Augmented Reality Charts

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Problem

Nautical charts are an invaluable reference for mariners and oceanic researchers. Although charts are available digitally, some mariners still prefer physical paper charts. The National Oceanic and Atmospheric Administration (NOAA) releases weekly updates for every chart to address changes to navigational aids and new information. Currently, updating paper charts using NOAA's descriptions of changes can be difficult and tedious.

Chart Update Mashup

- The Center for Coastal and Ocean Mapping's (CCOM) web application for chart updates
- Overlays updates on digital chart
- Failed to mitigate all inconveniences during manual updates
- Did not reduce time to update

Project Goals

- Create an innovative application with use of augmented reality
- Use a virtual overlay of the chart to place updates accurately
- The ability to manipulate data with user interaction

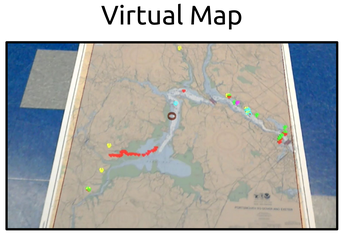
Tools:

Microsoft HoloLens, unity, vuforia, Visual Studio

Features

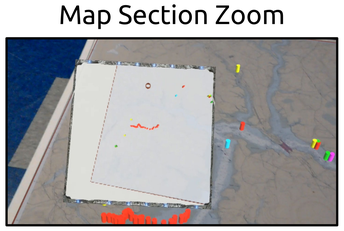
Chart ID Input

Virtual Map



Virtual HUD

Map Section Zoom

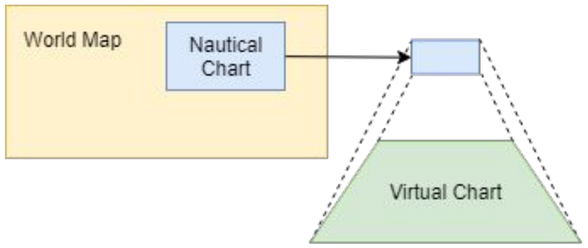


Methods

Nautical chart coordinates are in the 2-D form (lat, long)

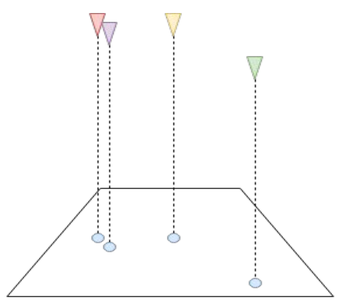
- $-90 \leq lat \leq 90$ and $-180 \leq long \leq 180$
- AR coordinates are Cartesian coordinates (x, y, z) where $x,y,z \in \mathbb{R}$

Window-to-Viewport Transformation



- Creates an AR mesh for the virtual chart with coordinates in the form of (x, y, z)
- Project the (lat, long) coordinates onto the virtual chart
- Scale the projection's x and z coordinates with respect to mesh dimensions

Convert 2D TO 3D with Raycasting



- The projected coordinates are placed at D(x', y', z')
  - D = -Normal of the mesh with an arbitrary scale
  - {x', z'} = projected(lat, long) respectively
  - {y'} = the highest corner's Y coordinate.
- Raycast towards the mesh
  - The mesh-raycast intersection is the projected coordinate

Design Decisions

State Machine:

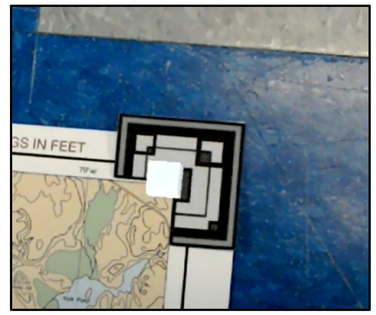
- Allows for high level planning
- Understanding application's flow and process

Gestures to UI:

- Gestures were the main source for interacting
- Utilize 3D space
  - Virtual HUD
- Update models are small
  - Difficult to interact with gestures
  - Hololens would "jitter"
- Virtual HUD handles this problem

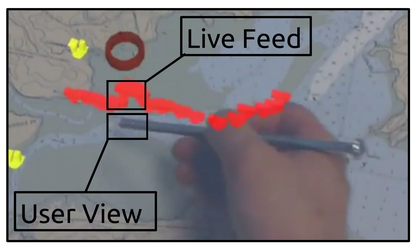
Chart Representation:

- Initially, image entire recognize chart
- Get map bounds
  - Spatial mapping
- AR Tags
  - Recognize map corners



Limitations

- Vuforia Limitations
  - Long upload process
  - Dependant on size & quality
- Limitations of Hololens
  - Hologram inaccuracies
  - User's limited field of view
  - Processing power
  - Slow online data retrieval
  - Remapping of area
  - Limited documentation



Going Forward

- Last updated date
  - Updates may be irrelevant depending on chart version
- Extensive testing on dynamic environment
  - Most testing done in an open indoor area
  - Works well while docked (subtle swaying)
- Mobile device version
  - Hololens expensive
  - User most likely to have smart device
  - No known available SDK