Explore Human Reference Atlas Data in 3D VR

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Vision...

https://www.reddit.com/r/Thatsabooklight/comments/kf2ve0/the_medical_infusion_devices_center_background/

...and Reality


Where is the Data?
Data Visualization in VR: Vision

“Visual data exploration seeks to integrate humans in the data exploration process, applying their perceptual abilities [...]. The basic idea is to present the data in some visual form, allowing data analysts to [...] interact with it.” (Keim, 2001)

• Symbiosis of computers and humans
• Visualization is for humans only
• Many formalizations for making, interpreting, and teaching data visualization
Information-Rich Virtual Environments (IRVE)

• “An information-rich virtual environment (IRVE) is a realistic VE that is enhanced with the addition of related abstract information.”

The Common Coordinate Framework (CCF) Organ VR Gallery

Also called the “Human Reference Atlas in 3D VR”
The CCF Organ VR Gallery

• Human BioMolecular Atlas Program (HuBMAP) and other single-cell mapping efforts

• Integrates 3 data types for human tissue:
  • Spatial
  • Biological structure
  • Specimen/clinical metadata (not covered in this talk)

• Code: https://github.com/cns-iu/ccf-organ-vr-gallery

Spatial Data

Warning: graphical image of a kidney coming up!
The Meat of the Matter

• Documenting tissue extraction sites is non-trivial

• Photos of reference organs (if available) on cutting boards with spatial markers

• We used the Visible Human male, left kidney (100 mm high, 60 mm wide, 40 mm deep)

4.3.6.20 Colon

4.3.6.20.1 Preferred Location: Transverse colon. Gently rinse mucosa with normal saline before aliquot preparation. Aliquots should contain the full thickness of the colonic wall, i.e., mucosa and muscularis propria. Trim adjacent adipose tissue.

4.3.6.20.2 Preferred Aliquot: 20 mm x 10 mm x thickness (64 mm), divided into two adjacent 10 mm x 10 mm x thickness aliquots. Each cassette should contain two 10 mm x 10 mm x thickness aliquots.

4.3.6.20.3 Preferred Location: Sigmoid colon. Preferred Location: Sigmoid colon. Gently rinse mucosa with normal saline before aliquot preparation. Obtain only muscularis propria, discard mucosa and any seminal adipose tissue.

4.3.6.20.4 Preferred Aliquot: 20 mm x 10 mm x thickness (64 mm), divided into two adjacent 10 mm x 10 mm x thickness aliquots. Each cassette should contain two 10 mm x 10 mm x thickness aliquots.

Sigmoid Colon ("pelvic colon") Dissection Guide (Diagram 4)

Recover the transverse colon starting 10 cm back from the right colic (hepatic) flexure.
CCF Registration User Interface (RUI)

https://hubmapconsortium.github.io/ccf-ui/rui/
CCF Exploration User Interface (EUI)

https://portal.hubmapconsortium.org/ccf-eui
CCF

Allows us to 3D register tissue and explore tissue blocks spatially and semantically across macro-, meso-, and micro-scale.
Biological Structure
Linked Open Data (LOD)
Anatomical Structure, Cell Type, Plus Biomarker (ASCT+B) Table
Background—Structuring Knowledge: What does an ASCT+B Table Do?

Structured knowledge unifies nomenclature that describes datasets so we are all speaking in the same language.
ASCT+B Reporter Vis of ASCT+B tables

https://hubmapconsortium.github.io/ccf-asct-reporter
Tie to Spatial Data: 3D Reference Models

- Custom built by our medical illustrator team with input from subject matter experts
- Support the RUI, EUI, and CCF Organ VR Gallery
- Anatomical structures labeled with ontology IDs

A Closer Look at the Gallery
Try it out yourself in the demo session today!
Data from CCF API

- **https://ccf-api.hubmapconsortium.org/#/**

- Endpoints for individual organs, tissue blocks, entire scene
  - `/scene` to get all 3D objects
  - `/reference-organs` to get organ sex

- Query strings to refine search for sex, organ, age, etc.
Data from CCF API

• OrganData.cs
• TissueBlockData.cs
Future Work
Future Work

• Organ pullout
• Utility glove
• Visualizations
• Deploy version 1.0 by the end of 2022

https://www.youtube.com/watch?v=g_PQB6RIIU

Retrieving Cell Counts on User Input (in Development)

https://hubmapconsortium.github.io/tissue-bar-graphs/

https://github.com/hubmapconsortium/tissue-bar-graphs/blob/static/csv/Skin_Soumya_et_al_paper/HBM229.HKHH.537.csv
Organ Pullout (in Development)

(V) Input Action: (A) Pull-out / Float Back to source position functionality for Organs

**Step 1**
- Quest Controller
- Palm Trigger to grab
- Organ Grab State
  - Kidney Model w/ Tissue Blocks
- Organ Position

**Step 2**
- Quest Controller
- Kidney Model w/ Tissue Blocks
- Moves to controller position, rotation with the help of XR Grabbable script

**Step 3**
- Quest Controller
- Press A or X to revert back to original position
- Linearly interpolates back to original position using
  - FloatBackOrgan.cs
- Organ Position
  - Kidney Model w/ Tissue Blocks

Press B or Y to change between organ / tissue grab state

PullOutStateChanger.cs
XRGrabbable.cs
Offset.cs
FloatBackOrgan.cs
Wrist Pockets (in Development)

https://www.youtube.com/watch?v=JmaAHyNvA98
Conclusion

- Preserve spatiality
- Visualize biological structure
- Use specimen data as filters
- Create Information-Rich Virtual Environment in VR
- Integrate spatial and abstract data in one continuous immersive environment
Become a Tester!

- Documentation: https://www.figma.com/file/TopdFvriKNcV9Af2Hgo8aK/Documentation-Organ?node-id=0%3A1
- Feedback: https://forms.gle/wnGnZLyDvU9MEs5o8
- Meta Quest 2 setup (general introduction): https://www.figma.com/file/0MgWkoPyuWLWb8esFsYya5/CNS-Documentation?node-id=0%3A1
- GitHub issues: https://github.com/cns-iu/ccf-organ-vr-gallery/issues
- Please contact Andreas Bueckle at abueckle@iu.edu!
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Your Turn