Integration of AR Technology and Gamification: An Exploration of Cooking Guide Devices

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Abstract:

With the rapid development of augmented reality (AR) technology, its application in educational has become prevalent. Nevertheless, research in the domain of cooking guidance remains relatively limited. This study aims to address the gap by comparing and analysing the three existing AR-based cooking guide device - Magic Leap 1, AREasyCooking, and Pic2Dish, as well as the virtual reality (VR) cooking games. Based on these insights, the study proposes CulinARy, an innovative cooking guide tool that employs AR technology to provide real-time cooking step-by-step instructions, gamified challenges and a multi-platform experience. The objective of CulinARy is to improve the users' cooking ability and make cooking more accessible and enjoyable.

Keywords: Augmented Reality (AR), Cooking Guidance, Gamification, Kitchen Technology

1. Introduction

In the contemporary era, augmented reality (AR) technology is becoming increasingly integrated into the daily life. It is employed in numerous educational contexts, including civil engineering[1], biological learning[2], and nursing[3]. Based on its teaching guidance function[4], AR technology has the potential to be applied in the field of cooking, where it could serve as a cooking guide. The ability to cook represents a fundamental life skill that is essential for everyone. However, there are some individuals who lack the cook ability, thereby creating an urgent need for effective cooking instruction.

To meet the need, we envisioned a new cooking instruction tool, CulinARy, which enables users to become immersed in cooking tasks and enhance their culinary abilities through more realistic and direct interactions with AR technology. Moreover, the incorporation of gamification elements enhances the enjoyment of the cooking process. This paper examines the design objective, functional features of CulinARy, a cooking guide that integrates AR technology and gamification elements to enhance the utility of cooking guidance.

2. Related Work

There are researches concerns the VR cooking games and relevant cooking instruction devices. The VR cooking games are broadly categorised as either casual or competitive based on the gameplay experience. Casual cooking games, exemplified by Cooking Simulator VR and Lost Recipes, offer a more relaxed and

high-degree-of-freedom experience. Competitive games such as Clash of Chefs and Cook-out more focus on precision, pressure and time management. Their multiplayer modes also make the games more intense and exciting. While these VR cooking games enhance the enjoyment of cooking, they have simplified the specific cooking steps to a certain extent. Players cannot learn and experience the real preparation of a dish in these games, thereby makes it difficult to uses them as an effective guide for real-life cooking. While VR technology creates a fully immersive environment experience, it lacks direct interaction with real-world elements. Consequently, AR is more suitable for providing cooking instructions, which allows interaction with both virtual and real elements.

Following an investigation, it is found that Magic Leap 1 [5], AREasyCooking [6] and Pic2Dish [7] all the equipment that have the function of cooking guidance, and all employ AR technology to a greater or lesser extent. In comparison to AREasyCooking and Pic2Dish, Magic Leap 1 has chosen to provide assistance in the form of a head-mounted device. Both AREasyCooking and Pic-2Dish have chosen to provide assistance in the form of mobile devices, such as mobile phones. In contrast, the head-mounted device allows users to engage in the cooking process without being interrupted by the operation of the mobile software, thus enabling users to maintain clean hands clean and a smoothly operational process. Their basic functions are largely analogous, which are identifying ingredients, recommending recipes and guiding the users in cooking. Furthermore, all three devices utilize deep learning and convolutional neural network (CNN) technology to facilitate the identification of food ingredients. For instance, Magic Leap 1 has adopted YOLO v5 as its deep learning model [8]. After the large-scale database training, it can be used for the detection and recognition of food ingredient. In accordance with the same theoretical framework, CulinARy chose to adopt YOLOv10 as the deep learning model for the crucial function of ingredient recognition. YOLOv10 maintains the speed of detection while enhancing the accuracy through a dual-label assignment strategy and architectural enhancements [9].

However, none of the three devices incorporates gamification, which makes cooking instructions a bit boring and unlikely to engage users over an extended period. Furthermore, each system only can be used in the single platform. Magic Leap 1 is exclusively head-mounted devices, while AREasyCooking and Pic2Dish are only available for software platforms, which restricts their applicability.

In order to address these issues, CulinARy will combine AR technology with gamification elements that are commonly found in VR cooking games. Moreover, CulinARy will leverage the strengths of these three systems while mitigating their limitations, providing users with a more flexible platform that includes a head-mounted AR device as well as a proprietary mobile app. Furthermore, by integrating gamification, CulinARy will enhance user engagement, thereby making cooking both enjoyable and educational.

3. Product Design

CulinARy is a cooking instruction tool that combines AR technology and gamification to enhance users' cooking abilities and elevate the enjoyment of cooking. CulinARy provides users with two phases of meal preparation and cooking. CulinARy also provides two cooking modes: Free Mode and Competitive Mode, which afford users the option of selecting a cooking environment that is either relaxing or exciting. Furthermore, the application of the gamified reward system encourages users to enhance their cooking abilities while completing tasks. Additionally, the incorporation of gamified virtual guidance serves to augment the overall enjoyment derived from the cooking process. CulinARy can be a valuable assistant in the kitchen for both novice chefs and experienced cooks.

To use CulinARy, the user simply wears a head-mounted device and interacts with it through gestures. As illustrated in Fig. 1, the user is progressing through the cooking phase and viewing the second step of the video tutorial. The specific window displayed by the device is shown in Fig. 2.

Fig. 1 User usage diagram

Fig. 2 Cooking stage UI

3.1 Meal preparation

The meal preparation stage has two major functions around virtual recipes: recipe customization and recipe search. These two features work in conjunction to enhance user experience, enabling them to adapt recipes to their preferences and readily locate the recipes they wish to follow.

3.1.1 Recipe Customisation

Users can add their own recipes and upload video tutorials. The number of likes and favourites bestowed upon the recipes and video tutorials will be converted into game coins in accordance with the established algorithm.

3.1.2 Recipe search

In the event that the user does not have a recipe that they wish to prepare, the camera will initially identify the ingredients that the user already has. It will then provide the user with a feasible recipe based on the ingredients that are already available. In the event that the user decides to prepare a recipe independently, the camera will scan the ingredients after the user has chosen the recipe. If there is a deficiency in the requisite ingredients, the device will automatically generate a shopping list with the assistance of AI. Furthermore, it will conduct a price comparison through the merchants in the cooperating grocery delivery apps, thereby providing the user with an optimal purchase option. The specific interaction of the recipe search function is shown in the Fig 3.
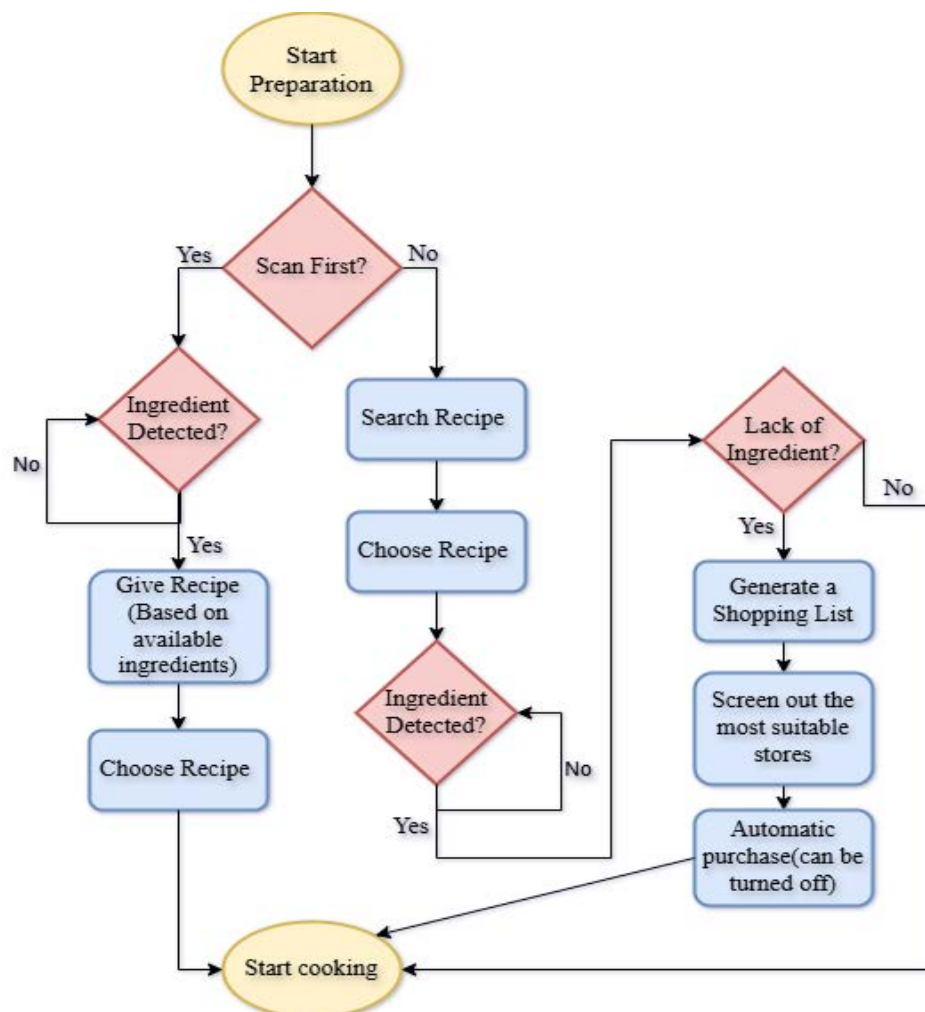

Fig. 3 Search function flowchart

3.2 Cooking

Once the preparation stage has been completed, the user is then directed to the cooking stage. At this stage, the AR device will display each step of the recipe, as well as a video tutorial on how to do each step. The video window is initially positioned above the headset's field of view and remains in this location as the user moves their head. The user can also modify the position through the use of

gestures. The device will project lines for food cutting or liquid scales, display the current temperature of the food, and show the multitasking progress bar as a guide, according to the specific needs of each step. The free mode and competition mode of the cooking stage exhibit a similar interaction flow, with the exception of the introduction of real-time competition with friends in the latter. Additionally, both modes have the potential to obtain game coin rewards. The general interaction flow of the cooking stage is illustrated in the Fig. 4 below.
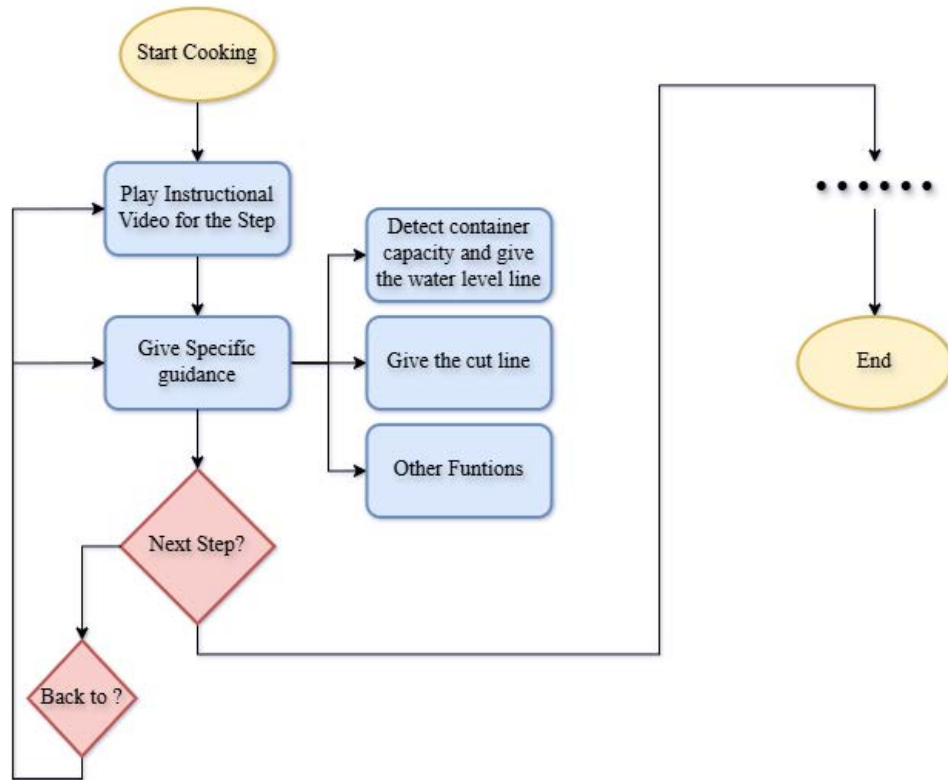

Fig. 4 Cooking stage flowchart

3.2.1 Heat control

Through another study [9], YOLOv10 end-to-end object detection can detect the cooking status (color, texture, etc.) of objects in real time, and the infrared sensor can detect the surface temperature of ingredients in real time. The temperature of the ingredients is displayed on the head-mounted device to remind the user that the temperature needs to be adjusted. YOLOv10 detects the size of the heat and informs the user that the heat needs to be adjusted to the corresponding level.

3.2.2 Seasoning control

CulinARy uses the nutrition dataset for testing [8]. By scanning or identifying ingredients, a bounding box is obtained. The bounding box detects objects, and each object is identified one by one. The nutritional value is evaluated through the corresponding nutrition website information. Users can input their own dietary preferences into the device through the voice system. According to the requirements of the selected recipe, CulinARy integrates the above information and prompts the user to pick up the seasoning jar. When the user starts to operate, the artificial neural network will recognize the user's gesture and judge the amount based on the user's gesture operation [10]. When a certain amount is reached, the voice system will remind you to recommend the appropriate amount of seasoning.

3.2.3 Virtual measurement tool

By combining camera detection with AR technology, a container cloud platform is established using the virtual measurement system [11]. According to different containers, the required capacity of the object is detected through cloud computing, and then the virtual scale line is projected onto the container. The user can directly pour water according to the scale line to complete the corresponding requirements and improve efficiency.

3.2.4 Multi-task collaboration and time management

1) Cooking timer
CulinARy will display a timer in the upper left corner of the user's field of view, allowing the user to always pay attention to the cooking time of each step and strictly con-

trol the "minutes and seconds". For example, when the user needs to fry or grill meat, AR will start an automatic timer to identify the degree of doneness of the object and remind the user to turn it over at the appropriate time.

2) Task progress bar

When the user needs to process multiple ingredients, a multi-task collaborative multimodal network model [12] is established to complete the corresponding task requirements. For example, when it is necessary to perform frying and frying eggs at the same time, the progress status of multiple devices will be displayed in the form of a progress bar in the upper right corner of the user's field of view.

4. Integration of gamification elements

In order to enhance user engagement and enjoyment, CulinARy incorporates gamification elements. Gamification is mainly reflected in the following aspects.

1) Reward mechanism and virtual mall: Users can obtain game coin rewards through various ways. The earned game coins can be exchanged for tangible rewards in the virtual mall, including items such as cookware or ingredient coupons. This reward mechanism serves to enhance the user's stickiness.

2) Tasks and Achievement System: Users are able to gain game coins by completing daily or weekly cooking tasks. Examples of tasks include the preparation of specific dishes, the completion of a specific number of challenging recipes, the acquisition of specific cooking skills, the winning of a friendly competition, and so forth. The task-driven approach facilitates the incremental development of cooking abilities.

3) Real-time interaction and feedback: The device provides real-time visual and auditory feedback to the user through AR technology. For example, upon the user's successful completion of the instructed processing of ingredients, the device will play the corresponding encouraging audio and display a special animation, thus enhancing the user's sense of achievement.

5. Exclusive mobile software

In addition to use the CulinARy via the head-mounted device, users are also able to make interactions on the exclusive mobile software. The software comprises a variety of functions, including recipe customisation, uploading and collection; shopping delivery for the lack ingredients; achievement system, daily tasks virtual mall and so on.

Through the mobile software, CulinARy provides users a rich interaction platform. The head-mounted device and the mobile software complement each other, enhancing the overall experience of using CulinARy.

6. Conclusion

AR (augmented reality) technology is quietly changing the face of home kitchens, not only simplifying the cooking process, but also making cooking, a daily activity, more interesting and interactive. Through AR devices, users can get detailed guidance and suggestions in real time during the cooking process, which can benefit both beginners and experienced chefs and give them a sense of happiness and satisfaction. This technology helps those who don't know how to cook quickly get started, and also provides innovative cooking inspiration and skill optimization for skilled chefs, bringing more taste experience.

As a cooking guidance tool, CulinARy deeply combines AR technology with cooking, gamifies and interacts with the cooking process, and brings users an immersive experience. Through it, users can not only learn basic cooking easily and freely in free mode, but also stimulate learning motivation and improve skills through competition mode and task challenges. The device provides real-time feedback, and helps users improve each step of the operation based on the recognition of the user's operation, avoid common mistakes, and avoid accidents. In addition, CulinARy's auxiliary functions are carefully designed to make the user experience more humane and intuitive, ensure that the cooking steps are concise and clear, and improve the user's cooking skills.

In the future, with the continuous advancement of AR technology, CulinARy is expected to further expand its functions and integrate more intelligent and personalized services, such as automatically recommending recipes based on users' taste preferences and dietary needs, or deeply linking with smart kitchen equipment. It will bring revolutionary changes to home cooking, not only making cooking more efficient and convenient, but also promoting it to a creative and fun activity, so that every family member can enjoy the process of making delicious dishes. Through AR technology, the home kitchen is no longer just a simple cooking place, but an intelligent, interactive and fun space.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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