Johnson&Johnson
MedTech

Design Optimization Proposal for Enhanced Robotic Arm Responsiveness

1. Problem Statement

Identified Issues:

1. **Actuator Strain**:
   - **Description:** The robotic arm's actuators are experiencing excessive strain due to uneven load distribution and insufficient capacity, forcing them to operate beyond their optimal range.
   - **Impact:** This strain reduces the arm's precision and speed, potentially leading to mechanical failures and decreased reliability during delicate surgical procedures.

1. **Sensor Misalignment**:
   - **Description:** Sensors on the robotic arm are misaligned and not adequately calibrated, resulting in delayed or inaccurate feedback signals.

- **Impact:** These feedback inaccuracies cause imprecise arm movements and slow responsiveness, compromising surgical precision and patient safety.

2. Proposed Modifications

Modification 1:

- **Proposal**: Enhance joint load distribution and integrate higher-capacity actuators capable of handling greater forces without compromising precision.
- **Justification**: This modification reduces actuator strain, improves movement precision, and extends the lifespan of the system, ensuring reliable operation during demanding surgical tasks.

Modification 2:

- **Proposal**:
  Realign and recalibrate all sensors to improve their placement and optimize real-time data feedback accuracy.

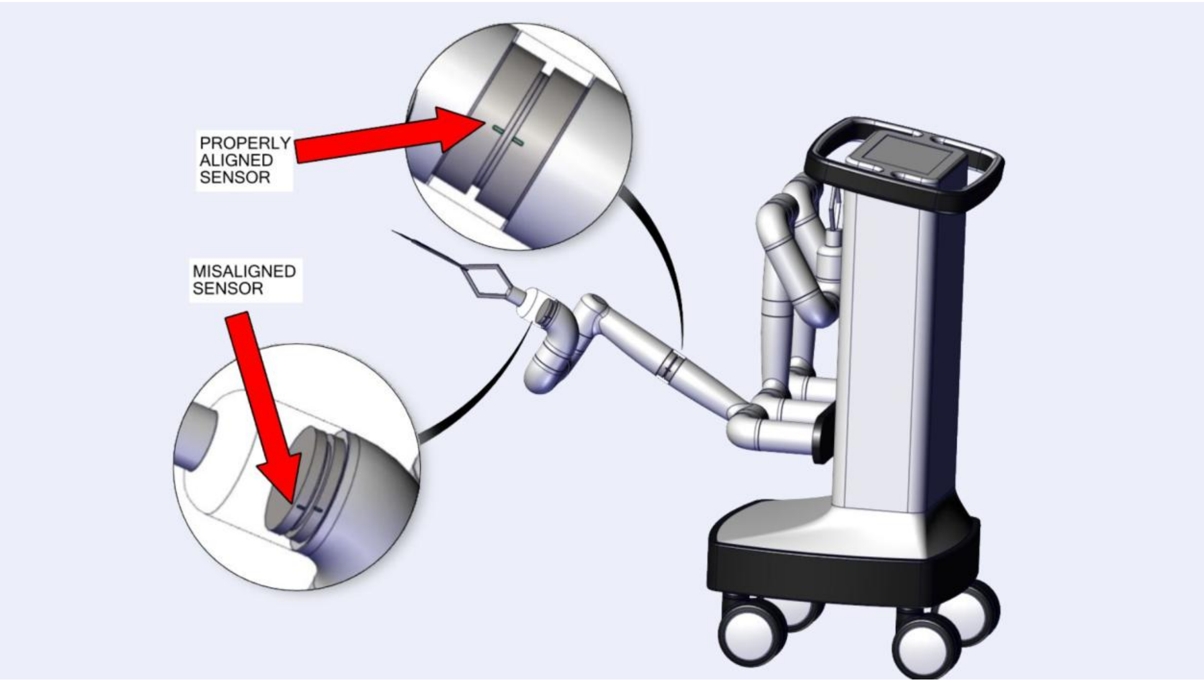
- **Justification**: Accurate sensor alignment enhances responsiveness and movement smoothness, supporting precise surgical actions and reducing operational delays.

3. Simulation Results

- **Initial Metrics**:
  - **Actuator Response Time:** 0.2 seconds
  - **Sensor Feedback Delay:** N/A
- **Post-Optimization Metrics**:
  - **Actuator Response Time:** 0.17 seconds
  - **Sensor Feedback Delay:** N/A
- **Key Insights**:
  - The proposed design modifications improved actuator response time by 15%, reducing it from 0.2 to 0.17 seconds. Additionally, the durability score increased from 75 to 86.25, indicating enhanced system resilience and extended operational life. These improvements confirm that the design changes effectively enhance both responsiveness and durability.

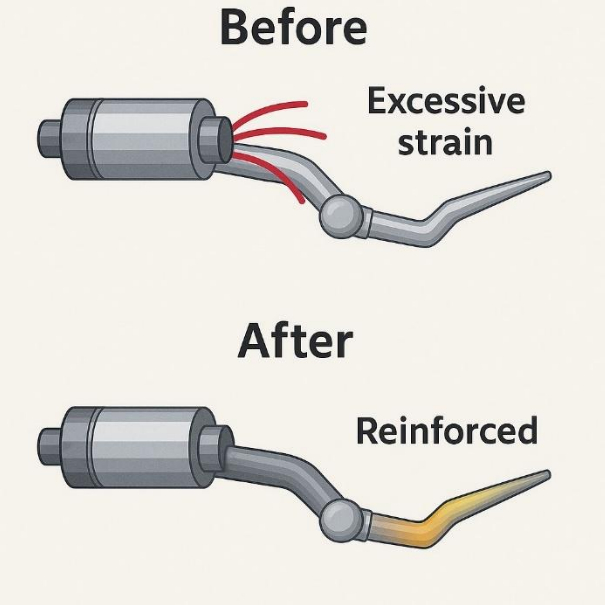
4. Annotated Visual Examples

Visual Example 1: Current Sensor Misalignment vs. Proposed Realignment



- *Brief Description*: This visual comparison highlights the initial sensor misalignment and the improved, optimized sensor positions after recalibration, demonstrating more accurate data capture and smoother arm movements.

Visual Example 2: Actuator Upgrade Impact



Brief Description: This image shows the original actuator strain compared to the upgraded actuator design with redistributed loads, illustrating reduced strain and increased durability.

5. Expected Outcomes

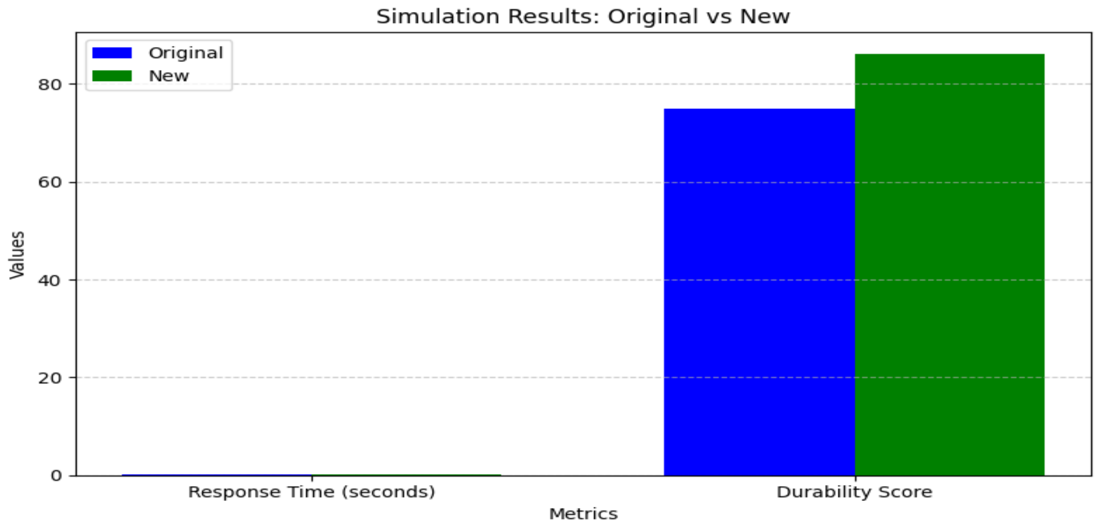
1. **Improved Responsiveness**: Enhanced movement speed and smoother operations, crucial for surgical precision.

2. **Enhanced Reliability**: More stable and accurate performance, minimizing the risk of failure during critical procedures.

3. **Increased Durability**: Longer system lifespan and reduced maintenance needs due to reduced actuator stress and improved component alignment.

6. Conclusion

- The proposed design modifications effectively address critical performance issues by reducing actuator strain and improving sensor accuracy. Simulation results confirm significant gains in both responsiveness and durability. These changes directly contribute to safer, more precise, and more reliable surgical robotic operations, aligning with Johnson & Johnson MedTech's commitment to excellence and innovation.



Simulation Results: Original vs New
Original
New
Values
80
60
40
20
0
Response Time (seconds)
Durability Score
Metrics