### Collaboration (messaging)

A handshake is made between the two robots. Each robot broadcasts an availability message. The distance to the table is sent with the first broadcast message. The robot that is closest to the table is elected the leader. The other robot that is not the leader moves away from the table and the leader. The second robot sends a *movedAway* message to the leader confirming that the way has been cleared for the leader to move to the table. Upon receiving the *movedAway* message from the other robot, the leader aligns itself to the table. After the leader has aligned itself to the table, a message is sent to the other robot confirming its status. When the other robot receives this message, it aligns itself to the opposite side.

### 1. Elect Leader

**PRE-CONDITION:**

Robot is connected to a network

**POST-CONDITION:**

Failure if no timely reply from another robot. Otherwise, this robot and another robot have formed a pair.

The leader raises its left hand to visually display its leadership status.

**MESSAGE:**

Distance to table

Unique IP Address

**DESCRIPTION**

Robot broadcasts an existence message. If another robot replies, the two robots exchange messages to make a pair. The robot that is closest to the table become the leader and the second robot becomes the assistant.

### 2. Run Away

**PRE-CONDITION:**

Robot is anywhere in the room

**POST-CONDITION:**

Robot has made a U-turn and moved away for t seconds.

**DESCRIPTION**

Robot makes a U-turn and moves away in that direction for t seconds avoiding obstacles

### 3.Make Way

**PRE-CONDITION:**

* Robot is the second robot of a pair

**POST-CONDITION:**

* Robot is away from the table.
* Robot has sent a message to the leader. The message notifies that the robot is not in the way of the leader and the table.

**MESSAGE TO LEADER ROBOT:**

* Way to table cleared

**DESCRIPTION** Robot looks for the table and moves away from it if it is close to the table. The robot checks the direction of the table. Once the direction of the table is found, the robot turns and walks away from the table.\*\*\*\*\*\*\*\*check this

### 4. Align To Other Side Of Table

**PRE-CONDITION:**

The leader has aligned close to a longer edge of the table.

The leader has given the ready to lift message.

**POST-CONDITION:**

* This robot has aligned to the opposite side of the table to the leader.

**Description**

The other robot locates the leader and the table. This robot goes to the opposite side of the table with respect to the leader.

### 5. Look For Table

**PRE-CONDITION:**

There are no pre-conditions for this behaviour.

**POST-CONDITION:**

* the robot has stopped.
* the robot is either facing the table or has not found the table within the set time limit.
* The table is in the middle of the field of view.

**Description**

This robot looks left, straight ahead and right turning its head to locate the table. If the table is not found, then it spins around to face the opposite side and looks left and right to locate the table. If the table is still not found, this robot walks randomly for x metres and looks again.

### 6. Go To Table

**PRE-CONDITION:**

The table is in the field of view of the robot.

**POST-CONDITION:**

The corner of the table is in the central bottom region of the field of view. That is, the robot is close to a corner of the table.

**Description**

If the previous behaviour was successful, the robot can approach the table. The robot aims at the nearest corner of the table so that it will be well positioned later to assess which side of the table is the longest by simply looking left and right

The robot walks towards the corner the table until the corner of the table is in the middle of the field of view of the robot.

After determining which side adjacent to the corner is the longest, the robot performs a walk sideways (like a crab) to position itself at the middle of the longest side of the table.

Once at the corner, this robot calls position to centre of table.

### 7. Position To Centre Of Table Side

**PRE-CONDITION:**

The pre-condition is that the robot is standing close to a corner of the table.

**POST-CONDITION:**

The post-condition is that the robot is standing close to the middle of the long side of the table.

**Description**

The robot is looking at the V corner of the table. The robot turns at an angle (45 degrees) to align horizontally to the table. The robot then walks sideways to move toward the middle of the table. The robot ends up horizontally on the longer side of the table.

### 8. Re-centre to middle of table

**PRE-CONDITION:**

Robot is aligned at the longer edge of the table.

**POST-CONDITION:**

Robot is aligned in the centre of the longer edge of the table.

**Description:**

The robot looks left and right to determine its position at the table. It then moves sideways left or right until it adjusts to the middle of the longer edge of the table.

### 9. Go To Opposite Side Of Table

**PRE-CONDITION:**

The pre-conditions are

* the table is in the field of view of the robot.
* Robot 1 is positioned at a long side of the table.

**POST-CONDITION:**

The post-condition is Robot 2 is positioned opposite to Robot 1 across the table.

**Description:**

Robot 2 can detect whether Robot 1 stands behind the table by checking whether the image blob of the table is below the image blob of Robot1. When Robot 2 arrives at its target position opposite to Robot 1, it sends a signal to Robot 1. Once the signal is received, Robot 1 can initiate the simultaneous movement of the two robots. The MoveTable behaviour is essentially the same for Robot 1 and Robot 2 apart from the signalling part as Robot 1 orchestrates the motion.

### 10. Move Table

The pre-condition is that the robot is standing at the long side of the table opposite to the other robot. The post-condition is the table has been moved sideways by a predened distance. The behaviour MoveTable relies on the repeated iteration of five other behaviours. These behaviours are PositionToCentreOfTableSide, PrepareToMoveTable, LiftTable, SmallStepSideWays and LandTable. A synchronised version of the behaviours of Section 3.1 is used in this scenario.

### 11. Prepare To Move Table

The pre-condition is that the robots are positioned at the centre of the opposite long sides of the table. The post-condition is the protocol handshake has been completed. In particular, both robots have sent and received a ReadyToLift message.

### 12. Align To Middle Of Table

Pre-Condition: Table is in the field of view Longer edge is horizontal relative to the robots field of view

**Post Condiition:**

The robot is now in a position to put its arms under the table and lift it.

**MESSAGE TO OTHER ROBOT:**

* Robot is in the centre of the table
* Ready to lift

**Description:**

Blue pixels on either side of the field of view Bottom most point > 80% of field of view

The robot align horizontally with table with 5% error margin The robot then looks left and right to adjust to the middle of the longer edge of the table such that c <= L/R <= 1 where c is the threshold. The robot walks ahead until bottom most edge is > 90% of field of view.

### 13.Go To The Lifting Point

**PRE-CONDITION:**

Robot is at the corner of the table

**POST-CONDITION:**

Robot is in the middle of the longest side of the table.

**Description** Turning its head, the robot measures the two sides adjacent to the corner.