

WRS Future Convenience Store Challenge
2020

Restroom Cleaning Task

Rulebook

2020/04/06

Revision History

April 6, 2020

- Clarified the number of team members working in renovation time.
- Added the rule of tie break.
- Clarified the score about interrupting the cleaning task.
- Added the initial position for mobile robots.

July 23, 2019

- Added the side of the toilet bowl to cleaning target.

April 24, 2019

- First draft.

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. |
| Disposal Item(s) or Disposal Product(s) | Expired product(s) that should be removed from the Display Cases and discarded |
| 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. |
| Cashier Area | Section of the convenience store where the cashier counter is installed. |
| Eat-in Area | Section of the convenience store where customers can consume the purchased products. |
| Restroom | Section of the convenience store where the toilet is installed. |
| Aisle | Section of the convenience store for customers and robots to come and go. |
| Backyard | Section of the convenience store where customers are not allowed. |
| Playground | Area located outdoors where children and others can play. |
| Home Area | Area located in the Backyard and used as a standby |

| | |
|-----------------|---|
| | area for the mobile robot before starting the task. |
| 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

This challenge aims to develop technologies to automate the restroom cleaning task in a convenience store, which is a daily task currently performed by employees. Participants of this competition will develop a robot system that operates autonomously and performs cleaning operations, as well as the infrastructure they deem necessary to perform these operations, which can be installed inside of the restroom area. In this challenge, the participants will use their developed robots and infrastructure to compete in terms of the performance of their systems by performing a demonstration of cleaning a toilet and the floor of a simulated restroom.

The restroom area consists of a toilet, floor, and an area to install infrastructure, as shown in Figure 1.

The demonstration will consist of the following two subtasks:

- Cleaning simulated urine on the toilet. The rim (top of toilet bowl), the side of toilet bowl, the toilet seat (when up), and the floor around the toilet should be cleaned. The inside of the toilet bowl does not need to be cleaned.
- Cleaning garbage scattered on the floor (scraps of toilet paper, toilet paper tube, and paper cup).

A comprehensive explanation about the cleaning task is included in Section 3.

In addition, the proposed system must contribute to energy saving in general and/or to the reduction of the staff workload that leads to energy saving in convenience stores.

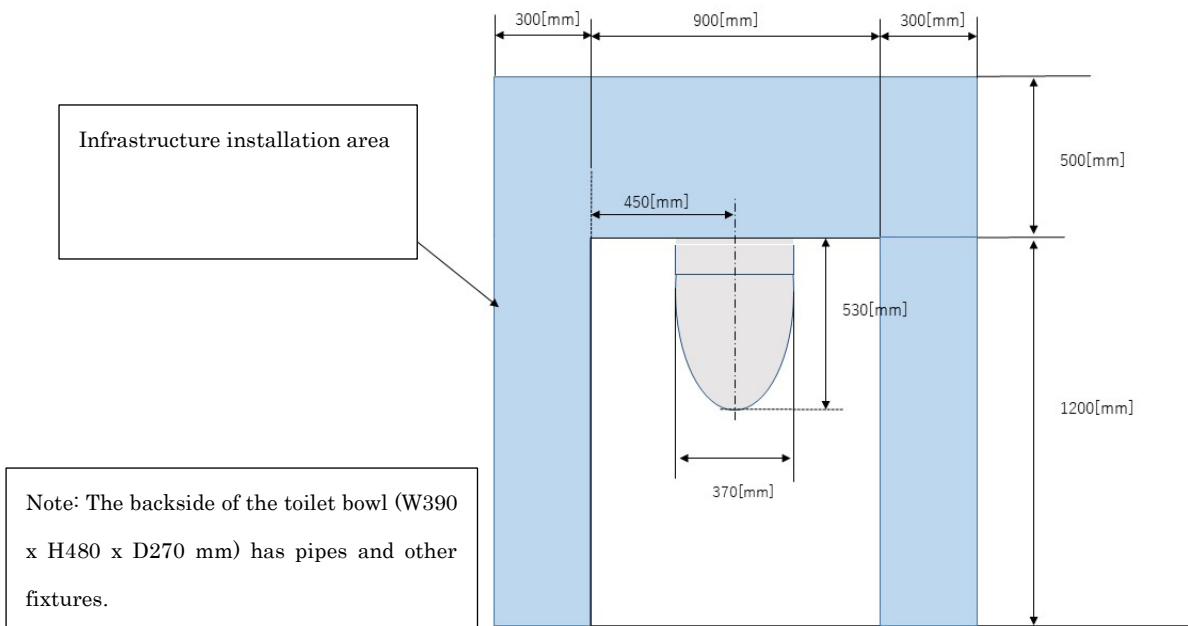


Figure 1. Restroom area layout

2. Flow of the Competition Task

The flow of the task in the mandatory order is:

- (1) Renovation time (participants install their equipment)
- (2) Setting time (time for judges to set up)
- (3) Cleaning demonstration (time for the robot to perform the tasks autonomously)

(2) is the time for the judges to prepare for the task, so it does not count toward the time allotted for the competition. Each team will have a maximum of 15 minutes to complete (1) and (3). Participants can allocate the time to these two phases as they prefer.

2.1. Renovation Time

Participants will install their infrastructure inside the infrastructure installation area, and place their mobile robot in a designated spot outside the restroom or in an initial position anywhere inside the infrastructure installation area. Participants should inform the judges when they finish their renovations or if renovations are not required.

Up to 10 team members can do the renovation work.

2.2. Setting Time

After the renovations, the judges will set up the simulated urine and scatter trash. After the judges confirm that these preparations are complete, they will declare the start of the demonstration. This time does not count toward the total time.

2.3. Cleaning Demonstration

Participants will input the start command into the system that controls the mobile robot and the infrastructure. After the cleaning work is done within the allotted time, the mobile robot and infrastructure should return to their initial positions, or remove themselves from the toilet and floor.

After the system operation starts, participants are not allowed to control the robot or to take any actions that will influence the operation of the system. Any team that manipulates the operation of the system will be withdrawn from the task at that point.

However, participants can decide to retry the task as described in Section

3.4, if continuing the demonstration is deemed difficult due to system malfunction.

If the demonstration is not completed within the allotted time, a time-up will be declared and the score will be purely for reference i.e., it will be a zero score. However, if there are many teams with the same score, the reference points will be used to determine superiority.

3. Details of the Challenge

The challenge will have a maximum score of 100 points:

- Cleaning the simulated urine: 50 points
- Cleaning the garbage: 50 points

If there are multiple teams with the same score, the team with the least number of retries will be the winner. If the number of retries does not give an advantage, the team with the shortest working time will be the winner. If there is still a tie, the judging committee will determine the ranking.

3.1. Cleaning the Simulated Urine

Judges disperse simulated urine (about 300 ml) around the restroom by spraying it into the toilet bowl with the toilet seat open using a sprayer (peeing boy statue), as shown in Figure 2. The simulated urine is water colored with water-based blue paint.

Images will be taken to record the state of the restroom before spraying the simulated urine as well as before and after cleaning, and the removal rate of the simulated urine will be measured. The full 50 points will be given to participants with a 100% removal rate. Points will be deducted if the simulated urine is further spread or the contents of the paper cup (as explained in Section 3.2) spills out. The simulated urine left in the restroom area after scoring will be cleaned by the venue staff.

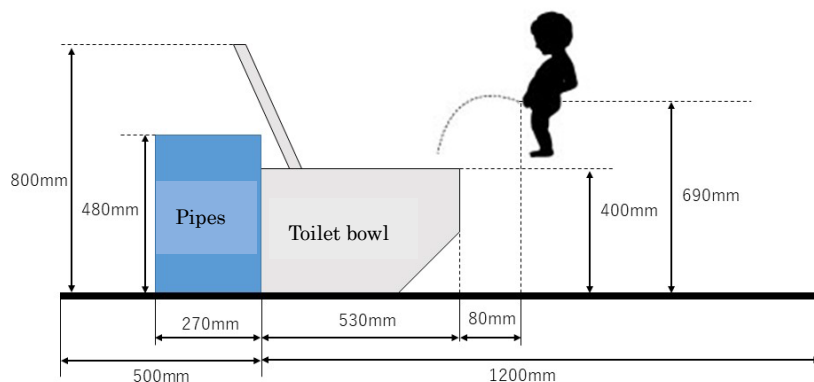


Figure 2. Sprayer and toilet bowl position

3.2. Cleaning the Garbage

Judges will randomly scatter a total of 5 pieces of garbage on the floor: 3 scraps of toilet paper (5-cm long maximum), 1 toilet paper tube, and 1 paper

cup. A small amount of liquid (blue paint) will be inside the cup, and it will have a lid with a drinking spout affixed to the top. The garbage may be wet due to the spray of simulated urine. If the garbage is placed in a garbage can or stored inside the mobile robot, it will be deemed as cleaned. Participants are allowed to decide the shape of the garbage can. The garbage can be placed in the mobile robot and/or in the infrastructure installation area. 10 points will be awarded for each piece of garbage that is cleaned (maximum of 50 points).

3.3. Interrupting the Cleaning Task due to a Customer Intervention

A customer (role-played by a judge) will try to use the restroom at any random time between one minute counted from the start of the cleaning demonstration and the end of the cleaning demonstration time. The system must register the request to use the restroom via a switch (e.g., a push button). Upon this request, the robot must immediately stop cleaning and restore the infrastructure and the mobile robot to the initial position, or remove itself from the toilet and floor to restore the conditions in which the toilet can be used. The judge will check the status of the restroom space and push the switch again. After that, cleaning may continue. Participants must supply the switch and install it near the door of the toilet.

The score for interrupting the cleaning task is as follows:

- If the cleaning work is not interrupted despite the judge's request to use the restroom, 10 points will be deducted.
- If the cleaning work is interrupted but the restroom cannot be used, 5 points will be deducted.

3.4. Retry

Participants can ask the judges to terminate the demonstration in order to retry the task if the system malfunctions and continuing the demonstration is deemed difficult.

However, the clock will continue to run while the demonstration is stopped. Furthermore, the mobile robot and infrastructure should be returned to their initial state. The points awarded for cleaning the simulated urine will be a reference score. In other words, cleaning will be considered as zero points and multiple participants with the same score will rank higher or lower based on the removal rate. Participants will keep the points already earned for pieces

of garbage that have been cleared, and the garbage still left to be cleared will be returned to its position before the demonstration was stopped. Then, the task can be retried.

4. Specifications and Restrictions

4.1. Standard Toilet Bowl

The standard toilet bowl and toilet seat installed at the venue are as follows:

- Toilet bowl: TOTO Pure Rest QR
- Toilet seat: Standard toilet seat for above

The simulated urine will be sprayed while the toilet seat is up.

4.2. Original Toilet Bowl

Participants can use a toilet bowl that has a unique geometry or functionality instead of the standard toilet bowl. However, an original toilet bowl must satisfy the following requirements.

- It should be white in color
- It can be flushed, and can hold water
- It can handle both stool and urine
- The toilet seat can be lowered to sit on it.
- The height of the toilet seat is approximately 400 mm from the floor.
- The toilet bowl accommodates men to urinate while standing.
- The toilet must have a footprint (i.e., projected area on the floor) of approximately W370 x D530 mm.

4.3. Floor

The floor will be a white vinyl chloride sheet.

4.4. Mobile Robot and Infrastructure Restrictions

4.4.1. Hardware Restrictions

- The mobile robot and the infrastructure must not use any parts that are blue or emit light. If emitting light is unavoidable, the light must be turned off or physically covered while the judge is evaluating the restroom.
- There are no restrictions for the number of mobile robots.
- Each mobile robot must occupy less than 1 m x 1 m of floor space and all mobile robots must fit into an area of 2 m x 2 m.
- The initial position of the mobile robots must be within an additional home area for the restroom cleaning task (this home area is different from the one in the layout map and its location will be announced at a later date) or infrastructure installation area.

- The initial position of mobile robots must fit in the infrastructure installation area, if the mobile robots will be placed inside such area.
- The initial position of infrastructure must be within the infrastructure installation area.
- Infrastructure may not be set up outside the toilet area.
- Some lightweight sensors may be allowed to be installed at a height of approximately 2 m but this must be approved by the competition committee. Details will be announced at a later date.
- Mobile robots and infrastructure may not have an external supply of water. However, a total of one liter of water may be carried inside for the robot to use.
- The use of cleansers or cleaning substances is prohibited.

4.4.2. Software Restrictions

- The 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.
- After cleaning, the mobile robots must leave the restroom area or return to the infrastructure installation area. Infrastructure must return to the infrastructure area. If the mobile robot and/or infrastructure remain, the points awarded for cleaning the simulated urine will be a reference score. In other words, cleaning will be considered as zero points and multiple participants with the same score will rank higher or lower based on the removal rate.

4.4.3. Energy Source Restrictions

- Participants should prepare an energy source 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 flooding, dirtying, or damaging the convenience store or restroom area.

- Infrastructure must be removed immediately after the task ends to return the venue to its original state.
- A beam will be installed 2 m above the floor and below the ceiling in the toilet area. Lightweight measuring devices can be mounted into the beam. However, equipment mounted on the beam must not interfere with the operations of the camera used to measure the simulated urine.
- The convenience store has no ceiling or walls.

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.