**Objective**: Design and develop an actuator system capable of replicating human operator actions to control various machine interfaces, including steering wheels, joysticks, levers, and other mechanical controls essential for machine operation. This will involve creating the mechanical mechanisms, control system architecture, and software necessary to operate the devices. The system must be universal and the intended use is “temporary” which I will have designed fasteners/attachments case by case to retrofit to equipment. Once developed, the system will be integrated with my RF control system to enable seamless wireless actuation.

**Core Functionalities**:

* **Steering Wheel Operation**:
  + Rotate the steering wheel with precision and torque similar to human input.
  + Capable of handling continuous and variable speed rotations.
  + Include feedback mechanisms to adjust to resistance and ensure smooth motion.
* **Joystick Operation**:
  + Move the joystick in multiple axes (e.g., up/down, left/right, diagonal) with controlled speed and force.
  + Capable of fine adjustments for precise control.
* **Lever Operation**:
  + Push, pull, or lift levers with varying levels of resistance.
  + Account for both single-action and multi-step lever operations.
* **Switch replication:** 
  + Parallel electrical circuitry by replicating with control system digital or analogue

**Design Considerations**:

* **Human-like Dynamics**: The actuators should replicate the force, speed, and range of motion of human arms and hands.
* **Feedback Mechanisms**: Integrate sensors (e.g., force, position, torque) to provide feedback for adaptive control and safety.
* **Safety and Redundancy**: Include functional safety mechanisms to prevent unintended movements or overloads.
* **Ease of Integration**: Design the actuators to fit into existing machine setups with minimal modifications.

**Control System**:

* Programmable user interface (external) to make adjustments in field to add/remove functions.
* Must allow programmable input to execute predefined movement patterns.
* Should have a manual override option to switch between autonomous and manual modes.
* Include interfaces for real-time monitoring and diagnostics.
* Programmable inputs/outputs for digital/analogue
* RS232/CAN or other communication interface for expansion.

**Performance Metrics**:

* Accuracy: ±1 degree for rotational movements; ±1 mm for linear movements.
* Force/Torque: Match typical human exertion levels for the tasks.
* Speed: Adjustable, with ranges matching typical human motion.
* Ideally, if the actuators can be installed, record range of motion and then replicate.

**Environment**:

* Designed for operation in industrial and outdoor environments, withstanding temperature variations, dust, and vibrations.

**Future Expansion**:

* Modular design to support additional actuators or control interfaces for other tasks as needed.