Hands On Learning: The Augmented Reality (AR) Sandbox

Thomas Pingel[1], Nicole LaDue[2], Justin Moore[2]

[1]Department of Geography, [2]Department of Geology and Environmental Geosciences, College of Liberal Arts and Sciences, Northern Illinois University

## What is an Augmented Reality Sandbox?

- **Augmented Reality (AR)** is the overlay of computer generated imagery on top of real world information.
- AR is used in many domains, and is used very often in televised sports.
- The AR Sandbox uses this same idea to simultaneously detect the height of the sand, and then to colorize it and draw contour lines via the projector.
- **It draws a topographic map on the sand in real time as you move it!**

How does an AR Sandbox work?

The AR Sandbox consists of four main parts; the sandbox, the projector, a Microsoft Kinect, and a computer. The box is an 8" deep, 40" x 30" box that has 3 walls made of transparent acrylic for better visibility of the sand. The sand is special type of play sand ("Sandtastik") that is colored white so that the image projected onto the sand is easily seen.

The projector is an ultra short throw projector with an aspect ratio of 4:3. The ultra short throw of the projector means it can project a relatively large image compared to the distance to the projected surface. The height of the sand is detected using a Microsoft Kinect. The computer processes the data received from the Kinect to produce topographic maps in real time!

The AR Sandbox is an open source project developed by Oliver Kreylos at the University of California Davis Keck Center for Active Visualization in the Earth Sciences (KeckCAVES).
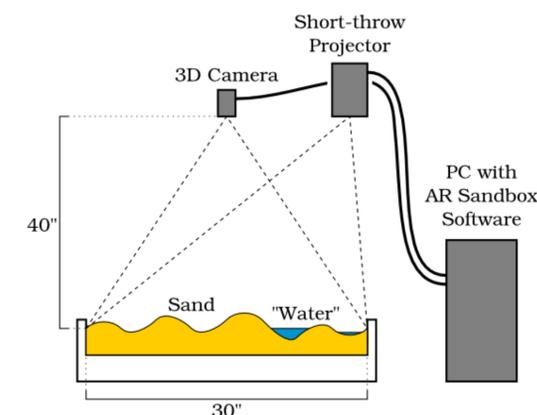
Schematic diagram of the AR Sandbox by O. Kreylos

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What can I do with it?

Draw Topographic Maps

- Move the sand and watch as the computer detects the sand position and draws a topographic map on top of the sand.
- The colors represent elevation. Blues represent areas below "sea level" and greens and browns represent land. *Hypsometric maps* are those where color is used to represent elevation.
- The contour lines connect areas of equal elevation. They form circles and do not intersect.

Make it Rain

- Hold your hand over the surface to add "water" to the table.
- The water simulation uses physics models to make the water flow over the surface.
- The water seeps into the sand over time, and flows out at the table edges.

Teaching Applications

- **Topographic Map Instruction**, where students can see how changes in the terrain affect how the map is drawn.
- **Hydrology**, where students can observe how water interacts with the terrain.
- **Geomorphology**, where students can practice creating the landforms they are studying.
- **Geovisualization**, where students can see how creative visualizations can improve learning outcomes.

Research Applications

- **Geoscience Education Research** - What kind of activities with the AR Sandbox best promote learning, and why?
- **Geographic Information Science** – What modifications of the AR Sandbox platform can improve responsiveness and aid in the communication of 3D spatial information?
- **Computer Simulation** – How can the AR Sandbox be used in combination with Geographic Information Systems to allow the user more control over model inputs?