WRS Future Convenience Store Challenge 2024

Stock and Disposal Task

Rulebook

2024/07/1

Revision History

July 1 , 2024

- Update for FCSC2024

0. Terminology

Term	Definition
Mobile Robot	A robot that can move autonomously.
Infrastructure	Unique infrastructure that can be installed inside the convenience store to support the robot's tasks. This equipment includes markings, IC tags, sensors, actuators, and auxiliary tools attached to products, etc. Infrastructure consisting of sensors and actuators can also be considered as stationary robots.
Manipulator	Robot arms, end effectors, and other equipment for manipulation tasks which can be installed on a mobile robot or as part of the infrastructure.
Product(s) or Item(s)	Article(s) for sale in the convenience store.
Customer	Person who visits the store to purchase products.
Container	Box-like repository for holding and transporting multiple products.
Product Display Area	Section of the convenience store where display cases or shelves are installed.
Display Cases	Shelves for displaying products. At the start, multiple products are mixed in these cases.
Chief Judge	Judge who declares the start of the task and issues instructions to the participants.
Assistant Judge	Judge who assists the Chief Judge by performing measurements for scoring, catching rule violations, etc.
Operator	Team member who starts the robot operation inside the competition field. After starting the robot, the operator leaves the competition field.
Safety Observer	Team member who manages the safety of the system inside the competition field and performs operations such as emergency stop. This team member may be the same as the Operator.

1. Overview

The challenge aims to develop technologies to automate the stocking of products and the collection of expired items in a convenience store. Participants in the competition will develop a robot system that autonomously moves and performs these tasks, as well as the infrastructure they deem necessary to install inside the convenience store. In the challenge, the participants will use their developed robots and infrastructure to compete in stocking and disposal demonstrations inside a simulated convenience store as competition field.

In the competition field, a display case is placed in a predetermined position and the robot is placed in a workable position. Stock and Disposal task consists of the following two subtasks.

Stock subtask: the robot competes for the speed of stocking products that have been previously stored in a container.

Stock and disposal subtask: the robot collects expired products from the display cases and the products are displayed on a first-in, first-out along with the products stored in the containers.

In addition, the proposed system must contribute to energy saving in general, and/or to work efficiency.

2. Flow of the Competition Task

The competition consists of two subtasks and are carried out separately. The participants have completed setup for the demonstration before it starts and give a 10-minute demonstration at the competition.
The following describe the flow during the preparation and the demonstration.

2.1. Preparation of the Robot System and Infrastructure

The participants can start the system setup for the demonstration on the field at the preparation time indicated by the organizer. The preparation time is 15 minutes before the starting time of demonstration, The system setup must be finished within this time. At this time, up to 10 participants can work. The robot system used for both sub tasks must be the same. However, the exchange of end-effectors is permitted.

The following provides details on the stock subtask and the stock and disposal subtask, respectively.

2.1.1 Stock Subtasks

(a) Receive the products

The participants receive a container filled with several types of rice balls and places this container in a predetermined position on the robot system.

(b) Renovate the store

Participants can install infrastructure inside the competition field, replace the display case, and so on, if necessary. No infrastructure may be installed outside the competition field.

(c) Place the robot to start position and demonstration preparation

The robot is placed at the competition start position which is in front of the display case. Participants prepare to start the demonstration at the competition start time.

2.1.2 Stock and Disposal Subtasks

(a) Receive the products and install of infrastructure

The participants receive a container with products to be pre-installed on the display shelves and a container with new products. If necessary,

participants install infrastructure such as markers. After the infrastructure is installed, the participants give the referee the products to be pre-arranged on the display cases and the products are placed on the shelves by the referee.

(b) Renovate the Store

Participants can install infrastructure inside the competition field, replace the display case, and so on, if necessary. No infrastructure may be installed outside the competition field.

(c) Place the robot to the start position and demonstration preparation.

The robot is placed at the competition start position in front of the display case. Participants prepare to start their demonstrations at the time of the competition start time. Then, the IDs of disposal items are announced and participants input the information to the system.

2.2. Demonstrations

After the chief judge announces the start of the demonstration, the assistant judge will start the timer. Once the system starts, the operator must leave the competition field, and after that, no one is allowed to control the robot or take any actions that will influence the operation of the system. Any participants who are found to interrupt the operation of the system will be disqualified.

However, the safety observer may stay in the competition field to check the robot's operation and press the emergency stop switch if necessary. The safety observer must not get within 1.5m of the robot, and they must try to avoid the not to block the view of the judges or the audience.

A retry can be declared if the system behaves unexpectedly. After the declaration, the operator prepares for the retry. Simultaneously, the referee returns all products to their initial position. However, items which have fallen to the floor are not returned. The demonstration is restarted when the retry is ready. The retry preparation is included in the competition time and the timer is not stopped.

After 10 minutes have passed, or when the operator declares the task finished or withdraws from the task, the demonstration time is finished.

3. Details of the Challenge

The details of the task for each subtask are described below.

If there are multiple teams with the same score, the team with the fewest number of retries is a winner. If there is no tie in the retry times, the team with the shortest demonstration time is a winner. If there is still no superiority or inferiority, a winner will be decided based on the deliberation by the jury.

3.1 Stock Subtask (out of 54 points)

There are three types of rice balls to be displayed, each with 18 pieces, for a total of 54 pieces.

Display the rice ball in the correct position awarded 1 point each: total 54 points

3.1.1 Use of Display Case

The display case consists of five shelves. The stock subtask uses one of the five shelves. The participants can decide which shelf to use.

3.1.2 Initial Conditions of the Display Case

At the start of the demonstration, the display case is empty of items.

3.1.3 New Items to be Displayed

Items are placed on display shelves from containers densely packed with three types of rice balls by type. Each type is displayed in a different position, with a specified number of items in each row. 1 point is awarded for placing one rice ball in the correct position and giving 54 points in total.

3.1.4 Initial State of the Display Container

In initial state, the display container must be mounted on the robot.

3.2 Stock and Disposal Subtask (out of 96 points)

The assignment points are as follows. Before the start of the demonstration, there are 18 items on the display shelf (2 items each of 9 types) and 9 items in the containers mounted on the robot (1 item each of 9 types). For cases where markers or other infrastructure are not installed to all items, points

are given if the items are stocked or disposed correctly.

- Disposing expired items and straightening preexisting items (2 points for each): 36 points.
- Stocking new items (2 points for each): 18 points.
- Detection of approaching customer and its notification: 5 points
- Operation for all types of items: 10 points.
- Points awarded unused infrastructure for items (1 point each): 27 points

3.2.1 Use of Display Case

The display case consists of five shelves. Two of five shelves are used in this subtask. The upper shelf is used to display three types of rice balls, sandwiches, and packaged drinks, and the lower shelf is used to display boxed lunches, coleslaw, and salad sticks.

3.2.2 Initial State of the Display Case

When the demonstration starts, there are 18 items in the shelf in a non-straightened state: 2 items per each of the 9 types of items. Straightening means that after the items are removed from the shelves by customers, the items behind them must be brought forward until they are at the front of the display case. Of the 18 items, 9 items need to be collected as they are close to their expiration date.

The robot system must check the label of each item, and dispose the items with expiration date from the shelf and straighten the remaining items.

Points are awarded by arranging items in their designated positions and removing the disposal items from the shelf, as follows:

- 2 points are awarded for each disposal item stored in the disposal container.
- 2 points are awarded for each remaining item straightened up in the correct position.

If all preexisting items are processed correctly, a total of 36 points will be awarded.

3.2.3 Stocking New Items

Assuming a scene in which new items are placed on display shelves, the new items stored in display containers are placed on the robot.

The display container stores a total of nine items: three types of rice balls, two types of lunch boxes, and one each of sandwiches, packaged drinks, stick salad, and coleslaw. Each item must be placed next to or behind like items on the display shelve. It is allowed to stack up the lunch boxes, in which case the new one should be below the already stored one.

Each correctly placed item will be awarded 2 points. The maximum score of 18 points can be awarded by correctly placing all the items from the display container.

3.2.4 Display of Multiple Types of Items

Displayed items come in a variety of shapes and sizes and require flexible grasping devices and strategies to correctly display and dispose of each item. In this regard, a bonus of 10 points is awarded for correctly displaying or disposing of at least one of each type of product.

3.2.5 Initial State of the Display Container

Initially, the display container must be mounted on the robot.

3.2.6 Stopping the Work and Inform When a Customer Gets Close

If a customer gets close to the display case during the demonstration, the system should temporarily stop working and move away from the front of the display case so that the customer can access the items. When the system detects the approaching customer, it should stop the operation immediately and notify the customer has been detected. The notification should be provided by voice or by a method that is visually recognizable. Originally, it is necessary to open the front of the shelves and return the shelves position so that customers can access the products. However, in order to facilitate the progress of the demonstration, only a notification of customer detection is required, and the operation is resumed after the notification. If the customer can be detected and notified correctly, and if the demonstration ends without any retry, the participants awards a bonus of 5 points.

3.2.7 Infrastructure for Products

Only markers are allowed to be placed on the infrastructure for each product. 20 mm x 20 mm (400 mm^2) is the maximum area allowed for markers per product, and no more than this area may be used for markers. However,

any number of markers may be placed within a total area of 20 mm x 20 mm (400 mm^2).

Possible example: 4 markers of 10 mm x 10 mm
Not allowed: 1 marker of 30mm x 30mm

Markers that cannot be placed in a microwave oven are not acceptable. Markers must be placed by the participants before the demonstration starts.

If even one marker is used, no points are awarded for display or disposal of the items.

3.3 Retry

If an error occurs during the demonstration, the demonstration can be stopped and can be restarted from the initial state by operating an emergency stop switch by the operator declaring a retry. At this time, the scores obtained up to the retry stage and the conditions for obtaining bonuses are also reset. At this time, the referee will rearrange the items on the display shelves to their initial state*.

The timer is not stopped during the preparation for the retry. In the case of multiple demonstrations due to retries, the score will be awarded for the last demonstration.

*If an item is dropped from a shelf or container onto the floor during an operation, or if an item is damaged, the item is removed when a retry is declared, and the operation is resumed with the total number of items reduced from the initial state.

4. Specifications and Restrictions

4.1. Products for the Task

In the stock subtask, there are three types of rice balls. In the stock and disposal task, there are three types of rice balls, two types of lunch boxes, and one each of sandwich, coleslaw, salad stick, and drink pack, for a total of nine types of items. Examples of each item are outlined below. The competition organizers will prepare the items. Please note that some of these products may not be used for the task on the day of the challenge due to changes in the product availability. Alternative items with similar specifications will be used in the event of a change. These changes will be announced on the official website of the competition.

4.1.1. Rice Balls type 1

- Product name: Plum Rice Ball.
- Outer dimensions: approx. H75 x W80 x D35 mm.
- Weight: approx. 110g.

4.1.2. Rice Balls type 2

- Product name: Salmon Rice Ball.
- Outer dimensions: H75 x W80 x D35 mm.
- Weight: approx. 110g.

4.1.3. Rice Balls type 3

- Product name: Tuna Rice Balls.
- Outer dimensions: H75 x W80 x D35 mm.
- Weight: approx. 110g.

4.1.4. Sandwiches

- Product name: Egg Sandwich.
- Outer dimensions: approx. H140 x W90 x D70 mm.
- Weight: approx. 105g.

4.1.5. Coleslaw

- Product name: Coleslaw
- Outer dimensions: approx. H30 x W180 x D220 mm

- Weight: approx. 145 g

4.1.6. Salad stick

- Product name: Salad stick.
- Outer dimensions: approx. H100 x ϕ 105 mm
- Weight: approx. 145g

4.1.7. Packed drink

- Product name: Orange juice.
- Outer dimensions: approx. H120 x W47 x D38 mm
- Weight: approx. 220g

4.1.8. Lunch Box 1

- Product name: Deep-fried Chicken Lunch Box.
- Outer dimensions: approx. H50 x W250 x D175 mm.
- Weight: approx. 535g.

4.1.9. Lunch Box 2

- Product name: TBD.
- Outer dimensions: TBD.
- Weight: TBD.

4.2. Container

4.2.1. Standard Container Specifications

- Sanko SN Container C#32S.
- Outer dimensions: W690 x D441 x H136 mm.
- Inner dimensions: W629 x D380 x H120 mm.

4.2.2. Usage Restrictions for Unique Containers

Participants can create their own containers to use instead of the standard containers. However, the following requirements must be satisfied:

- Products used for the stocking task must all fit inside the container.
- The containers must be stackable.
- The size must be equivalent to the standard container (outer dimensions: approx. W760 x D480 x H150 mm).

If an original container is used, the applicant may be requested to submit documents showing that the above requirements are met in advance.

4.3. Display Case

4.3.1. Standard Display Case Specifications

- Slit-type system fixture (gondola shelving).
- Outer dimensions: H1500 x D454 x W950 mm.
- Five display shelves (D400 x W900 mm): approx. 200 mm between shelves.
- The first shelf from the top is the top shelf, the third shelf is the middle shelf, and the fifth shelf is the bottom shelf.
- The heights of each shelf are: 500 mm, 700 mm, 900 mm, 1100 mm, 1300 mm from the floor, respectively.
- Each shelf is transparent and has a transparent front rail to prevent products from falling (H35 mm).
- Both sides of the display case have a side mesh.

4.3.2. Usage Restrictions for Unique Display Cases

Participants can create their own display cases to use as infrastructure instead of the standard display cases. However, the following requirements must be satisfied:

- Outer dimensions: within H2000 x D2000 x W2000 mm.
- The display cases must not protrude into the aisles.
- The display cases must have five or more shelves (D400 x W900 mm).
- The minimum height of the bottom shelf is 300 mm, and the maximum height of the top shelf is 1500 mm.
- The shelves must have 150 to 250 mm of space between them. *1
- Each shelf must be transparent, or it must be possible to see the shelf below it if there are no products on the shelf (mesh, netting, etc.). There must be measures in place to keep products from falling.
- The products displayed on the shelves must be accessible to customers.
- The display case cannot be secured to the ceiling, floor, or walls of the venue.
- When using drawer-type shelves, the shelves must be stowed at the beginning and end of the demonstration. *2

*1 The standard for shelf spacing shall be the distance from the top surface

of the shelf board located below to the bottom surface of the shelf board on the next level.
*2 Note that if the shelves are not stowed at the beginning or end of the demonstration, no score will be awarded for actions on the non-compliant shelves.

4.4. Mobile Robot and Infrastructure Restrictions

4.4.1. Hardware Restrictions

- There are no restrictions for the number of mobile robots.
- Each mobile robot must be within 1m x 1m of the floor.
- A mobile robot must have a maximum size of 1 m^2 in its initial position and during movement. Please note that the container will be considered as part of the robot if the container is built into the robot. However, the robot may exceed this maximum size temporarily while unloading the container, stocking products, or collecting disposal items.
- Infrastructure can be installed anywhere inside of the convenience store but different restrictions apply according to the area of the store. Please see the documents provided for more information.
- The weight of robot system should be within 200 kg.
- If the mobile robot or infrastructure separates during the demonstration, the team members should remove any separated objects from the field after the demonstration has finished.

4.4.2. Software Restrictions

- The mobile robots and infrastructure must operate autonomously after the start of the task. However, participants may monitor the internal status remotely to know the state of their system.
- Mobile robots are prohibited from moving outside of the convenience store.

4.4.3. Energy Source Restrictions

- Participants should prepare an energy source for their mobile robots.
- A power supply within AC100 V/1500 W is planned as the energy source for participants to use.
- Any energy source deemed to be dangerous or inappropriate for use will not be allowed.

4.4.4. Venue Restrictions

- Participants are prohibited from intentionally dirtying or damaging the convenience store.
- Infrastructure must be removed immediately after the task ends to return the venue to its original state.
- The convenience store has no ceiling.
- Field lighting conditions are dependent on the regulation of the competition venue and cannot be controlled.

4.4.5. Safety Restrictions

- Systems must have an emergency stop switch.
- The emergency stop switch must be separate from the switch used to start the system.
- The emergency stop switch must be located in a place where it can be safely pressed while the system is in motion or activated remotely.
- When activating the emergency stop remotely, only a wired push-button emergency stop switch may be used, and it must be located more than 1.5 m away.
- If the emergency stop switch is pressed, all of the movable parts included in the system must immediately stop operating.
- The design must prevent the system from tipping over at all times, including during an emergency stop.
- Measures must be taken to shield any area with a danger of pinching the arms and legs of people in the vicinity.
- Hot areas and sharp edges must not protrude.
- Energy sources utilizing fire or high temperatures are prohibited.
- Any laser used in the system must be class 1 or lower.
- Products and parts of robots must not eject anything.

5. Other

This rulebook is subject to change without notice.