**Robotic Arm Documentation**

**1. Design Process**

**CAD Design**

* **Software Used**: SolidWorks
* **Components**:
  + **Base**: Includes the mounting plate and base structure.
  + **Revolute Joint**: Used at the elbow joint for rotational movement.
  + **Prismatic Joint**: Implemented in the arm segment for linear extension/retraction.
  + **Spherical Joint**: Incorporated at the wrist for omnidirectional rotation.
* **Assembly**: Detailed assembly process ensuring all components fit together correctly.

**Design Considerations**

* **Dimensions**: Detailed measurements for each component.
* **Material Selection**: Chosen for durability and weight considerations.
* **Interference Check**: Ensured no collisions between moving parts.

**2. Simulation Setup**

**Simulation Environment**

* **Software Used**: Gazebo
* **Importing CAD Model**:
  + Ensured accurate import and scaling of the robotic arm model.
* **Joint Configuration**:
  + Set up revolute, prismatic, and spherical joints according to CAD specifications.
* **Physics Simulation**:
  + Validated movements and interactions with virtual environments.

**3. Control Algorithms**

**Algorithm Development**

* **Task**: Object Manipulation (Pick and Place)
* **Approach**: Implemented inverse kinematics to calculate joint angles for desired end-effector positions.
* **Programming Language**: Python
* **Integration**: Ensured smooth communication between control algorithm and simulation environment.

**4. Testing and Validation**

**Test Scenarios**

* **Scenario 1**: Pick an object from coordinates (x1, y1, z1).
  + **Execution**: Ran simulation to verify arm's ability to grasp and lift object.
  + **Results**: Object successfully lifted without collision.
* **Scenario 2**: Place object at coordinates (x2, y2, z2).
  + **Execution**: Simulated arm movement to place the object accurately.
  + **Results**: Object positioned within specified coordinates with precision.
* **Scenario 3**: Follow predefined path (trajectory).
  + **Execution**: Programmed arm to follow a defined trajectory in simulation.
  + **Results**: Arm successfully traced the trajectory path, demonstrating path-following capability.

**5. Documentation**

**Summary**

* **Objectives Achieved**: Successfully designed, simulated, and controlled a robotic arm with revolute, prismatic, and spherical joints.
* **Challenges**: Addressed integration issues between CAD, simulation, and control algorithms.

**Conclusion**

* **Future Improvements**: Enhance control algorithms for real-time responsiveness and explore more complex tasks.

**Visual Aids**

* **Screenshots**: Included snapshots of CAD design, simulation setup, and test scenarios.
* **Videos**: Recorded videos demonstrating arm movements during test scenarios.