1. Purpose:

To develop a controller for my home-made robot arm that uses common robotics inverse kinematics principles for under $300 with 1 centimeter accuracy and the ability to track linear trajectories in its operating space. It will complete a linear path following task where the robot will move to a location while maintaining the orientation of the end effector from point a to b.

2. Deliverables:

- The robot CAD and design files including drawings and BOM.
- The robot hardware 3D printed in PLA.
- Updated robot hardware for my robot arm with a claw gripper.
- A controller that allows me to move the robot with Arduino code.
- A set of mathematical functions representing the robot position of the arm tip and the angles of the arm's joints at any given point in time.
- A demonstration of the robot completing a pick and place task

Project Start Date: August 1st, 2023

Projected Expected Completion Date: August 24th, 2023

Figure 1 Current Custom Robot Arm Hardware

3. Logical sequence phase map for project organization:

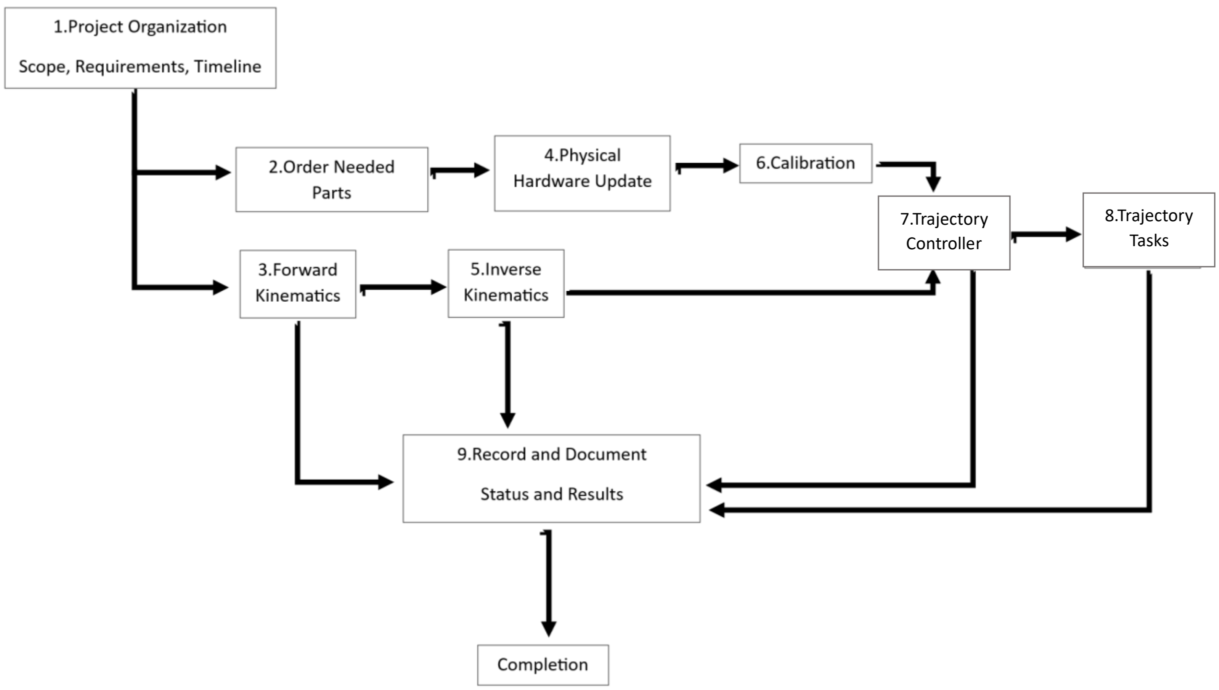

Figure 2 logical sequential phases for Robot Inverse Kinematics Project

The above logical phase sequence diagram contains a list of 9 primary actions to achieve the expected deliverables. Each phase or task corresponds to a number as listed in the diagram. The arrows indicate the project flow. Where the branch splits at tasks 2 and 3 represents actions that can be completed in parallel or are otherwise independent of each other. Task 7 requires that both tasks 5 and 6 be completed first. Note that regular documentation and recording of the work done will be updated in tandem with each phase as indicated by task 9. The numbers of each task will be listed below with related dependencies and a timeline for accomplishing those tasks. Dependencies indicate the needed resources.

4. Task dependencies and timeline

1. Dependencies: None
   Timeline: August 1st to August 3th
   Task State: Completed

2. Dependencies: Costs Status: Resolved
   Contingency plan: Go without gripper. Simply move robot to pick and place locations as if holding object.
   Timeline: August 1th to August 3th
   Task State: Completed

3. Dependencies: CAD Model
   Timeline: August 3th to August 10th
   Task State: Completed

4. Dependencies: Robot Hardware Status: Resolved
   Contingency plan: Perform tasks in simulation only
   Timeline: August 3th to August 10th
   Task State: Completed

5. Dependencies: Completed Forward Kinematics Status: Resolved
   Contingency plan: Use Iterative IK rather than direct IK
   Timeline: August 10th to August 20th
   Task State: Completed

6. Dependencies: None
   Timeline: August 19th to August 21th
   Task State: Completed

7. Dependencies: Calibration and Inverse Kinematics Status: Resolved
   Contingency plan: Push back project deadline
   Timeline: August 25th to August 23
   Task State: Completed

8. Dependencies: Trajectory Planner Status: Resolved
   Contingency plan: Push back project deadline
   Timeline: August 1st to August 23th
   Task State: Completed

5. Project References

The below citations are useful resources for guiding the project development and helping to complete the expected tasks.

Anfis. MATLAB & Simulink. (n.d.). Retrieved April 12, 2023, from https://www.mathworks.com/help/fuzzy/modeling-inverse-kinematics-in-a-robotic-arm.html

Earl, B. (n.d.). *Adafruit PCA9685 16-channel servo driver*. Adafruit Learning System. Retrieved April 12, 2023, from https://learn.adafruit.com/16-channel-pwm-servo-driver/hooking-it-up

Instructs, R., & Instructables. (2017, November 5). *Servo feedback hack (free)*. Instructables. Retrieved April 12, 2023, from https://www.instructables.com/Servo-Feedback-Hack-free/

Wikimedia Foundation. (2023, April 10). *Inverse kinematics*. Wikipedia. Retrieved April 12, 2023, from https://en.wikipedia.org/wiki/Inverse_kinematics

G. -S. Huang, C. -K. Tung, H. -C. Lin and S. -H. Hsiao, "Inverse kinematics analysis trajectory planning for a robot arm," 2011 8th Asian Control Conference (ASCC), *Kaohsiung, Taiwan, 2011, pp. 965-970.*