Week 5: 3Dscanning and printing

25.2. 2015

This week we will learn about additive versus subtractive processes – and how to do 3D scanning and printing.

The agenda:

additive vs subtractive processes **printing** *constraints* materials ABS, HIPS, acrylic, PLA resolution time cost supports post-processing wall and edge thickness fills *processes* stereolithography fused-deposition molding ink-jet binder multi-jet modeling cut sheets selective laser sintering two photon digital *machines* RepRap Ultimaker MakerBot Formlabs MTM **file formats** STL ASCII solid object_name facet normal n1 n2 n3 outer loop vertex v11 v12 v13 vertex v21 v22 v23 vertex v31 v32 v33 endloop endfacet ... endsolid object_name binary 80 byte ASCII header 32-bit integer number of facets 50 byte facet records 32-bit IEEE floats normal vertices 1,2,3 2 byte attribute right hand rule normal (optional) AMF OBJ, 3ds, VRML, X3D FREP, BREP adaptively-sampled distance fields sample.f volumetric .vol, .tiff, .gif marching cubes fab modules vol_gif gif_stl gif_png **software** 123D SketchUp Inventor SolidWorks Rhino Grasshopper Blender FreeCAD OpenSCAD antimony VTK MeshLab netfabb meshmixer Geomagic ReplicatorG Skeinforge Slic3r Cura **scanning** point cloud, triangulation, watertight, texture tomography Radon transform micro-CT scanned probe confocal serial sections opacity digitizer laser lidar array illumination time of flight photogrammetry 123D Catch PhotoScan speckle OpenKinect ReconstructMe Sense structured light light stages SLAM **assignment** * design and 3D print an object (small, few cm) that could not be made subtractively * 3D scan an object (and optionally print it)

The assignment for this week is in two parts:

- design and 3D print an object (small, few cm) that could not be made subtractively
- 3D scan an object (and optionally print it)

Reviews:

Mexico – good presentation of week's assignment
UK – temperature controlled soldering iron
Till Kramer:
http://fabacademy.org/archives/2015/eu/students/cremer.till/index.html –
Netherlands. Final project…personal guru or Buddha. Sculpture.
Digital companion
Shirley Nieman – Waag society:
http://fabacademy.org/archives/2015/eu/students/niemans.shirley/index.html

Wesley Williams, USA:
http://fabacademy.org/archives/2015/na/students/williams_jr.wesley/index.html
Leoardo Zaccone, Italy:
http://fabacademy.org/archives/2015/eu/students/zaccone.leonardo/index.html

Printing:

Building up the object – additive process
3D printing dates back decades ago
3D printer tolerance test – good to do before spending hours printing

Contraints:

materials: ABS, HIPS, acrylic, PLA (is carbon negative) are typical.
3D printing – 0.010 mils are typical minimum size
Positioning is down to microns…
Second limitation is time, takes hours to make anything
Next limitation is costs
DIY machines – cost is lower, than professional machines
Support – the lower end printers need support removal
Common mistake – excruding filament, minimum size is needed
Need to design according to the capabilities of the printers
3D printers are notorious on not to print exactly as designed
Clearance is to be checked
Fillers – make it porous?
Print as little as possible

Processes:

3D printing: Shapeways: http://www.shapeways.com/
Stratasys: 3D printers: http://www.stratasys.com/ - http://www.stratasys.com/industries/education
Stereolithography: http://www.3dsystems.com/3d-printers/production/overview

Selective laser-sintering: http://www.3dsystems.com/3d-printers/production/overview
Two-photon: http://www.tuwien.ac.at/en/news/news_detail/article/7444/
Digital: http://cba.mit.edu/events/13.03.scifab/index.html
Chuck Hole – original design for 3D printing
How they compare: http://makezine.com/magazine/guide-to-3d-printing-2014/3d-printer-overview-how-they-compare/

RepRap: http://reprap.org/
Ultimaker: https://ultimaker.com/
Makerbots: http://www.makerbot.com/ - better mechanical machining nowadays
Formlabs: http://formlabs.com/en/ - geometric vases, people have problem with the machines because of cleaning. But by far the best resolution.
No single winner…
MTM: http://mtm.cba.mit.edu/ - general purpose machines, can serve different purpose

File format:

.stl – 3D systems, what is bad about it is that it can only become one thing – triangles. ASCI – binary. Put .istl on file sharing site.
Binary file – 2 byte attribute, that almost no-one uses. To use .stl – you need to turn it into triangles and lose information about the design.

AMS - http://amf.wikispaces.com/ - not stable, not mature yet

OBJ / 3ds – native format for Alias: http://www.autodesk.com/products/alias-products/overview

X3D & VRML: http://www.web3d.org/x3d-vrml-most-widely-used-3d-formats – for the web – good for colors

NURBS – paranomial, it has to cut the sphere into sections

Volumetric – sending the bitmap straight to the machine

Software:

123D: http://www.123dapp.com/
SketchUp Inventor SolidWorks Rhino Grasshopper Blender FreeCAD OpenSCAD antimony VTK MeshLab netfabb meshmixer Geomagic ReplicatorG Skeinforge Slic3r Cura
VTK: visualization toolkit: http://www.vtk.org/
MeshLab: http://meshlab.sourceforge.net/ - tools to do surgery on your meshes
Meshmixer: http://www.meshmixer.com/ - app for printing
Antimony: quickly maturing…
When you read in the .stl you need to agree on the units.
ReplicatorG: http://replicat.org/ - open source 3D

Look at the design in details
Look at the settings, and the path it is generating

Scanning:

Most of the tools – meshes, turn points into triangles. Before printing the model needs to be watertight.

Volumetric scanner – a housefly
Nikon scanner – 1 millj. Dollar
Volume (.vol)
The Nature of A. Modelling

Scanned Probe: Keysight technologies: http://www.keysight.com/en/pc-1678601/afm-atomic-force-microscope?cc=IS&lc=eng

Confocal – Zeiss: http://www.zeiss.com/microscopy/en_de/products/confocal-microscopes.html - has not been really well developed, but is improving

Serial sections: reconstructing brains:
http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.0020329

Opacity – Fluid scanning: http://milkscanner.moviesandbox.net/
Requires an object that you can pour liquid over

Digitizing arms: http://www.3d-microscribe.com/

3D Scanco: http://www.3dscanco.com/products/3d-scanners/3d-laser-scanners/konica-minolta/

Leidar: http://www.seeedstudio.com/depot/RPLIDAR-360-degree-Laser-Scanner-Development-Kit-p-1823.html

Pico second timing:

Photogrammetry: http://opensourcephotogrammetry.blogspot.com/ - open source.

Sense: http://cubify.com/en/Products/Sense - reconstruction of 3D model from several - easy and reliable, to quickly get results

Structured light:
http://academy.cba.mit.edu/classes/scanning_printing/light/index.html - plays series of patterns.
Paralell detector, removes pairs of them from the background. The optics and resolution can be varied.

Light stages: http://gl.ict.usc.edu/LightStages/ - workhorse for 3D scanning of people

SLAM: Project Tango: https://www.google.com/atap/projecttango/#project

Designing and making your own scanners: pico projector scanner + a camera.

Logitech HD Pro Webcam C920c

CTK + UT: http://www.commontk.org/index.php/Main_Page

Open CV: http://opencv.org/ -

Assignment:

Test part for the lab: design and 3D print an object (small, few cm) that could not be made subtractively
Scan an object and optionally print it