Earth Science Data Visualization through Augmented Coloring Books

Nihanth W. Cherukuri, Tim Scheitlin, Matt Rehme
National Center for Atmospheric Research, 1850 Table Mesa Dr, Boulder, CO 80305

Abstract
The process of scientific visualization often involves making design choices—colors being one of them—to effectively communicate and highlight features in the data (e.g., high/low temperatures). Using the techniques of registration and image tracking, which are widely used in Augmented Reality (AR) applications to anchor digital content to the real world, an iPad/iPhone application has been developed that transforms hard-coded scientific data sets. The application enables users to hand-color a palette of images of the world dataset, obtain the colors used, and connect that to an AR interface, 3D globe with the dataset in situ, animated with the users’ colors. This exercise could also be used to educate students about different map projections and a flexible, customizable, interactive tool for teachers to teach a variety of geoscience topics. The engaging interactive environment helps instill a sense of ownership of the data and encourages the students to be more engaged with the science being presented.

What is Augmented Reality (AR)?
AR is a visualization environment wherein the user’s view of the real world is enhanced with virtual objects, when viewed through a screen or an optical head mounted display. This gives the user the illusion of virtual objects coexisting with real world objects. The term “mixed Reality” (MR) is sometimes used interchangeably with AR.

How is Augmented Reality (AR) different from Virtual Reality (VR)?
VR is an environment in which the user sees a head mounted display whose display is updated in-sync with the user’s physical movement. This creates an illusion of being visually immersed in a new environment. AR, on the other hand, brings virtual content into the real world, whereas VR transports the user into a virtual world.

Advantages and Challenges of AR in Education
- Enhances spatial ability, learning achievement, learning motivation (Akay et al., 2017; Martín-Gutiérrez et al., 2010).
- Technological complexity, potential distraction, novelty effect (Akay et al., 2017).

Use Case: Map Projections

1. Students are accustomed to seeing flat maps of the earth, often in Mercator or Cylindrical-Equidistant projections which introduce severe distortions near the poles.
2. The following activity helps teach map projections and great circle distances through an immersive smartphone/tablet application.
3. The application allows students to color blank maps (cylindrical-equidistant projection) with geographical features or visualizations which can then be view in different map projections interactively using AR.
4. Using AR helps to connect the coloring activity with digital enhancements making the learning activity engaging and enjoyable.

Preliminary Findings (Informal)
- The application was demonstrated at a local outreach event at UCAR Super Science Saturday and a science festival in Cheyenne, WY giving an opportunity to identify the primary audience and gather preliminary user feedback.
- The activity received a positive feedback overall with the primary users being 9-12 studen
ts. The Great Circle distance activity was popular with parents as well.
- Younger students were primarily interested in seeing their drawing transformed onto a globe with a few of them identifying continents and some shapes on the maps with the parent’s help.
- Most of the older students actively tried switching between different map projections to identify the projection which best visualized their drawing.
- Very few students knew about Great Circle arcs and appeared very fascinated with the activity. Many students interested the great circle path activity via hallway while trying to navigate the Cylindrical Equidistant Map with the Globe.

Relevant Work
- One of the first applications of interactive books was demonstrated by Billinghurst et al., 2001. Markers in story books were used as a trigger and an anchor to drive a relevant AR context.
- Clark et al., 2012 demonstrated an AR pop-up book application in which the hand drawings were used to feature 3D AR objects.

Summary & Future Work
- An interactive application of AR to teach map projections using a coloring book approach is presented.
- This activity could be built on the GLOBE 2014 exercise on drawing your own visualization to add component representation projections.
- A formal user/interaction evaluation study to assess the advantages and disadvantages of using this approach needs to be conducted using focus groups. This will also help identify other avenues where AR could be used to address a pedagogical need beyond the novelty effect.
- This application and AR in general is not accessible for students with visual impairments. In order to make the activity inclusive, it is recommended to use AR as a supplemental feature along with an option to view the scanned map projections, thereby allowing the students to obtain larger and tangible prints if required.

Are you Interested in Collaborating? rinse, educating, and informing the public about our research and about the wonder and relevance of science is one of the primary missions of our organization. Fostering new technologies that enhance our storytelling capabilities and engage our audience plays a key role in making that possible. We are always looking for new collaborations. Please contact us if you are an educator interested in parts of the AR/VR technology evaluation studies or interested in using AR as a tool to address a pedagogical need.

References