

# Real-Time Human Modeling from Visual and Contact Data for Medical Robotics





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## PROBLEM and MOTIVATION

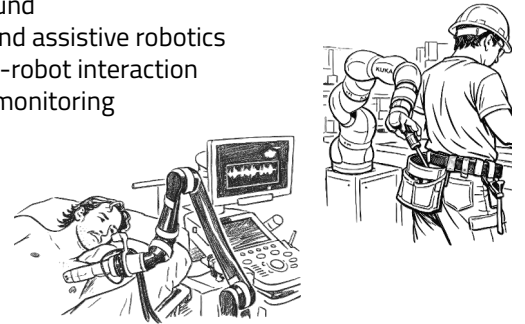
Robotic systems in clinical tasks require human representations that provide:

-  **patient-specific geometry**
-  **semantic anatomical structure**
-  **real-time update**
-  **safe physical interaction**

**Standard perception** outputs often provide only **partial information**: images capture appearance, skeletons capture sparse pose, and point clouds capture geometry without anatomical semantics.

## APPLICATION SCOPE

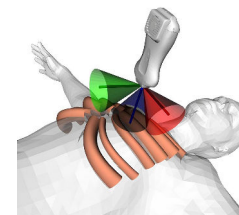
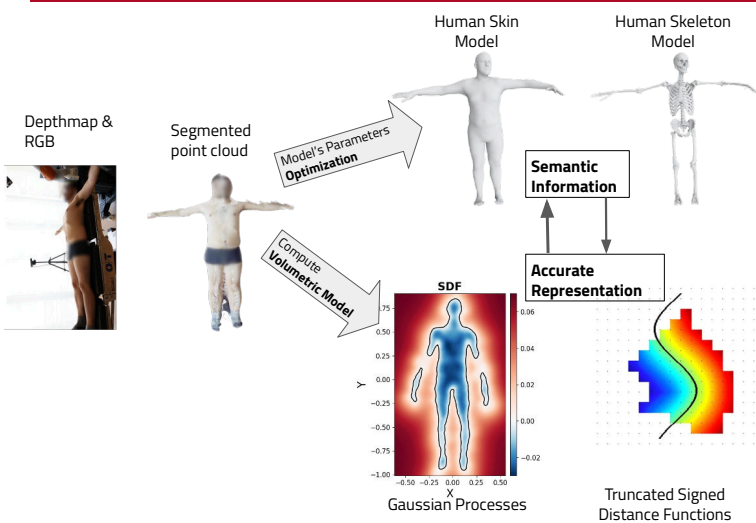
- Robotic ultrasound
- Rehabilitation and assistive robotics
- Physical human-robot interaction
- Biomechanical monitoring
- Teleoperation



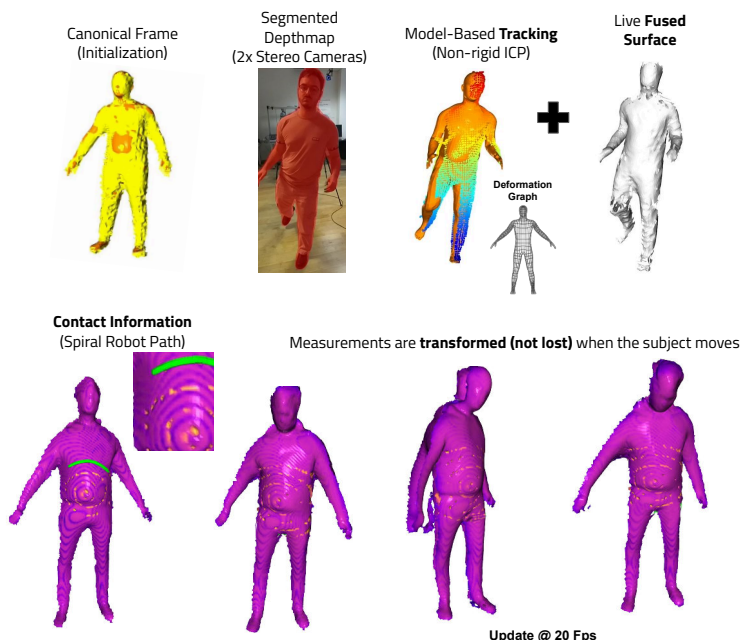
## INTEGRATION in ROBOTIC APPLICATIONS

1. **Real-time tracking and robot adaptation:**
  - online body pose updates
  - continuous alignment between sensed human motion and robot planning
  - dynamic adaptation of robot behavior to body posture
2. **Visual and haptic feedback for physicians:**
  - 3D visualization of the patient model
  - anatomical overlays
  - feedback about constraint activation
  - force/vibrotactile cues during interaction
3. **Anatomical priors for robotic assistance/shared control:**
  - forbidden regions
  - target anatomical regions
  - preferred tool orientations
  - anatomy-aware motion constraints






## DIGITAL TWIN BODY MODEL



## SETUP AND PRELIMINARY RESULTS



## CONCLUSIONS

-  **Accurate patient-specific human models [1,2]**
-  **Rich volumetric anatomical representation [1,2]**
-  **Real-time tracking and robot adaptation [1,2]**
-  **Automatic anatomy-aware shared control [2]**
-  **Faster teleoperated ultrasound [2]**

## REFERENCES

- [1] D. Nardi, G. Martinelli, N. Bisagno, D. Fontanelli, M. Saveriano, L. Palopoli, and E. Lamon, "SMPL\_ROS: A ROS 2 package with parametric human body models for robotic applications," in *Proc. I-RIM 2025*, 7th Italian Conference on Robotics and Intelligent Machines, Rome, Italy, Oct. 2025.
- [2] Nardi, D., Lamon, E., Fontanelli, D., Saveriano, M., & Palopoli, L. (2026). An Anatomy-Aware Shared Control Approach for Assisted Teleoperation of Lung Ultrasound Examinations. *IEEE Robotics and Automation Letters*, 11(3), 2570-2577.