

CAE-based design of a cable driven human-like robotic wrist

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Goal

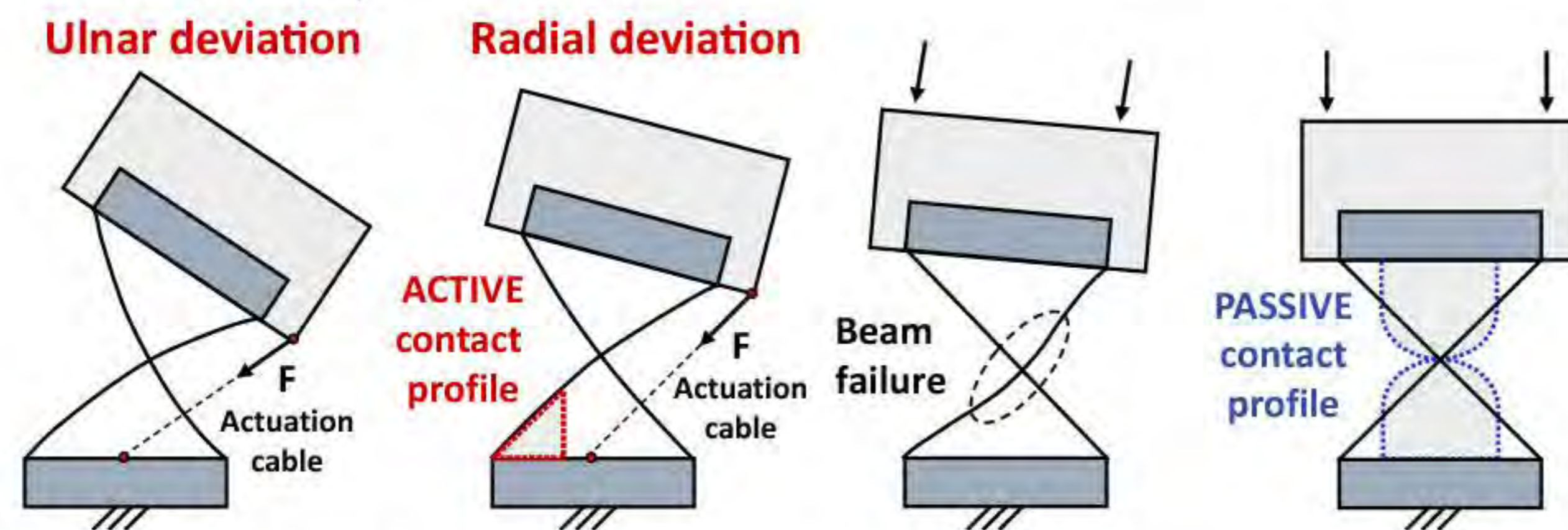
Design a tendon driven **bio-inspired compliant wrist** employing four **flexible components (FCs)**.

1. Introduction

The proposed device aims at mimicking the **natural asymmetry** of the human wrist, both in terms of angular deflection and passive stiffness, using two pairs of FCs in parallel spring configuration.

Design Steps:

1. **shape optimization** of the FCs;
2. synthesis of the **active contact** (to achieve the correct stiffness asymmetry);
3. generation of **passive contact** profiles (to avoid failure under external loads).



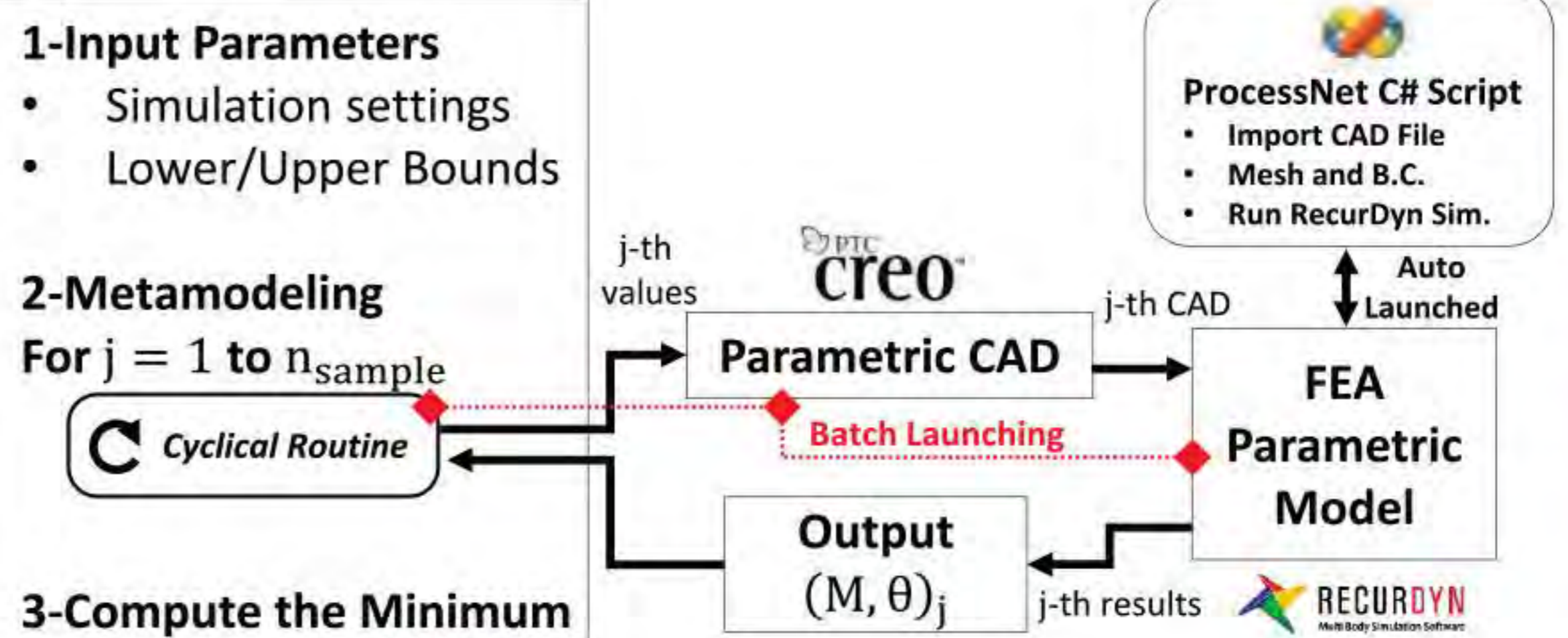
Wrist functional features:

| Action | Deflection | Stiffness |
|------------------|------------|-------------|
| Ulnar deviation | 0.52 rad | 2.10 Nm/rad |
| Radial deviation | 0.26 rad | 2.65 Nm/rad |
| Flexion | 1.13 rad | 1.20 Nm/rad |
| Extension | 0.96 rad | 1.20 Nm/rad |

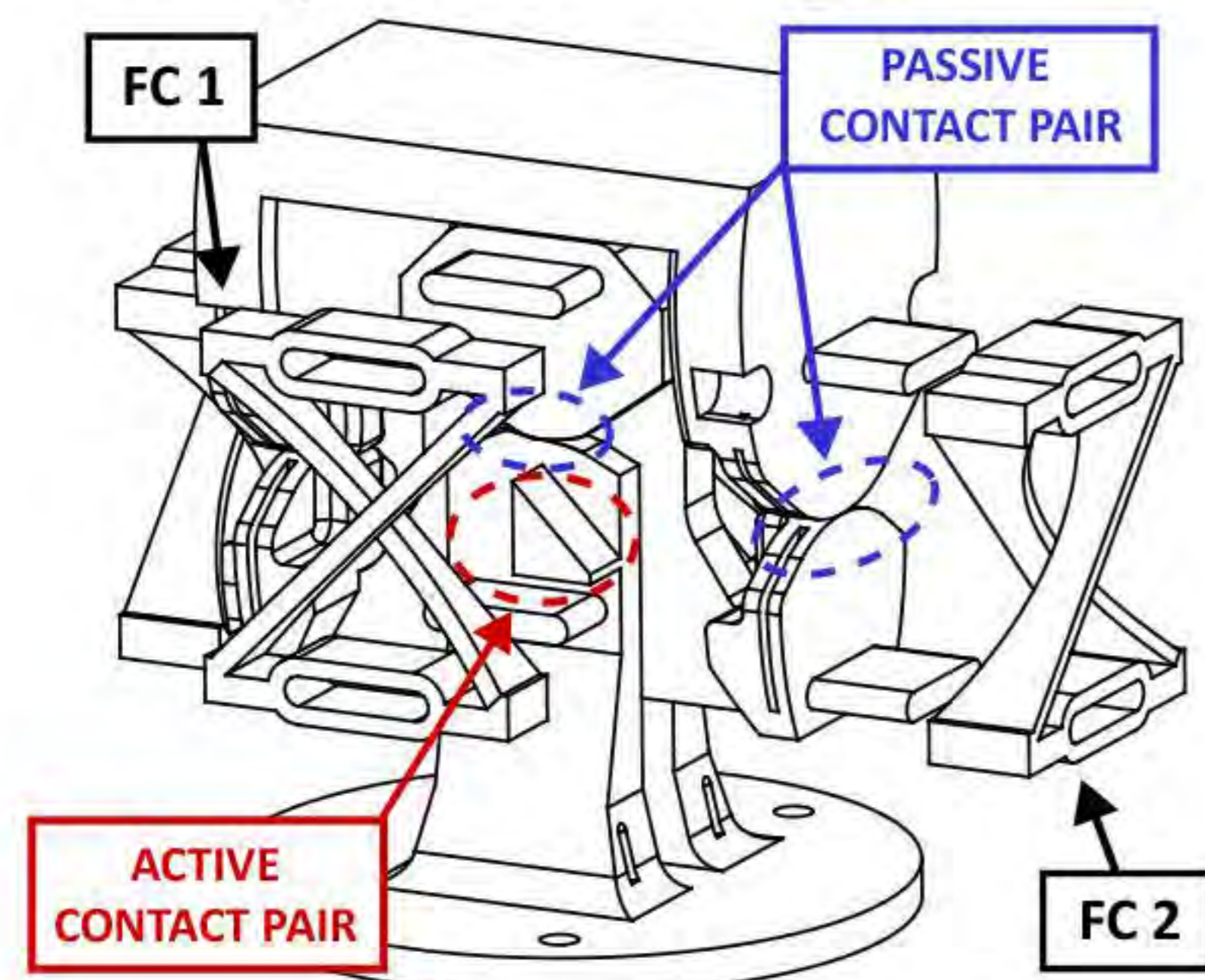
2. Shape Optimization

Modeling, simulation and optimization routine in a **CAD/CAE integrated environment**:

- Matlab manages the optimization;
- PTC Creo provides the geometry in batch mode;
- Recurdyn performs multi-flexible body dynamics simulations of each candidate.



3. Proposed Design



5. Conclusions

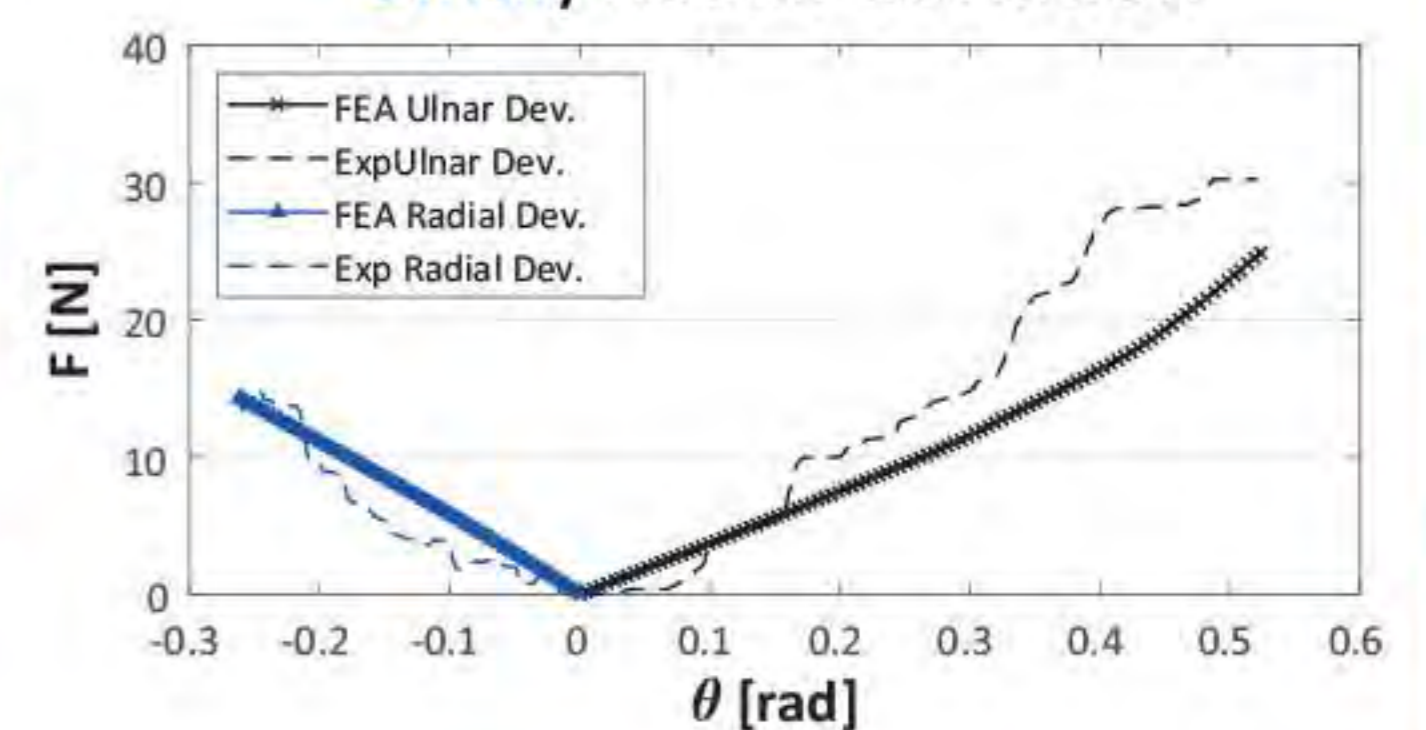
The final wrist shows:

- customized stiffness properties;
- overall high dexterity and robustness;
- easy to assembly and actuate;
- limited production cost.

4. FEA vs Exp. results

Actuation force [N] vs deflection [rad]

Ulnar/Radial deviation



Flexion/extension

