

Requirements for the RL system:

Accuracy:

- **Requirement:** When the orientation has changed, the robot shall accurately estimate its actual orientation (**Root orientation & root angular velocity**).
- **Potential Design Solutions:**
 - Use high quality sensors that better measure the actual orientation of the root in the 3D space.
 - Estimate the orientation using advanced computer vision techniques
 - Combine the output of many sensors and techniques for a better estimation of the actual orientation.
- **Requirement:** When the position has changed, the robot shall accurately estimate the root linear velocity.
- **Potential Design Solutions:**
 - Combine kinematics and vision-based data for a better estimation.
- **Requirement:** When executing PD position targets for 12 joints, the PD controller shall control the joint positions to accurately track the desired targets within acceptable error margins.
- **Potential Design Solutions:**
 - The robot should use a well-designed control system for each joint that ensures smooth, stable, and precise joint movements.

Robustness:

- **Requirement:** When the robot loses balance, the robot shall quickly adjust and stabilize.
- **Potential Design Solutions:**
 - Implement a predefined rebalance policy when the robot starts losing balance.
- **Requirements:** When an external disturbance appears (wind or an intended push), the robot shall quickly adjust and stabilize.
- **Potential Design Solutions:**
 - Implement a predefined rebalance policy when the robot starts losing balance.
 - Use sensors to detect external disturbance.

- **Requirements:** When the environment has changed, the robot shall minimize performance degradation.
- **Potential Design Solutions:**
 - The robot should be trained in different environments.
 - Use force/pressure sensors on feet to detect terrain softness. This information can be included in the state variable so the agent can recognize and adapt to different terrains.
 - The robot could swap foot attachments based on terrain type.

Quality of Data:

- **Requirements:** When collecting data for joint positions, the system shall ensure that the measured position does not deviate from the true position.
- **Potential Design Solutions:**
 - High-precision sensors
 - Use of calibration techniques to reduce errors.

- **Requirements:** When recording environmental data, the system shall ensure high precision for numerical values (distances, speeds) and high resolution for images and videos.
- **Potential Design Solutions:**
 - high-accuracy sensors
 - high-resolution cameras
 - Data validation techniques to ensure data quality

- **Requirements:** When recording environmental data, the system shall minimize data redundancy and ensure sufficient variability to capture diverse environmental conditions.
- **Potential Design Solutions:**
 - Implement a data filtering mechanism that appends only new or significantly different data to storage.
 - Introduce an adaptive reset policy that activates when the robot is repeatedly collecting the same data (when stuck against a wall).

Verifiability:

- **Requirements:** When the robot moves, The robot shall log sensor data to allow for post-test verification.

- **Potential Design Solutions:**
 - The robot should have a data logging system that records all relevant sensor data.