ENPM 663:
Building a Manufacturing Robot Software Systems

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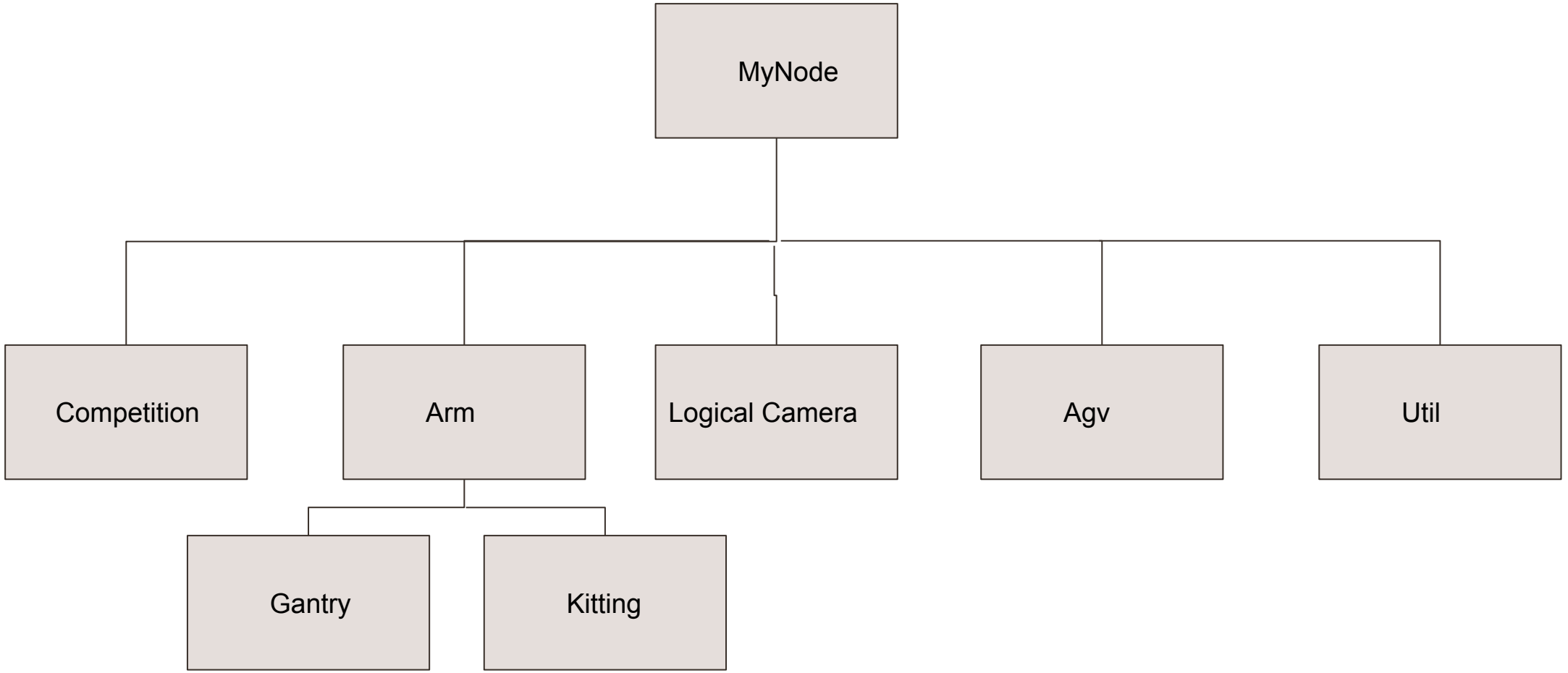
Architecture

- Reactive Control
- Condition-based, similar to finite state machine.
- All the parts seen by logical cameras are used to create an **internal map(world model)** of the environment by storing their world poses.
- Order processing is done by responding to **real-time** requirements of the competition.


MyNode
Competition
Arm
Logical Camera
Agv
Util
Gantry
Kitting

Order Processing

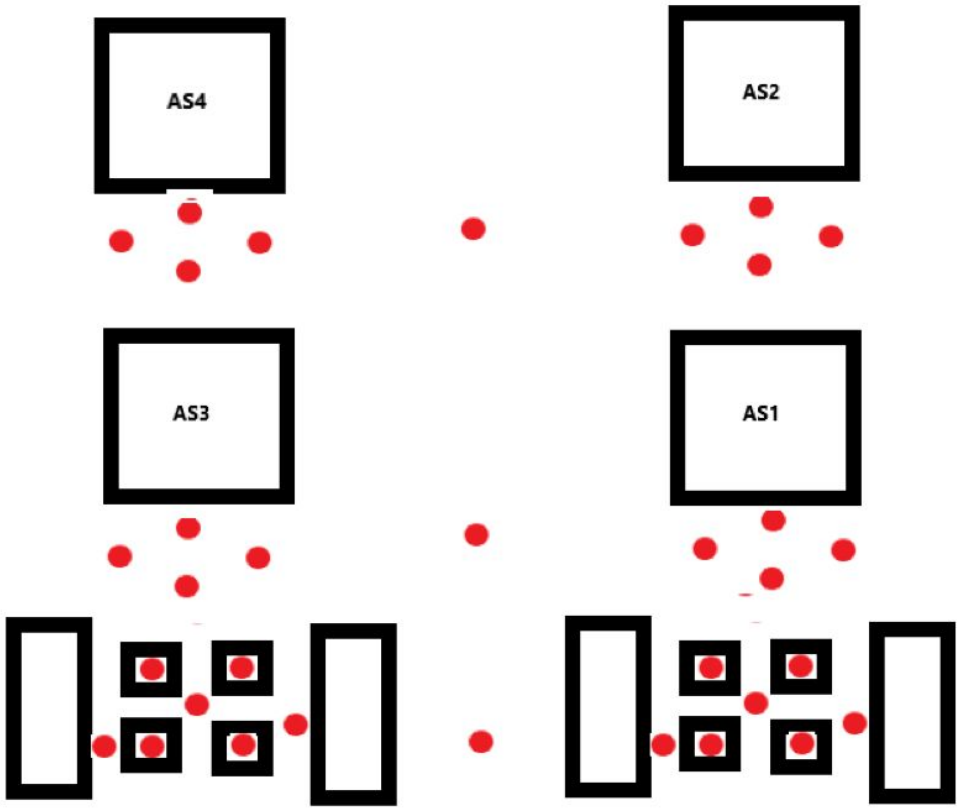
- Logical cameras broadcast frames for all the detected parts and the parts are saved in a list.
- Parts are segmented according to their type, which is used as a key in the unordered map created. The values are a list of all the products of a particular type.
- List and maps are created after picking the parts from conveyor and before any of the assembly process begins.
- Flags used to update the status of process of each order and each product has a boolean associated with it to track its status.

AGILITY CHALLENGES

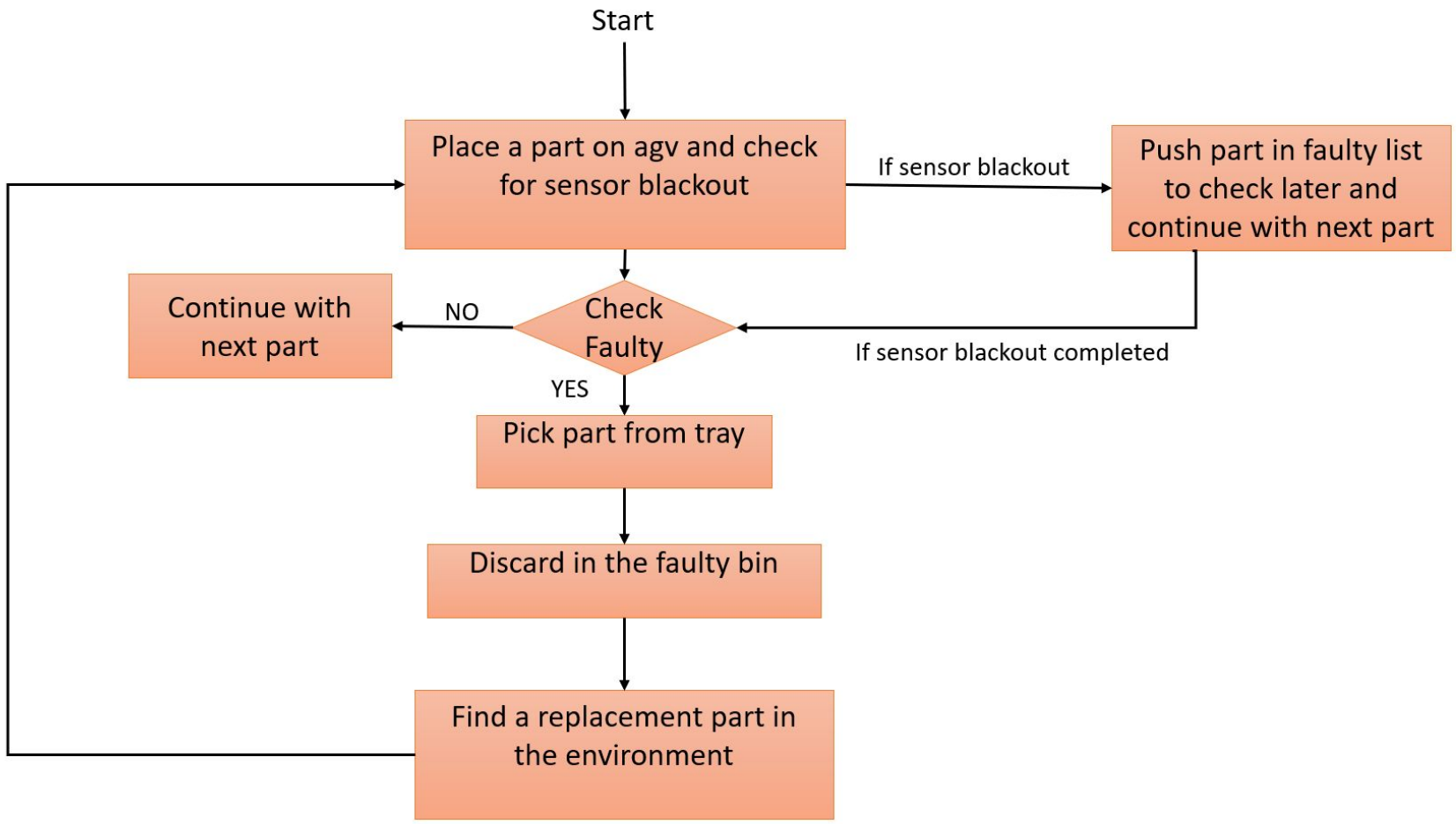
The Following agility challenges were addressed:

- Faulty Parts
- Flipped Parts
- Sensor Blackout.
- High Priority Order.

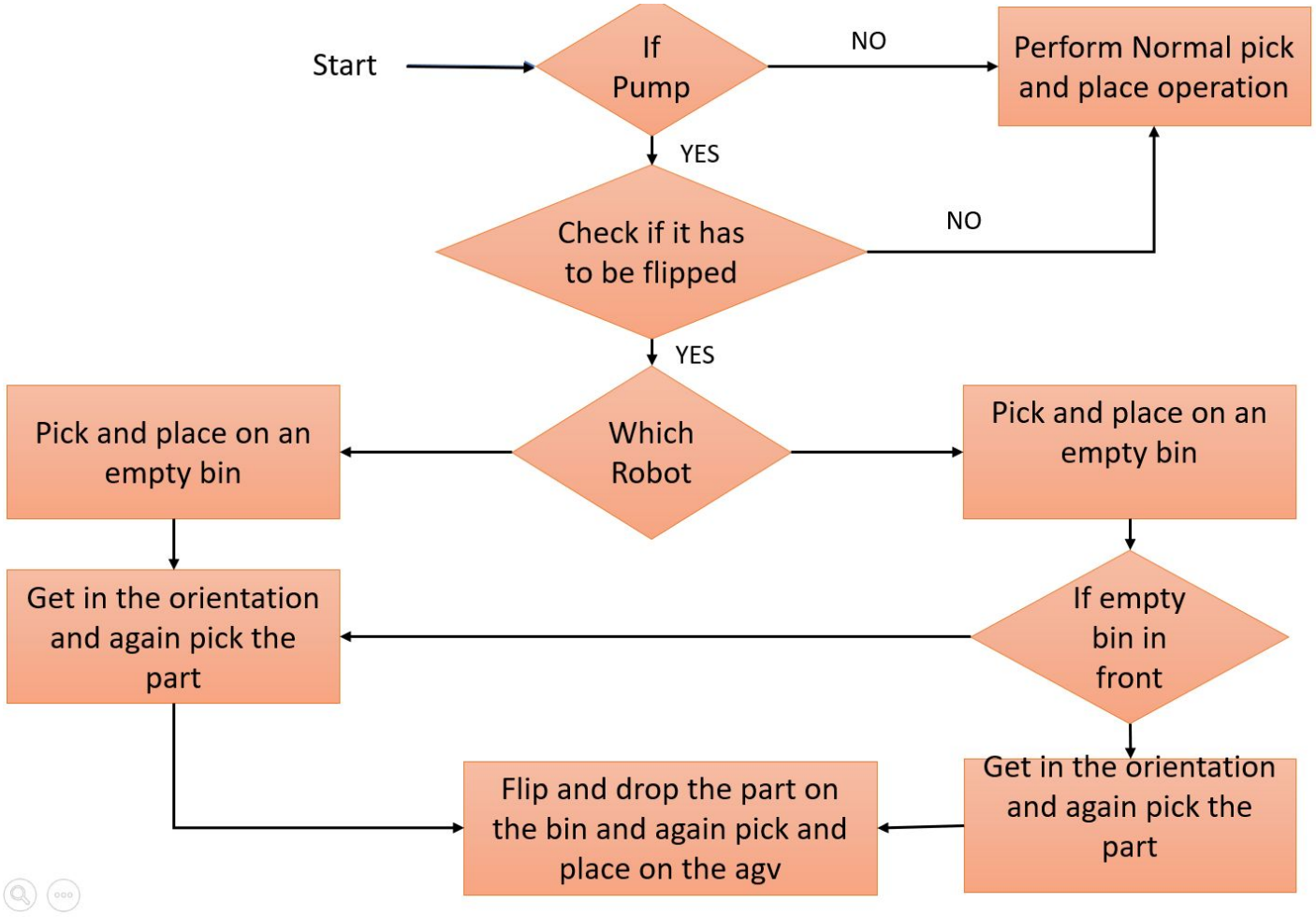
Gantry Preset Locations



Faulty Parts



Flipped Part



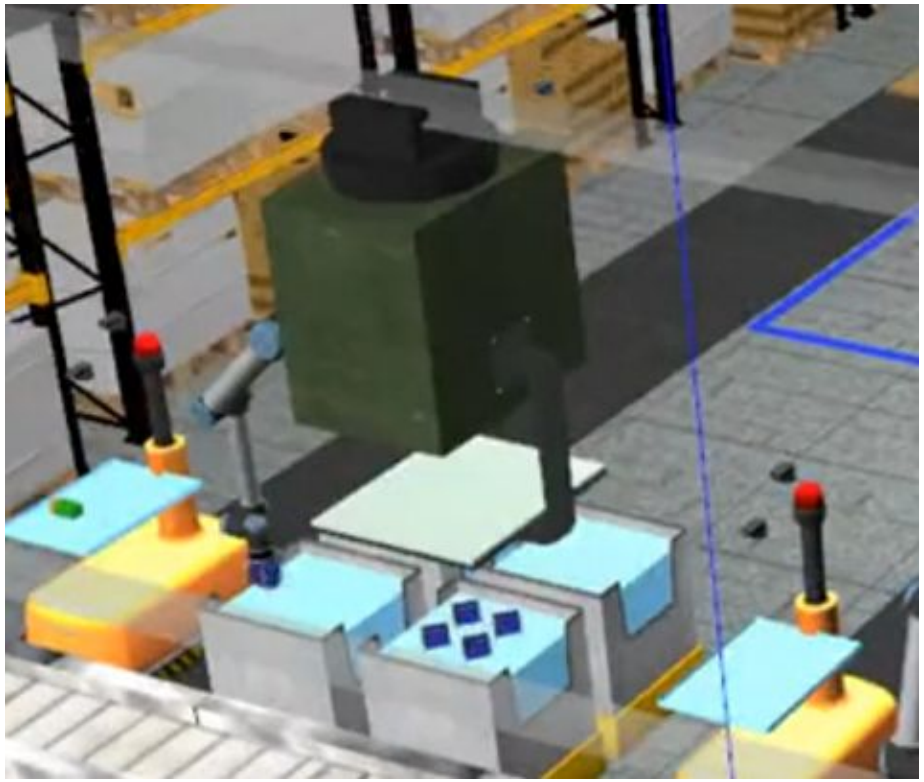


Fig. 1 : Pump pick-up from bins away from belt

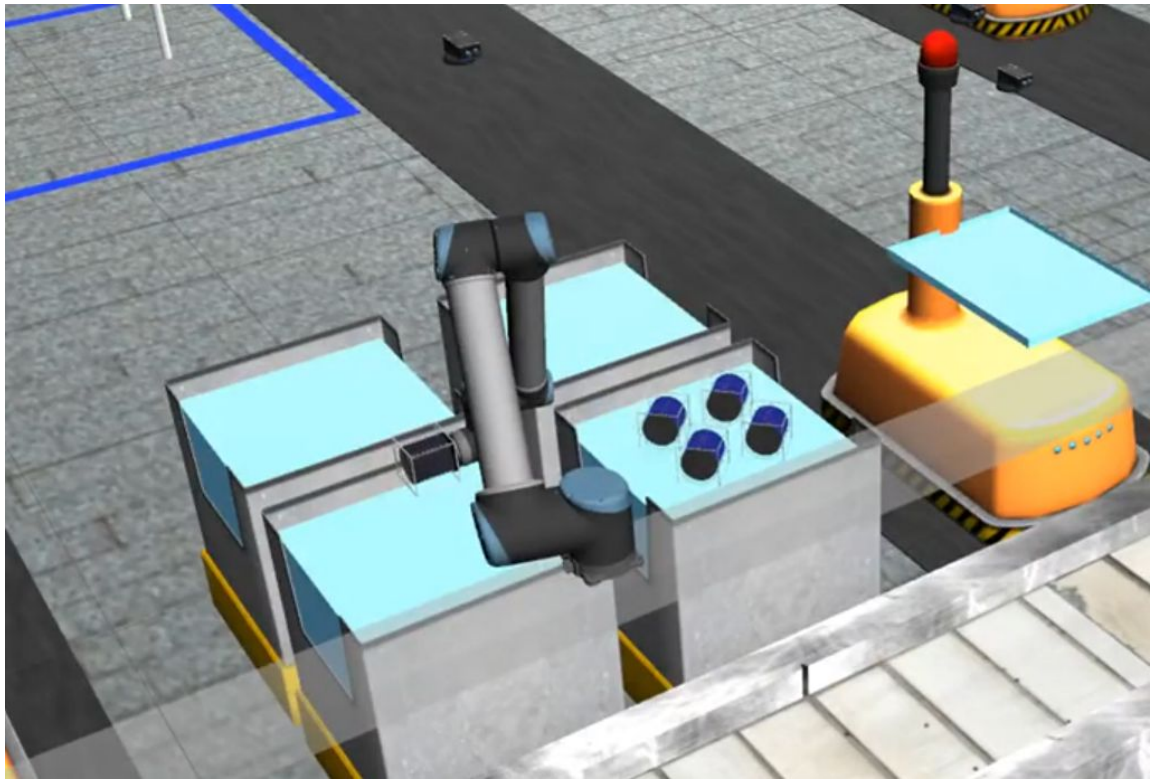


Fig. 2 : Flip using kitting arm

High Priority Order

- Begin kitting shipment for Order 0.
- If High priority order gets announced:
  - Halt kitting shipment process and start processing high priority shipment(either kitting or assembly).
  - Check whether pump needs to be flipped or any part placed on agv is faulty.
  - Submit shipment(s) for high priority.
- Place the remaining parts from the current shipment in order 0.
- Check if any faulty parts are still on agv(placed during blackout), if so replace.
- Move to assembly for Order 0, if required.

Sensor Blackout

- Logical camera(on bins) callback functions reset a timer when called.
- If the timer exceeds above a time limit, it is assumed to be a sensor blackout scenario.
- Parts placed during blackout get stored in a list to be replaced once all the products in the current shipment are processed.

Insufficient Parts

- Initially we create a world map and search for the parts required for the order and set a flag accordingly.
- Then we pick the parts from the conveyor and place them on the empty bins.
- Then we again call the logical cameras and create a new map.
- Finally we find the parts required for the order and set a flag accordingly.

Conveyor Part Pickup

- Kitting arm is used to pick parts from conveyor at the start of the competition.

- Breakbeam sensor on the conveyor belt used to trigger kitting arm movement for pickup.

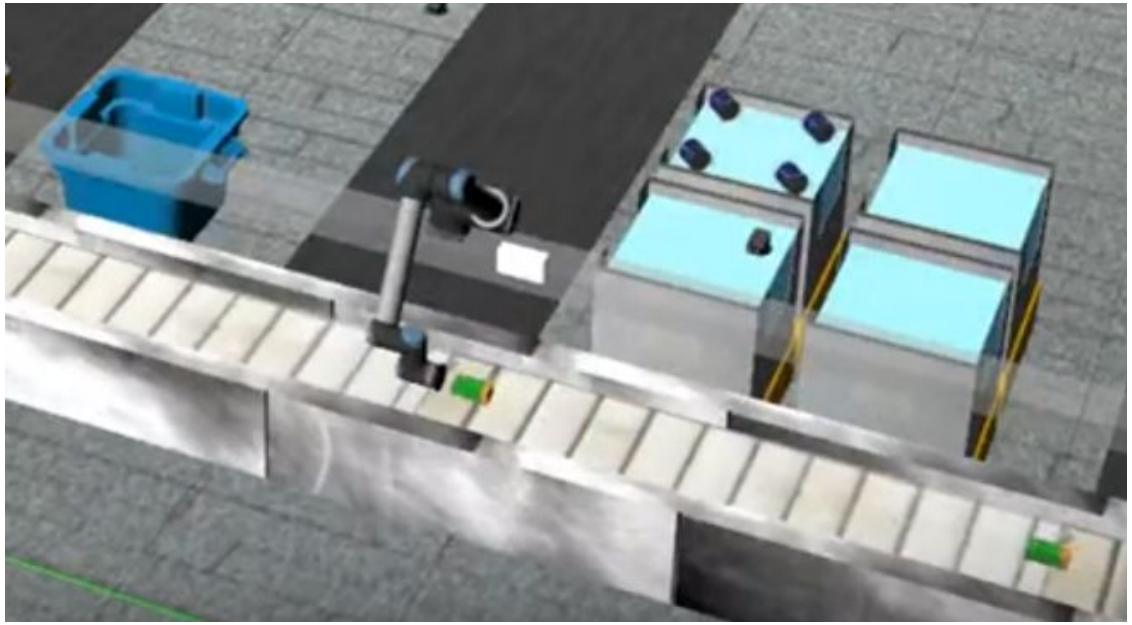


Fig. 3 : Battery pick-up from conveyor

Problems Encountered:

- Retrieving part frame names.
- Triggering sensor blackout condition using multiple logical cameras.
- Unexpected behavior of kitting arm during pick-up operation.
- Removal of correct faulty part from AGV after sensor blackout.
- Gantry preset location movement sequence.