

Embedded Hardware Protocol

English Algorithm Description

Approach: Sensors can be used to determine the position of the gripper assembly, but also to determine if the system has blockages or issues that need to be resolved before motors can move, or the tubes are picked up and placed. Errors/warnings will be thrown if blockages or movement issues are detected.

Startup Sequence:

1. Check carousel for tubes using sensors: for each reading of 1, map it's placement in the carousel as an unanalyzed tube and position of the carousel.
(Recording the placement allows us to test each tube one at a time using the gripper assembly and analyzer until we have picked up and analyzed each one in series. Once the tube is analyzed, it will be updated in the mappings as analyzed.)
2. Check gripper assembly is in a neutral/safe position to start running the program (top right): top sensor should read 1, right sensor should be 1. Check bottom and left sensors read 0. If bottom and left do not read 0, throw error to check for blockages. If the gripper assembly is in a position other than top right, with only two gripper assembly sensors reading 1, move the gripper assembly so that the top sensor and right sensor read 1 respectively so that the gripper is out of the way of the analyzer and carousel.
3. Check the analyzer currently does not have a tube on startup - Analyzer sensor reading should be 0. If it is NOT 0, and there's an open place in the carousel with a sensor reading of 0, move the existing tube into the carousel (using the running sequence) and update the mappings so the tube is recorded as analyzed, show a warning to the user. If there is no room in the carousel, throw an error for manual user intervention to remove the tube.

Running Sequence:

1. If carousel is full of unanalyzed tubes (all carousel sensors read 1, mappings show all are unanalyzed), move to step 2, if not move the carousel to the position where the gripper can grab the nearest unanalyzed tube, update position of carousel.
(If startup sequence has run correctly, the gripper assembly is starting at the top right position, with top sensor reading 1 and right sensor reading 1).
2. Move gripper assembly down to grab the tube until the bottom assembly sensor reads 1 and the gripper sensor reads 1.
3. When the gripper sensor is 1 and the carousel sensor is 1, start the gripper motion upwards, continue motion until the top sensor for the gripper assembly reads 1, carousel sensor with closest tube in position should now read 0, if not, throw error.
4. Retract gripper assembly to the left until left sensor reads 1, top sensor reads 1. Bottom and right gripper sensors should read 0, if not, throw error.
5. Move gripper down into the analyzer until the analyzer sensor reads 1, check bottom sensor for gripper assembly also reads 1.
6. Wait for signal from sampler that sample is finished analyzing.

7. Grip the tube in the sample analyzer and raise gripper assembly to the top-left, top sensor should read 1, left sensor 1.
8. Check the carousel sensor still reads 0 where we removed the tube, if so proceed to the next step, if not, throw error for manual intervention.
9. Move gripper assembly to the far right until right sensor reads 1, top sensor reads 1.
10. Move gripper assembly down to replace the tube until the bottom assembly sensor reads 1, right sensor reads 1, and the carousel sensor reads 1. Update carousel mappings and record the analyzed tube.
11. Move gripper assembly so the top sensor reads 1, right sensor reads 1.
12. Repeat the running sequence until all tubes are analyzed.