CAPTURING FORM

Module III: Lesson Plan

MODULE GOALS

3-D scanning is an alternative approach to digital modeling that functions by capturing the shape and exterior attributes of physical objects using a laser or infrared light to measure their surfaces. 3-D scanning is commonly used for manufacturing, design, and archival purposes due to its ability to make accurate digital replicas of existing forms. This module will expose students to accessible scanning technology (including Kinect, photogrammetry phone apps, or the Occipital Structure scanner for iPad) and broaden their understanding of where and how this technology can be applied to real-world projects. Students can build on their prior **remix** experiments by drawing from the physical world around them as well as repositories of digital models.

ESSENTIAL QUESTIONS

- What is 3-D scanning?
- What are the programs and devices that are used to scan 3-D objects?
- How does 3-D scanning technology work?
- What are the applications of 3-D scanning?
- What are the differences between modeling form and capturing form? What are the similarities?
- In what ways can scanning be used jointly with 3-D modeling programs and processes?
- How do objects change when they are expressed as data (e.g. a 3-D model)? How do the ways we work this them change? What new possibilities and limitations result from scanning an object?

MEANING AND ACQUISITION

- Students will gain a basic understanding of the various techniques and programs available for capturing forms digitally.
- Students will learn techniques for incorporating scanning into the design process, and how to apply 3-D scans to other digitally-modeled 3-D objects.
- Students will experience post processing of a scan in order to understand the potential for real-world application of captured forms.
- Students will create a new 3-D remix by recontextualizing or transforming a scanned object from their environment.

CAPTURING FORM

Module III: Lesson Plan

FORMATIVE ASSESSMENT STANDARDS

- Students demonstrate active problem-solving skills throughout the 3-D scanning and the digitization processes, converting their designs into functional digital forms **(Cr2.I.8a)**.
- Students know and use fundamental vocabulary relevant to the different object digitalization processes **(Cr3.1.1a)**.
- Students actively consider the meanings and implications of using a particular image or object as they incorporate these into their designs **(Re.7.2.4a)**.
- Students are able to discuss and explain 3-D scanning processes and techniques to their peers and help facilitate peer-to-peer learning **(CrI.1.11)**.

SUMMATIVE ASSESSMENT STANDARDS

- Student work exemplifies an effective use of materials, equipment and tools into the digitization of physical objects **(Cr2.1.IIa)**.
- Student work exemplifies a synthesis between creative and analytical principles and techniques of the visual arts and the sciences **(Cr2.3.IIa)**.
- Student work demonstrates how the introduction of digitalized objects into an existing design can provide new meaning to it **(Cr3.I.3a)**.
- Student work demonstrates the conceptualization and use of both traditional and contemporary technologies, merged by the scanning process, within the design **(CrI.2.IIa)**.

CAPTURING FORM

Module III: Lesson Plan

MATERIALS

- One or more of the following:
  - A free 3-D scanning app such as Scandy (iOS), Display.land (iOS/Android) or Qlone (iOS/Android)
  - A Kinect or Structure sensor and computer with Skanect software
  - A Structure iPad sensor
- Wi-fi for using the free photogrammetry app on phone.
- Laptops, with mouse
- Clay
- Multiple flash drives
- Objects to be scanned

KEY TERMS

- **3-D scanning** - A process of capturing the shape of physical 3-D objects as digital data. This may involve a focused line of laser light that runs across the surface of the shape, or an infrared light shone of the surface of the shape. In both cases, the interaction of these lights with the surface of the object is captured by a sensor to determine depth information (See Figure 1).
- **Photogrammetry** - An alternative way of capturing 3-D information without special hardware. A program analyzes several photos taken from multiple angles of an object, and determines its 3-D form.

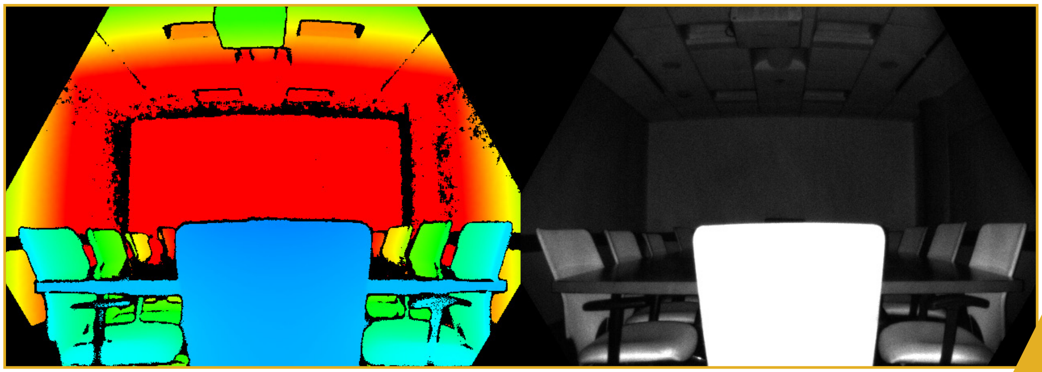


Figure 1. The infrared light shone by a Kinect sensor (right) and the depth image Kinect "sees" (left) with captured 3-D information.

CAPTURING FORM

Module III: Lesson Plan

PROPOSED ACTIVITY

1. Students will obtain a 3-D scan from their environment (of a found object, something they sculpt themselves, or of a person's body) using their smartphones and understand the photogrammetry method for scanning.
2. Students will use laser/infrared-based 3-D scanners (if available).
3. Students will work with the scanned model(s) in TinkerCAD, either extending their previous remix project, or developing a new one.

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from https://docs.microsoft.com/en-us/azure/kinect-dk/media/concepts/depth-camera-depth-ir.png

MATERIAL SPECULATION: ISIS

Realized by Iranian-American new media artist Morehshin Allahyari, Material Speculation: ISIS is a **3-D printing** project featuring the reconstruction of statues from the Roman period city of Hatra and Assyrian artifacts from Nineveh that were destroyed by ISIS in 2015 (Allahyari, 2017). Each recreated artifact contains a flash drive or memory card embedded inside of the printed object. Similar to the concept of a time capsule, these flash drives are meant for future generations and include images, maps, PDF files, and videos documented prior to the artefact's destruction (Soulellis, 2016, para. 3).

The project demonstrates how 3-D printing and scanning technology can be both a practical tool for documentation and an inherently political form of resistance (Soulellis, 2016, para. 6).

Figure 1. King Uthal. One of the destroyed artifacts meticulously reconstructed and 3-D printed by Allahyari.

Figure 2. Lamassu. Another of the destroyed artifacts meticulously reconstructed and 3-D printed by Allahyari. Visible in the body of the sculpture is a flash drive, containing 3-D data as well as other information about this artifact.

CAPTURING FORM

Module III: Case Study I

PROJECT DESCRIPTION

The recent and widespread destruction of precious cultural artifacts in Middle Eastern conflict zones and via natural disasters around the globe has inspired researchers, archeologists, and historians to reconsider the vulnerability of our cultural histories and the objects that represent them (Reilly, 2015, p. 225). Cyber Archeology, a form of archiving that uses images of historical artefacts to create 3-D reconstructions (i.e. photogrammetry), has gained momentum in recent years as a solution to offset some of these losses (2015).

However, using photogrammetry, 3-D scanning, and additive manufacturing to recreate history poses numerous challenges to traditional archeological study in that it problematizes conventional understandings of materiality and authenticity (Reilly, 2015, p. 225).

This contentious relationship is one of the many points of entry into Morehshin Allahyari's work in Material Speculation: ISIS. Allahyari exploits the illusory condition of the recurring copy that challenges concepts of memory, the past, and loss (Karimi & Rabbat, 2016, p. 2). In the traditional sense, the artifacts that Allahyari prints are considered obsolete. However, Allahyari's Material Speculation: ISIS utilizes cutting-edge technology to open up new possibilities for obsolescence with the understanding that these technologies will continue to evolve and get better in the future (Allahyari, 2017, para. 5).

By combining 3-D scanning, photogrammetry, and 3-D modeling, the artifact is resurrected and a new use-value is assigned to it (Karimi & Rabbat, 2016, p. 5). The objects themselves reside somewhere between tangible and ubiquitous as freely circulating open-source entities (2016, para. 10). The artefactual aura (Benjamin, 1969) is exchanged for immortality and guaranteed survival (Soulellis, 2016). In this way, Material Speculation simultaneously acknowledges the questionable authenticity of substituting digital recreations for lost cultural objects and hints at further possibilities born from forward-thinking technology.

Resource Materials:

The artist has provided a .zip folder of .STL and .OBJ files for some of her objects via The Download - a project by Rhizome "that considers posted files, the act of downloading, and the user's desktop as the space of exhibition" (Soulellis, 2016, para. 1).

CAPTURING FORM

Module III: Case Study I

REFLECTION QUESTIONS

1. In Material Speculation: ISIS, digital 3-D scanning is used in combination with 3-D modeling to create artistic pieces that not only preserve existing ones, but also add new meanings to them. In this sense, what are the artistic possibilities that 3-D scanning brings to the table? What is gained, and what is lost, in preserving artifacts this way?
2. Many museums have made 3-D scanned digital and printed objects of their collections available to the public for educational and research purposes. What are examples of other potential applications for photogrammetry and 3-D scanning?
3. Material Speculation: ISIS allows lost cultural objects from our past to be reborn. If you could recreate a landmark or artifact from your past, what would you recreate and why?

REFERENCES

Allahyari, M. (2017). Material speculation: ISIS (2015-2016). http://www.morehshin.com/material-speculation-isis/

Benjamin, W. (1969) The work of art in the age of mechanical reproduction. (H. Zohn, Trans.). Schocken Books. (Original work published 1935).

Karimi, P., & Rabbat, N. (2016). The demise and afterlife of artifacts. In P. Karimi & N. Rabbat (Eds.), The destruction of cultural heritage: From napoleon to ISIS (pp. 1 -24). Aggregate Architectural History Collaborative.

Reilly, P. (2015). Additive archaeology: An alternative framework for recontextualising archaeological entities. De Grutyer Open, 1(1). https://www.degruyter.com/view/j/opar.2014.1.issue-1/opar-2015-0013/opar-2015-0013.xml?for=&print&print

Soulellis, P. (2016). The distributed monument: New work from Morehshin Allahyari's 'material speculation' series. https://rhizome.org/editorial/2016/feb/16/morehshin-allahyari/

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from http://www.morehshin.com/material-speculation-isis/

Figure 2. Retrieved from http://www.morehshin.com/material-speculation-isis/

BOOMcast

The BOOMcast is an example of how additive manufacturing can be used for medical applications. BOOMcast was initially created as a customized cast by Studio Fathom for T.V. personality Mike North of Prototype This! and Outrageous Acts of Science (Holterman, 2015, para. 1).

A design team that uses their expertise in 3-D printing and additive manufacturing to help customers find innovative solutions to problems, Studio Fathom was tasked with creating a support system for a broken fibula that would allow its wearer to maintain on active lifestyle and wouldn't compromise the healing process (2015, para. 2). They utilized computer software and **3-D scanning** technology to determine the most fitting shape for their client's leg. Outfitted with lights, bluetooth speakers, pressure sensors, on accelerometer, and wi-fi, the BOOMcast is capable of collecting real-time medical data and sending it to your doctor while simultaneously playing music from a smartphone ("North & FATHOM Take Medical To The Cloud", n.d., para. 1).

Despite the BOOMcast being a one-off project, it points to directions other innovators may take 3-D printing and scanning to better serve the particular medical needs of individual bodies.

Figure 1. Assembling the 3-D printed components of the BOOMcast.

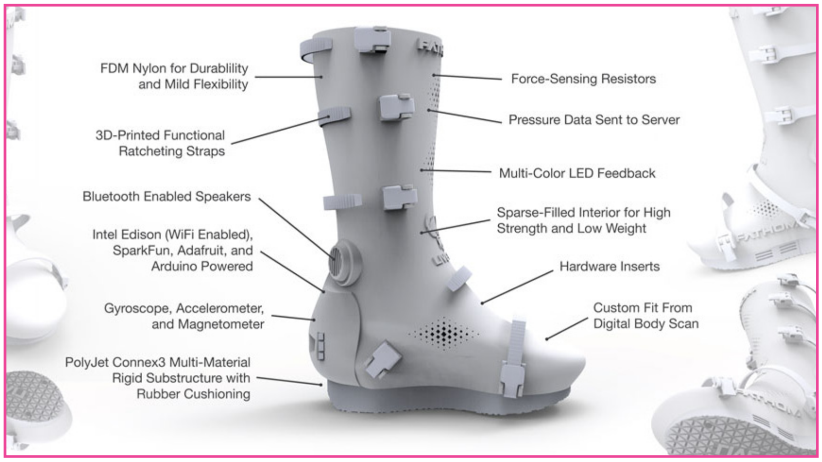


Figure 2. A rendering of the assembled BOOMcast, itemizing its various features.

CAPTURING FORM

Module III: Case Study II

PROJECT DESCRIPTION

3-D printing is becoming increasingly common within the healthcare field . Additive manufacturing is currently used to custom-print hearing aids, removable braces, prosthetics, and even replacement organs (Ventola, 2014, para. 1). In many ways, 3-D printing is already playing on important role in streamlining traditional medical treatments. As on easily customizable and less expensive option for production, 3-D printing is gaining more and more momentum in the medical field every day (2014, para. 5). The BOOMcast is one example of the potential for improving the way doctors treat broken bones by combining 3-D scanning, digital 3-D design, and additive manufacturing ("North & FATHOM Toke Medical To The Cloud", n.d., para. 1).

As a television host who travels frequently, Mike North of Prototype This! And Outrageous Acts of Science needed a durable and easily removable cost to support the healing process after breaking his fibula. Many people's lives ore hampered when they suffer on injury, and the BOOMcast exemplifies the ways in which 3-D printing con make a patient's specific needs more addressable (Holterman, 2015, para. 5). This particular cast tokes customizability to the next level, since data from 3-D scanning processes and a special software were used to determine and generate a 3-D model that fitted North's leg. This is a process that can be found in other examples of 3-D printed medical casts as well (Holterman, 2015, para. 4). Also, North's cast integrates technology from industry-leading companies like Intel and Google: due to a hectic schedule, the cast is programmed to deliver medical information to a doctor in leu of office visits, map pressure and audio data, and contribute other extensive auxiliary features (Domanico, 2015, para. 2). Finally, the body of the cost and the strops that ore used to hold it in place were printed in Nylon 12 filament, while the sole of the cast was built with PolyJet multi-materials (2015).

While BOOMcast is unlikely to become a full-fledged consumer product, it manages to demonstrate as proof-of-concept how open-source development, 3-D scanning, and 3-D modeling con be integrated and used to design and build novel and more effective products in the near future (Domanico, 2015, para. 9).

CAPTURING FORM

Module III: Case Study II

REFLECTION QUESTIONS

1. What are the possibilities and limitations of 3-D scanning for medical purposes? What other medical uses can you imagine for 3-D scanning technology?
2. What about beyond medical uses? How else might 3-D scanning be used to customize items? What are the potential possibilities and setbacks of this technology?
3. What will happen with the BOOMcast when Mike North is done wearing it? Are customizable, single-use items a sustainable practice, from an environmental or resource-conscious perspective? How might we address these issues?

REFERENCES

Domanico, A. (2015). 3D-printed cast heals broken bones, doubles as Bluetooth speaker. https://www.cnet.com/news/this-wacky-boomcast-brings-medical-casts-into-the-future/

FATHOM (n.d.). North & FATHOM take medical to the cloud. http://studiofathom.com/boomcast/

Holterman, T. (2015). BOOMcast: 3-D printed disco leg cast includes music and mood lighting. https://3dprint.com/86160/3d-printed-boomcast/

Ventola, C. L. (2014). Medical applications for 3-D printing: Current and projected uses. Pharmacy and Therapeutics, 39(10), 704-711.

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from http://studiofathom.com/boomcast/

Figure 2. Retrieved from http://studiofathom.com/boomcast/

CAPTURING FORM

Module III: Handout

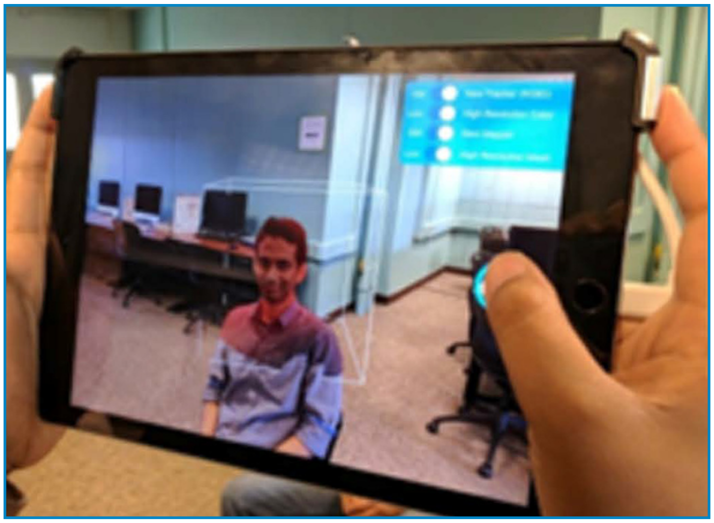
3-D SCANNING

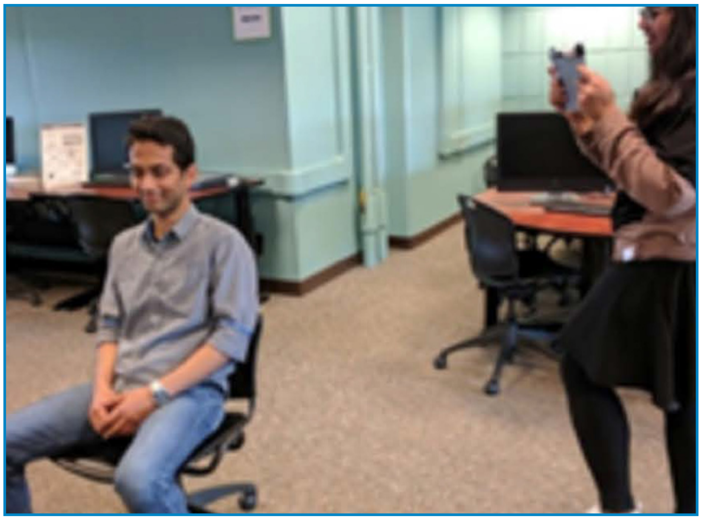
Capturing form is an alternative approach to digital modeling. This technique can be applied for solving real-world challenges.

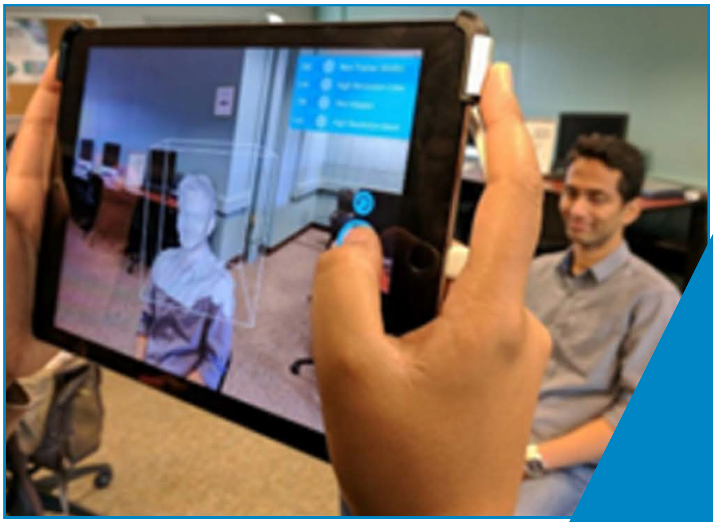
INFRARED-BASED 3-D SCANNING WITH STRUCTURE SCANNER

The Occipital Structure Sensor , for the iPad, is one available tool for 3-D scanning. Infrared dots are projected onto the object, which is used by the infrared camera to create a pattern and visualize the shape and distance of an object. This tutorial focuses on this tool, but others are available.

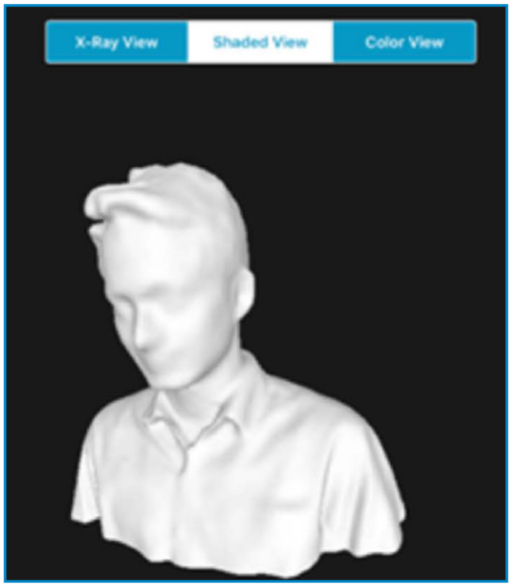
1. To scan an object or person, place it/ them in a properly lit area and, make sure to have a one meter of walkable radius free around it.
2. Hold the scanner at an appropriate distance, adjust the enclosure box accordingly in the Occipital app.
3. Once the object is captured in the box, and is tinted red. Walk around the object slowly, to capture the 3-D model.
4. Be sure to capture the top, and, if necessary, the bottom of your scanned object/ person!



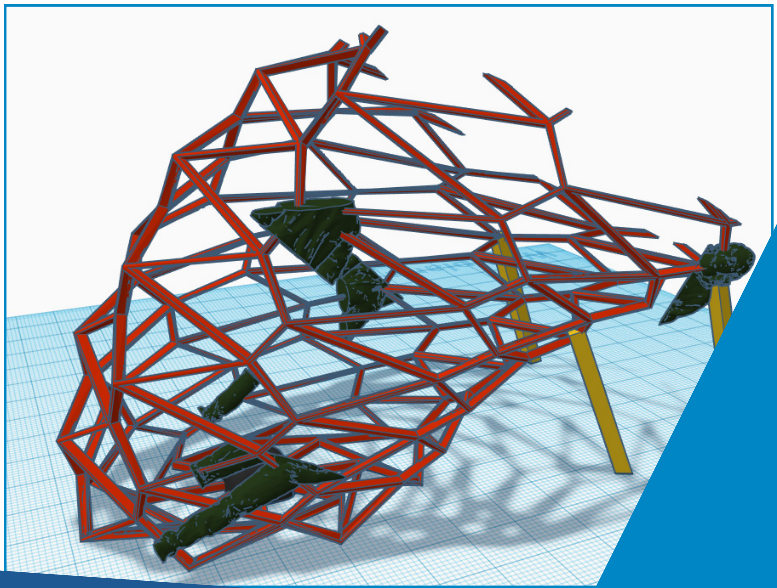




5. Once complete, preview the three views (X-Ray, Shaded, and Color) in the Occipital app. If you are satisfied with the scan, email it to yourself.



6. **Post-processing** means taking the scanned image and "cleaning it up" before printing. This might mean getting rid of unnecessary extra bits the scanner captured, or fixing holes in areas the scanner didn't capture.
7. We can open our models in TinkerCAD to post-process them, and also to transform, extend, and remix them.
8. Once in a TinkerCAD project, import the .obj file from your scan, by clicking the **Import** button in the upper-right.
9. Your scan will probably be tiny initially, so scale it up by holding the shift key and dragging one of the corners.
10. Now, explore and play! You can add this scan to the remix from the previous module, or turn it into something new. If you notice any messy or unnecessary bits of the scan, you can remove them with 'hole' shapes.



CAPTURING FORM

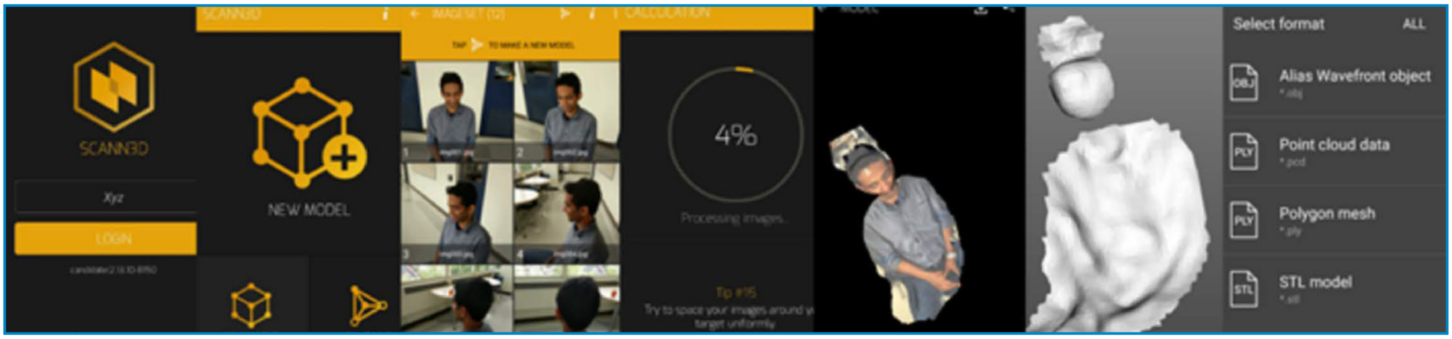
Module III: Handout

PHOTOGRAMMETRY

Photogrammetry is 3-D scanning through smart phones, with no special hardware required. Software analyzes photos taken from multiple perspectives around an object and uses them to construct a 3-D model of the object being photographed.

AVAILABLE TOOLS

SCANN3D for Android, pictured here, is one tool for photogrammetry, though there are many options. Each of the available apps is designed to be self-explanatory. If you seek out your own, make sure to use an app that allows you to download or export your model for free. At the time of writing this, Scandy (iOS), Display.land(iOS/Android), Scann3D (Android), or Qlone (iOS/Android) are potential options.



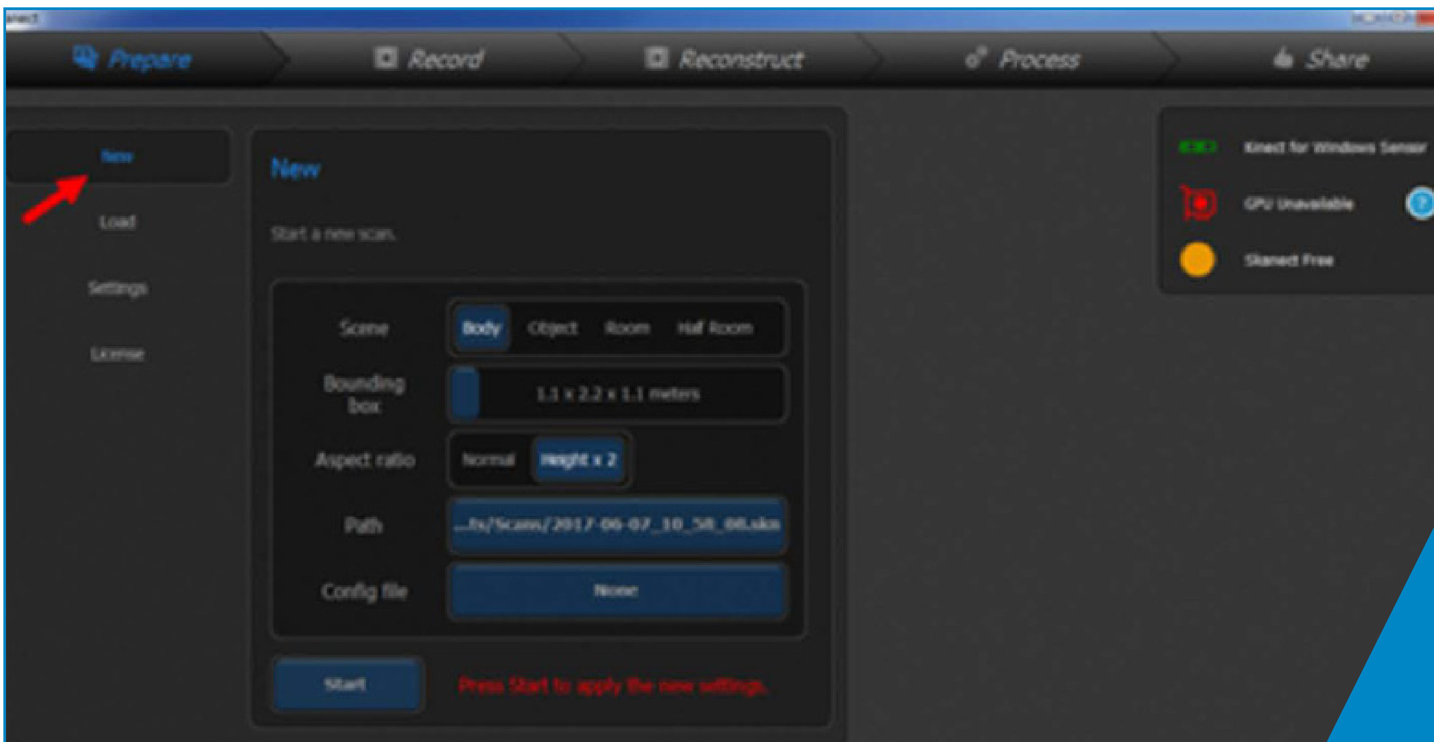
INFRARED-BASED 3-D SCANNING WITH KINECT SCANNER

The Microsoft Kinect, initially designed for gaming applications on the XBox, was quickly adapted by hackers and artists for other uses, and soon supported by Microsoft as a tool for 3-D scanning and interaction with computers. There are several software tools that allow for scanning with a Kinect, including Skanect and KScan. The Kinect projects infrared dots onto an object, which is used by the infrared camera to create a pattern and visualize the shape and distance of an object.

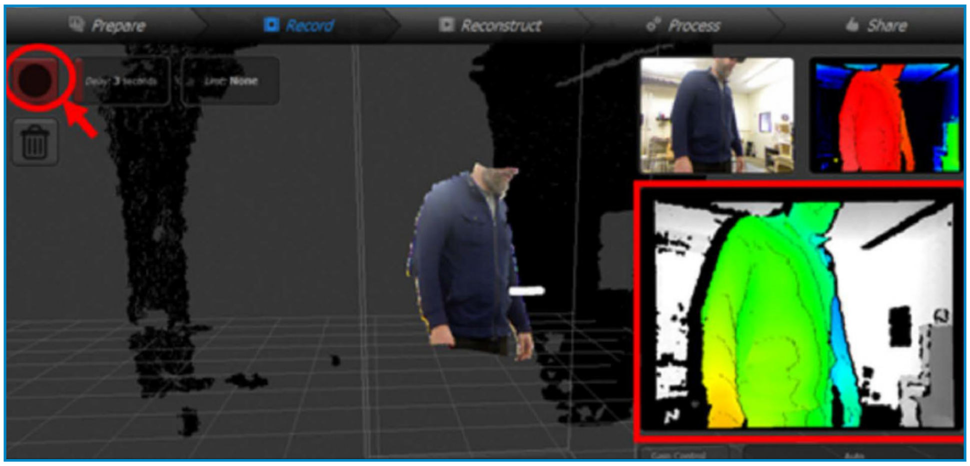
This tutorial focuses on using Skanect software with a Kinect v1 device, but other options are also totally viable, depending on what your have available.

USING SKANECT + KINECT v1

1. Open Skanect on the computer the Kinect is attached to. Prepare a new scan, adjust settings as required. A bounding box is the enclosure in which the object to be scanned must fit.



2. Place the object or person to be scanned on the lazy Susan. Adjust the Kinect such that the object to be scanned turns green on the screen. Start the scan, and switch on the rotation of the lazy Susan. Stop by clicking the button again, once all the sides are captured.



3. Once the reconstruction is done, go to Process, and Mesh the file to Watertight. Once complete, share your file in any file format.