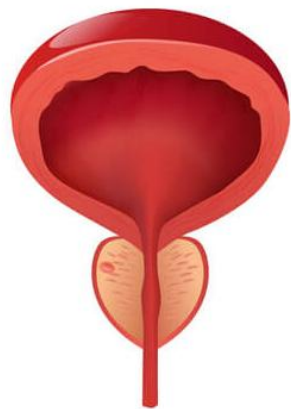


Trajectory simulation for robot-assisted prostate biopsy system

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Introduction

- Prostate cancer is one of the major causes of cancer-related death for US men
- Early detection can help to improve survival rate of patients
- Biopsy is the golden standard for cancer detection



I stage



II stage



III stage

<https://www.urophenix.com/2022/07/22/what-happens-during-surgery-for-prostate-cancer-treatment/>

Introduction

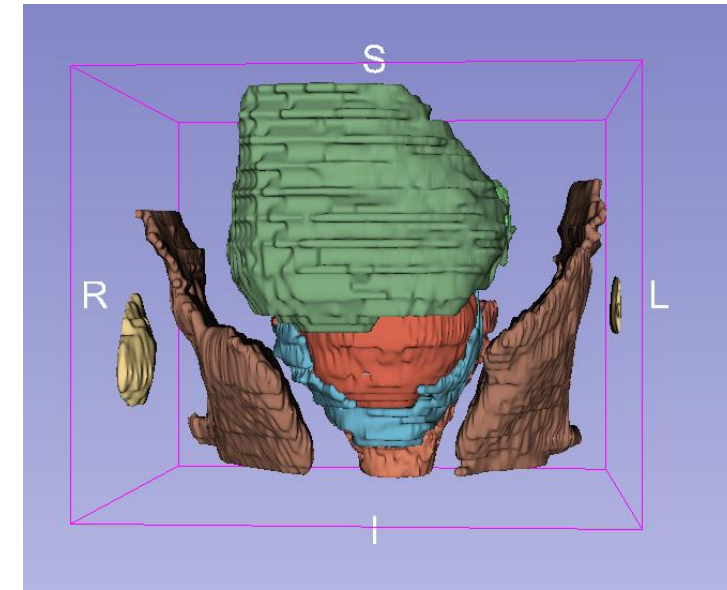
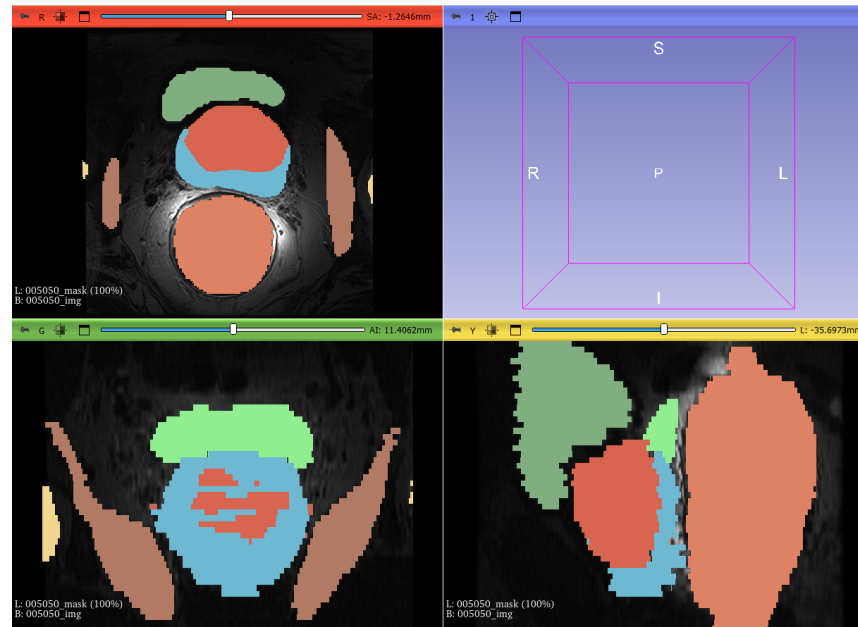
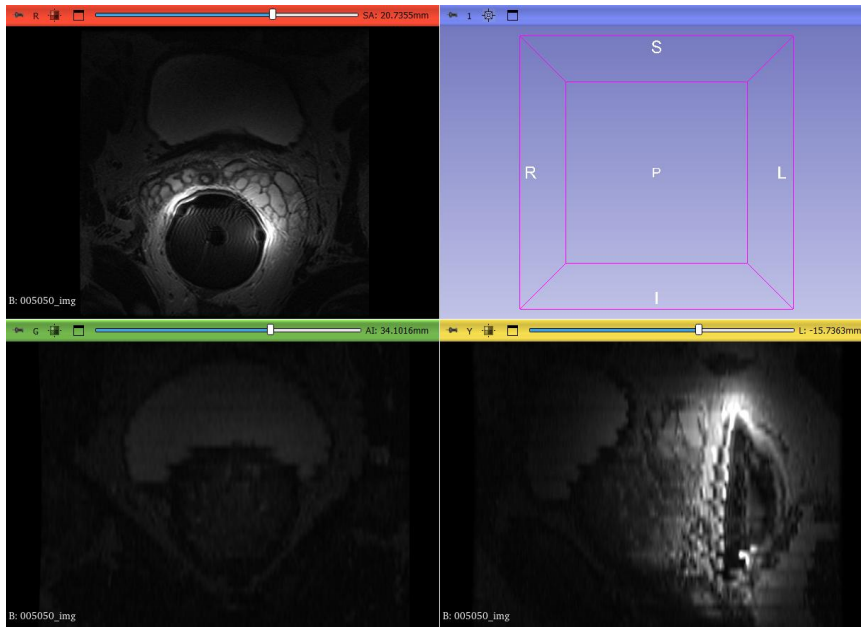
- Challenges: prostate is very small and deformable
- Contributions: Robot-assisted prostate biopsy



<https://www.kuka.com/en-be/company/press/news/2017/02/kuka-leichtbauroboter-lbr-med-geht-in-serienfertigung>

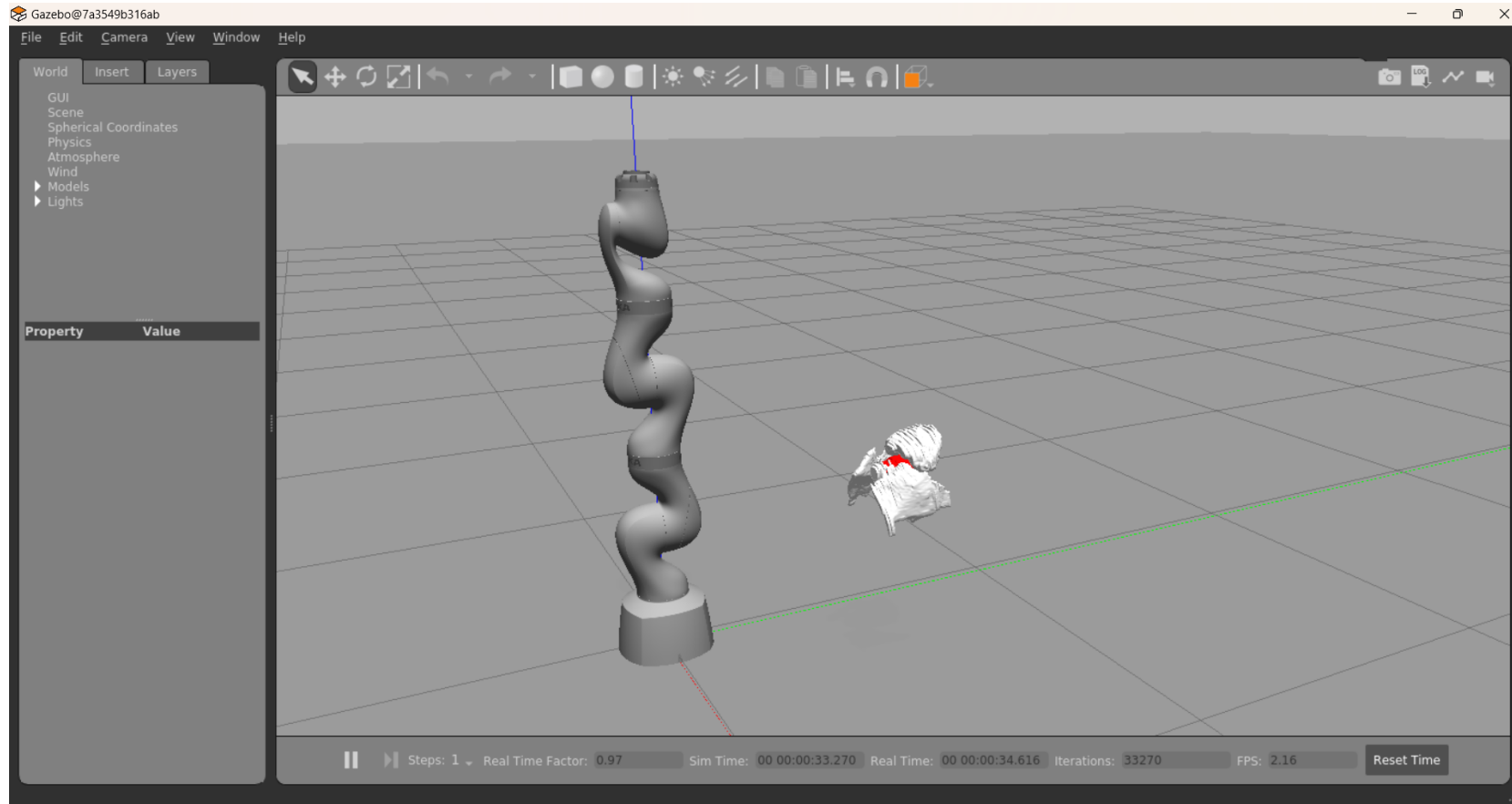
Methods

- Utilize Gazebo + Moveit to simulate robot-assisted prostate biopsy procedure
- Create 3D models of prostate and surrounding organs from medical images



Methods

- Create a virtual surgical scene in Gazebo
 - prostate is highlighted in red



Methods

- Query a pose of the prostate
- Apply RRT* algorithm through Moveit for motion planning of the robot

```
process[lbr/rrt_motion_planning-1]: started with pid [25054]
[ INFO] [1733124666.527120721]: Loading robot model 'med7'...
[ INFO] [1733124666.528348000]: No root/virtual joint specified in SRDF. Assuming fixed joint
[ WARN] [1733124667.348863686, 35.395000000]: Could not identify parent group for end-effector 'ee'
[ INFO] [1733124668.549432758, 36.585000000]: Ready to take commands for planning group arm.
[INFO] [1733124668.581286, 36.615000]: Pose of prostate: position:
  x: 0.5
  y: 0.5
  z: 0.5
orientation:
  x: -0.706825181105366
  y: 0.0
  z: 0.0
  w: 0.7073882691671998
[INFO] [1733124668.583306, 36.618000]: Planning motion using RRT*...
[INFO] [1733124678.602551, 46.519000]: Plan found. Executing motion...
[INFO] [1733124696.010663, 50.939000]: Motion execution complete.
[lbr/rrt_motion_planning-1] process has finished cleanly
log file: /root/.ros/log/4af1dba8-b07f-11ef-a88b-0242ac110002/lbr-rrt_motion_planning-1*.log
```

Experiments

- It took about 10 s to calculate the proper trajectory to prostate

You can start planning now!

```
[ INFO] [1733124634.141666997, 3.179000000]: Loading robot model 'med7'...
[ INFO] [1733124634.141746590, 3.179000000]: No root/virtual joint specified in SRDF. Assuming fixed joint
[ WARN] [1733124634.395418989, 3.423000000]: Could not identify parent group for end-effector 'ee'
[ INFO] [1733124634.874812671, 3.882000000]: Starting planning scene monitor
[ INFO] [1733124634.878581483, 3.886000000]: Listening to '/lbr/move_group/monitored_planning_scene'
[ INFO] [1733124635.671958616, 4.670000000]: Constructing new MoveGroup connection for group 'arm' in namespace ''
[ INFO] [1733124636.742592683, 5.707000000]: Ready to take commands for planning group arm.
[ INFO] [1733124668.594362042, 36.629000000]: Planning request received for MoveGroup action. Forwarding to planning pipeline.
[ INFO] [1733124668.597905780, 36.633000000]: Planner configuration 'arm[RRTstar]' will use planner 'geometric::RRTstar'. Additional configuration parameters will be set wh
[ INFO] [1733124668.598390273, 36.633000000]: arm/arm[RRTstar]: No optimization objective specified. Defaulting to optimizing path length for the allowed planning time.
[ INFO] [1733124668.598783417, 36.634000000]: arm/arm[RRTstar]: Started planning with 1 states. Seeking a solution better than 0.00000.
[ INFO] [1733124668.598865830, 36.634000000]: arm/arm[RRTstar]: Initial k-nearest value of 607
[ INFO] [1733124668.624616339, 36.660000000]: arm/arm[RRTstar]: Found an initial solution with a cost of 12.80 in 85 iterations (86 vertices in the graph)
[ INFO] [1733124678.599586532, 46.517000000]: arm/arm[RRTstar]: Created 5957 new states. Checked 17745903 rewire options. 10 goal states in tree. Final solution cost 10.651
[ INFO] [1733124678.599685351, 46.517000000]: Solution found in 10.001054 seconds
[ INFO] [1733124678.600545229, 46.518000000]: SimpleSetup: Path simplification took 0.000756 seconds and changed from 3 to 2 states
[ INFO] [1733124678.605518987, 46.523000000]: Execution request received
[ INFO] [1733124696.005163188, 50.936000000]: Controller 'PositionJointInterface_trajectory_controller' successfully finished
[ INFO] [1733124696.009670052, 50.939000000]: Completed trajectory execution with status SUCCEEDED ...
[ INFO] [1733124696.009890340, 50.939000000]: Execution completed: SUCCEEDED
[ INFO] [1733124696.010604769, 50.939000000]: Received event 'stop'
[ INFO] [1733124876.592839037, 179.905000000]: Stopping planning scene monitor
```

Experiments

