MFG 598 FINAL PROJECT

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Robot for Part (A)

- **Robot Selected**: R-2000iC/165F
- **Justification**:
- **Payload Capacity**:
  - The **R-2000iC/165F** has a **payload capacity of 165 kg**.
  - **Reason for Selection**: This is suitable for the machine tending workcell because it allows the robot to lift both **heavy raw parts and finished parts**. Machine tending often requires the robot to carry components of various weights, and this payload is more than sufficient to handle the parts without reaching load limits, ensuring reliability.
- **Reach**:
  - The **maximum reach** of the R-2000iC/165F is **3095 mm**.
  - **Reason for Selection**: The large workspace for machine tending often requires the robot to have **sufficient reach to load and unload parts into the CNC machine**, as well as move between different stations (e.g., raw part area to finished part area). The reach of 3095 mm easily accommodates the movement between these positions, providing flexibility and ensuring that no extra motions are required.
- **Speed/Cycle Time**:
  - The **speed** and robust design of the R-2000iC/165F make it ideal for keeping up with the demands of a **24-hour cycle** while maintaining high precision.
  - **Reason for Selection**: It can easily maintain the desired cycle time requirements to meet 350, 600, or 1000 operation cycles, as the high payload also adds stability during high-speed operations. This combination ensures **minimal downtime** and consistency throughout the operation, which is key for machine tending.

https://www.fanuc.eu/eu-en/product/robot/r-2000ic165f

Work-cell Explanation

- **Workcell Part A: Machine Tending**
- **Robot Selected**: R-2000iC/165F
- **Robot Tasks in the Workcell**:
- **Picking Up Raw Parts**:
  - The robot starts at a **pick-up station** where raw parts are presented. The robot uses a **pneumatic gripper** to pick up the raw part securely.
  - **Sensors** detect the presence of a raw part, and the robot is triggered to approach the part, align using its 6-axis capabilities, and close the gripper for secure handling.
- **Loading into CNC Machine**:
  - The robot then moves the raw part to the **CNC lathe machine**. It must position the part precisely to ensure accurate loading.
  - The CNC machine opens, and the robot carefully places the part inside, ensuring it is properly aligned before releasing it.
  - **Cycle time and synchronization** are crucial—sensors indicate when the CNC machine is ready for loading, and the robot waits if the CNC is still in operation.
- **Unloading and Moving to Finished Part Area**:
  - Once the machining process is complete, the robot re-engages to pick up the finished part from the CNC machine.
  - The finished part is then moved to a designated **finished part area**, where it is placed accurately for further handling or quality inspection.
  - The **reach** of the R-2000iC/165F allows it to efficiently transition between the pick-up station, CNC machine, and finished part area without needing repositioning.
- **Status Indication**:
  - A **light bar** is integrated within the workcell to indicate the robot's status:
    - **Green**: Robot running and tending the CNC.
    - **Yellow**: Robot waiting for CNC to become available.
    - **Red**: Stopped due to error or emergency stop.

Part A Roboguide Video

https://drive.google.com/file/d/1LfGBOQbzOS59Pkr2mU_UkoCtXQdPP49i/view?usp=sharing

This video demonstrates the **R-2000iC/165F** robot in action, executing the full machine tending process. The robot picks up raw parts, loads them into the CNC machine, and then transfers the finished parts to the designated area with precision.

Robot used for Part (B)

- **Robot Selected**: CRX-20iA/L
- **Justification**:
- **Payload Capacity**:
  - The **CRX-20iA/L** has a **payload capacity of 20 kg**.
  - **Reason for Selection**: For palletizing, the parts are **small, uniform cubes**, and each part has a relatively **low weight**. The 20 kg payload capacity is more than enough to handle the weight of a single cube, even if multiple parts are being manipulated simultaneously. This ensures that the robot is capable of handling any variations in part presentation without issues related to payload.
- **Reach**:
  - The **maximum reach** of the CRX-20iA/L is **1418 mm**.
  - **Reason for Selection**: The workcell requires the robot to pick up cubes from a conveyor and place them into a box that can hold up to 270 parts. The reach of 1418 mm is optimal for accessing all areas within the workspace, ensuring efficient palletizing without repositioning the robot or conveyor.
- **Speed/Cycle Time**:
  - The **cycle time** for part B is critical—each cube reaches the optimum position every **10 seconds**.
  - **Reason for Selection**: The CRX-20iA/L has sufficient speed to **pick up the part and place it within the box** within the required 10-second timeframe. Its **collaborative nature** also makes it well-suited for palletizing tasks, as it can operate with precision and adapt to the 10-second intervals without unnecessary waiting or bottlenecks

https://www.fanuc.eu/eu-en/product/robot/crx-20ial

Workcell Explanation

- **Workcell Part B: Palletizing**
- **Robot Selected**: CRX-20iA/L
- **Robot Tasks in the Workcell**:
- **Picking Up Parts from the Conveyor**:
  - A conveyor presents **small, uniform parts (cubes)** at regular intervals (every **10 seconds**). Sensors along the conveyor detect when a new part has arrived at the pick-up location.
  - The CRX-20iA/L uses a **vacuum gripper** to lift the cube from the conveyor. The vacuum gripper is ideal for this task because it provides a fast and reliable method of handling lightweight, uniform objects.
- **Moving Parts to the Box**:
  - The robot then moves the part to a **larger box** on a separate conveyor where the cubes are to be placed.
  - The box can hold up to **270 parts**, and the robot carefully positions each cube in a predetermined layout to maximize space efficiency.
  - The robot's **1418 mm reach** allows it to access the entire box without any repositioning, making the operation smooth and efficient.
- **Cycle Time Maintenance**:
  - Since a new part arrives every **10 seconds**, the robot is programmed to **complete each pick-and-place operation** within this cycle time to avoid backlog.
  - The robot's collaborative nature ensures safe and adaptive operation within the workspace, and its **speed** ensures that there is no delay in picking up parts as they arrive.
- **Status Indication**:
  - The **light bar** within this workcell displays:
    - **Green**: Robot picking and placing cubes as intended.
    - **Yellow**: Waiting for a cube to reach the optimal pick-up position.
    - **Red**: An error has occurred, such as a jammed conveyor or faulty vacuum suction.

Part B Video and Lab Demo

https://drive.google.com/file/d/1PaUdxAmvGVDGNy1udMRsbI4iCxg5y4XS/view?usp=drive_link

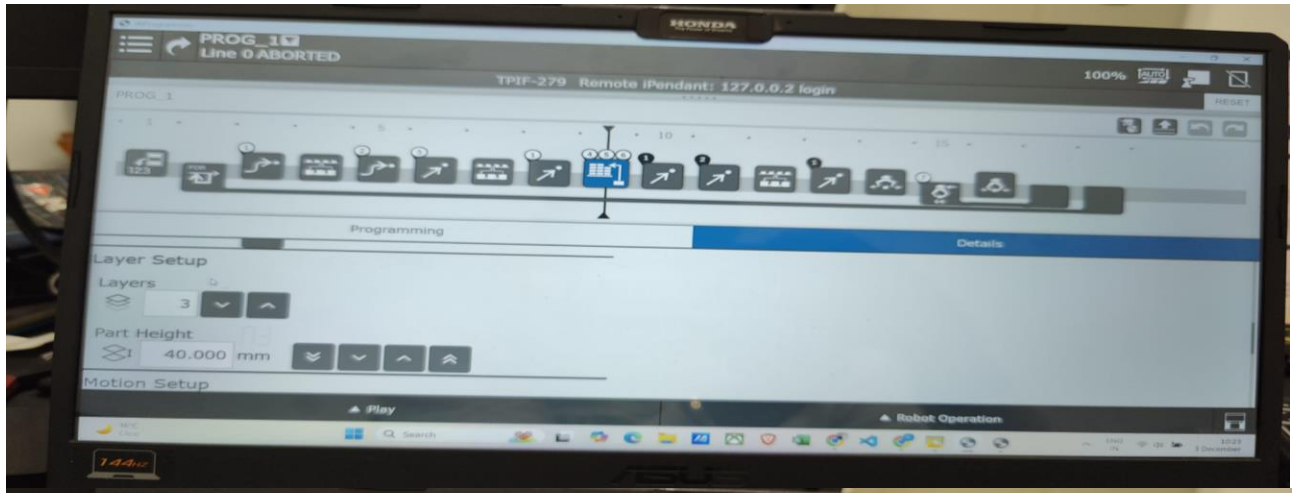
https://drive.google.com/file/d/1sb3MhL-aGIM-s4rP5SaUhlQmk-qjS4su/view?usp=sharing

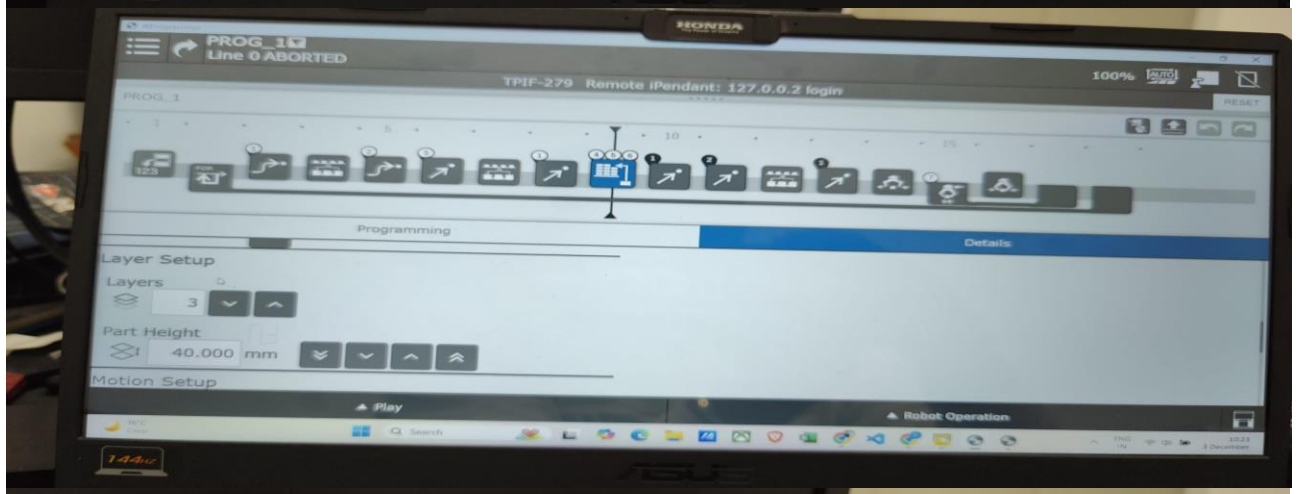
This lab demonstration shows a similar palletizing setup, where the robot picks up **square blocks** and places them into a palletizing box. The operation replicates the same functionality as the digital Part B workcell, focusing on precise block handling and efficient placement.

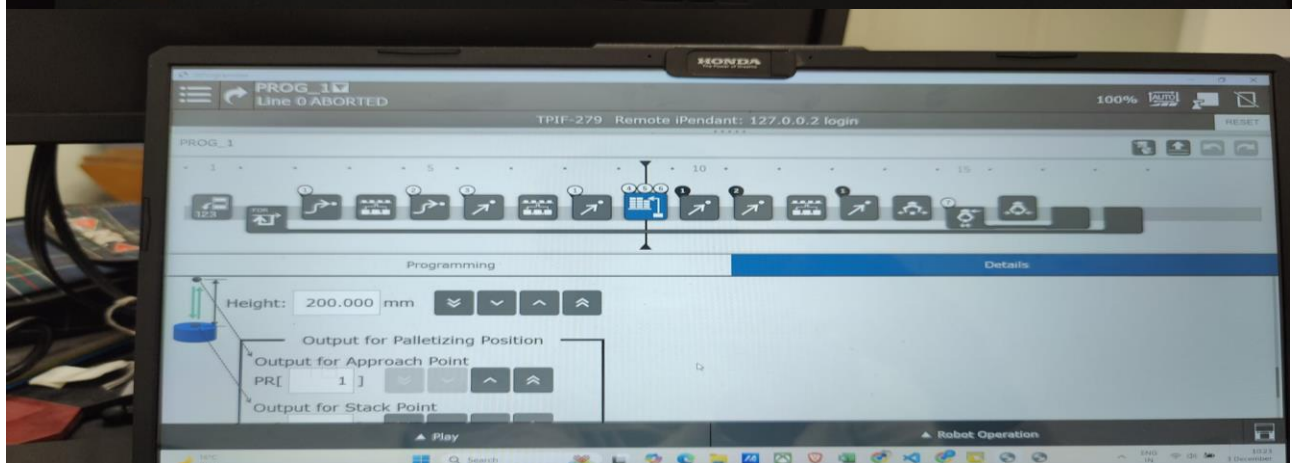
https://drive.google.com/file/d/104BWwXeaYhW0bOotz8sig5ni0sEmjpYS/view?usp=sharing

In this video, the **CRX-20iA/L** robot performs palletizing by picking up cubes from the conveyor using a **pointer vacuum gripper**. The robot accurately places the parts into the palletizing box, maintaining a 10-second cycle time.

Part B Roboguide code







Light Station Setup: Workcell Overview

- **Light Station Setup and Status Indicators**
- **Purpose**:
  - Provides **real-time visual feedback** on the robot's operational status.
  - Enhances **operator awareness** and ensures **safety**.
  - **Color Indicators**:
- **Red Light**:
  - **Status**: Robot stopped due to an issue or emergency.
  - **Action Required**: Operator intervention needed.
- **Yellow Light**:
  - **Status**: Robot waiting for a specific condition (e.g., part positioning).
  - **Example**: In the palletizing workcell, the robot waits for the cube to reach the pick-up position.
- **Green Light**:
  - **Status**: Robot is running smoothly.
  - **Action**: Indicates normal operation—picking, loading, unloading, or assembling parts.
  - **Key Benefits**:
- **Efficiency**:
  - Operators can understand the robot's status at a glance.
  - Minimizes downtime by enabling quick response to any issues.
- **Safety**:
  - **Visual cues** help operators avoid approaching the workcell during hazardous states.
  - Ensures a safe working environment with clear, actionable signals.

Part C Robot

- Robot Selected: CRX-20iA/L
- Justification:
- Payload Capacity:
  - The CRX-20iA/L robot is also used for kitting, where it has to handle 5 distinct parts.
  - Reason for Selection: Since the parts are not uniform but still relatively lightweight, the 20 kg payload capacity ensures that it can handle a variety of part sizes without compromising on accuracy or exceeding payload limits.
- Reach:
  - The reach of 1418 mm makes it suitable for accessing all areas within the kitting box.
  - Reason for Selection: This reach allows the robot to place the parts into specific locations in the kitting box, even if those parts are positioned at different angles. It ensures that every corner of the kitting container is accessible, which is critical for precise part placement.
- Speed/Cycle Time:
  - Kitting typically requires the robot to adapt to different part sizes and orientations.
  - Reason for Selection: The CRX-20iA/L, being a collaborative robot, has sufficient speed to handle the parts in a timely manner while still offering fine control for accuracy. This is crucial in ensuring that each part is placed exactly as required, maintaining consistency across the kitting operations.

https://crx.fanucamerica.com/crx-20ia-l

Workcell Explanation

- **Workcell Part C: Kitting**
- **Robot Selected**: CRX-20iA/L
- **Robot Tasks in the Workcell**:
- **Picking Up Distinct Parts**:
  - The robot is tasked with assembling a **kit of 5 distinct parts**. These parts are not uniform in size or shape, and are presented at different angles within a bin or on a conveyor.
  - The CRX-20iA/L uses an **electric parallel gripper** for this task, as it offers precise control and adaptability for handling parts of different shapes and orientations.
- **Positioning Parts into the Kitting Box**:
  - The robot carefully places each part into a **kitting box** in specific positions. Since each part is distinct and might need different orientations, the robot uses its **6-axis capability** to precisely position each part as needed.
  - The **reach of 1418 mm** allows the robot to access all areas of the kitting box, ensuring that each part is accurately placed without repositioning or misalignment.
- **Ensuring Precision and Quality**:
  - To guarantee that each part is placed correctly, the robot uses a combination of **vision sensors** (if available) and pre-programmed points for precise part positioning. This ensures the assembly meets the required quality standards.
- **Status Indication**:
  - The **light bar** indicates the following statuses:
    - **Green**: Robot assembling the kit correctly.
    - **Yellow**: Waiting for parts or adjusting position.
    - **Red**: Error due to part misplacement or incorrect gripping.

THANK YOU!