Robot-ouille: The In-Home Cooking Assistant that Serves Independence with Food

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***Abstract*— With age causing natural disabilities in mobility and cognitive decline, the population of the elderly, especially those with disabilities is growing, thus raising the need for independence in the home. This paper presents a simulation study of a chef robot system. The system of Robot-ouille is designed with inclusivity and disability in consideration,- while giving users customizable options, such as the delivery of ingredients for meals, to include a wide range of disabilities to work with. An optional connection to a meal delivery service such as HelloFresh allows users to choose their meals based on the shown ingredients and nutrition facts in case of a restrictive diet. The size of the robot is of importance so as not to hinder mobility around the system and ensure the robot can fit in homes of various sizes and can fit on stoves of many sizes. Typically, assistive robots for cooking are built for a single specialty. In contrast, the proposed system is designed that would allow widespread usage. The goal is to ensure people with paraplegia and other differently-abled users the ability to make their meals confidently while remaining independent, practicing fine motor control through use, adopting healthier gastronomy, and remaining aware of important upcoming events within the cooking scene and IRL calendar. A key feature of our design is the interface that instills trust in the system between the user and the robot and allows interaction. Within the simulation, the user can interact with the systems interface through four means: a touch screen application interface, verbal/auditory-based communication, and visual and vibration cues to ensure preciseness in the cooking process.**

***Keywords*— cooking, robot, assistive technology, differently-abled independence, assistive meal prep, Webots**

I. Introduction

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II. Related Work

Refer to "Assistive Cooking Technology and Needed Future System Components: An Overview" by Alexander Spivey and Merritt Cahoon

III. Problem Formulation

The main problem at hand is not the lack of cooking robot systems, but the shortcomings of those systems in the field. The systems discussed in our previous paper have three main issues:, too large of a system, lack of independence for the user, and too specific of a specialty. Robot-ouille was built to combat these issues.

A. Chinese Cooking Robot

The previously mentioned Chinese cooking robot inspired our team to build our machine. While their robot provided aid, and researchers built it explicitly for elderly people in wheelchairs, the system has a significant flaw. The cooking robot is able to load, cook, and deliver dishes and self-clean. For a robot to perform these tasks, it requires plenty of space to do so. As seen in Fig. 1, the size of the cooking system is overwhelming. The dimensions of the robot, excluding the fume treatment module and the touch screen system, are 2.295 m (length), 0.770 m (width), and 2.000 m (height). The system cannot fit in every home or kitchen, thus inspiring us to make a robot that can sit right on a stove, ensuring it can fit in every home and kitchen type.

Fig. 1 A picture of the chinese cooking robot for elders

B. RAMCIP

The Robotic Assistant for patients with Mild Cognitive Impairments or RAMCIP was also a major inspiration for our format due to both its shortcomings and its achievements in the field. Similar to the previous robot, RAMCIP is not a small robot. It needs room to roam through the house with the user. In some homes it may not have the room to achieve this process. RAMCIP demonstrates that a robot can cover a wide range of fields in assisting the user. It encouraged us to add capabilities into our robot like recognizing forgotten actions in the cooking stages and reminding the user when to take medication if needed.

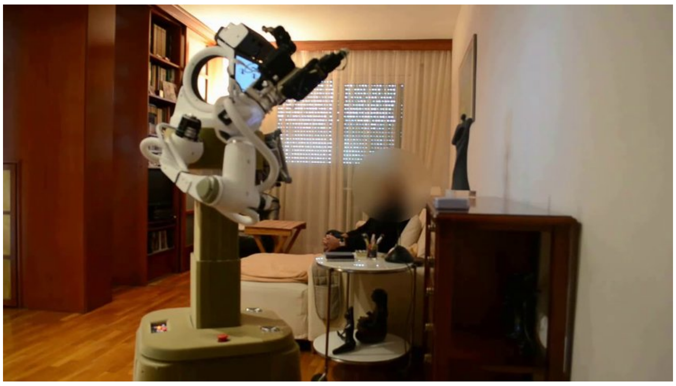

Fig. 2 A picture of the RAMCIP robot. User's face was blurred for privacy reasons.

IV. Proposed Methodology

Before we decided what our robot wanted to look like, we examined the faults of current cooking and assistive machines and focused on creating a list of intentions for our robot. It was important to design our machine with inclusivity and the obstacles of disabilities in mind. With that, we made sure to have customizable options for our users. For instance, we wanted our machine to pair with a meal delivery system like HelloFresh or Blue Apron. This service provides the user the option of having pre-cut and pre-portioned ingredients delivered to their door, and it cuts down on meal preparation time and strain and the amount of waste. We also wanted to reduce the size of the system so as not to hinder mobility. It is imperative that the machine can fit in any household and any kitchen space. We wanted an interface to instill trust in the system. It was important to us to give the robot a voice to interact with the user. The user needs to have confidence in the machine they are working with, but we wanted to also make sure the user has independence in the cooking processes well. We did not want the robot to do every step in cooking a meal. Instead, we wanted the robot to encourage the user to practice fine motor control while cooking. People with disabilities can have a restrictive diet. If the user opts out of using the delivery system, we want the interface to show the list of ingredients for the meal they are preparing and the nutrition information to help adopt healthier gastronomy. Our last intention is not necessarily related to cooking. However, with the interface in our system, we wanted it to remind the user about things like upcoming events or even doctor's appointments or medication times.

V. Experimental Environment

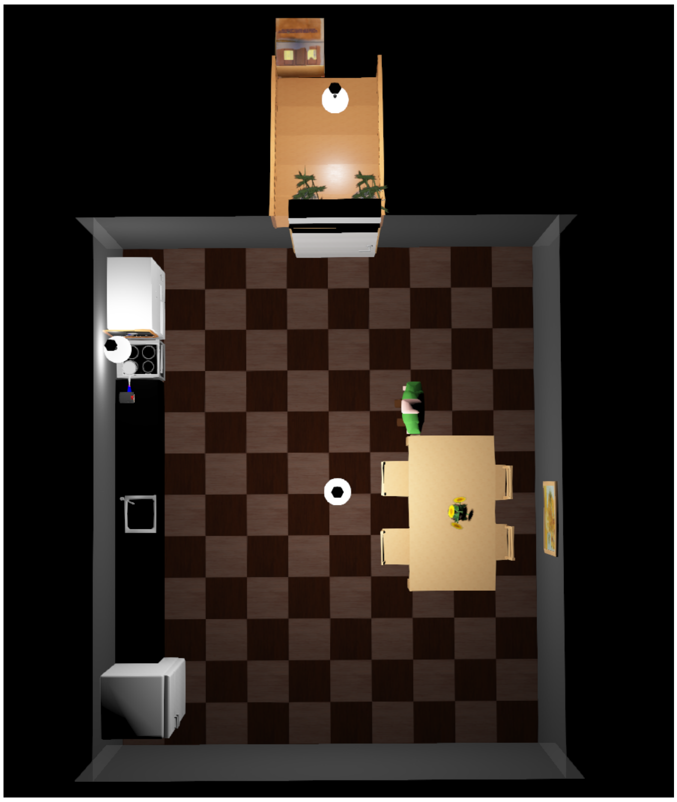

Fig. 3 The figure above is a top down perspective of the simulation environment.

After concluding the objectives of our robot, we went into working on the environment, or in our case, the simulated kitchen space. We began by trying to use ROS and Gazebo, but due to installation issues and other errors we had to look to find other avenues to create our simulation. We decided to use Webots to hold our environment due

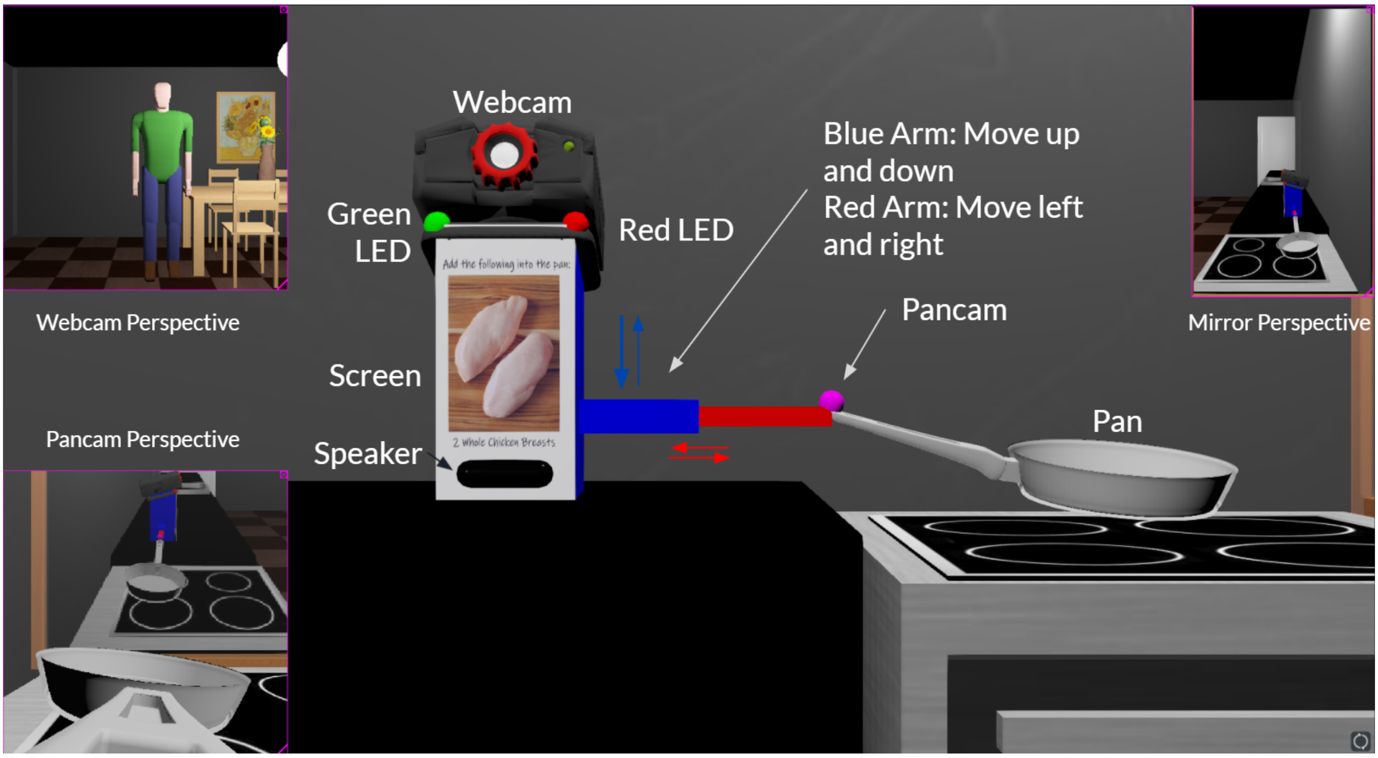

Figure 4. The figure above is an overview of each component of the Robot-ouille system.

to its instructive built-in tutorials and innovative, commercialized functions. For our environment, we decided on a simple kitchen with the necessities such as a counter with a built-in sink, a refrigerator, cabinets, and a dining table. Outside the boundaries of the kitchen, we have a walkway that leads up to the door, with a simulated delivery box at the end of the steps. Due to the nature of simulation revolving the cooking system, it is implied that the user will be capable of transporting the delivery indoors, store away the prepackaged components, and be able to remove the cover when needed for cooking.

VI. Results

The Robot-oullie system contains a multitude of sensory and interface components. For visual scene understanding, there are two cameras attached to the system. The first camera is the webcam, this component's main focus during the cooking process is to track the users movements and send an alert when necessary to either caretakers or customer support agents. The webcamera's perspective is viewable in the top-left corner of the figure above. The other camera is labeled as the pancam, which respectively monitors the ingredients within the pan. The pancam, once integrated with object recognition using an API like OpenCV, should be capable of determining if the proper ingredient is being added, track and predict ingredients motion trajectory, and be able to recognize when ingredients are visually considered cooked. As for Robot-ouille's interaction system, it has two LEDs, a display screen, a speaker, and built-in vibration capabilities. As mentioned previously, for a system to be compatible with a multitude of differently abled users, the system needs to be capable of interacting with more than one dimension of feedback. The display screen, that is touch-screen capable, will display during the cooking process the next ingredient needed. The user will then follow its request and based on the ingredient and amount added, the system will activate one of it's two LEDs;

1. Red - this occurs when the user has added something that is either incorrectly proportioned or visually recognized as incorrect. Based on the severity of the mistake, the system will determine the urgency needed to be conveyed through flashing (at a non-epleptic rate) or increased emissivity.

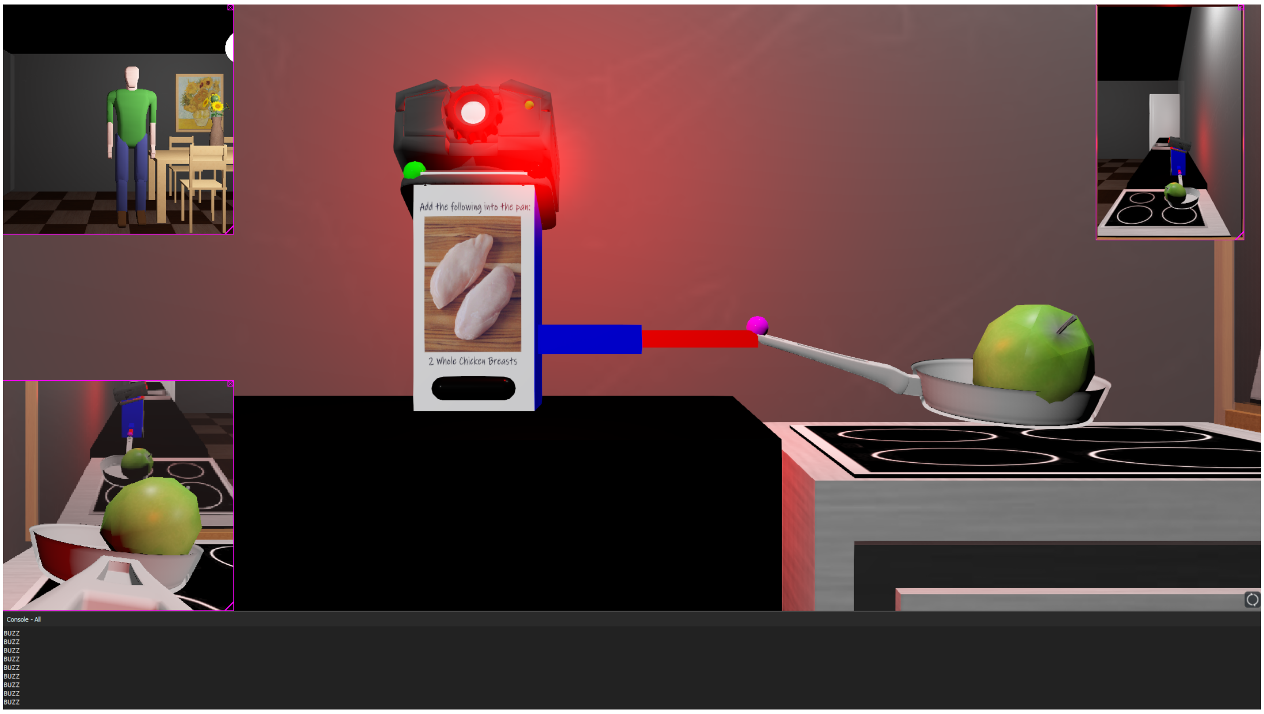

Figure 5. An image representing how the user would receive interface feedback when an error is recognized.

2. Green - similar to that of the red LED, its job will be to alert the user when they have completed the action correctly. This can occur when the system asks for an ingredient or when users want to reconfirm their action plan and double check their current standing.

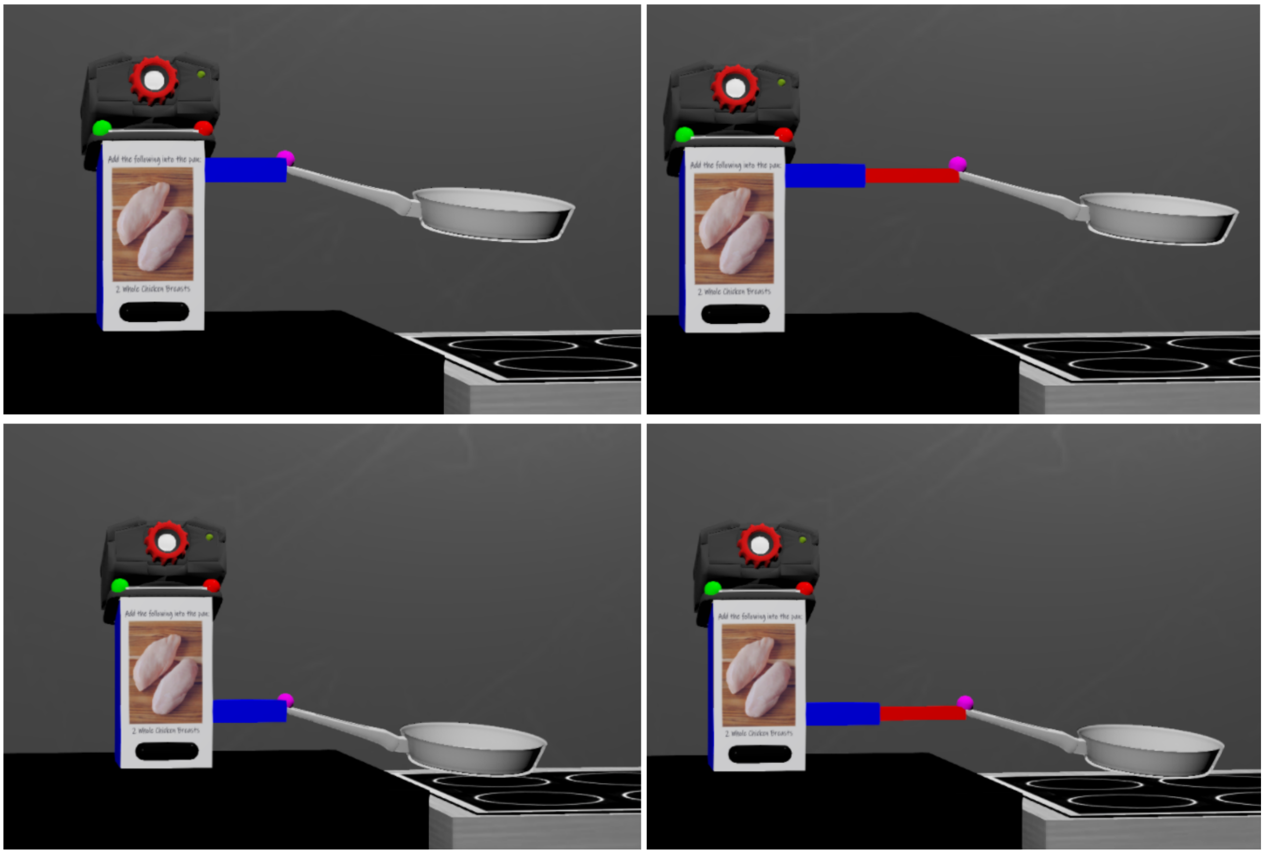

Figure 6. A collection of images representing the systems arms and range of motion. The images show, respectively in order, the system's ability to move to the top right, top left, bottom right, and bottom left.

Since the system needs to communicate multi-dimensionally, it will also communicate to users if they are in the right and wrong through the speaker and vibration component. When the RED led is on, the users can expect the system to vibrate at different intensities and frequencies based on the urgency of the mistake, which can be seen in the figure above. When the green LED is activated, the system will buzz three times in a consistent manner. As one might expect, the speaker acts as the unit's verbalization system. In time, the system will be integrated with an episodic memory that will be capable of generating its own speech when processing the instructions needed to be conveyed to the user, that can analyze the users questions and answer them within the users specifications.

The system's ability to cook is transposed of two linear motors with arms attached to them. These two arms are capable of moving the pan linearly by having the primary arm (blue) travel on the y-axis, with the extension arm (red) traveling on the x-axis. With both motors active, it allows the pan to travel diagonally as well. Using a combination of linear and diagonal movement allows the system to mimic the basic Chinese cooking techniques (such as the toss and flip). In time, a one dimensional rotation motor should be added to the top of the primary arm, allowing the system to stir the food, another required cooking technique. As mentioned previously, in time the pancam should be implemented with object recognition/tracking, with Convolution Neural Network working best in this scenario. This CNN then needs to work in relation to another machine learning algorithm, that focuses primarily on controlling the arms movement through translation and rotation to flip, stir, and toss the food.

VII. Conclusion

Sadly, due to lack of assistance from our directing professors and overall lack of care, our team’s work was the most completed, but was never published.

VIII. Future Research

Merrit and I, Alexander, would love to one day publish our work and be properly rewarded for our efforts.