

HUMAN ROBOTIC INTERACTION

After the components are recognized through computer vision, they are then integrated in place through Human- Robotic- Collaboration (HRC).

HUMAN ROBOTIC ASSEMBLY SET UP

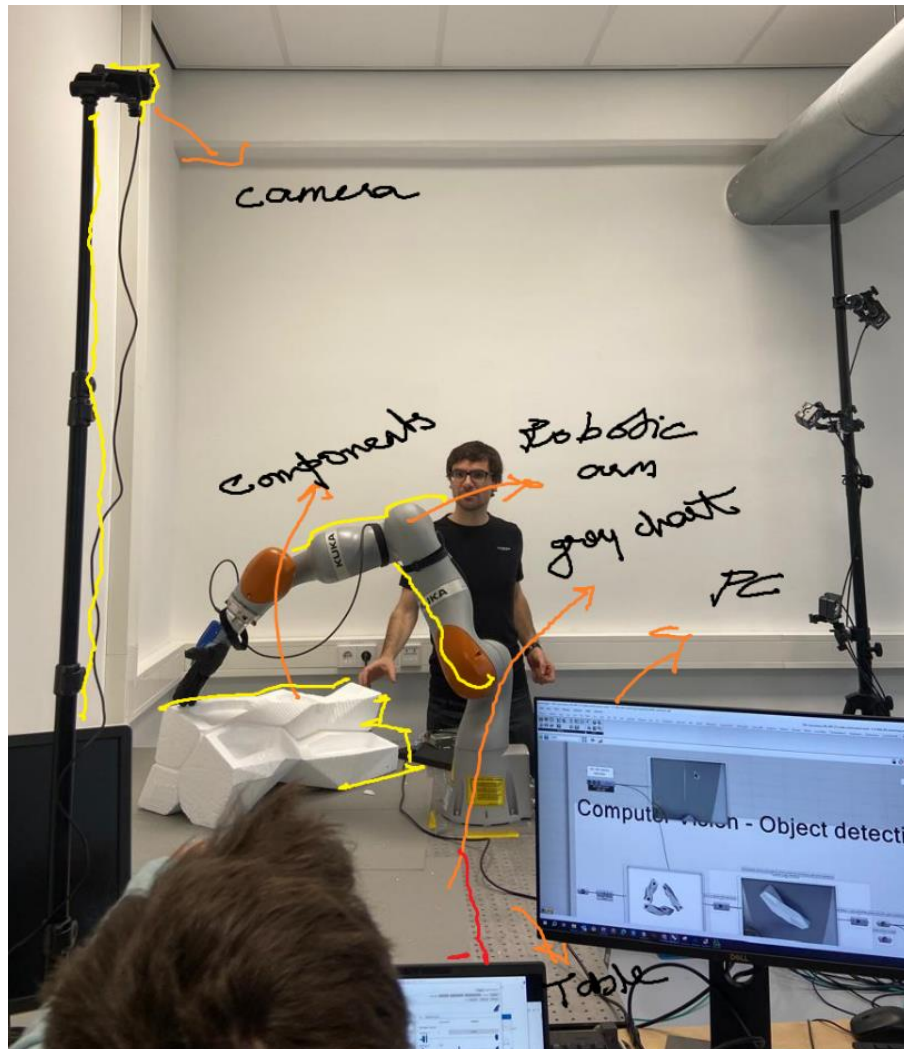


Fig 1. HRI Set up

- Camera: It is a part of computer vision to identify the location of the components in relation to the component and the table.
- Marker points: Here, grey chart was placed on the table and its end coordinates were to be identified by the camera and translated to the computer as location points for the robotic arm.
- Grip location: The robotic arm follows a defined path through set of coordinate points to the location where it can grip the component in a secure and balanced way.
- Point of origin and end point: These points are generated after computer vision by providing the coordinates and defined path for the robotic arm movement from the origin to the endpoint.
- Size of component and distance from the table: To reduce crashing between the component and the table, the robot should have this information when generating the path between points.

HUMAN ROBOTIC ASSEMBLY PROCESS

1. The robot must accurately locate the frame and table by providing the coordinates of each vertex of the frame and capturing corresponding images with the camera to mark their positions in the computer.
2. Safety protocols necessitate, defining specific mid-air node points to guide the robotic arm's movement and limiting its speed to minimize potential damage in case of accidents.
3. Precise and relative positioning of cells is crucial for integration. For instance, when moving a cell to the right of another, the robot's hand should grasp the right side to avoid collisions with the left cell. Additionally, the robot should slow down as it approaches the target cell.
4. Due to inaccuracies in translating 3D vision from the camera into a 2D control frame on the computer, simply pointing to the component hole does not guarantee the robot arm's exact placement. Calibrating for height discrepancies requires human collaboration.
5. Upon reaching the hole, the robot hand is provided with human instructions on how to grasp it and the appropriate force needed to lift the component.
6. The robot arm with human support to balance the component, moves towards the other components based on the coordinates provided and places the components together. The arm is slowed down and stiffness in it reduced to place the component down.



Fig 1. HRI process