**Individual Research Project Interim Report**

**Project Overview:**

In modern industrial and research contexts, robotic arms must dynamically adapt to changing tasks and environments. Conventional position-based controllers often lack responsiveness and might not be able to meet real-time precision requirements. Resolved-Rate Motion Control (RRMC) provides a robust alternative by mapping desired end-effector velocities to each joint’s velocity command through the Jacobian pseudo-inverse. This project seeks to develop Advanced Velocity Control using the RRMC method. The aim is to enhance adaptability, accuracy, and operational safety in applications such as manufacturing pick-and-place or logistics sorting.

**Project Description:**

* **Simulation & Modeling**
  + Using Robotics System Toolbox to import a rigidBodyTree model
  + Validating forward and inverse kinematics in Simulink.
* **RRMC Algorithm Development**
  + Defining end-effector velocity targets.
  + Computing the Jacobian each step, then apply the pseudo-inverse.
  + Commanding joint velocities, ensuring enforcement of joint limits and avoiding collisions.
* **Implementation & Testing**
  + Visualising results in Simulink 3D.
  + Collecting data on tracking accuracy and responsiveness.
  + Comparing basic RRMC vs. advanced approaches (e.g., QP-based velocity control).

**Literature Review:**

In the early research of differential kinematics, the major trend is to focus on basic velocity control. However, advanced techniques have emerged, such as using null-space projection for redundancy and optimization of secondary objectives. The recent researches emphasize integrating second-order kinematics for better performance near singularities and for complex motion planning. From two references, the detailed introduction about how RRMC can be extended into a robust closed-loop scheme that accounts for velocity constraints, improving real-time adaptability compared to static IK solutions is presented. In particular, the pseudo-inverse of the Jacobian is key to converting desired task-space motion into safe and precise joint-space commands.

**Future Plan:**

