Research and Analysis on the Positive Feedback Experience and Information Display of XR in Cooking

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Abstract. Nowadays, with the development of Extended Reality (XR) technology, this technology is gradually being applied to daily cooking. This article mainly analyzes the positive feedback and information display in three cases (AR based interactive cooking guidance system, HoloChef XR mixed reality cooking assistant, Counter Intelligence kitchen AR system), and finds that XR's ad-vantages in cooking are significantly improving the user experience, increasing the accuracy of user guidance, and making assisted cooking more convenient. There are defects in information display, such as insufficient clarity and lack of uniformity in ingredient information. Thus, it was concluded that personalized switch options, clear information display, and unified cooking standards can be provided to enhance user immersion and provide appropriate positive feedback, thereby improving the overall experience. Reasonable optimization and targeted functional adjustment can effectively make up for existing shortcomings, further promote the popularization of XR cooking technology, and lay a solid foundation for the future progress of smart home catering services.

Keywords: Extended Reality; Cooking assistance; User experience; Information visualization

1 Introduction

In recent years, the application of augmented reality technology in various fields has be-come increasingly widespread, changing the way people learn, work, and interact [1,2]. In the scenario of cooking guidance, traditional cooking teaching relies on paper recipes or video tutorials, and users need to frequently interrupt their current actions to view the device during the operation process, making this interactive method particularly inconvenient. In addition, the existing XR cooking guidance system still has problems such as weak interactivity, insufficient feedback, and unclear information layering, which directly affect users' immersion and operational experience. From this, it can be concluded that how to optimize the XR cooking guidance method, enhance the user's interactive experience and operational accuracy during the cooking process, has become a problem worthy of research.

There have been some studies worth paying attention to the application of Extended Reality (XR) technology in cooking and related fields. From a macro perspective, Woo

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et al.'s review summarizes the integrated application of XR technology and robots in the food industry [3], covering multiple directions such as VR for consumer behavior research, AR for nutrition labeling and restaurant ordering, providing a macro framework for understanding the potential application of XR technology in the food industry. In terms of specific AR cooking assistants, Vir and Madinei have developed the ARChef system [4], which integrates Google's Gemini big language model and can recognize ingredients in the camera's field of view and generate recipe options with nutritional information. Research has shown that AR technology can help reduce food waste, while also proving that positive feedback and clear guidance can reduce novice cooking anxiety.

In terms of VR cooking education applications, Hu et al. developed a VR cooking skills training course [5]. Through experiments with 82 students, it was found that VR cooking courses have a positive impact on learning outcomes, and students generally have a high acceptance of VR technology. In terms of VR skill training, Nakazato and Kano proposed a VR knife worker training system using tactile devices [6], which allows users to practice repeatedly in a virtual environment and obtain real strength feedback, solving the problem of high food consumption in traditional training.

Regarding spatial augmented reality, Ghasemi et al. designed the sAR Kitchen system [7]. Through comparative experiments with 22 participants, sAR technology was shown to significantly lessen users' perceived workload and the frequency with which users shift their gaze while cooking, and increase the system's usability.

In conclusion, current studies show XR technology's outstanding potential for developing cooking instruction and other areas. Nonetheless, the existing system suffers from inadequate intuitive information display and design of user response mechanisms, as well as a lack of sufficient immersion. This paper's contribution is to improve positive feedback and information display in the XR cooking guidance system. Take a moderate positive feedback approach and combine it with a clearly designed information hierarchy in order to increase the interactive experience and operational accuracy of the users. In the end, assisted cooking will be more flexible and efficient.

2 Case Analysis

2.1 AR Based Interactive Cooking Guidance System

AR based interactive cooking guidance system [8], this project is an immersive, interactive intelligent cooking assistance system built on AR and XR technology, which solves the disadvantages of traditional recipes being difficult to under-stand, steps being prone to errors, operations not being standardized, and cooking processes frequently switching perspectives. The system will use users' mobile phones and AR glasses to overlay virtual cooking instructions, 3D step animations, ingredient recognition prompts, and fire control reminders on real kitchen environments and utensils in real time, in addition, after entering the kitchen, users only need to select the dishes they want to make. The system will automatically recognize the position of the countertop, kitchen utensils, and ingredients through the camera, and then guide the operation step by step in a 3D visualization way (gesture OK and voice can be used for the next step).

This indicates that positive feedback and clear guidance can reduce the anxiety of novice users. (see Fig.1).

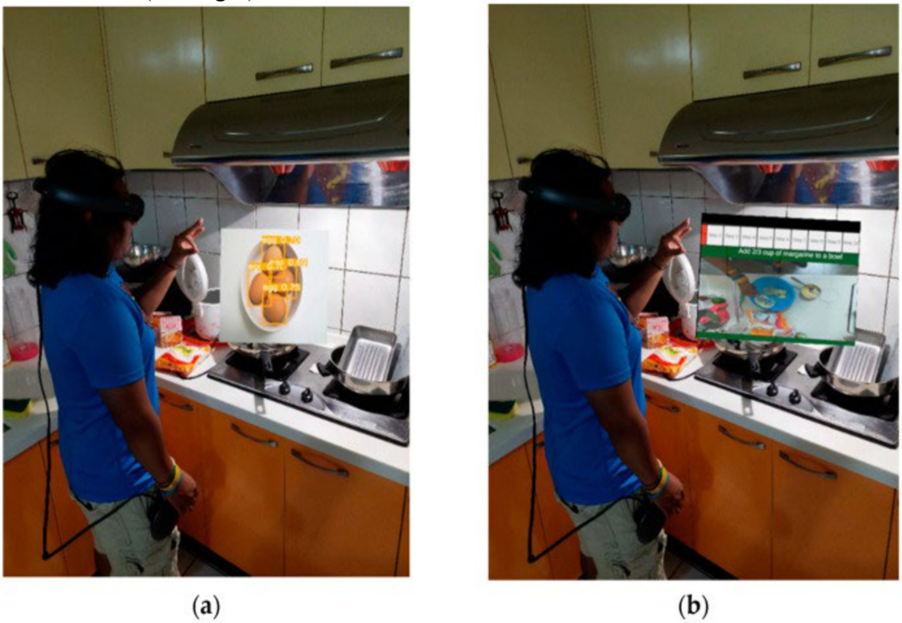

Fig. 1. AR based interactive cooking guidance system [6].

2.2 Holocook XR Mixed Reality Cooking Assistant

Holocook XR Mixed Reality Cooking Assistant is a mixed reality cooking assistance system [9]. After the user wears the device, the system will perform 3D scanning and spatial positioning of the kitchen space, kitchenware, and ingredients, and then form holographic cooking instructions in real scenes. It will directly overlay every step of dish preparation on the corresponding real kitchen utensils through 3D animation, spatial ruler, dynamic prompts, and other methods. At the same time, it supports interactive control through gestures and voice, presenting the cooking process in an immersive holographic way throughout the process. It shows that through simple voice and gesture control and positive feed-back, the user experience can be improved, the task completion rate can be in-creased, and the willingness to reuse can be high.

2.3 Counter Intelligence Kitchen AR System

Counter Intelligence Kitchen AR System is a context aware augmented reality kitchen system developed by MIT, which uses projection, capacitive sensing, and environmental perception technologies to transform countertops, refrigerators, stoves, and other surfaces into screenless interactive interfaces [10]. The system can project recipe steps, ingredient information, and operation instructions in real-time. Users can directly interact with gestures or touch the tabletop. Free people's hands, reduce distractions caused by looking at people's phone or flipping through recipes, and improve cooking efficiency and safety. Create a smoother and more intelligent immersive kitchen experience. It indicates that XR's projection can make it more convenient for users to see information, without switching perspectives (such as mobile phones, recipes, and stoves), making users more immersed. (see table 1).

Table 1. Comparison of three cases in terms of information clarity, communication efficiency, immersion, and interactivity i-formation clarity, communication efficiency, immersion, and interactivity.

Chart analysis (red for advantages, blue for advantages)	Case 1: AR based interactive cooking guidance system	Case 2: HoloChef XR Mixed Reality Cooking Assistant	Case 3: Counter Intelligence Kitchen AR System
Information clarity	The information display is relatively comprehensive, and at the same time, the information is displayed on real ingredients	This is 3D information, which is more convenient and accurate for obtaining information (better than displaying flat information in case three)	Can display ingredients, step-by-step instructions, prompts, etc
communication efficiency	Action based communication for the next step and voice based communication for the next step (but without real-time hand interaction)	Can move on to the next step, also equipped with voice control	Just information projection, only action communication, no language.
immersion	The guidance interface is relatively rough and has a sense of fragmentation (although it also has 3D, it is only 3D animation)	3D interaction provides a stronger sense of immersion	Just projection, no interaction, but the interface display is better than case one
interactivity	There is 3D animation guidance, but there is no real-time hand interaction, and the interactivity is weak	There is 3D interaction, which is superior to the flat interaction in Case Three	Weak interactivity

3 Summary of Advantages and Disadvantages

An example of this is how XR technology incorporates overlay instruction so that users do not have to go back and forth between the step and the stove. Projection technology, which is a type of AR, projects the instructions directly on the workspace, and head-mounted AR technology or display, places the video so that it is always in the user's line of sight. This, for example, adds to the user's comfort. Additionally, the XR cooking system enhances guidance by presenting the step in a simplified and more comprehensive manner compared to a text-based recipe. The video tutorial overlay, along with gesture control, provides the capability to guide the user to a specific location to conduct the step. For novice chefs, visual guidance is of utmost importance.

Most feedback can disrupt users' concentration. There is a dilemma between feedback being positive or useful. If feedback is constructive (i.e. users gain understanding or im-prove knowledge), then it is positive and improves the user case. However, if feedback disrupts attention, then it is negative. For instance, if a user is executing precise tasks and the system either continually pops up window prompts or is utilizing voice feedback, it will sever the user's operational rhythm and disrupt their attention. As well, if the system has high "sensitivity," it will activate the system while the user is performing commonplace tasks and everyday gestures, and thus switching functions, which will create confusion. The next consideration is the need to consolidate the measurement units for the ingredients and overcome the standardization of units of measurement, which is prevalent in various XR cooking systems. Some recipes say things like, "3/4 cup butter", or "a pinch of salt". In actual cooking, ingredients can vary a lot, especially with respect to their brand. Even things like the thickness of the package can influence how much people end up using, and that makes it really difficult to judge things. In cooking with XR, the lack of universal standards for measuring makes it really difficult for a newcomer to get the measurements right.

4 Conclusion

In XR cooking applications, the hierarchy of information presentation is not clear and unified enough, and various prompts, step instructions, and progress status are often overlaid in the user's field of view, resulting in information overload and cognitive burden. At the same time, designing a reasonable positive feedback mechanism has a positive effect on improving user experience, which can enhance users' sense of experience and immersion. (Subsequent suggestion) Firstly, provide personalized switch options that allow users to turn on or off excessive rewards and prompts according to their habits, making the interactive environment more comfortable. Secondly, clear information display can make the in-formation more refined. For example, displaying the required ingredients first (stone images can be added for user recognition) and then displaying the steps can break down complex steps into smaller parts. When the user says the next step or the system detects that the action has been completed, the next step can be taken. During the cooking process, each ingredient can display its own description, such as the weight of the ingredient, the variety of the ingredient, the processing of the ingredient (such as cutting it into blocks first), the required cooking time, the final state of completion, and other foods that need to be paired. Then, unify cooking standards and reduce cooking barriers for users. For example, using the weight of ingredients instead of 3/4 in case one, or specifying the variety of ingredients (such as mushrooms), can eliminate users' doubts and obstacles during cooking. Finally, corresponding rewards can be set in the system based on cooking time or the amount of food cooked, for example, if the user starts with a copper pot and gradually up-grades to a silver or gold pot. Users can also DIY their own exclusive pots (such as drawing patterns, pasting stickers, etc. on the pots)

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