Development of AR System for Grasping String Foods on Introduction of Industrial Robot

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Abstract

In recent years, the food service industry has been facing a labor shortage. However, the introduction of industrial robots is not easy due to the high cost of equipment and system integration. Therefore, we are developing an Augmented Reality (AR) application for the purpose of introducing robots to small and medium-sized companies. By using this application to perform tasks necessary for introducing robots, such as teaching, cost reductions can be expected when introducing industrial robots. In a previous study, an AR-based grasping and serving simulation system was developed for solidified foods such as fried chicken and rice balls. In this study, we focused on string-shaped food items such as spaghetti and attempted to develop an AR system for grasping and serving a string-shaped object by controlling a gripper.

Keywords: AR, Factory Automation Robots, Unity, ROS, String Foods

1. Introduction

In recent years, the food service industry has been facing a labor shortage. However, the introduction of industrial robots is not easy due to the high cost of equipment and system integration. Therefore, we are developing an Augmented Reality (AR) application for the purpose of introducing robots to small and medium-sized companies. By using this application to perform tasks necessary for introducing robots, such as teaching, cost reductions can be expected when introducing industrial robots.

In a previous study, an AR-based grasping and serving simulation system was developed for solidified foods such as fried chicken and rice balls. However, since there are a variety of foods that can be served in lunchboxes, it is necessary to develop a system that can simulate the grasping and serving of not only solidified foods but also other food items.

In this study, we focused on string-shaped food items such as spaghetti and attempted to develop an AR system for grasping and serving a string-shaped object by controlling a gripper.

2. Methodology

2.1. Robot Overview

Fig. 1 shows the appearance of the robot used in this study. The robot arm UTRA 6-550 and the gripper FLXI E-Type 2Finger manufactured by UmbraTek were used in this study. Since this robot is required to perform the same work as a human in a food factory, a 6-axis vertically articulated robot with a high degree of freedom of movement was used.

a. UTRA 6-550 b. FLXI E-Type 2 Finger

Fig. 1. Appearance of the robot

2.2. *System Configurations*

The system in this research is a simulation environment that reproduces the control of a gripper on a computer. The system consists of two main platforms, ROS (Robot Operating System) and Unity. ROS# [1], a Unity package, was used for communication between Unity and ROS.

In addition, AR Foundation was used for AR application development. AR Foundation is a framework developed by Unity for AR application development, and by using this platform and software, it is possible to develop applications for different operating systems without worrying about program differences. By using the above platform and software, it is possible to develop applications for different operating systems without worrying about program differences. In this study, we used Google ARCore XR Plug-in, an asset for AR application development, assuming operation on Android devices.

Obi Rope is a particle-based physics engine based on the XPBD method that can simulate the physics of various objects.

The system configuration is shown below in Fig. 2. A comparison of software versions with previous studies is shown in Table. 1.

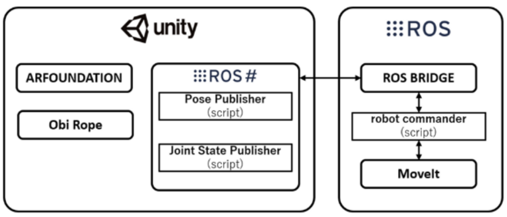

Fig. 2. System configuration

Table 1. Comparison of software versions

	Previous Research	This research
Unity	2019.4.28f	2021.3.7f
ROS	Melodic	Noetic
ROS#	1.7.0	1.7
AR Foundation		4.2.7
ARCore	ARCore SDK for Unity 1.24.0	ARCore XR Plugin 4.2.7

2.3. *Robot Accuracy of numerical integration*

This section describes the operation of the system in this study. Fig. 3 shows the motion planning of the robot. Each posture of the robot is described below. First, the coordinates of the grasping target and serving position are sent to the robot commander of ROS by Unity's Pose Publisher. Next, the trajectory of the robot arm is calculated using MoveIt based on the sent coordinates.

The calculation results are then sent to the Joint State Subscriber, which draws the robot arm and gripper on the Unity side. In the robot commander, the robot arm and gripper operate sequentially according to the motion planning shown in Fig. 3.

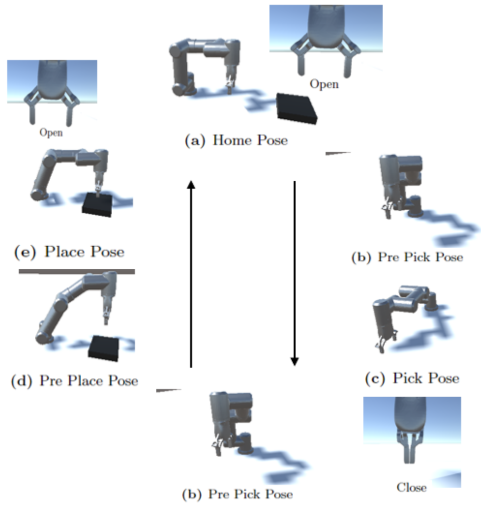

Fig. 3. Robot Planning

(a) Home Pose: Initial pose before motion is started
(b) Pre Pick Pose: Preliminary pose before grasping the object to be grasped
(c) Pick Pose; Pose when grasping the object to be grasped
(d) Pre Place Pose: Preliminary posture before placing the object to be grasped
(e) Place Pose: Pose when placing the grasped object

3. Results and Discussion

3.1. *Results of implementation*

The results of the implementation of this system are described below. First, we confirmed that the robot arm and gripper can be controlled by Unity, since the robot operates in the same way in Gazebo and Unity. Next, the grasping of the string object is shown in Fig. 4. Fig. 4 shows that the robot was able to lift the string object. However, it did not reach the point where it was heaped up, and the string object behaved in an unnatural manner. Next, communication between Unity and ROS was confirmed, as the robot control was confirmed, so communication was possible during Unity execution.

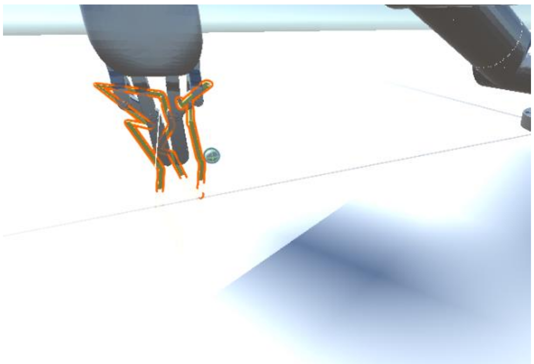

Fig. 4. Grasping

3.2. *Considerations*

First, we describe the grasping of string-like objects. The Obi Rope asset used to reproduce the string-like object is a chain of spheres, and the XPBD [2] method is used to reproduce the string. We believe that the gripper's pinching motion and the complicated structure of the gripper caused the string object to move in an unnatural manner. As a solution to this problem, we consider designing and introducing a gripper with a simple structure.

Next, we discuss communication between ROS and Unity in an AR environment. In this study, we use an updated version of the software used in the system in the previous study. We believe that this update has caused a problem in the conversion to JSON format for communication using ROS#. To solve this problem, it is necessary to check compatibility and find a new communication method.

4. Conclusion

In this study, we attempted to develop an AR system for grasping and serving string-shaped food items, with the main objective of extending the simulation environment for the application of AR applications for the introduction of industrial robots.

As a result of the implementation of the system in this study, it was confirmed that the gripper can be controlled and the Obi Rope can draw string-like objects in the AR environment, in addition to the system in the previous study. However, the communication between ROS and Unity in the AR environment and the grasping and placing of string-like objects could not be confirmed to work properly. In addition, we will continue to develop an application that combines the system with previous research.

References

1. ros-sharp, https://github.com/siemens/ros-sharp
2. Position Based Dynamics , Matthias Müller Bruno Heidelberger Marcus Hennix John Ratcliff, 2006.

Authors Introduction

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