A VR-based volumetric medical image segmentation and visualization sytem with natural human interaction

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Volume rendering and its challenges

- Volume rendering : produces 2D images from 3D medical volume

- Challenges :

  - High dimensional **transfer function** is required

  - **Differentiate neighbor** objects with subtle variance is difficult

  - Exploration / manipulation of 3D volumes with **2D interfaces** is limited

- Objective : Develop an immersive VR-based system with **natural interactions** (gestures, voice)

The proposed solution : NUI-VR2

- NUI-VR2 System :

  - Combines **image segmentation** and **volume rendering**

  - Operates entirely in a VR environment

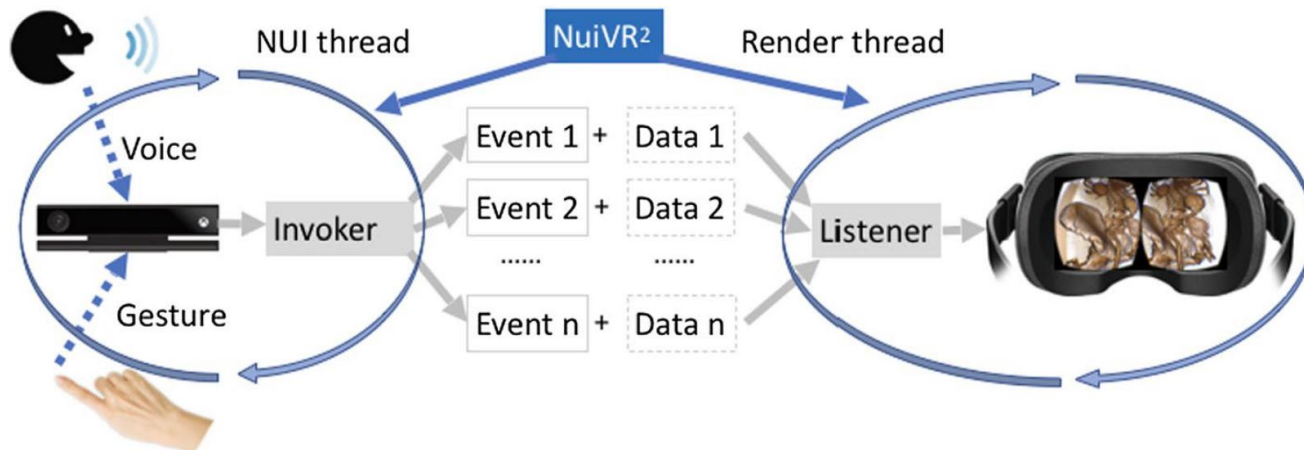 - Natural user interface : **gestures** + **voice commands**

Table 1 A few voice command examples in NUI-VR^2

| Commands	Actions
Scan	Switch to image browsing mode
Insert	Add a voxel to the set of seeds
Circle/Polygon	Construct a 3D surface with circles or polygons
Render	Render the probability volume
Preset i	Use the ith transfer function preset
Rotate X/Y/Z	Rotate the volume along the X/Y/Z-axis
Up/Down/Left/Right	Move the volume up/down/left/right

Workflow of NUI-VR2

- User specifies **seeds / masks** for target segmentation

- Seed features: spatial location, intensity, texture

- Feature selection speeds up rendering and improves accuracy

- Segmentation algorithms creates a probability map
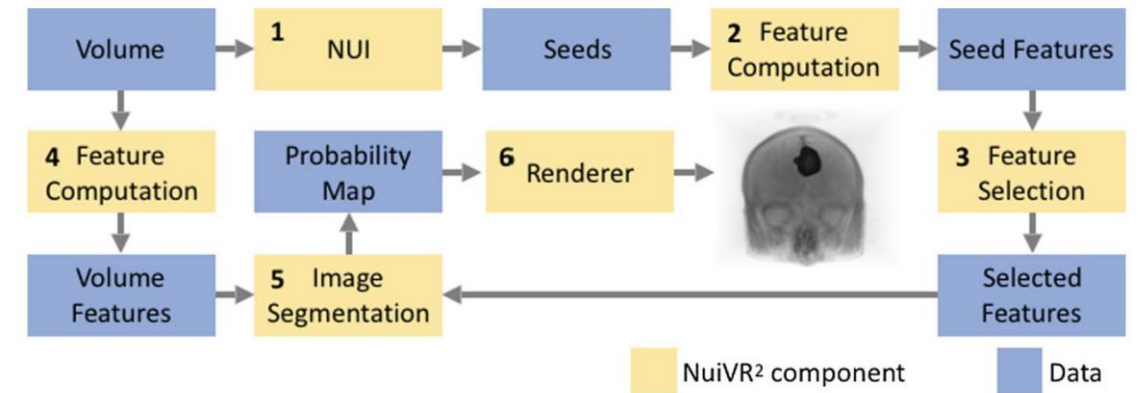
Evaluation of the system

1) Comparison image segmentation : NUI-VR2 versus Mouse-based interaction

(a) (b) (c) (d) (e)
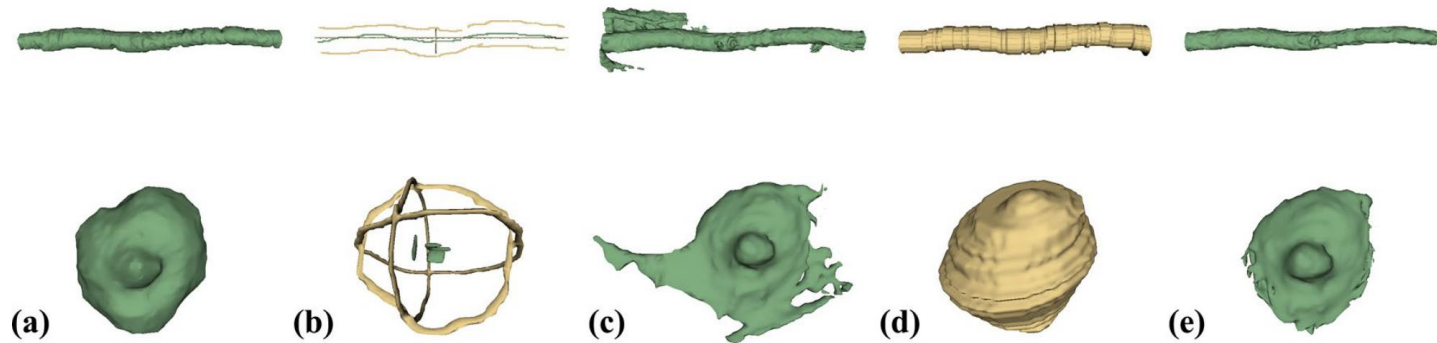
Measurements	Vessel	Tumor 1	Tumor 2	Tumor 3	Tumor 4
Dice coefficient (mouse)	0.807	0.922	0.691	0.853	0.942
Dice coefficient (NUI)	0.88	0.951	0.84	0.934	0.944
Hausdorff distance (mouse)	30.7	28.4	51.9	16.2	5.2
Hausdorff distance (NUI)	7.0	3.46	11.0	12.1	4.7

Evaluation of the system

2) Comparison volume rendering : NIU-VR2 versus ImageVis3D
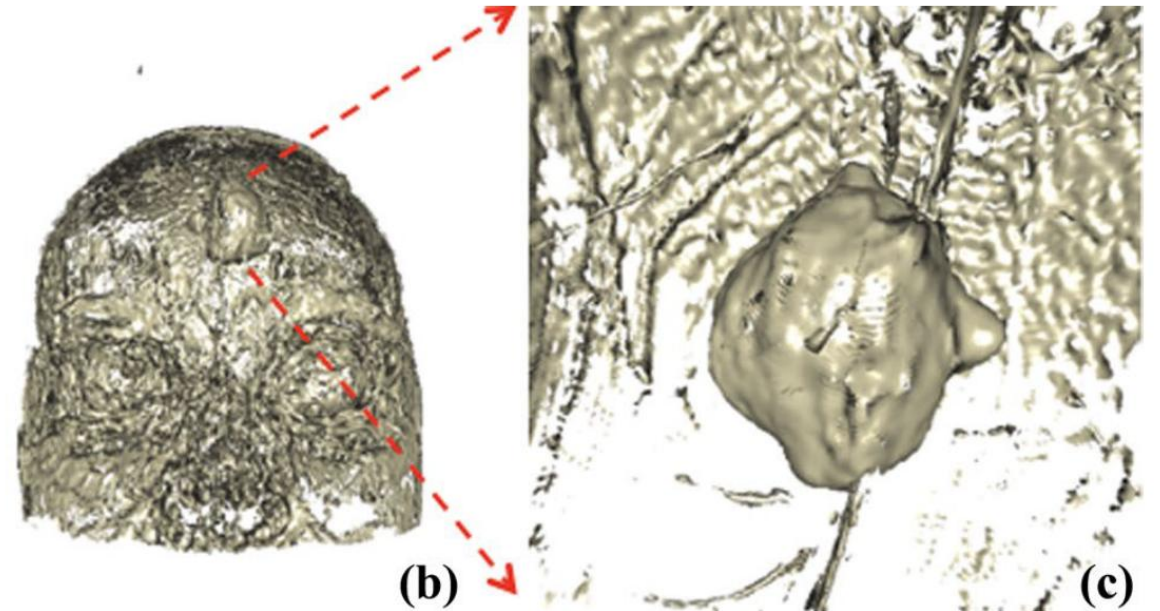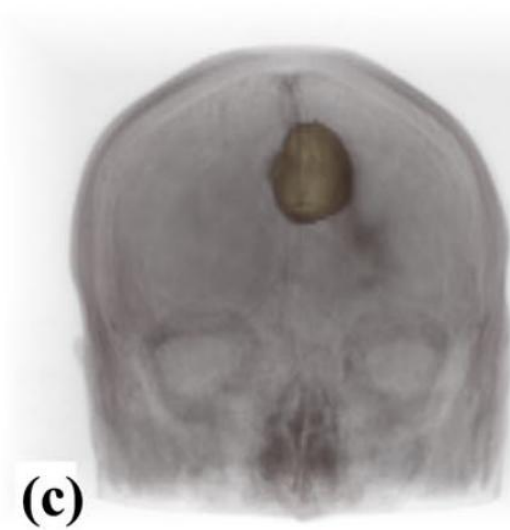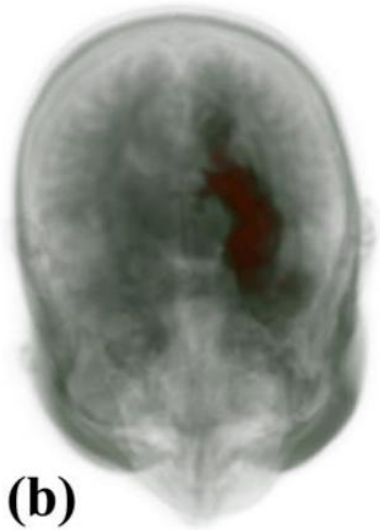
Conclusion

- NIU-VR2 : combines **volume rendering** and **segmentation** in VR

- User interact via **gestures** and **voice commands**

- No need for complex transfer function, just define **seeds/masks**

- Improve **user experience** in perceiving volume in 3D

Thank you