HuBMAP

SOP: Using 3D Reference Objects

Integrating 3D Reference Objects into EUI and RUI Tools

Authors: Ellen Quardokus, Andreas Bueckle
Approved by: Bruce Herr (02/01/2022), Katy Börner (02/01/2022)

HIVE MC-IU Team, Indiana University
PI: Katy Börner
NIH Award No: OT2OD026671

Updated: February 1, 2022

Introduction

The procedures outlined in this document describe how 3D reference organ objects are integrated into the CCF Portal 3D Reference Object Library on the CCF Portal, the Registration User Interface (RUI), and the Exploration User Interface (EUI).

Roles and Responsibilities

Below, please find definitions for each role in the procedures outlined here. Table 1 identifies the people occupying these roles currently.

The **Medical Illustrator** builds 3D models, negotiates and implements suggested changes with SMEs, and uploads the models for use in HuBMAP services and user interfaces.

The **Senior Research Analyst-Biologist** is the Medical Illustrator's main contact in the MC-IU team. The Medical Illustrator and the Senior Research Analyst-Biologist meet weekly.

The **Systems Architect** uses the 3D objects in the Registration User Interface (RUI) and Exploration User Interface (EUI). The Systems Architect offers technical expertise in the areas of 3D model storage options and the integration of the 3D models into the HuBMAP ecosystem (e.g., how anatomical structures should be labeled to work well with existing ontology schemas).

The **Principal Investigator (PI)** is responsible for delivering anatomically correct 3D models for use in the HuBMAP Human Reference Atlas construction effort. The PI approves budgets associated with the 3D reference object modeling and usage process, hires relevant experts, sets high-level goals and associated deadlines, attends meetings, and reviews notes and recordings from relevant

meetings between the Senior Research Analyst-Biologist and other key personnel as outlined in this SOP.

Table 1. Roles, names, and email addresses of key personnel.

Role	Name	Email
Medical Illustrator	Heidi Schlehlein	hschleh@iu.edu
Senior Research Analyst-Biologist	Ellen M. Quardokus	ellenmq@iu.edu
Systems Architect	Bruce W. Herrr II	bherr@iu.edu
Principal Investigator	Katy Börner	katy@indiana.edu

Procedures

Step 1: Updating the United Body File as Needed

1. The Medical Illustrator updates the United body file, which contains all of the SME approved 3D reference objects built to date for the Visible Human Male (VHM) and Visible Human Female (VHF) bodies, with every newly approved organ or organ change, following the steps in the Standard Operating Procedure (SOP) on 3D Reference Object Approval and and the SOP on 3D reference organ ontology crosswalk.
2. The Medical Illustrator exports a node list for the Senior Research Analyst-Biologist and the Systems Architect following the SOP: 3D reference organ ontology crosswalk.
   Maya node names begin with any character from a-z or A-Z and an underscore, followed by a sequence of characters from a-z or A-Z, underscore or numerals; Maya does not allow spaces or punctuation marks in the node names with the exception of the underscore _ or the pound sign #.
3. The Senior Research Analyst-Biologist and the Medical Illustrator returns the node list with ontology mappings, metadata and any changes required to the node-names.
4. The Medical Illustrator attaches the metadata to models following the SOP: 3D reference organ ontology crosswalk by using a script written in MEL (Maya Embedded Language), a programming language that interfaces with Maya, deposited here: https://github.com/hubmapconsortium/ccf-3d-reference-object-library/blob/master/MetadataScript/setExtraAttributes.MEL
5. The Medical Illustrator will export an updated node-list with metadata and provide it to the Systems Architect and the Senior Research Analyst-Biologist as a confirmation step.
6. The Senior Research Analyst-Biologist adds the necessary metadata and column headers for the downstream integration into RUI and EUI integration workflows.
7. The Medical Illustrator will save the United body file as a low-polygon version. This version is saved in two file formats: .fbx and .glb.

8. The Medical Illustrator will individually export each organ from the United body file with updated naming as outlined below.

File naming schema: DataInstitutionOriginABBR_Sex_Organ.glb

Data Institution Origin Abbreviation	**Sex: Male (M) or Female (F) Abbreviation**	**Organ Name**	**Laterality if applicable Left or Right**	**File format .glb, .fbx**	**Example:**
Allen Institute (Allen)	F	Brain		.glb	Allen_F_Brain.glb
NIH	F	Lymph_node		.glb	NIH_F_Lymph_Node.glb
Stony Brook University (SBU)	F	Large_intestine		.glb	SBU_F_Large_Intestine.glb
Visible Human (VH)	F	Kidney	Left	.glb	VH_F_Kidney_Left.glb

9. The Medical Illustrator pushes the models to the CCF 3D Reference Object Library repository on Github: https://github.com/hubmapconsortium/ccf-3d-reference-object-library
10. The Medical Illustrator notifies the Systems Architect, Senior Research Analyst-Biologist and the PI via email of new organ additions.
11. The Senior Research Analyst-Biologist keeps a local clone of the repository to track changes for their own records.
12. The Systems Architect adds the new United body file to the CCF Ontology.

Step 2: Adding Organs to the CCF Portal

13. The CCF Portal contains a sub-page with a link to the CCF releases GitHub repository https://github.com/hubmapconsortium/ccf-releases . Reference organs are shown in a preview window and may be rotated in 3D. Direct links for downloading the corresponding object on GitHub appear next to the organ.
14. The Systems Architect adds all final organs to the CCF Portal and CCF-releases GitHub Repository https://github.com/hubmapconsortium/ccf-releases

References

- The CCF 3D Reference Object Library repository on GitHub is where the Medical Illustrator uploads their models.
- GitHub Desktop can be used by the Senior Research Analyst-Biologist and/or the Medical Illustrator to commit and review changes to the models.
- The CCF Portal is the central hub for many MC-IU contributions, such as the ASCT+B Tables, the CCF 3D Reference Object Library, and the CCF Ontology.
- 3D Reference Object Approval Standard Operating Procedures

Glossary

3D model: A 3D model is a digital object, consisting of vertices and edges, who, when taken together, can form a potentially endless variety of primitive (e.g., cubes, spheres, cones) and complex shapes (such as organs). 3D models come in many formats with various capabilities and limitations (OBJ, FBX, GLB, see below). We use GLB and FBX as output formats.

ASCT+B Tables: see HuBMAP Glossary.

Common Coordinate Framework (CCF): see HuBMAP Glossary.

Exploration User Interface (EUI): see HuBMAP Glossary.

FBX file format: 3D file format specification, see https://code.blender.org/2013/08/fbx-binary-file-format-specification/

GitHub: an online service for version control and code-sharing

GLB file format: 3D file format specification, see https://docs.fileformat.com/3d/glb/

OBJ file format: 3D file format specification, see https://www.cs.cmu.edu/~mbz/personal/graphics/obj.html

Registration User Interface (RUI): see HuBMAP Glossary.

Standard Operating Procedures (SOPs): SOPs are issued to specifically instruct team members in areas of responsibility, procedural steps, appropriate specifications and required records. SOPs outline procedures, which must be followed to support the reproducibility of scientific research. Procedures can take the form of a narrative, a flow chart, a process map, computer screen printouts or combination of all or any other suitable form, however must be written in appropriate, effective grammatical style. (e.g. plain English).

United File: The United File is a GLB 3D object that contains all the modeled organs in the Human Reference Atlas. It is hosted on GitHub and used in the Exploration User Interface to display registered tissue blocks. The United file is thus a compound file with all 3D organ objects combined.