such as recipes for cooking often resulted in problems because of the limited possibilities for overview and navigation. Users first had to learn the right words to increase the chance of understanding. Interactions that are more complex often lead to misunderstandings, breakdowns

(Lahoual and Fréjus 2019) As per the study, following were the difficulties faced while using voice assistance : It may be unable to respond to a complex command or be limited in its understanding of keywords and syntax at the beginning of use.  And if there is some failure in case of auditory and visual feedback from VAs end, the user tries to improve voice recognition: they may have to repeat, rephrase, clarify by

changing phrases or keywords, enunciate more carefully, speak more loudly or more slowly, or shorten the command.

If there is a failure, users explore potential solutions. It may involve other devices or other forms of interaction, such as using a smartphone to check the history of the conversation, check that the router is working, or renew the request via a phone application. This activity thus consists of making hypotheses, testing them and perhaps looking for new solutions. Note that with these activities, users develop knowledge-in-action and gain a form of expertise about their devices coupled to the environment.

As opposed to the expectations of ease of use, vocal interactions lead to unanticipated control and assistance activities. These activities disrupt and interrupt the flow of activity, leading to control that is no longer exclusively vocal but instead tends to involve a wider variety of supports and multimodal interactions (smartphones; older dedicated devices like conventional radios or paper shopping lists; and visual, auditory and physical interactions). Users begin to focus exclusively on the control activity, making it the top priority. The disadvantage of assistance activities is thus that they prevent the users from carrying out another task simultaneously, although this has been touted as one of the best attributes of VAs.

It is therefore important to design vocal interactions around problem-solving during use. This would prevent spending too much time on assistance activity and turning to other media or forms of interaction.

(Hou and Yang 2018) There is a "Pseudo phonetic" Interaction. When Siri gives multiple options for the user to choose from, it is expected that the user will manually click on the selection rather than the form of the dialog, where a manual trigger button is required to continue the conversation. Most users do not notice this detail, and they will continue to input information until a sentence is finished but found not recognized, can only say again, and affect the efficiency of the interaction.
The process of getting information quickly with the eyes is much faster than listening to the Siri voice reading screen, especially when Siri gives a long paragraph of text feedback, users have a "Fast forward" requirement.

Voice assistants provide users with a detailed guide to native application voice operations, but users often have no patience to take a closer look, and prefer to learn through their own trial and error.

When the user enters a piece of information, the system outputs the wrong result due to some reasons, such as incorrect identification, ambiguous understanding or beyond the ability of the voice assistant. At this time, if the user wants

to change through the voice, the result will be more confusing. The user will want to start over after the change fails, but the voice assistant can't tell if it's a new conversation, and his memory will stay in the last conversation, so there will be a situation where the answer is wrong and the user is farther away from the user's intention. In most cases, the user has to exit the voice assistant and reenter, so as to ensure the correct dialogue context.

The problems identified above, which users may encounter while using voice interactions, should be addressed. It's important to find a solution that can turn this experience into a pleasant one.

### 4.4. Design Guidelines for Speech Interactions

(Murad et al. 2018) As per the literature, following are the guidelines for speech interaction analyzed on the basis of existing guidelines for graphical user interface:

**Visibility/Feedback of System Status:** Major observation in this section was lack of visibility and feedback which led to users not knowing if it was their turn to speak, misinterpreted recognition errors from speech interfaces, users often did not know if speech interfaces understood their spoken input.

(Hou and Yang 2018) People have a better memory of pictures than words or breakthroughs. Therefore, when the voice interface to feedback more information, we should try to use the form of charts rather than large sections of text stacked. When people inadvertently receive information, and receive a limited time, this principle will be better. Users usually do not look at the screen carefully but glance at it roughly when using voice interaction.

Interface feedback: Users expect different feedback on different tasks, such as book a car, text messages, such as tasks that need to look at the screen to check output results, and tasks such as looking at the weather, users do not want to disperse the visual channels to see the results.

Content Feedback: Simplifying the content when it comes to feedback. According to the existing way, the voice reading screen will waste a lot of time, and occupy the user with too much attention, then it will increase the memory burden of the user, and it is not easy for the user to focus on the key information quickly.

Technical Feedback: For example, the system might indicate that it no longer has a wi-fi/internet connection or that it has not understood when the user repeats or reformulates a request that fails.

One of the concerns of users when using voice interactions is that they are not sure what terms can be recognized. When there are multiple operational errors, most users will choose

to give up the voice operation directly, rather than viewing the operation guide to learn. Voice assistants should prompt users immediately when they make mistakes or become hesitant, such as "You can ask me: What's the weather like today?" The timing and content of the feedback given by the voice assistant is very important to improve the user's satisfaction.

(Murad et al. 2018) **Mapping Between System and Real World:** Users map their own mental models of conversational interaction to speech interfaces. Giving users the schema of a familiar interaction in the world increases task performance and ease of use whereas unfamiliarity with the interaction style can decrease usability.

**User Control and Freedom:** There is a need for user control and freedom in speech interfaces as users felt rushed when interacting with a voice UI, and worried about missing parts of the interaction. Providing users with control over interaction can improve performance and user satisfaction. “Out-of-turn interaction” system, which allowed users to provide information that would be needed later in dialogue, which reduced task completion time and was more usable. (Perugini et al. 2007) Out-of- turn interaction is a technique which empowers the user (un- able to respond to the current prompt) to take the conversational initiative by supplying information that is currently unsolicited, but expected later in the dialog. The technique permits the user to circumvent any flows of navigation hard- wired into the design and navigate the menus in a manner which reflects their model of the task. Out-of-turn interaction is optional and can be in- voked (and interleaved with in-turn utterances) by the user at multiple points in a dialog at the user’s discretion. Out-of-turn interaction helps isolate the menu choice(s) relevant to the user’s task by pruning out irrelevant options. However, since a bypro- duct of the reduced menu is an improvement in speech reco- gnition accuracy, expanding our lexicon with synonyms for menu items (e.g., passcode or PIN for password) is within the scope of viable approaches to this problem.

**Recognition Rather than Recall:** The level of cognitive load required to remember speech commands. Using audio as the only output modality increases cognitive load, and requires users to remember long pieces of information. Users often are not aware of how to structure their speech to a voice UI.

**Flexibility and Efficiency of Use:** When comparing a textual vs. speech search interface, found that the use of keyboard shortcuts are a useful feature that improves task efficiency. That speech interaction can improve efficiency because users are able to just say their requests.

**Minimalism in Design and Dialogue :** Maintaining large pieces of information presented by speech interfaces. When exploring the primacy and recency effects in presentation of menu options, five or more options affected the ability to

remember earlier options. Implicit confirmations within dialogue are more preferred over repetitive explicit confirmations.

**Allowing Users to Recognize and Recover from Errors:** the need to develop ways to recover from communication errors. users often repeat and refine, speak louder misunderstood requests. Another struggle is the ability to go back to a previous menu or undo an action. Considering a possibility to edit speech.

**Providing Help and Documentation:** Users performed better with a speech interface after an interactive tutorial. Providing help progressively throughout interaction guides the user in performing tasks efficiently.  Help that was provided contextually within the interaction was particularly useful. This both decreased cognitive load and provided assistance to users only when required.

(Politis et al. 2015) A study suggests abstract visual feedback when informing drivers during a non-critical situation and audio in a highly critical one. Language-based warnings during a critical situation performed equally well as abstract ones, so they are suggested as less annoying vehicle alerts. This study was used to understand alerts in case of driving. Similarly the beeps in case of cooking can be designed as per the criticality of the situation.

(Hou and Yang 2018) **Avoid "Pseudo phonetic" interaction:** The voice assistant assumes that the user has not looked at the device screen all the time and responded to the user's instructions as fully as possible. For example, when looking at the weather, the user's expectation is for the system to broadcast today's temperature directly, with human cues such as "Colder weather and more clothes." Instead of giving a temperature list for each time period, users can use visual channels to get information.

**Personalized Customization:** Many voice assistants need fixed statements as activators, such as "Hey! Siri". In fact, let users give their own voice assistant a personalized name, each time the user awakens like a pet call, and the voice assistant's answer can be changed from "Hello" to "Master" and so on. The addition and change of this kind of person will increase the interest of the speech experience, cultivate the user's usage habit, and enhance the user's stickiness.

To create a user-friendly conversational design, follow these design guidelines and add the suggested features mentioned in the literature.

## 4.5. Visually Augmented audio interface

(Shrivastava and Joshi 2019) As per this study, emergent users in the developing regions can interact better with a visually augmented audio interface (AV, the audio-visual) than an audio interface (A) like IVRs and a graphic user interface

(G) on two grounds. First, audio prompts users to meet goals and thereby brings directedness to the interface. Second, visuals bring persistence by presenting options on the screen in parallel. The results of the study mentioned that with AV, users exhibited better task completion than G and A. Though they were not as fast as G but they took less time than A. They rated AV higher on SUS scale than A, G.

Based on the general design principles and voice interaction design principles, the voice interaction feedback interface in handheld mobile devices is optimized to improve the validity and reliability of the intelligent voice assistant.

### 4.6. Prototyping Techniques

(Iyengar and Joshi 2013) The research paper describes a unique Anonymous Social Networking (ASN) product concept for PLHA called *Sangam* that connects to its users through an Interactive Voice Response System (IVRS). This paper explores the potential of such anonymous socialization among PLHA and to understand the design requirements and the constraints under which such a system would operate. Such a prototyping technique can be used to understand design requirements as well as test them with the users to evaluate the system before implementation.
The Wizard-of-Oz method is valuable when building the technology behind a concept is too expensive or when the problem space is too wide and could benefit from being narrowed down. The applications of the Wizard of Oz paradigm expand beyond traditional dialogue testing. The method can help creators of interfaces assess utility, explore the system's limits, and discover inputs that users might provide to the system before investing resources into building a full technical solution.

In a closed Wizard of Oz paradigm, there is a fixed set of system responses from which the wizard can choose. These responses could be various screens or text snippets.This variation can reveal gaps in system content. In an open Wizard of Oz paradigm, the wizard composes responses in a timely manner, on the fly, during sessions with users.This variation is commonly used in the discovery phase to understand user mental models, expectations, and vocabulary. In hybrid variation, there is an existing body of system responses, which are used whenever possible, like in a closed test. However, if there is no appropriate response in the response corpus, a new one is created and provided to the user during the session. This approach can generate insights about the existing, already implemented system responses and explore alternatives to current dead ends.

These are the possible prototyping techniques to consider for the design intervention.

## 4.7. Design implications of literature review

1. Though voice would be the main mode of interaction, the system needs to have visual assistance as that would help the user with better task completion rate.
2. Temperature based feedback and actions to be taken are important for users with minimal cooking experience.
3. Cooking is an interactive process, hence a conversational voice assistant will be more helpful than the current voice assistant.
4. The system should give users freedom and control over the interactions. Considering out-of-turn interaction method while ideating the design.
5. System should be able to give crisp and precise instructions on the next action to be taken by the users. The voice commands given should be self explanatory and not dependent on visual assistance.
6. System should be able to understand errors and be flexible to suggest course corrections
7. The system involves futuristic technologies and hence Wizard of Oz technique to brainstorm on techniques to build evaluation prototypes.

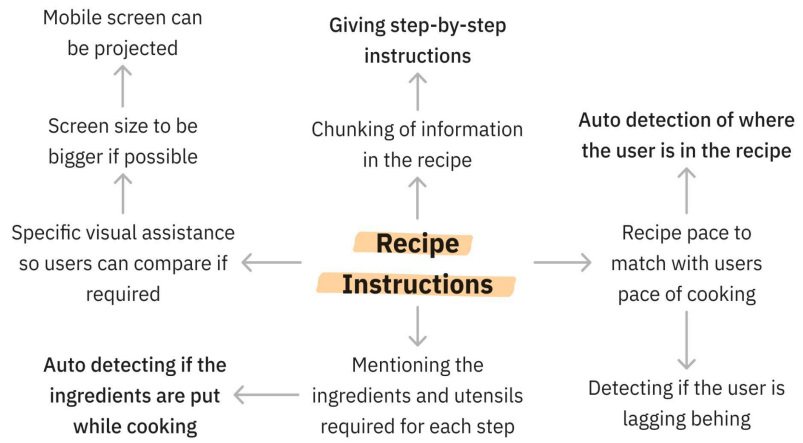
# 5. Ideation

## 5.1. Initial Ideation

### 5.1.1. Mind Mapping

Mind Mapping was used initially as a method for idea generation.  Ideas were generated on the three key areas identified from the primary research.

Recipe Assistance *(Focused on Persona 1)*

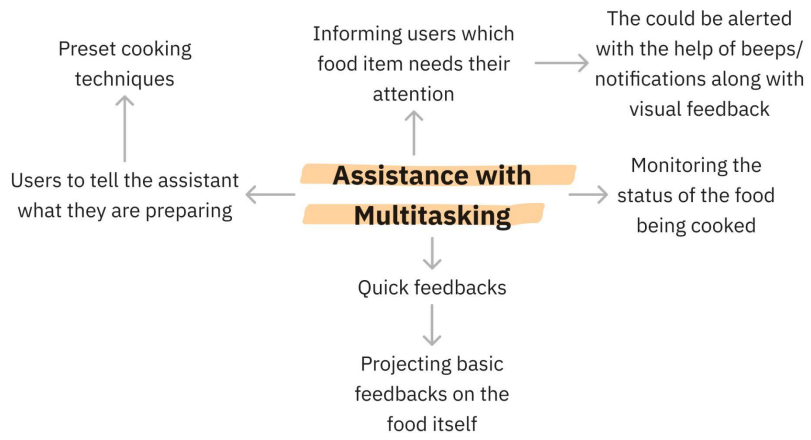



Following are the potential areas for future development in recipe assistance:

1. Providing real-time, step-by-step instructions to the user, allowing them to follow along seamlessly as they cook.
2. Developing a system that can automatically detect the pace at which the user is progressing and adjust the instructions accordingly, ensuring a personalized cooking experience.
3. Implementing ingredient detection technology that can identify the ingredients the user has added to the recipe in real-time. This would enable the system to provide relevant feedback or suggestions based on the detected ingredients.

These ideas aim to enhance the user's cooking experience by offering timely and tailored instructions, adapting to their individual pace, and providing feedback based on their specific ingredient usage.

Assistance with Multitasking *(Focused on Persona 2)*

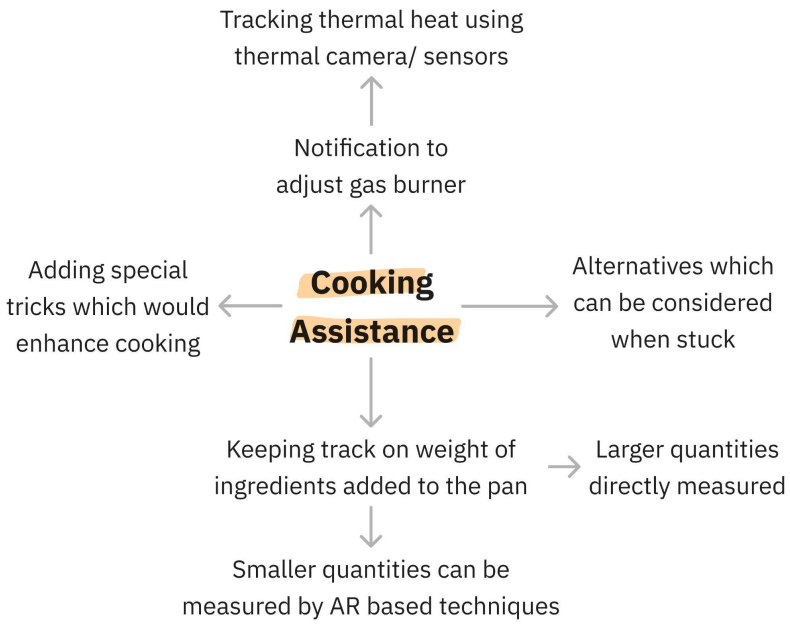



The following areas show potential for future development in multitasking assistance:

1. Providing users with notifications or alerts indicating which specific task or preparation requires more attention and precisely when it needs attention.
2. Offering quick and actionable feedback to users, possibly exploring visual feedback options such as projecting basic feedback directly onto the food items.
3. Implementing automated timer settings whenever necessary, based on preset timers or contextual cues, to help users keep track of different cooking or preparation times.

These ideas focus on improving assistance in multitasking scenarios by prioritizing tasks, providing clear and actionable feedback, and automating certain aspects like setting timers to enhance the user's ability to manage multiple cooking activities effectively.

Cooking Assistance *(Focused on both Personas)*



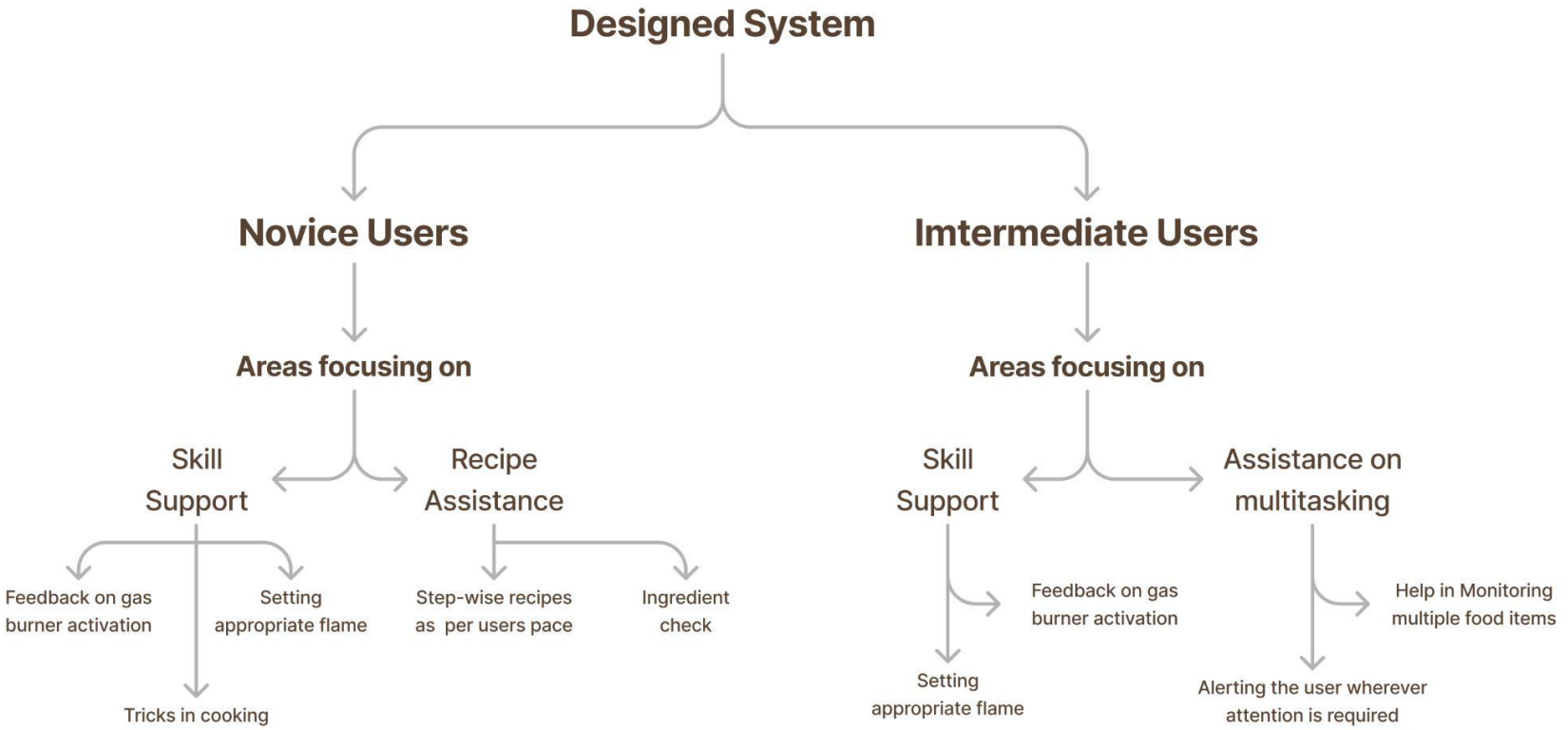
Here are some potential ideas for enhancing skill support:

1. Utilizing AR-based techniques to provide visual indications or overlays that help users accurately measure the quantity of ingredients while cooking.
2. Implementing temperature tracking technology to automatically control the operation of the gas burner or providing feedback to adjust the flame intensity based on the desired cooking temperature.
3. Introducing troubleshooting mechanisms that offer guidance and solutions when users encounter difficulties or get stuck during the cooking process. Additionally, providing tips and tricks to enhance the quality and flavor of the food being prepared.

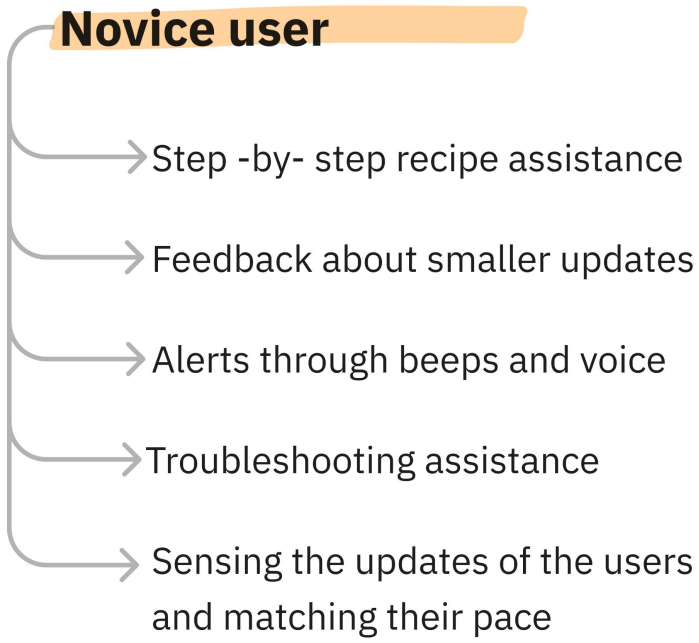
These ideas focus on leveraging emerging technologies such as augmented reality, temperature tracking, and interactive guidance to improve the cooking experience by assisting with ingredient measurement, gas burner control, troubleshooting, and enhancing culinary outcomes.

### 5.1.2. Designed System

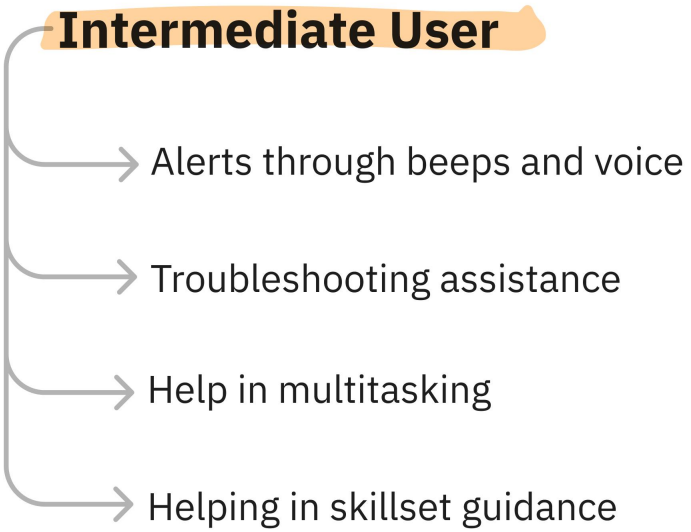
To cater to the identified problem areas, it is essential to provide different types of interactions for the two personas. Novice users will be primarily given assistance on skill support and recipe assistance while intermediate users will primarily need skill support and assistance in multi tasking. The system will be able to give choices on the kind of support needed. E.g. If an intermediate user wants to try a new recipe then they can use the recipe assistant feature. Similarly when a novice user is aware of a certain dish they can be supported on multitasking.



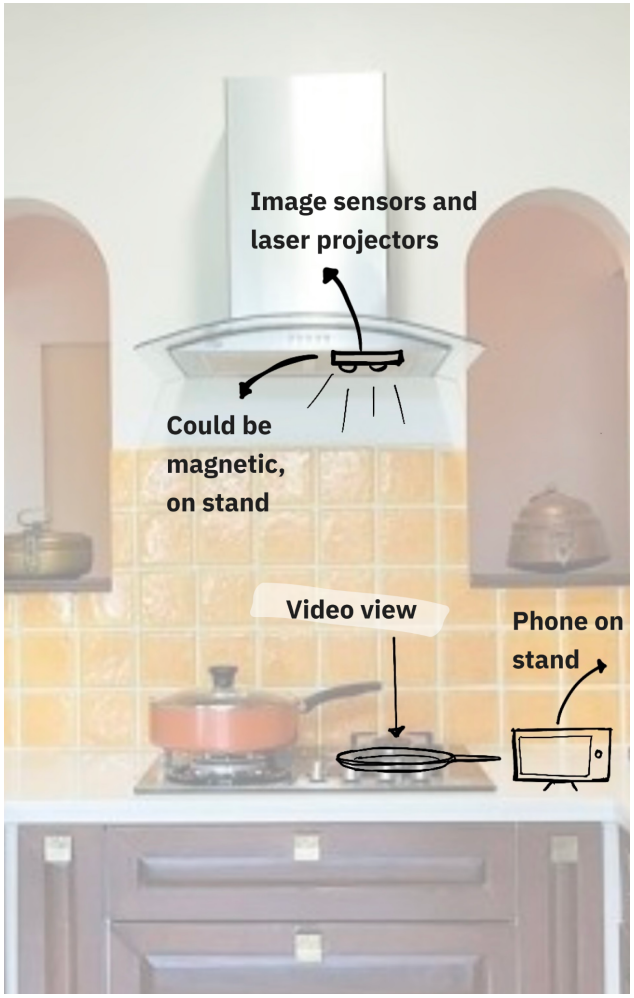
Novice user - The system will provide step-by-step guided recipe assistance, accompanied by important beeps and instructions. It is specifically designed to support users who are novice in the kitchen, ensuring a more structured and guided cooking experience.




Intermediate user - This assistance is tailored to assist users in their daily cooking routines by emphasizing important beeps and instructions. It aims to enhance multitasking efficiency, allowing users to handle multiple tasks simultaneously without feeling overwhelmed by excessive guidance.



### 5.1.3. Possible System Setup

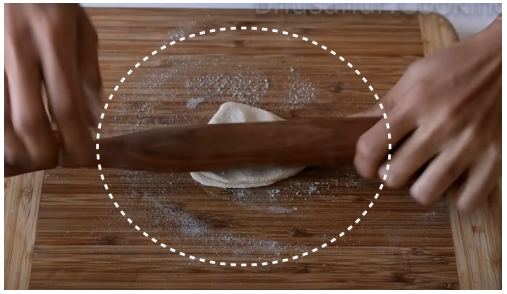



A camera system installed on the top of the stove, equipped with image sensors and laser projections, can be incorporated into a stand or designed to be magnetic for easy placement. Voice and visual feedback can then be provided through the connected phone placed on the stand, allowing users to receive real-time guidance and assistance during the cooking process.

### 5.1.4. Ideating as per recipes

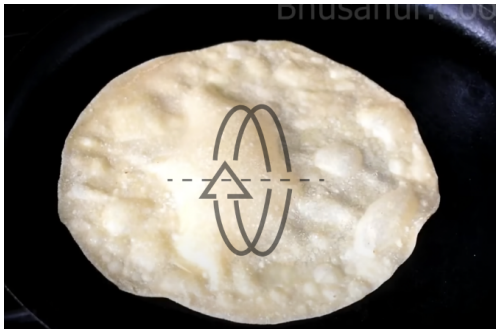
1. Making a Roti

Video Link



During the process of making a roti, a dotted circle is projected as a visual guide, indicating the specific area where the user should shape the chapati further.

After placing the chapati on the stove, the system guides the user by projecting an arrow along with a beep sound, indicating the need to rotate it based on the temperature. This feature assists users who are multitasking, providing timely reminders for the rotation of the chapati.



To provide immediate feedback during the cooking process, a flipping symbol is projected, accompanied by either a double beep or a distinctively different beeping sound. This feature ensures that the user receives prompt and noticeable indications regarding the need to flip or turn the roti being prepared.

Upon the completion of the roti, a thumbs-up symbol is displayed on the pan, accompanied by a beep sound as positive feedback. This visual and auditory feedback is intentionally presented on the pan itself, ensuring that the user's attention remains focused on the cooking process without being diverted elsewhere.

2. Making Rice
Video Link

Users have the flexibility to add water until the assistant provides a beep sound and displays a sign indicating to stop. This action can be accompanied by a voice command stating, *"Enough water for the rice to be cooked."*

Once the appropriate water level is reached, the system will automatically set the flame to high or notify the user to do it and activate an 8-minute timer for the rice to cook.

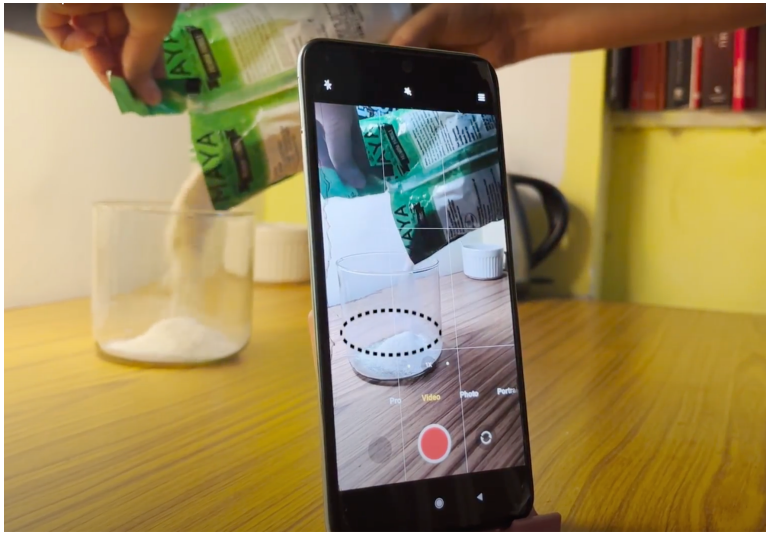
Additionally, a voice command will assure the user by stating, *"You will be notified if the rice requires your attention"* ensuring that the user can focus on other tasks without worrying about the cooking progress of the rice.

To alert the user when it's time to stir the rice, a beep sound is emitted along with a projected indication. This dual feedback mechanism provides a clear and noticeable signal to the user.

In a similar manner, if it is necessary to cover the rice during the cooking process, the user can be notified through voice commands or projections. Additionally, once the rice is fully cooked, a thumbs-up sign will be projected onto the rice as a visual indicator of readiness.

Moreover, the assistant will keep track of the ingredients added to the recipe. If the user forgets whether they added salt to the rice, for example, they can inquire by asking the assistant directly:
User: *"Did I add salt in the rice?"*
Assistant: *"Yes, you did."*

3. Amount of maida added in pasta
Video Link



By utilizing augmented reality (AR), users can employ a container to measure precise quantities of ingredients. The assistant will detect the volume of the container and provide a visual guideline, indicating the amount of maida (flour) that

should be added. As the user pours maida into the container, the assistant will monitor the quantity, and once the desired amount is reached, a beep will signal its attainment.

4. Boiling an Egg

To guide the user when to add the egg to the boiling water, instructions can be conveyed through projections, beeps, or voice-based instructions. Since preferences for boiled eggs vary among individuals, the assistant offers three basic modes: Soft Boil, Medium Boil, and Hard Boil.

The assistant initiates the process by asking the user's preference through a voice command: "In which mode would you like to boil the egg - Soft Boil, Medium Boil, or Hard Boil?" The user responds with their choice, such as "Soft Boil".

An automatic timer is then set for 6 minutes, as soft boiling typically requires this duration. Once the eggs have been soft boiled, the user will receive a notification, indicating that they are ready.

**5.1.5. Other Ideas**

Screen to be projected on Wall: The mobile screen can be projected onto the wall of the platform or any nearby device. This projection serves as a visual assistance tool, allowing for hands-free interactions.

Cooking Mode: Whenever users engage with the app, they will be prompted to switch to the cooking mode. Once in this mode, all other interactions, including incoming calls, will be conveyed to the user through voice notifications. The purpose of this mode is to enable hands-free operation, allowing users to perform various actions without the need for manual interaction while they are cooking.

Specific Device: A specific device attached with the system which won’t have any other interruptions.

Keeping an eye on the food away from the kitchen: In cases where a recipe requires a longer waiting time and the user prefers not to remain in the kitchen, they can use this app to keep an eye on the food being cooked from another room. This feature allows users to remotely view the progress of their cooking by accessing the app, providing convenience and flexibility while ensuring that they stay informed about the status of their dish. In case any dish requires immediate attention even that can be notified.

Attaching earphones to the system: Users have the option to attach earphones, which facilitates easier listening to voice commands, particularly in situations where there may be background noise in the kitchen. By using earphones, users can ensure that they receive clear and uninterrupted audio instructions from the assistant, enhancing their overall cooking experience. Since wireless earphones do not have

physical connections, there is a possibility of them accidentally falling out of the user's ears while they are engaged in cooking activities.

Hand/ Human Detection: The ability to detect the presence of a human nearby enables the assistant to provide the necessary assistance.

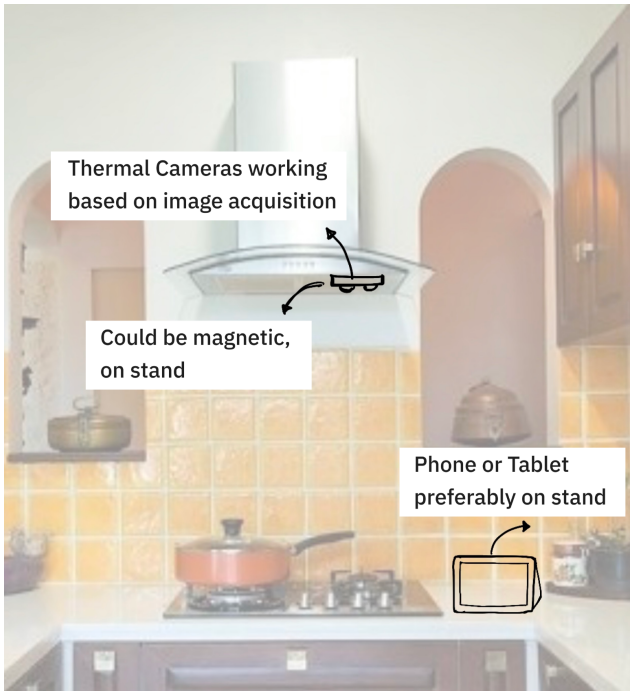
### 5.1.6. Scope of Improvement in Initial Ideation

Taking into account the modes that provide both voice and visual feedback, it is important to consider the design in the context of multitasking scenarios, particularly for intermediate users. In such cases, where the user needs to juggle multiple cooking tasks simultaneously, the system architecture needs to be explored in-depth to ensure its feasibility and effectiveness.

The system should be capable of handling and prioritizing multiple cooking activities, providing timely guidance and assistance based on the user's needs and the status of each task. It may involve incorporating advanced algorithms and AI technologies to accurately detect and monitor the progress of each cooking item, as well as the user's interactions and actions. Detailing the system architecture and thoroughly assessing its feasibility to design a robust and user-centric solution for both the considered personas.

## 5.2. Design Development

### 5.2.1. Designed System Setup




The hardware of the designed system consists of:

Thermal censored camera - The integration of a thermal imaging camera with specialized software will enable various functionalities related to the cooking process. The camera will capture thermal images, providing valuable information such as the status of the burner (active or inactive), presence or absence of pots on the burner, and detection of human

activity in the cooking area. Additionally, the acquired thermal images will allow for the analysis of burner temperature trends. These temperature trends can then be utilized to generate alerts and suggestions for the user. By monitoring the changes in burner temperatures over time, the system can provide real-time feedback and recommendations, ensuring optimal cooking conditions and enhancing the user's cooking experience. Furthermore, the thermal imaging camera can be integrated with other sensor systems to facilitate automated actions based on the detected data.

Device (Phone/ Tablet) - The system will use a Wi-Fi connection to establish a link with the thermal sensor-equipped camera. To facilitate user interaction, an app will be designed, which will serve as the interface for visual and voice-based interactions. The device, placed on a stand, will be positioned on the kitchen platform, a safe distance away from the gas burners that prioritizes safety.

Led Lights - Based on the number of gas burners, LED lights will be installed on the stove. These lights will provide feedback to the user regarding the burners that require attention, indicated through different colored lights. Additionally, the LED lights will allow the user to easily determine which gas hob is currently active, providing visual feedback. They can also be utilized to indicate the status of the burner's flame, aiding in comprehension and monitoring during cooking activities.

LED lights to indicate the status of gas burner

### 5.2.2. Detailing out the interaction for each mode

**Intermediate Mode**

This mode is designed specifically for proficient users who face challenges when multitasking with multiple food items in the kitchen.

Gas Stove Indicator Lights:
Following the principles of color theory to align with the user's conceptual model

1. Red Light - The red light serves as a visual indicator that a specific gas burner requires the user's attention. For tasks like flipping rotis, the red light will illuminate to indicate the need for action.
2. Blinking Red Light - In the event that the user misses an initial alert from the system, the red light will start

blinking as a more noticeable signal. This blinking pattern draws immediate attention, especially in critical situations.

3. Yellow/White Light - When a gas burner is turned on, this light will illuminate, providing a clear indication of which burner is currently activated on the stovetop. This helps users quickly identify the active burner, enhancing safety and convenience.

Beep Sounds:
Single Beep - A single beep serves as a proactive signal, drawing the user's attention to shorter tasks such as flipping a chapati. Additionally, it is synchronized with every voice interaction to keep the user alert and engaged during the cooking process.

Beep Intervals with Reducing Gap - This beep pattern is implemented when a user does not immediately respond to a single beep instruction, typically due to a lack of detected human activity. The time intervals between beeps gradually decrease, indicating the need for immediate attention. This is particularly useful when food requires urgent intervention, such as turning off the gas burner for rice to prevent burning.
Longer Single Beep - A longer single beep signifies that the food is ready to be served. This distinct sound helps users differentiate it from other prompts, making it clear that a specific action needs to be taken.

Voice Based Assistance:
The primary mode of interaction for the designed system will revolve around voice-based interactions. Users will engage with the system solely through voice commands, facilitated by an app connected to the system.

The adoption of voice commands is motivated by the following factors:

1. Understanding User's Cooking: Voice interactions enable the system to better comprehend the specific dish or recipe the user is cooking, allowing for more personalized and tailored assistance.

2. Delivering Warnings and Instructions: Voice commands serve as a means to provide timely warnings and instructions to the user, guiding them on necessary actions or precautions to be taken during the cooking process.

3. Notifying Ready-to-Serve Dishes: The system will use voice prompts to inform the user when a particular dish is ready to be served, ensuring that the user is promptly notified of the food's readiness.

4. Promoting Safety and Education: Through voice-based interactions, the system can educate users about potential hazards and provide guidance on how to avoid them, enhancing overall safety in the kitchen.

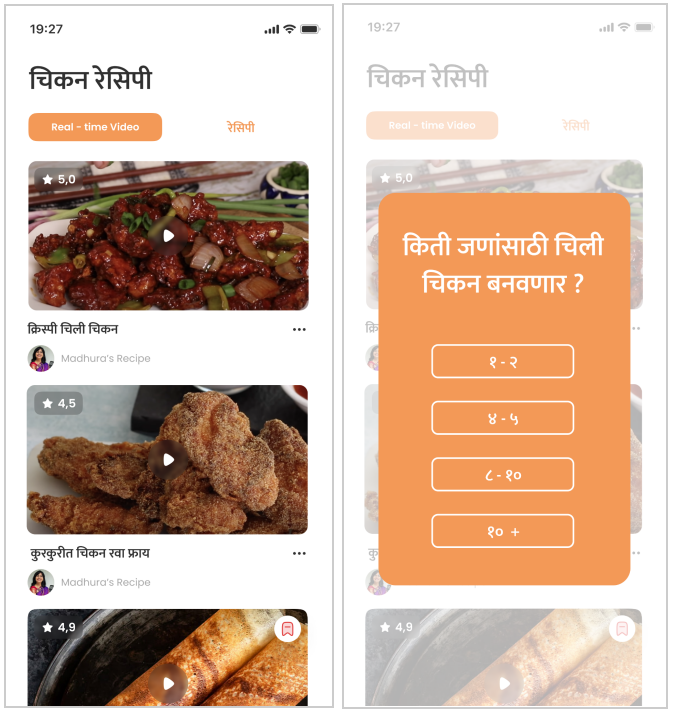
The system will incorporate preset programs for various types of food items, grouped based on common cooking requirements. For example, rolling foods like chapati and dosa may be categorized together.

Intended Design Video Link - Intermediate Mode
The video focuses on showcasing how the assistance system would aid in the preparation of a typical daily lunch in Indian households.

**Novice Mode**
The beginner mode is specifically designed to cater to users who are learning to cook and require assistance at each step. This mode encompasses all the interactions found in the assistance mode, with the inclusion of additional interactions that are detailed below.

Real - time recipe Assistance:

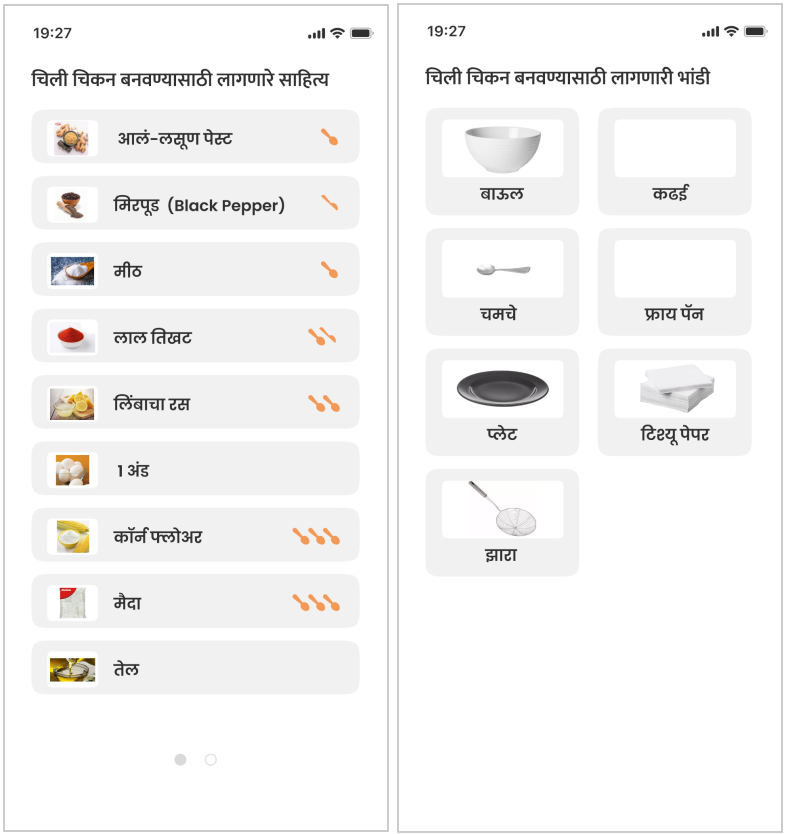
1. Recipe Selection: The beginner mode offers a selection of pre-set recipes that are stored in the app's library. Users can choose the specific recipe they wish to prepare.



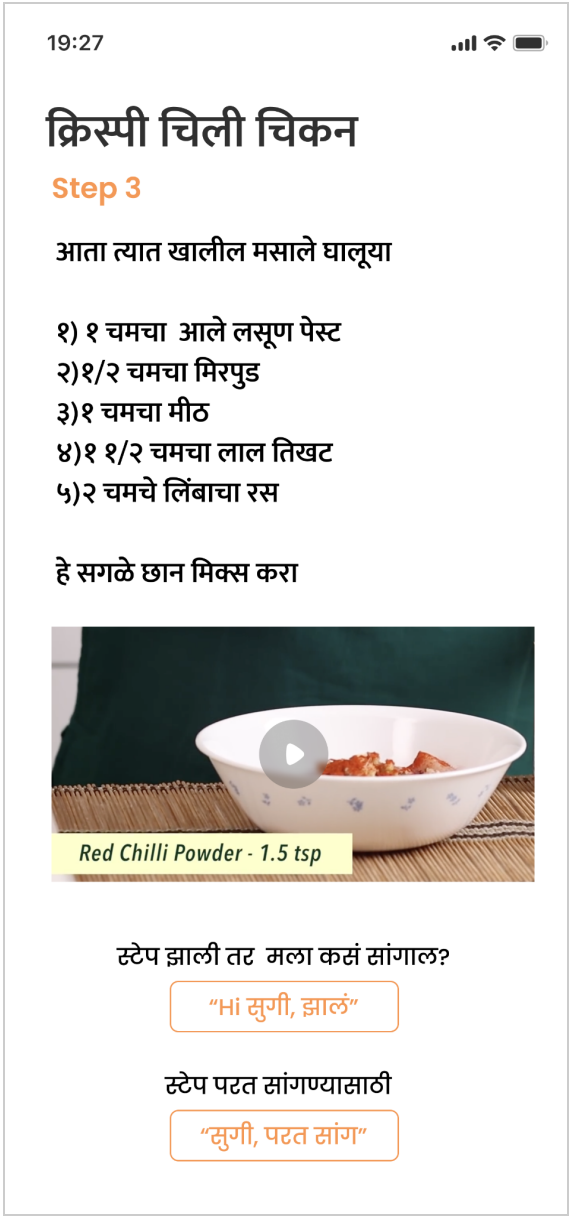

Additionally, the system will provide recipe recommendations based on the user's available ingredients. To provide an accurate estimate of quantities, the system will prompt the user for input. For example, the system may ask, "How many people do you want to cook the food for?" This information will help tailor the recipe to the user's needs.

2. Ingredient and Utensil Check: Based on the findings from primary research, it was observed that users often forget one or two ingredients and only realize it

while they are in the process of cooking. To address this issue, the system will display a list of ingredients on the screen prior to starting the recipe. The user will be required to confirm that they have all the essential ingredients before proceeding. Additionally, the ingredients will be categorized as essential and optional, providing users with greater convenience and flexibility in their cooking process. They are also at times confused about what utensil should be used for cooking the recipe. This can be resolved by showing them the list of utensils required to cook a specific recipe along with its images.



3. Recipe Information: The recipe will be displayed to the user on the connected device, tailored to their individual cooking pace. The recipes will be presented in a stepwise format, making it easier for the user to follow along. Voice instructions will accompany the video, providing additional guidance. For procedural steps, the user can confirm completion to the system hands-free using voice-based interactions. Upon confirmation, the system will proceed to the next step. In cases where the step is time-based or temperature-based, the system will automatically detect and notify the user, such as alerting them when the pan is heated to the desired temperature. The video accompanying the recipe provides a visual demonstration of how the particular recipe should be prepared.



Visual Assistance along with voice:
One idea for enhancing skill support is to provide visual assistance along with voice assistance. This combination would enable users to have a clear understanding of the precise cooking techniques required for specific dishes. Visual guidance can be particularly beneficial for demonstrating intricate tasks such as stirring vegetables, which may not be effectively explained through voice-based interactions alone. This idea emerged from the insights gathered during the primary research, emphasizing the importance of visual aids in supporting users' culinary skills.

Gas Burner flame feedback:
Taking into account the existing burner controls, novice users often struggle to adjust the flame accurately according to the recipe's requirements. LED lights can provide feedback on the current flame intensity of the gas burner. It is crucial to notify the user when they need to adjust the flame intensity. This can be achieved through voice-based interactions for seamless assistance.

Intended Design Video Link - Novice Mode
The video demonstrates the functionality of the assistance system during the preparation of an Indian recipe called Tikhat Puri.

Expert Mode
This mode is designed for experienced users who prefer minimal alerts from the system. They will only be alerted in critical situations, such as when there is a strong burnt smell coming from the food or when the food has been left unattended for an extended period (detected through the absence of human presence). The system will utilize the same setup with LED lights blinking and continuous sound beeps, accompanied by voice-based interactions. The primary emphasis will be on the beeps to promptly alert the user.

### 5.2.3. Scope of Improvement in the developed Design

The objective is to enhance the system's overall user experience by prioritizing the provision of accurate assistance to users. Specifically, for novice users, the aim is to offer appropriate skill support to facilitate their learning process. Another aspect involves considering improvements to the voice and beep design throughout the entire system, ensuring they are more effective and user-friendly. Additionally, designing a continuous sound for certain alerts, leveraging recognizable sounds from real-life contexts. Brainstorming a design concept to integrate urgency levels into the alert system. Moreover, there is a plan to conduct in-depth research into various potential methods for temperature sensing. By exploring these avenues, the intention is to improve the design of the system.

### 5.2.4. Identifying problem space in the current system design

These potential issues were identified during the evaluation phase based on the design guidelines mentioned in the literature review (Murad et al., 2018).

1. Users may struggle to determine if it is their turn to speak or ask a question to the system. There might be confusion about whether the system has understood their input and if it is actively listening to them.

2. The voice interactions of the system should align with users' mental models of conversational interaction. It is important to make the interactions familiar to users' daily conversations in order to reduce task completion time.

3. With the system primarily relying on sensors, it is crucial to ensure that users still feel that they have control in their hand. Otherwise, it could lead to frustration and a sense of helplessness.

4. Long and complex commands can increase the cognitive load on users, making it difficult for them to remember the assistance provided. Similarly, when there are long lists to recall, such as ingredient lists or numerous options, users may struggle to recall them accurately.

5. The current system lacks the flexibility for users to go back or fast forward a step in case of errors or the need to review previous steps. Users may feel stuck and unable to navigate through the system smoothly.

6. Though the system is based on generic principles of voice assistants, users may find it challenging to understand how to effectively interact with the system.

### 5.2.5. Key Ideas

Ideating on these problems identified to make the system user friendly.

Providing accurate feedback

1. To ensure that users feel acknowledged and understood, the system can provide feedback on the screen to indicate active listening. This feedback can be tailored based on the specific needs and preferences of the users. Visual cues in the form of images or icons can be utilized to enhance user understanding, allowing them to grasp the system's responsiveness at a glance.

2. The user's spoken sentence can be transcribed and displayed on the device, providing visual feedback. This allows users to verify if the system accurately understood their input. If there is any doubt or ambiguity, users can refer to the screen and decide whether they need to make any edits.

3. Feedback can be categorized based on the urgency of the required action. Non-critical tasks can be indicated solely through visual clues, utilizing LED light indications. Critical tasks, although not immediately urgent, can be associated with beeps along with LED light indications. Process-based tasks can incorporate relevant sounds, such as a boiling sound, to provide audio feedback. Urgent tasks, on the other hand, can be detected through blinking lights accompanied by intermittent beeps to immediately capture the user's attention.

4. Additionally, the pitch of the voice commands can be adjusted according to the urgency of the task at hand, further assisting users in prioritizing their actions.

Increasing flexibility of the System

1. Incorporating an interrupt dialogue feature allows users to seek assistance when they encounter difficulties or get stuck during their interaction with the system. By simply uttering the command "Help," users can signal their need for support. They can also interrupt “Skip” if they want to skip a step or want to look for a different recipe. Such more shortcuts could be identified and implemented in the system.

2. Users are provided with the flexibility to edit their speech in case the system does not accurately understand their input. Using a prompt "Edit" / “Repeat” which allows them to repeat the entire sentence and ensure that their intended message is correctly interpreted by the system.

3. The system can provide users with the option to navigate between recipe steps using voice commands, enabling them to move forward or backward in the sequence. This includes the ability to go back to a previous step, even if the system has detected that the step has been completed. By offering this functionality, users retain control over the system and can navigate the recipe according to their preferences and needs.

4. Implementing an out-of-turn interaction technique where users can directly state their commands, allowing synonyms to be recognized for improved task efficiency. This approach prevents users from having

to explore irrelevant options and streamlines the interaction process.

5. In situations where the system is uncertain about the user's input, it can provide a prompt to confirm if the understanding is correct. The system may offer suggestions based on the user's previous speech. For instance, it may ask, "Do you want to verify if the gas burner is active?" These prompts and suggestions help ensure accurate communication and provide an opportunity for users to clarify their intent if needed.

Enhancing Voice Interaction

1. To ensure ease of understanding and minimize cognitive load, the system employs concise and straightforward commands for users. By presenting information in smaller units, longer and complex information is broken down into more manageable chunks.

2. The voice interface communicates only the essential information about the action to be taken, while additional details are displayed on the interface for users to view.

3. When using voice-based interaction, it is important to carefully choose the words used to provide instructions, taking into account the level of urgency. Differentiating between "Danger", "Warning", "Caution", and "Notice" allows for appropriate communication of urgency levels.

4. When providing instructions, it is preferable to emphasize the actions that the user needs to take rather than conveying factual information. For example, instead of stating "Oil heated to _ temperature," the instruction could be framed as "Put the puri in the oil, it's heated." This approach directs the user's attention towards the necessary actions.

5. If the user gets a call in between and has to switch apps that should be possible. The auto sensor detection should remain active even during the call, allowing the system to continue monitoring the user's actions. During the call, it is recommended to provide only the most critical instructions. Utilizing more beeps than voice commands can be effective, as users may be more likely to notice and respond to auditory cues rather than voice instructions while on a call.

# 6. Prototyping Techniques

The system of the design is prototyped in two ways for better explanation and evaluation

## 6.1. Intended Design Prototype

To provide a comprehensive understanding of the system's features, a recorded video is created to demonstrate both the scenarios of novice user and intermediate user. This video showcases how the system reacts in various situations, offering viewers a precise depiction of its functionality. The video is scripted to highlight the key design elements of the system, addressing potential challenges users may encounter and demonstrating how the system can effectively overcome them.

The recording focuses on capturing the cooking process of a aloo paratha in case of an intermediate user, carefully edited to align with the system's actions. In the case of novice users, a specific recipe is recorded to provide step-by-step guidance. Additionally, the video addresses certain edge cases to ensure a thorough representation of the system's capabilities.

Setup for shooting Intended Design Prototype

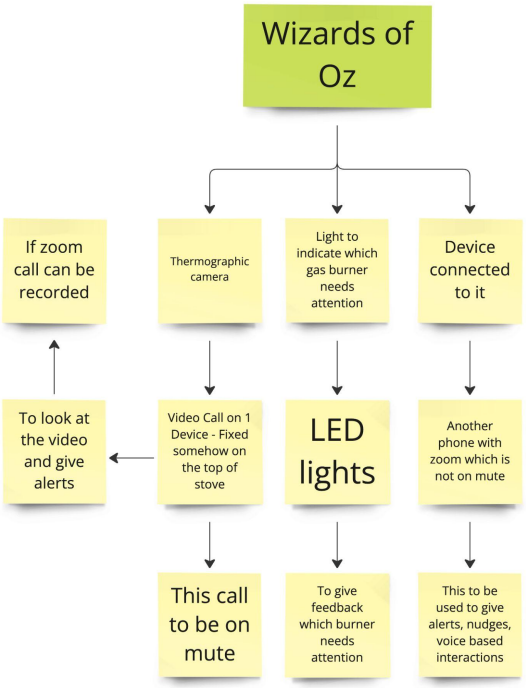
The final intended design video incorporates the design changes based on the feedback received during the evaluation process.

## 6.2. Evaluation Prototype

This is done for the purpose of evaluation through the method of Wizards of OZ. The Wizard of Oz method is implemented through a three-way Zoom call. Two devices are positioned

near the user: one is placed on top of the stove as a dummy thermal camera to mimic the actual system, and another is positioned on a platform for viewing the app interface and listening to voice-based interactions. The third device, located on the backend, monitors the user's actions and simulates alerts, voice interactions, and controls the lights accordingly.

The voice assistant was given the name "Sugi" to create a sense of ownership and a friendly atmosphere between the users and the assistant. Marathi was chosen as the language for the voice assistant. The name "Sugi" was derived from the Marathi word "Sugran," which translates to "cooking expert" in English.




Backend Setup

A cooking expert was designated to remotely monitor and offer comments and alerts as required. The expert was instructed to convey their comments to the person operating the assistant to ensure accurate guidance and assistance to the participant. This approach was necessary as the system lacked functional thermal sensors, making it crucial to rely on the expertise of a cooking professional to assess the food's condition and provide feedback.

# 7. Evaluation

## 7.1. Evaluation Goals

The evaluation process will focus on several parameters, including:

1. User Compliance: Assessing whether users follow the system's instructions without hesitation or irritation.

2. Alert Utility: Evaluating the usefulness of the alerts generated by the system and determining their relevance to the users' needs.

3. Feedback Integration: Examining how well users interpret the combination of voice and visual feedback provided by the system. Assessing whether the integration of lights and sounds enhances the feedback and alerts for users.

4. Beginner Support: Analyzing if the system aligns with the cooking pace of beginners and effectively assists them in their learning process.

The evaluation will involve approximately five users, and their feedback will be utilized to iterate and refine the system. Initially, a pilot evaluation will be conducted to ensure the proper functioning of the setup.

## 7.2. Pilot Evaluation

This was conducted to check the overall above mentioned Wizard of Oz prototype setup. This pilot was majorly conducted to test the setup.

The pilot study was conducted via a Zoom call utilizing three different devices. One device was positioned on top of the gas stove, with its camera activated to track the progress of cooking and generate simulations. Another mobile device was placed in close proximity to the gas stove, providing visual and

audio feedback to the user. The main device used for audio and visual assistance was a laptop, which was set up in the bedroom. Voice instructions and beeps were manually provided during the pilot. Whenever visual feedback was required, the screen sharing feature from the laptop was utilized, allowing the user to view the shared screen on the mobile device near the gas stove. Remote-operated lights were installed on the side of the stove with the assistance of electrical engineers. Although the lights were operated remotely, the physical driver had to be accessed in close proximity for operation.

Key Observations from Pilot

1. The user encountered difficulty in understanding how to interact with the system, indicating the need for a user manual or instructional video to provide the basics of system interaction.

2. During the pilot study, the user, being experienced, occasionally forgot to seek feedback from the system and relied on her own intuition. To gain insights into the system's intuitiveness, it would be beneficial to test with novice users.

3. Coordinating the operation of the lights in the kitchen and simulating voice commands from a different location proved challenging. Even with two people operating, synchronization was problematic. To address this, extending the range of the lights to enable operation from a slightly greater distance should be considered.

4. Placing electric-powered lights in close proximity to the gas burner is not advisable due to the risk of flames. Therefore, in the subsequent evaluation, the lights will be positioned on the wall above the stove to ensure safety.

## 7.3. Final Evaluation Plan

The evaluation will include both novice and intermediate users. The Wizard of Oz prototype will be set up in the participants' kitchens, where they will be instructed to cook either a daily meal or a specific dish based on their cooking expertise. Only participants fitting the criteria of Persona 1 or Persona 2 will be included in the evaluation process.

The participant's actions will be monitored from the backend device, and necessary alerts will be simulated accordingly. Following the evaluation, a semi-structured interview will be conducted to gather insights on the participant's experience cooking with the system.

The Zoom call during the evaluation will be recorded for subsequent analysis. Issues identified during the evaluation

will serve as a basis for further ideation and design enhancements.

### 7.3.1 Participant Screening

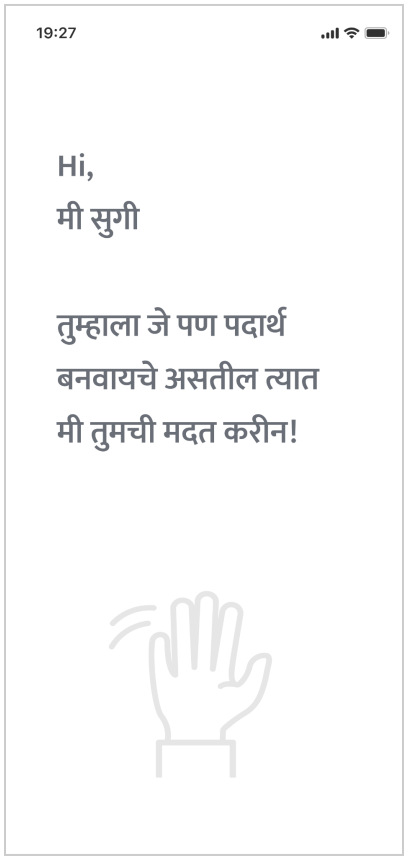
For the evaluation of the beginner mode, participants from any age group who have moderate technical proficiency and are new to cooking will be considered. It is preferable for participants to have an interest in learning cooking and have some experience using existing voice assistants. Additionally, participants will be screened to determine their familiarity with the Marathi language, as Sugi currently operates in Marathi.

When conducting the evaluation for the intermediate mode, the main criteria for participant selection will be their level of expertise in cooking. Specifically, individuals who possess cooking skills but often face challenges when multitasking or preparing multiple dishes simultaneously will be chosen.

A total of three users in each group will be selected for the evaluation. Any observations or feedback gathered during the initial evaluation will be taken into consideration for further improvements in subsequent evaluations.

### 7.3.2. System Onboarding

Before beginning their cooking session, participants will be provided with a system onboarding video that introduces them to **"Sugi - The Kitchen Assistant."** This video will familiarize them with Sugi and they can explore it using their previous experience with other voice assistants.



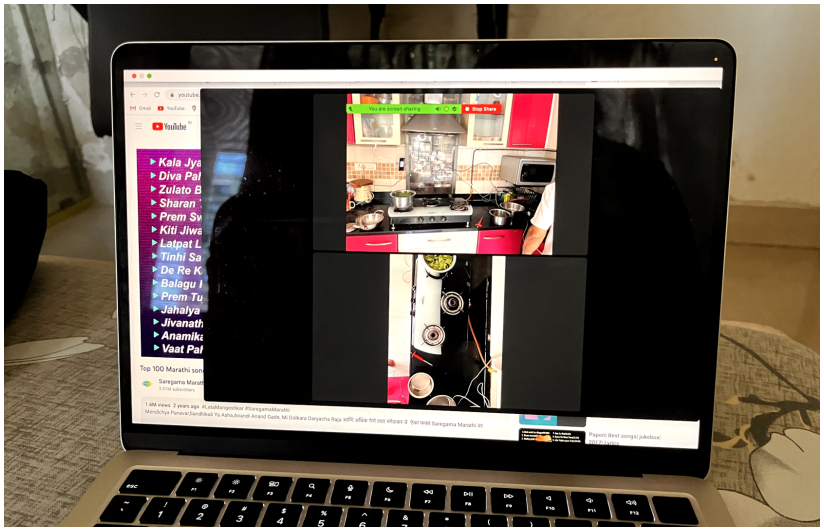
### 7.3.3. Task for Evaluation

Novice Users -
Participants will be suggested to select a recipe of their choice at least one day in advance. During the cooking session, Sugi will provide real-time assistance and guidance based on the selected recipe.

Intermediate Users -
Participants will have the freedom to cook a meal of their choice during the evaluation. The meal should include multiple items that require multitasking. Sugi will provide assistance to help participants efficiently handle and manage their multitasking activities.

### 7.3.4. Setup for Evaluation


The evaluation setup for the beginner mode involved the use of four devices and the light system, which were placed in the participant's kitchen.



Device setup inside to simulate voice based interactions and alerts.

### 7.3.5. Semi Structured Interview

After the entire recipe is cooked, a small semi-structured interview will be conducted with the participants to understand their feedback and input regarding the system. This feedback will be further considered to iterate the existing solution.

## 7.4. Novice Users

The first two participants (one female and one male)prepared two different recipes, and they were introduced to the onboarding video and real-time recipe assistance while cooking. Initially, they were shown the ingredients and utensils needed for the recipes followed by a detailed stepwise recipe. Based on the observations from the first two participants, some adjustments were made for the third participant. (female)

The modifications included providing more detailed procedural and skill-based instructions and offering assistance even for the smallest tasks, such as how to cut an onion.

### 7.4.1. Observations

Insights were drawn by observing the participants while cooking and through the semi-structured interviews. These were compiled using affinity mapping.

**Voice based interaction:**
All participants expressed their appreciation for the voice-based interactions with Sugi, finding them highly effective and valuable for learning cooking. They enjoyed the ability to have a conversation with the voice assistant, which enhanced their cooking skills. The participants found it easy to adapt to Sugi due to their previous experience with voice assistants. Responding to the voice assistant came naturally to them, requiring no additional effort. They appreciated that the recipe adapted to their cooking pace. While beeps were not necessary for every step, the voice interactions alone were sufficient for effective communication. The participants also found the alarms set for certain cooking tasks to be useful.

**Visual Feedbacks:**
Visuals were considered secondary by the participants, with the small size of the phone leading to them being overlooked at times. The participants rarely looked at the screen when the gas was on unless they encountered an issue. Some participants found using an iPad instead of a phone to be more beneficial due to the larger screen size. They relied on the screen to check quantities when steps were combined, but overall, videos were not deemed necessary for every step. Participants suggested including videos for procedural steps and using images when necessary. Since there was no visual feedback for the timer, participants were unsure if the system had actually set a timer and if they should also keep track of time. Occasionally, participants found the pace of the video to be too fast for comprehension, as it was often fast-forwarded. When written instructions were displayed on the screen, participants sometimes only read the ingredient quantities. Participants tried to match the exact utensils shown in the images and were confused if an exact match couldn't be found. The pre-provided list of ingredients was found to be helpful, although it could be more specific regarding the quantities required for the recipe, considering the number of people the recipe serves. The images of ingredients and utensils could be more relatable to the user group. It would also be beneficial to mention the ingredients in the form they are required for the recipe (e.g., "onion cut into small pieces"). One participant faced difficulty gathering ingredients while making white sauce, as that step involved continuous stirring. Therefore, it would be helpful to mention the ingredients that need to be kept ready in advance for such cases.

**Troubleshooting mechanisms:**
Two of the three participants got stuck in between while cooking the recipe, they needed rescue mechanisms to make their recipe better. For example, one participant accidentally spilled the tomato puree and wanted to know a suitable alternative ingredient to use instead. Participants expressed the need for an option to look up alternative ingredients in case something is unavailable. They also suggested considering adjustments in the quantity of the alternative ingredient. If a specific ingredient is crucial for the recipe, the

system should inform the user in advance so they can acquire it before starting to cook. Participants felt confused and concerned when the food they cooked didn't match the appearance of the dish shown in the video. They worried that they had made a mistake.

**Feedback in the form of Light:**
Novice users tended to overlook the lights as they had a lot of other things to focus on. For the first user, who was not provided explicit information about the lights, she had to interpret their purpose on her own and mistakenly associated them with heat indication. The other users were given a prompt about the usage of lights, but they only glanced at them once or twice throughout the entire recipe.

**Focusing on developing skill set:**
The first two participants had several inquiries regarding cooking skills, such as the precise method of frying chicken, etc. Providing smaller tips and guidance specific to the task being performed proved beneficial for the third participant. They were pleased to receive assistance even for the smallest details. All participants sought confirmation for actions they were unsure about. Procedural videos demonstrating skill-based actions proved helpful for the participants.

## 7.5. Intermediate Users

Three individuals (two females and one male) took part in the evaluation procedure, and their levels of cooking proficiency varied. This discrepancy highlighted the need for a more adaptable intermediate mode to be designed. Taking insights from the feedback received from initial users, certain adjustments were made to accommodate intermediate users.

### 7.5.1. Observations

Observing the participants' cooking activities and conducting semi-structured interviews provided valuable insights. These insights were gathered and organized using affinity mapping techniques.


Intermediate users overall found the system to be useful but wanted it to be more flexible as per their needs. This is majorly because intermediate users will also have different ranges of expertise.

**Reminders and Alarms:**

All of the participants unanimously agreed that instructing Sugi to set alarms for various cooking activities was beneficial. This feature helped to reduce their cognitive burden as they were already engaged in multitasking. Additionally, two users mentioned that they often had to leave the kitchen to attend to other activities while cooking. In such situations, they expressed the need for louder alarms that could alert them when a food item required their attention in the kitchen. However, they also mentioned that constant beeping while they were in the kitchen could be irritating. Therefore, it was suggested that the system should be able to detect the presence of a human and adjust the sound of the beeps and alarms accordingly. Another example mentioned by all three participants was the importance of counting the number of whistles produced by the cooker.

Two participants recommended providing visual feedback for the timers set by Sugi, allowing them to manually check the remaining time if desired. They emphasized that if they noticed only 30 seconds left on the timer, they would immediately pay attention, while if there was a substantial

amount of time remaining, they could continue with other tasks. This visual feedback was seen as beneficial for decision-making during multitasking. However, it should be noted that there was also contrasting feedback suggesting that there was not enough time to focus on visual feedback. To address this, the feedback could consist primarily of imagery rather than text, enabling quick comprehension. This visual feedback would serve as a secondary source of information after the voice feedback.

**Tips and Suggestions**

The participants acknowledged that Sugi's context-setting question about the participants' cooking plans at the start of a cooking session was acceptable. Intermediate users, on the other hand, favored having control over the system. They were open to Sugi's contextual suggestions and tips from time to time, but they did not want to be constantly bombarded with them since they already knew how to cook and found too many suggestions to be annoying. It was recommended that a parameter may be added to let users choose how frequently they receive tips and suggestions. Sugi's advice to the participants on effective time management while cooking was appreciated. When requesting advice on ingredient quantities, ingredient alternatives for certain recipes they valued getting help and suggestions. Additionally, one participant even requested Sugi to suggest a dish that could be prepared using specific available ingredients.

The users experienced a sense of confusion initially using the system, as it was their first time using it. However, they believed that with time, they would become more familiar with the system and learn how to effectively utilize its assistance.

**Feedback in the form of Light:**

The participants greatly appreciated the light-based feedback, particularly when it indicated whether the gas was left on. Although it took them some time to become accustomed to this form of feedback, they found it helpful. The combination of light feedback and beeping sound further enhanced and strengthened the feedback experience. One specific design feature that received positive feedback was the use of a beep accompanied by a changing light color when flipping parathas. However, there was also feedback suggesting that changing the light color alone might not be clear enough as it could be easily missed. To make it more evident that a specific burner requires attention, it was suggested that the light should blink along with the beep, which could potentially improve the effectiveness of the feedback.

**Multitasking expect Cooking:**

When participants faced interruptions such as receiving phone calls while cooking, they either asked Sugi to redirect the call to another person or they simply ended the call. In such cases, voice feedback could be useful by informing the

user about the caller's identity. Additionally, most participants expressed a preference for listening to their preferred music while cooking. Users also desired the ability to add ingredients to their shopping lists and requested Sugi to provide reminders when they went shopping later.

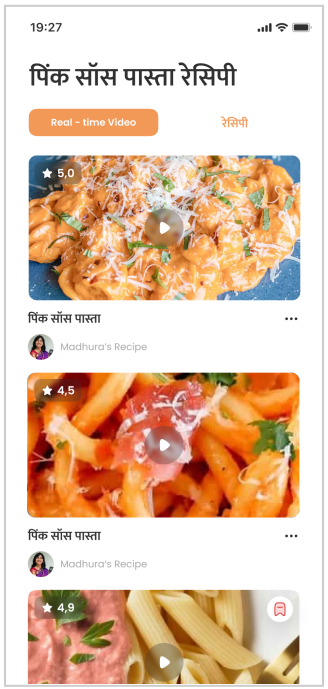
# 8. Final Design

Based on the insights gained from the evaluation, the following modifications have been made in the design:

## 8.1. Novice User (Scenario 1)

### 8.1.1. Selecting a Recipe

The process in case of recipe selection is still the same. The special care will be taken by including out-of-turn interaction for maintaining flexibility in the system. After recipe selection the system will suggest the user to rotate the device and keep it on stand.





### 8.1.2. Ingredient Check

The photographs of the ingredients need to be more relatable, along with a clear focus on the quantity of each ingredient. It is important to show the ingredients in the exact form required by the recipe, such as cutting the onion to the specific size needed. In cases where an ingredient requires a preparation process, like ginger garlic paste, the system will provide real-time instructions on how to prepare it. If a certain ingredient from the recipe is not available to the user, the system can suggest alternative ingredients if possible. Furthermore, if a particular ingredient is deemed essential for a specific recipe, the system will notify the user to ensure they are aware of its importance.


### 8.1.3.Utensil Check

Users will be provided with a variety of utensil alternatives, either through visual representations or by naming the utensils, allowing them to choose from their available options.

Additionally, the purpose of each specific utensil will be communicated to the user before they begin cooking, ensuring they have a clear understanding of its intended use.


### 8.1.4.Recipe Assistance

To cater to user preferences, the design focuses on prioritizing visual elements such as videos or images for specific cooking steps, while key written instructions like ingredient measurements are displayed alongside. When the output of a step is specific and not heavily procedural, an image can serve as a reference for the user to consult as needed. Procedural steps, particularly those involving skills, will be associated with video demonstrations.


The overall use of beeps in the assistance will be minimized, employing them only for user-set alarms or when an alarming situation arises. In the absence of human presence, beeps will be utilized. If a step in the recipe requires continuous attention, users will be provided with a disclaimer to ensure they have all the necessary ingredients ready before proceeding.

For novice users, a white light will indicate the on/off status of the gas. The steps in the recipe will be appropriately chunked to enhance user comprehension and ease of use. Contextual tips will be offered to users while they are cooking, providing them with a broader learning experience. The voice instructions provided to the user will specifically emphasize supporting their cooking skills, such as telling them to continuously stir the white sauce pasta without stopping in between.

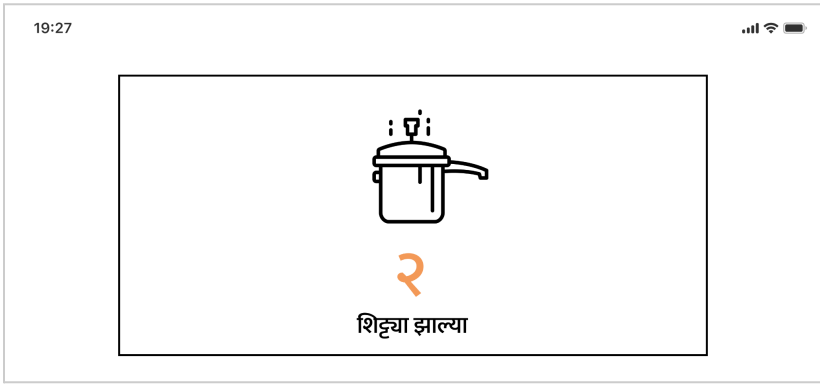
Additionally, the recipe assistance will incorporate troubleshooting mechanisms. If a user encounters a problem, the system will suggest alternatives or troubleshooting techniques. For example, if tomato purry spills during the preparation of red sauce pasta and the user has no tomatoes available, the system may recommend adding a larger quantity of tomato ketchup as a substitute. In cases where no solution is available, the user will be informed accordingly.

Users will have the flexibility to interrupt the voice assistant at any time if they wish to skip a step, proceed to the next step, or repeat a previous step.

Prototype Video Link:
In this video, we observe a scenario where an individual living alone, away from home, grows tired of eating outside food and decides to utilize the assistance of 'Sugi' to learn basic cooking. She is about to prepare pink sauce pasta with the guidance of 'Sugi'.

## 8.1. Intermediate User (Scenario 2)

1. To reduce cognitive load on the user, Sugi offers the capability to set multiple alarms and reminders simultaneously. The visual feedback of these timers will be displayed on the screen, ensuring easy visibility. The sound of the alarms will be adjusted based on human activity in the kitchen. If no human presence is detected at that time, the volume of the alarm will be increased to ensure that even when the user is not physically present, they can still hear the updates.




2. In order to provide effective assistance, the system needs to understand the context of what the user is cooking. This context is established by the system by asking the user "Aaj kai banavanar?" (What are you cooking today?) either when the user starts cooking or when the first burner is turned on.

3. Flexibility is a key aspect of the system, allowing the user to have control over the number of instructions provided. If the user feels that there are too many interruptions, they can instruct the system to refrain from giving certain commands. Additionally, user profiles can be created, enabling customized settings

based on individual preferences. For example, my profile may be tailored for novice users, while my mom would use the same system with controlled alerts that suit her needs.

4. 'Sugi' will provide suggestions and instructions on ingredient quantity, troubleshooting mechanisms, and side dish suggestions, among others. However, these instructions and suggestions will only be given when specifically requested by the user.

5. One key function of the light indication is to indicate whether the gas is left on. In urgent situations, the red light will blink to immediately capture the user's attention and alert them.

6. 'Sugi' will also handle miscellaneous activities such as managing incoming calls. It can not only reject the call but also remind the user to call back that person later. Additionally, it can assist with playing music, adding ingredients to the shopping list.

Prototype Video Link:

In this video, we witness a situation where an individual who regularly cooks but has guests coming over and wants to prepare food on time seeks the assistance of 'Sugi' to efficiently manage the tasks. The individual is planning to make Aloo Paratha and Tomato Chutney (suggested by 'Sugi').

# 9. Conclusion

The significance of cooking has increased during Covid times, with a wealth of recipes available online and easier access to raw materials. Nevertheless, the idea of cooking can be daunting due to limited skills, complexity in understanding recipes, and the time involved. Even those with cooking experience may struggle to multitask and end up spending long hours in the kitchen.

The project aimed to create a system to help users to cook food by reducing fear of failure also in desired time. The system will give precise instructions to the users to help when understanding the recipe's details. There will also be key tips during the journey with training videos to avoid common mistakes in the cooking journey. This will enable users to enjoy tasty food cooked with their own hands.

The project's objective was to take into account the entire kitchen environment that users encounter while cooking, going beyond just the app interface. It aimed to explore cooking experiences in various contexts. It was observed that the system should be adaptable to different users' needs and not limited to the predefined user personas mentioned earlier.

# 10. Limitations and Future Scope

The project primarily emphasized the design aspect. However, a major limitation was my limited understanding of the intricacies of technology and how it works. I struggled to delve deep into the technical aspects of the project due to my lack of knowledge in that area.

Nonetheless, efforts were made to explore the technology involved in the project to the best of my abilities. The focus was on creating a refined and well-thought-out design, taking into account the user's needs and preferences.

In the future, conducting evaluations with a larger number of users would provide more comprehensive and detailed insights.

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