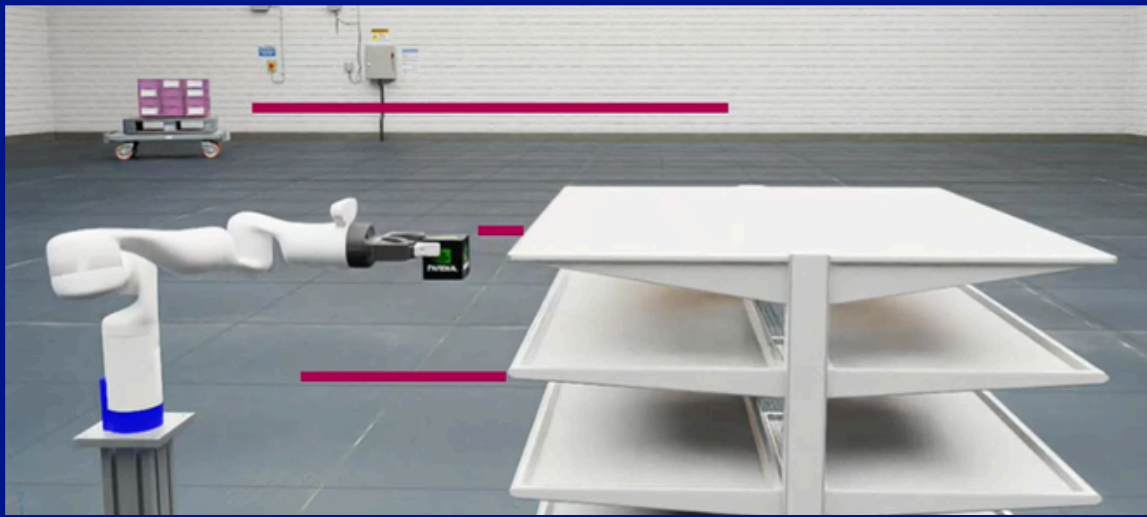
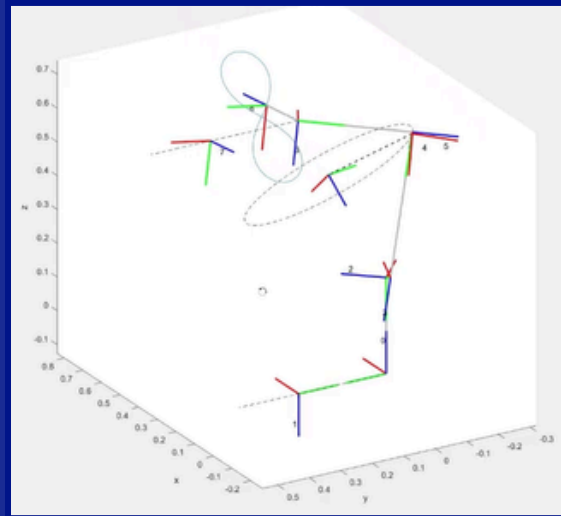
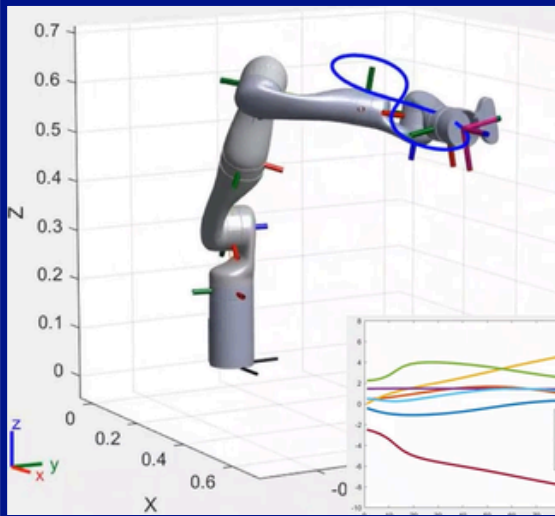




HUMAN-LIKE MOTION WITH NULL SPACE PARAMETERIZATION ON THE KINOVA GEN3

Case study



KINOVA

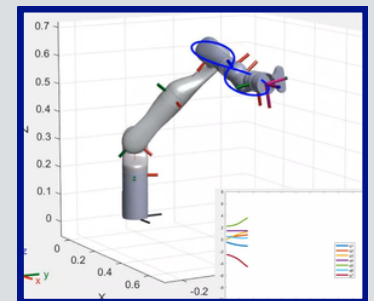
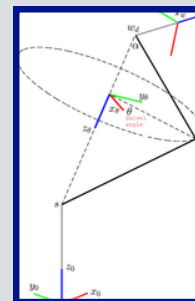
The challenge

Researchers in Professor David St-Onge's INIT Robot Lab, needed a safe and adaptable robotic arm to explore advanced motion planning strategies at ÉTS Montréal. Specifically, they aimed to demonstrate null space parameterization on a redundant manipulator, enabling robots to adjust their internal posture smoothly while maintaining task objectives. This capability is crucial for collaborative robotics and humanoid platforms operating in dynamic, human-centered environments. This capability is crucial not only in research but also for companies seeking robots that can adapt to human-centered environments without compromising safety or efficiency.

The approach

Using the Kinova Gen3, the research team implemented null space parameterization by leveraging the robot's swivel angle as a continuous control parameter. The setup allowed the Gen3 to maintain a fixed end-effector pose while exploring multiple valid joint configurations. This approach enabled smooth posture adjustment in real time, while avoiding obstacles, respecting joint limits, and reducing the risk of singularities as shown in this [video](#). The process unfolded in four key phases:

- **Setup & Integration:** The Gen3's collaborative design and intuitive API allowed rapid deployment. The robot was integrated into the research workflow within hours, making it possible to move quickly from concept to experimentation.
- **Null-Space Parameterization Development:**
The swivel angle was introduced as a continuous control parameter, enabling posture adaptation without compromising task objectives. This provided a simple yet powerful way to resolve redundancy and maintain natural motion.



- **Simulation Phase:** To validate the method's feasibility and robustness, the team first conducted pick-and-place experiments in Isaac Sim. These simulations ensured that the approach was safe, efficient, and ready for real-world deployment.



- **Real-Time Execution:** Finally, the method was deployed on the physical Gen3. The robot successfully demonstrated seamless posture transitions, reliable joint-limit and self-collision avoidance, and safe operation in dynamic environments.



The key objectives

- Demonstrate null space parameterization on a collaborative robot.
- Enable smooth, human-like posture control while maintaining task goals.
- Ensure safety, compliance, and obstacle avoidance in dynamic environments.
- Highlight real-time applicability for collaborative robotics and humanoid motion generation.

The results

The Kinova Gen3 proved to be an ideal platform for translating advanced control methods into practice. Leveraging an i7 laptop, the novel approach computed **over one million solutions in just 2.84 seconds**, and during deployment, the robot successfully executed **real-time, human-like**

motions through null space parameterization. The results demonstrated:

- Continuous, smooth joint trajectories
- Robust self-collision and joint-limit avoidance
- Intuitive, natural motion that enhances human-robot interaction
- A safe, collaborative platform that accelerated the transition from simulation to real-world testing

Both **Isaac Sim pick-and-place simulations** and **real robot experiments** validated the approach. This work highlights the Kinova Gen3 as a powerful tool for researchers and developers striving to bring human-like intelligence and adaptability into collaborative robotics and humanoid systems.

Beyond research impact, these results carry direct advantages for future clients: **safer collaboration**, **faster prototyping of advanced control methods**, and **robots capable of moving in natural, human-like ways**. All critical for deployment in healthcare, manufacturing, and service robotics.



“The Kinova Gen3 has been the perfect platform to bring our null space parameterization research to life – delivering smooth, human-like motion in real time, exactly what’s needed for the next generation of collaborative robots.”

- David Bedolla Martínez, Postdoctoral Researcher – GREPCI robotics lab at École de technologie supérieure (ÉTS), Canada

A brief description of your university...

École de technologie supérieure (ÉTS) in Montréal is a leader in applied engineering research, known for turning cutting-edge concepts into real-world applications. I am part of the **GREPCI robotic lab**, which focuses on human-centered robotics, exoskeletons, and intelligent rehabilitation technologies. For this project, I collaborated with the

INIT Robot Lab, which specialized in multirobots systems collaborating with humans through intuitive interaction.

Your role within the university...

I'm a Postdoctoral Researcher in the GREPCI group, working on motion planning, kinematics, and intelligent control for human-robot interaction. My research spans from rehabilitation exoskeletons to collaborative robots. In this project, I worked with the INIT Robot Lab to explore advanced motion generation on the Kinova Gen3.

A situation you were encountering that required you to seek out a company like Kinova...

We needed a safe, precise, and highly adaptable robotic arm to test advanced control strategies for collaborative robotics. I was already familiar with Kinova's strong reputation in assistive and research robotics.

Describe your first impressions of the product...

The Gen3 immediately impressed us with its smooth motion, responsive control, and ease of integration. Its lightweight, collaborative design allowed us to begin running human-interactive experiments within hours of setup.

The impact of this solution on your project...

The Gen3 enabled us to implement and demonstrate null space parameterization – a technique that allows redundant robots to adjust their internal posture while still achieving their primary task. By controlling the swivel angle in real time, we achieved smooth, human-like motions that can avoid obstacles, prevent self-collisions, maintain joint limit compliance, and optimize for task-specific criteria. This approach is vital for collaborative robots, humanoids, and collaborative systems operating in dynamic environments.

Who would you recommend this product for?

Researchers, developers, and companies working on collaborative robotics, humanoid platforms, or collaborative systems will find the Gen3 invaluable – a robust, safe, and flexible solution perfectly suited for human-like motion research and deployment.

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Kinova is a global leader in designing and manufacturing robot arm for various applications in the Industrial, Professional, Academic and Medical markets and for Assistive technologies. We have for mission to provide humanity with robots that empower them to achieve the extraordinary everyday.

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École de technologie supérieure (ÉTS) is a public engineering school in Montréal, Canada, specializing in applied research and industry collaboration. The GREPCI robotics lab focuses on intelligent rehabilitation robotics and human-robot interaction. The INIT Robot Lab, led by Professor David St-Onge, develops advanced assistive and collaborative robotic solutions for dynamic, real-world environments. Exactly what's needed for the next generation of collaborative robots in both research and industry applications.