

WRS Future Convenience Store Challenge
2020

Stocking and Disposing Tasks

Rulebook

2019/04/24

Revision History

April 24, 2019

- First Draft

0. Terminology

Term	Definition
Mobile Robot	A robot that can move autonomously.
Infrastructure (Robot)	Unique infrastructure that can be installed inside convenience stores to assist in the robot's tasks. This equipment includes markings, IC tags, sensors, actuators, and auxiliary tools to attach to products, etc. Infrastructure made up of sensors and actuators can also be seen as stationary robots
Manipulator	Robot arms, end effectors, and other equipment that execute operations which can be installed on a mobile robot or as part of the infrastructure.
Product	Products found at a convenience store.
Customer	Person who visits the store to purchase products.
Container	Container used to hold and transport multiple products. A container may also be called a "carton."
Product Display Area	Section of the convenience store with display cases or bookshelves installed.
Cashier Area	Section of the convenience store with the cashier counter installed.
Eat-in Area	Section of the convenience store where customers can eat and so on.
Restroom Area	Section of the convenience store with the toilet installed (Abbreviation: Restroom).
Aisle Area	Section of the convenience store for customers and robots to come and go (Abbreviation: Aisle).
Backyard Area	Area of the convenience store where customers are not allowed (Abbreviation: Backyard)
Playground	Area where children and others can play. Located outdoors.
Home Area	Standby station of the mobile robot. Located within the Backyard Area
Display Case	Cases for displaying products and for collecting disposal items. Multiple products are mixed in this case initially.

Chief Judge	The judge who declares the start of the task and issues instructions to the participants.
Assistant Judge	The assistant to the judge who performs measurement scoring and watches for violations, etc.
Operator	The person who performs the starting operation in the competition field. After finishing the operation, the operator leaves the competition field.
Safety Observer	The person who manages the safety of the system within the competition field. Performs operations such as emergency stop. May double as the operator.

1. Overview

This challenge aims to develop technology to automate the stocking of products and collection of disposal items at a convenience store. Participants in this competitive task will develop a robot that autonomously moves and performs these tasks as well as infrastructure to install inside of the convenience store. In this challenge, participants will use the robots and infrastructure they develop to compete at accurately performing stocking and disposal demonstrations in a simulated convenience store.

The layout of the store is provided in a separate document. In this challenge, participants use the backyard area, the home station, aisles, and display cases.

The following tasks will be performed in the demonstration:

- Place the products stored in the container located in the home station into the designated place on the display case.
- Straighten the products positioned in the display case already while collecting disposal items and carrying the disposal items to the home station.

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

2. Flow of the Competition Task

The flow of the task is:

- (1) Renovation time (Participants install their equipment)
- (2) Setting Time (Time for judges to set up)
- (3) Stocking and disposal demonstration (Time for the robot system to operate autonomously)

In that order. (2) is a time for the judges to prepare for the task, so it doesn't count towards the time allotted for the competition. Each team will have a maximum of fifteen minutes to complete (1) and (3). Participants can distribute the time to each phase as they prefer

2.1. Renovation Time

Participants will be able to do the following three tasks. Up to ten people may enter the convenience store to do this work.

(a) Product receipt and renovation

Once renovation time begins, participants will receive two containers. One will contain the products for the display case task (hereinafter, the display case container) and it will contain six types of products, and eight total products. Another container will hold the products for the disposal product task (hereinafter the disposal product container) and it will contain six types of products, and twelve total products. Participants can alter the products as necessary by adding infrastructure and so on. The products for the display case should be returned to the display case container or placed in a display case container supplied by the team, and placed in any location within the home area (the initial position for the demonstration). The disposal products should be returned to their container and passed back to the judges.

(b) Renovating the store

Participants can install infrastructure within the convenience store as necessary, replace the display cases, and so on. No infrastructure may be installed outside the convenience store.

(c) Place the mobile robot and prepare to start

Place the mobile robot in the home area along with the display case container, and standby to start the system.

Once all the work is done, participants must exit the store and end their renovation time to stop the timer. After that, only the operator and the safety observer (one person each) will be permitted to enter the convenience store.

2.2. Setting Time

The chief judge will announce the six products that will be disposal targets.

The operator, under the supervision of the assistant judge, will enter labels for the system to identify the disposal products. Then, the judge will take the twelve items in the disposal product container and place them in the display case.

2.3. Product stocking and disposal product collection demonstration

After the chief judge announces the start of the demonstration, the timer will restart.

Once the system starts, the operator will leave the convenience store, and after that, no one is allowed to control the mobile robot or take any actions that will influence the operation of the system. Any team that is found to have manipulated the operation of the system will be withdrawn from the task at that point.

However, the safety monitor (one person) may stay in the convenience store to monitor the operation and operate the emergency stop switch even during the demonstration, but they must not get within 1.5m of the mobile robot, and they must take care not to block the view of the judges or the spectators.

After 15 minutes has passed, or when the operator declares the task over or withdraws from the task, demonstration time will be over.

3. Details of Challenge

3.1. Display Case

The display case is made up of five shelves. The task will use the top, middle, and bottom three shelves, and the second and fourth shelves will not be used. The top shelf will contain plum rice balls and salmon rice balls, the middle shelf will contain sandwiches and deli food pouches, and the bottom shelf will hold drinks and lunch boxes.

3.2. Initial Condition of the Display Case and Arranging Preexisting Products

When the demonstration begins, there will be two each of six types of items, for a total of twelve items on the shelf in a “not face up state.” Face up means that after the products are sold, the products behind them must be brought forward to the front of the display case. Of the twelve items, six are near their expiration date and must be collected as disposal items.

The system must check the label of each item, remove disposal items from the shelf, and arrange the remaining products in a face up state.

Points are earned by arranging products in their designated positions and collecting disposal items.

- 4 points are awarded for each disposal item stored in the container
- 4 points are awarded for each remaining product facing up in the correct position

If all pre-existing products are dealt with correctly a total of 48 points can be earned.

3.3. Stocking New Products

This imagines a situation where newly arrived products must be placed on the shelves. The display case container placed in the home area and containing the products is carried to the display case and the products are placed in their correct locations on the shelves.

The display container will contain two each of plum rice balls and salmon rice balls, and one each of sandwiches, deli food pouches, drinks, and lunch boxes, for a total of eight items. Each product must be placed behind the products of the same type already on the display shelf (the lunch boxes may be stacked)

Each correctly placed product will be worth four points. It will be possible to earn 32 points by placing all of the products from the display case container correctly.

3.4. Initial Positions of Mobile Robot and Display Case Container

The display case container and the mobile robot must be within the home area as the initial state. Please note the display case container may be placed on the mobile robot.

3.5. Disposal Item Transport

Disposal item transport will be deemed a success if one or more of the disposal items can be brought back to the home area after the disposal item collection task is complete, which will earn five extra points.

3.6. Stopping Work when a Customer Gets Close

If a customer gets close to the display case during display work, the system should temporarily stop working and move away so the customer can access the products. If the system detects the judge acting in the role of customer, it should quickly stop working and ensure the customer has access to the products as necessary.

The following functions will earn extra points if they can be demonstrated during demonstration time.

- Temporarily stop working if a person gets within 1m of the system: 5 points
- If the above temporarily stopped condition continues for a predetermined length of time (over 3 seconds), move away so the customer can access the products (make the display case available, return the shelves to their normal condition): 5 points
- Resume working from the state of moving away after the human has left (do something to the products): 5 points

3.7. Retry

If there is an abnormality during the demonstration and the emergency stop switch is activated or the operator declares a retry, the task will be stopped, and the demonstration may be retried from the initial state. If a retry

is declared after the products in the display case have been touched, the judge will rearrange the products in the display case.

The timer will not stop during preparations for a retry. If the demonstration is done several times due to retry declarations, the final attempt will be the one evaluated for points.

4. Specifications and Restrictions

4.1. Products for the Task

There are six types or products for this task: plum rice balls, salmon rice balls, sandwiches, deli food pouches, drinks, and lunch boxes. Examples of each products are outlined below. The competition organizers will prepare the products. Furthermore, some of these products may not be used for the competitive task on the day of the competitive challenge due to changes in the product lineup. An alternative product with similar product specifications will be used in the event of a change. These changes will be announced on the official competition website.

4.1.1. Plum Rice Balls

- Product Name: Plum
- Outer Dimensions: Approx. H75 x W80 x D35 mm
- Weight: Approx. 110g

4.1.2. Salmon Rice Balls

- Product Name: Red Salmon
- Outer Dimensions: H75 x W80 x D35 mm
- Weight: Approx. 110g

4.1.3. Sandwiches

- Product Name: Egg Sandwich
- Outer Dimensions: Approx. H140 x W90 x D70 mm
- Weight: Approx. 105g

4.1.4. Deli Food Pouch

- Product Name: Hamburger Steak
- Outer Dimensions: Approx. H150 x W160 x D65 mm
- Weight: Approx. 215g

4.1.5. Drink

- Product Name: Café Latte (240 ml)
- Outer Dimensions: Approx. H108 x W76 x D76 mm

- Weight: Approx. 260g

4.1.6. Lunch Box

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

4.1.7. Adding Auxiliary Tools to Products

Participants can innovate the geometry and materials of the containers and packages of products as well as attach markings such as bar codes or IC tags to more easily operate the manipulator. However, auxiliary tools that harm the presentation as a product, are unsanitary, interfere with storage or stocking, or cannot be used in the microwave are prohibited. Participants must set up auxiliary tools during the renovation time.

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 in place 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 able to stack.
- The size must be equivalent to the standard container (Approx. Outer dimensions: W700 x D450 x H140 [mm])

4.3. Display Case

4.3.1. Standard Display Case Specifications

- Slit-type system fixture (gondola shelving)
- Outer dimensions: H1500 x D454(shelf 400) x W950 mm
- Five display shelves (D400xW900): approx. 200mm between shelves
- The first from the bottom is the bottom shelf, the third shelf is the middle shelf, and the fifth shelf is the top shelf.

- The height of each shelf are, from the floor: 500mm, 700mm, 900mm, 1100mm, 1300mm
- Each shelf is transparent and has a transparent front rail to prevent products from falling (H35mm)
- 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
- Display cases must not protrude into the aisles
- The display cases must have five or more shelves (D400xW900).
- The minimum height of the bottom shelf is 300mm, and the maximum height of the top shelf is 1500mm
- The shelves must have 150 to 250mm of space between them.
- 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.

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 occupy less than 1m x 1m of floor space and all of the mobile robots must fit into the home area.
- A mobile robot must have a size within one square meter in its initial position and during movement. Furthermore, the container will be seen as one part of the robot if the container is built into the robot. However, the robot may exceed this 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 the mobile robot must be less than 100kg if it will use the eat-in area.

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 to use for their mobile robots.
- A power supply within AC100V/1500W 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 competitive task ends to return the venue to its original state.
- The convenience store has no ceiling or walls.

4.4.5. Safety Restrictions

- Systems must have an emergency stop switch in case of an emergency.
- 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 can be activated remotely.
- When activating an emergency stop remotely, only a wired push-button emergency stop switch may be used, and it must be located over 1.5m 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 put in place 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 inject anything.

5. Other

This rulebook is subject to change without notice.