RWA-2

Building a Manufacuring Robotic Software System

March 14, 2022

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Semester:
Spring 2022

Course code:
ENPM663

Contents

1 Architecture Design Modifications

- An given order will have at most one kitting and assembly shipment so the previously defined kitting and assembly shipment lists were modified to a single instance of the same respectively.
- The competition class was also modified to remove the logical camera callbacks and a few functions were added to get the time in simulation.
- Additional attributes were added to the Product struct.Refer figure 2 in that it can be seen that the attribute world pose was added so that the structure can hold the world pose so that the values can be used by the robots.
- Additional class pertaining to the Logical camera was created which holds the method for finding the part from the logical camera frame, transforming the model pose into the world frame and saving into the relevant data structure.
- Figure 1 depicts the division the main structure implemented

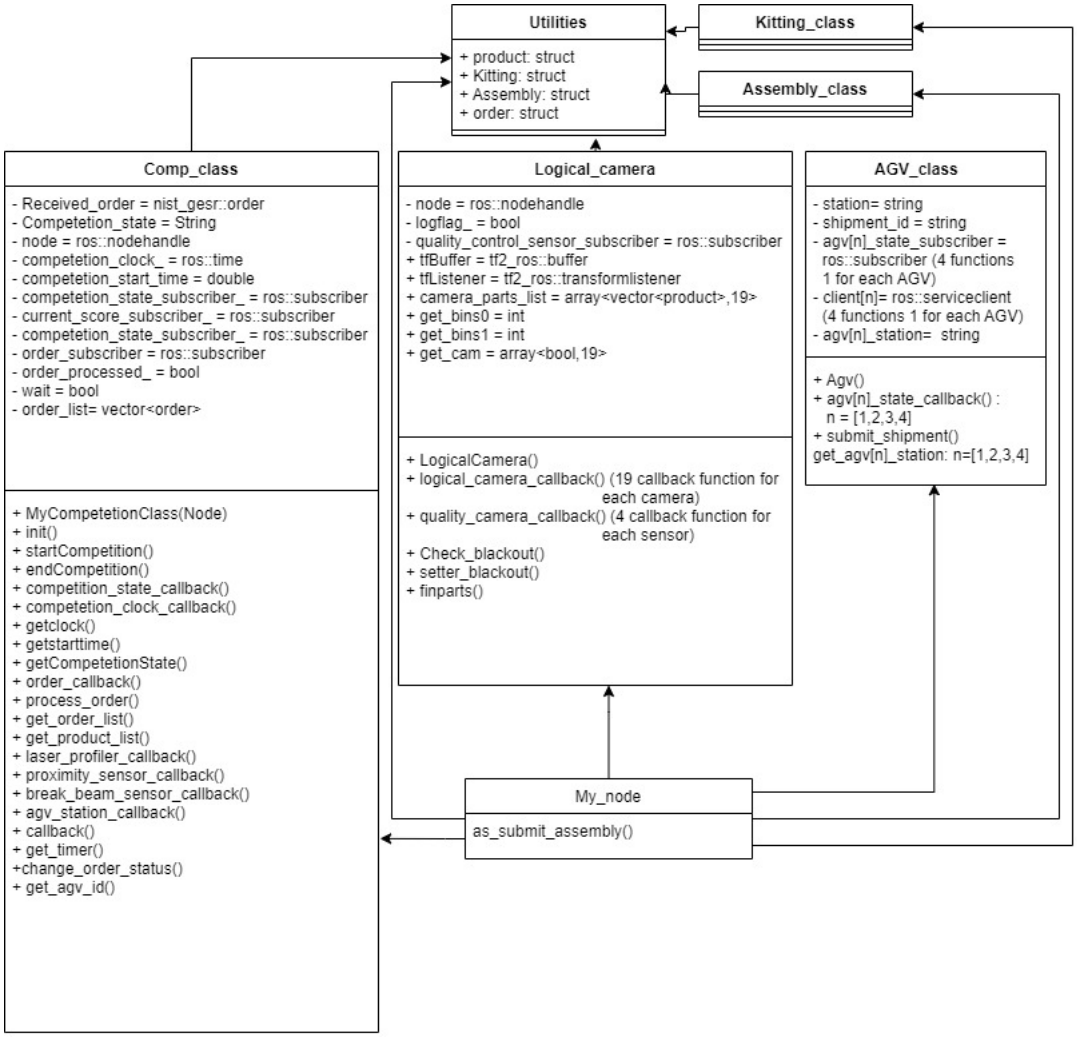

Figure 1: Modified UML class diagram

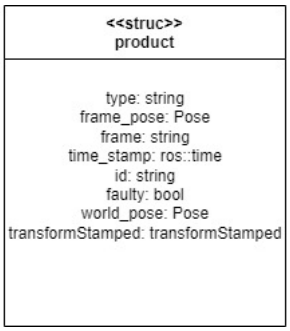

Figure 2: Modified Product struct

2 Sensor Placement

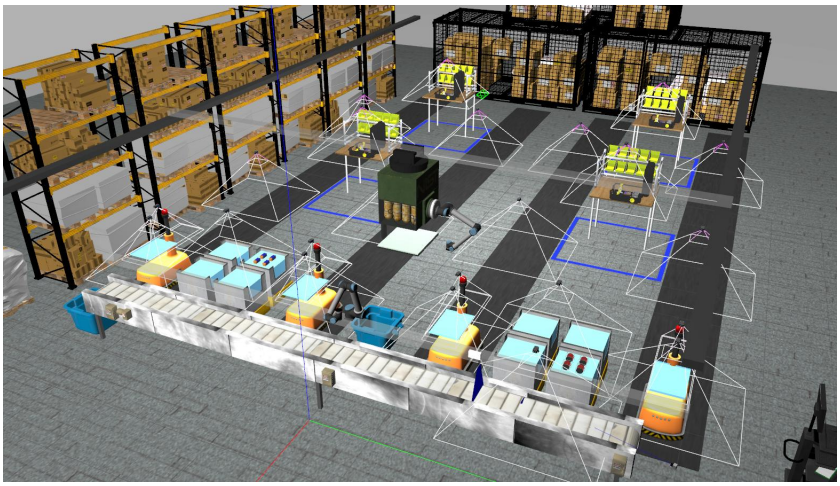

Figure 3: Gazebo visualization

The figure 3 depicts the placements of various sensors in the environment. It constitutes the following:

- 19 logical camera placed at following location:
  - 2 to cover all the bins.
  - 4 to cover the AGV location as kitting area.
  - 4 to cover the assembly station.
  - 8 to cover the AGV at assembly station.
  - 1 at the startng of the belt.
- 1 breakbeam sensor.
- 1 laser scanner.
- 1 proximity sensor.

3 Process Flow

3.1 Kitting Process

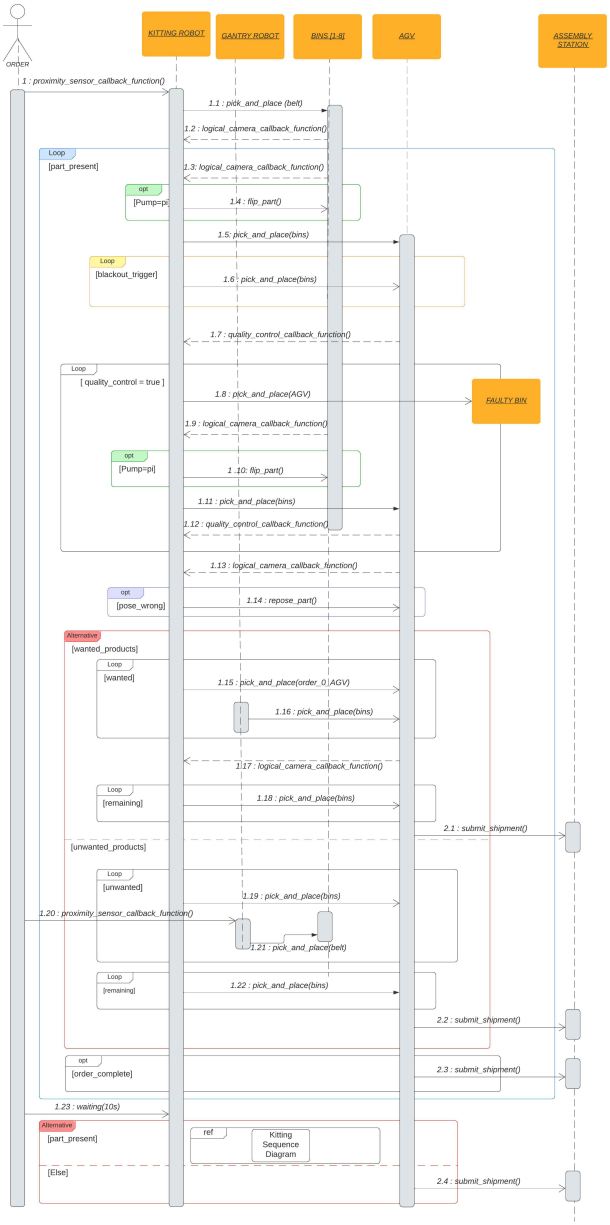

Figure 4: Kitting Sequence flow

Fig 4 represents the sequence diagram for kitting operation. The following assumptions were considered for the kitting process in this diagram:

- Order_0 has kitting shipment, followed by high priority order which also consists of kitting shipment .
- Insufficient parts are only considered for order_0.

- Sensor blackout occurs before the execution of priority changes.
- High priority order's Agv tray and order_0's tray are different.

The modified kitting diagram consists of:

- Step(1.4 and 1.10): These steps represent the flipping agility challenge.
- Step 1.6 : The loop executes when the blackout sensor challenge has occurred. In this step only the pick and place of parts from bins to AGV occurs, using information before blackout.
- Steps (1.7 - 1.12) : Represents the detection and removal of faulty parts.
- Step 1.14 : After checking the AGV tray for faulty part, the pose of part is determined to check whether faulty gripper challenge has occurred or not. If occurred, the part is reoriented to correct pose.
- Steps(1.15 - 1.22) : High Priority challenge execution.
- Step 1.15 : If the 'wanted products' condition is satisfied, a loop is executed where kitting arm picks parts from order_0 tray and places it in priority order tray.
- Step 1.16 : Simultaneously, the gantry arm picks parts from bins and checks whether faulty or not and refills the order_0 tray to previous configuration.
- Step 1.18 : Only executes when the priority order requires more parts than the 'wanted parts'.
- Step 1.19 : Picks parts from bins and places inside AGV.
- Step 1.20, 1.21 : While kitting arm does pick and place from bins to AGVTh, and parts keep spawning on belt. The gantry robot picks the part from belt and place it inside bins.
- Step 2.3 : This step represents the submission of order_0 to assembly station ,if the order is complete in the AGV.
- Step 1.23 : This step only occurs if there are no enough parts for order_0 submission. Waits for 10s to check whether any part is spawning on belt and identifies the part.
- Alternative block : If the part found during waiting is the missing part, the process starts again from the first step of kitting sequence, 'ref'.
- Step 2.4 : If it was not the required part, then submit shipment (Insufficient parts challenge).

3.2 Assembly Process

The 'objects' interacting in this diagram are 'Assembly robot' ,' bins', 'AGV' and 'Briefcase'. During sensor blackout, the information stored just before the challenge is saved and used as reference for processing orders.

- The Alternative block is executed only for high priority orders(identical for both 'wanted and unwanted products' conditions).
  - The remaining parts are gathered from bins or the AGV. These parts are checked whether they are faulty or not. Then these parts are placed on a briefcase to complete the assembly.
- Step 1.5, 1.6 : Represents processing of order_0 , picking parts from AGV and placing them on a briefcase ,followed by shipment submission.

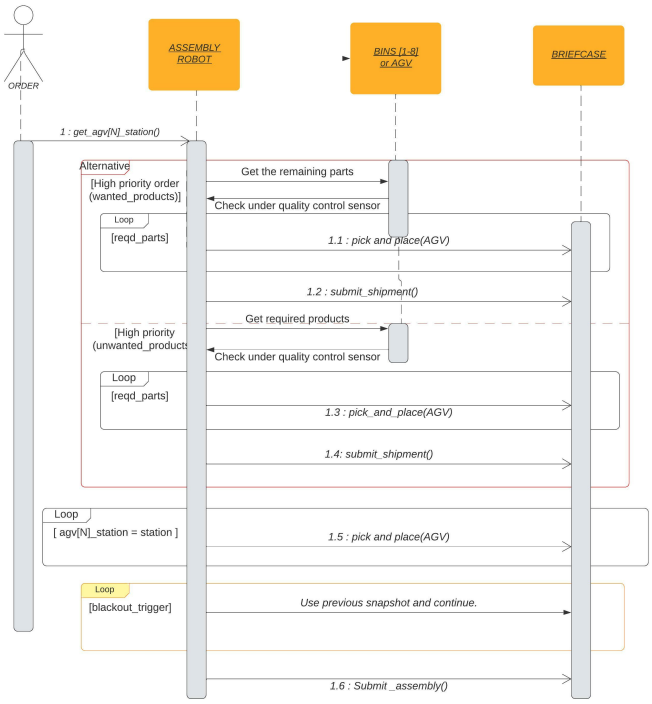

Figure 5: Assembly Sequence flow

4 Challenges

The following challenges are addressed in the following program.

- The high priority order challenge was addressed in the program in which it checks for the new order to be published after the first order and prints on the terminal that a high priority order has been detected.
- The insufficient part problem was published which checks for the required products in the environment under the logical camera and prompts the user if there are any part missing in the environment.
- Faulty part challenge was taken care by reading the quality control sensor topic which prompts the user when a faulty part is detected.
- Detecting the sensor blackout using a flag accessed from the callback functions of the logical cameras did not work out. This issue might be due to the async spinner running the callbacks in separate threads.