Antarctic Interactive Map

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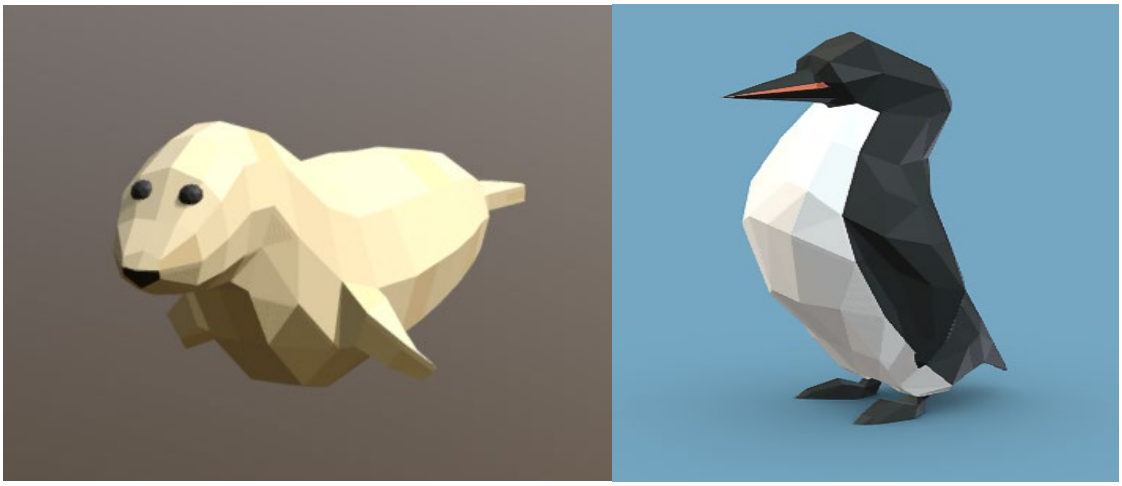
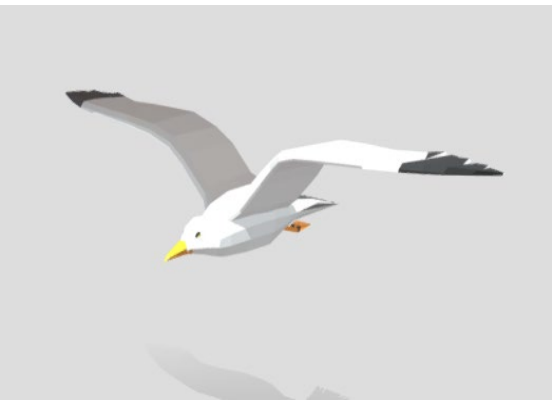
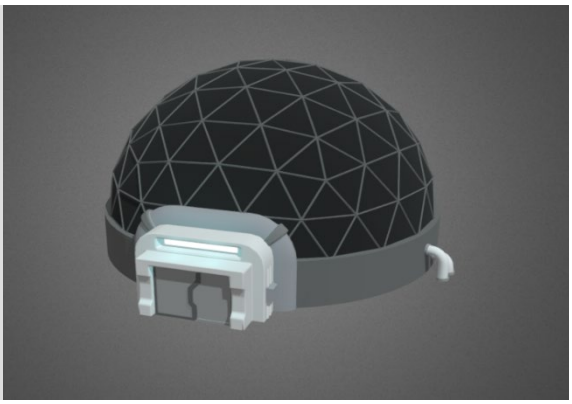
1. Introduction / Overview

This is an application designed to get students and young people engaged in the Antarctic experience. It uses AR technology to show the degradation of the ice sheets in the Antarctic on a sliding scale throughout the years as well as show points of interest (such as animal habitats) through pins on the 2D dimensional map.







2. **Description of the application**

This application allows a user to use a slider, to see the degradation of the ice sheets of Antartica over the period of the last 30 years. This will allow the user to compare different years to one another and hopefully shed light on just how much ice has been lost (on average Antartica loses 74 billion tons of ice annually). The 2D map will also show multiple pins throughout, that the user can click to gather information about the area the pin was stuck in. The application uses AR technology (leveraging the Vuforia engine) to show ice sheet data and points of interest in 3D. This will be designed in Unity, for the android operating system.

The map of Antartica will be a 3D model with precise 3D pins, on points of interest. These include; Antarctic research stations, key areas of Antartica that have experienced mass erosion and the habitats of animals native to the Antarctic.

When interacting with these key locations, a screen will be created as a pop-up to the side of the pin selected, showing information about the location. Key locations for ice degradation will be shown with a slider, informing the user how the erosion has worsened over the past 30 years.

3. **Description of the interface solution**

Augmented Reality (AR) was chosen for several key reasons:

- Ease of use – The goal of this application is to provide users in a school setting visual and educational information about the past and current state of Antartica.

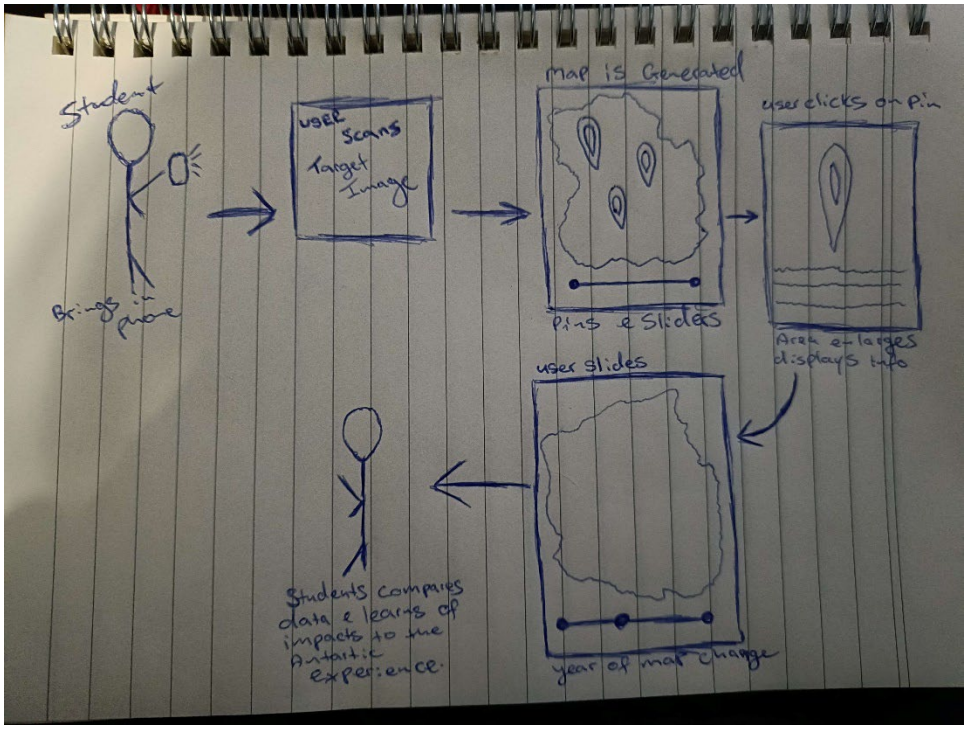
This will be easy to use, with a map of Antartica being the image target for the application. This application will include a slider and pins, being self-explanatory points of interest on a touch screen. Despite its simplicity, the application can still show high-level data effectively, making it a good choice to help visualize this data.

- Immersion – By being fully interactive, the user experiences a heightened sense of immersion, feeling as though their actions are impacting the world rather than just reading information on a website.
- Interactivity – Users can engage with the content and explore content at their own pace, which allows the user to learn in a manner that is conducive to their own education.
- Accessibility – AR is widely available on most smartphones and tablets, making the application widely available. This was chosen over Virtual Reality (VR) due to the ease of finding applicable smartphones vs needing specialized equipment such as the Meta Quest 3 or the HTC Vive.
- Novelty – The application itself is a novel experience for those using it, which will help the student using the application recall information with greater accuracy rather than through text-based systems.

4. **Interaction Design**

Interaction 1: Screen Space Slider – Visualizing the extent that ice levels have changed over the years is hard for students in a traditional web or video-based format, slide after slide of visuals is hard to compare. This interaction is used so that the user of the application can more easily compare multiple years' worth of data more quickly than by looking it up over multiple pages. Users can interact with a slider on screen to visualize changes in the ice over the years.
This is crucial to help students understand the climate change process. Providing a comparative view with previous years of data, allowing for a stronger mental image and more impactful learning experience.

Interaction 2: Points of Interest – User can tap pins on the 3D/2D map to reveal more details about areas like; research stations, wildlife habitats, and geological information. This interaction will capture a student's curiosity for further information, making the application highly engaging.



The following two interactions will be implemented depending on available time and difficulty.

Interaction 3: Zoom - The model can be enlarged or shrunk via a pinching gesture on their device. By enlarging the model, the user can more thoroughly inspect details like Points of Interest, in reverse zooming out will allow an overall view of the entire continent. Zoom will add an extra layer of control for users allowing them to get a broad overview of the ice degradation, this interaction provides flexibility and enhances the exploratory nature of the application.
Using this interaction in conjunction with the slider will allow the user to gain a greater understanding of the impact of the degradation which will allow for a greater appreciation of the work that scientists are doing in the Antarctic.

Interaction 4: Rotate – The user can rotate the model of Antarctica by physically rotating the marker image, or swiping the model left or right in the application.
The swipe-based motion provides a simple and tactile method for allowing the user to view the model from different vantage points.
Rotation further enhances the user's ability to interact with the model, particularly useful for exploring POI's that may be located on the far side of the model.

5. **Technical Development Planning**

The application is being designed using the Unity 3D engine, created on Windows/Linux based PC's.

We will be implementing AR image bases with images uploaded in conjunction with the Vuforia AR library. Further functionality will be supplied by Unity out of the box, i.e. touch input and rendering will be taken care of by the Unity3D engine.

Custom interactions and functions will be hand coded by the team, where opensource libraries are not available. These will include functionality to implement all our listed interactions and include code to handle generation of a mesh for Antarticia from elevation data and meshes for the monthly ice extents from shapefile data.

The application is planned to work on Android (10+) Mobile devices and Windows Laptops/PC's via UWP (Universal Windows Platform). The application was chosen to be made in AR to make the experience novel for students who otherwise may not pay as much attention to the information on display if it were simply in a text-based format.

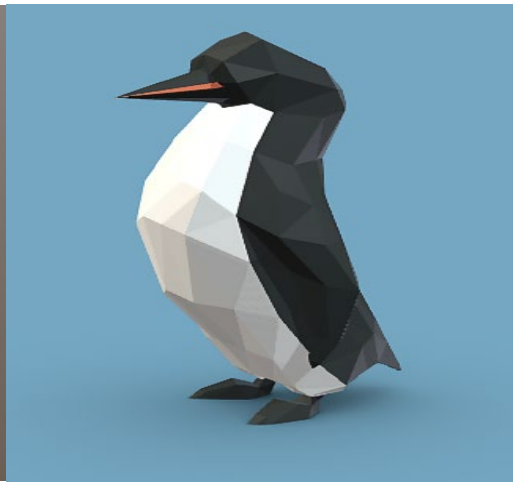
The Antarctic landmass model will be generated from the reference elevation model of Antarctica. ArcGIS library will be used to provide a 3D representation of monthly Ice extent and area data files. If this proves to be not feasible, 2D images will be layered to show the changes to the ice layers over time.

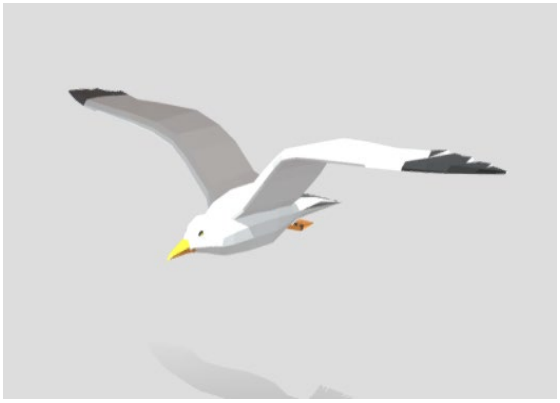
Other models have been sourced from the Unity asset store and Google Sketchfab. Low poly assets are to be used during the creation and deployment of this application. These were chosen for several reasons, with consistency of the assets and useability on every device since they are small in data size, being key amongst them.

Virtual Reality (VR) was considered for this project; however Augmented Reality (AR) was eventually chosen as the interface due to the prevalence and accessibility of available mobile phones vs the specialized hardware required for VR (such as the VR headsets and the VR hand controllers)

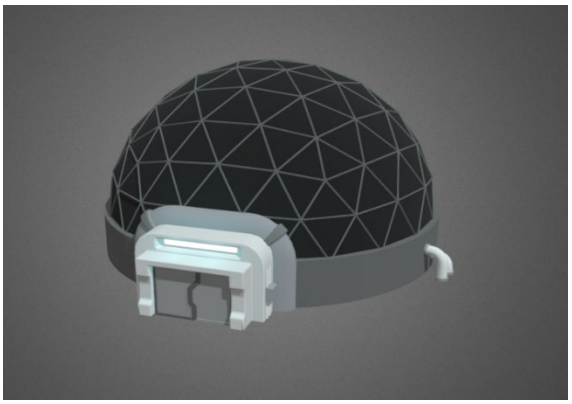
Future versions of this application will take advantage of more modern devices such as AR glasses, providing a hands-free interface.

6. **Initial 3D Models**



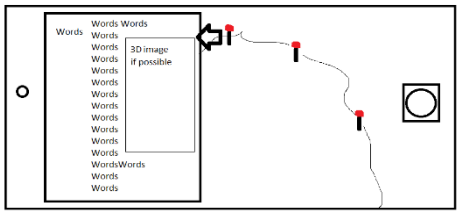


- Low poly animal assets will be used to show where animals live based on habitat. Low poly was chosen to keep the application light weight and to ensure uniformity with the rest of the assets in the application.

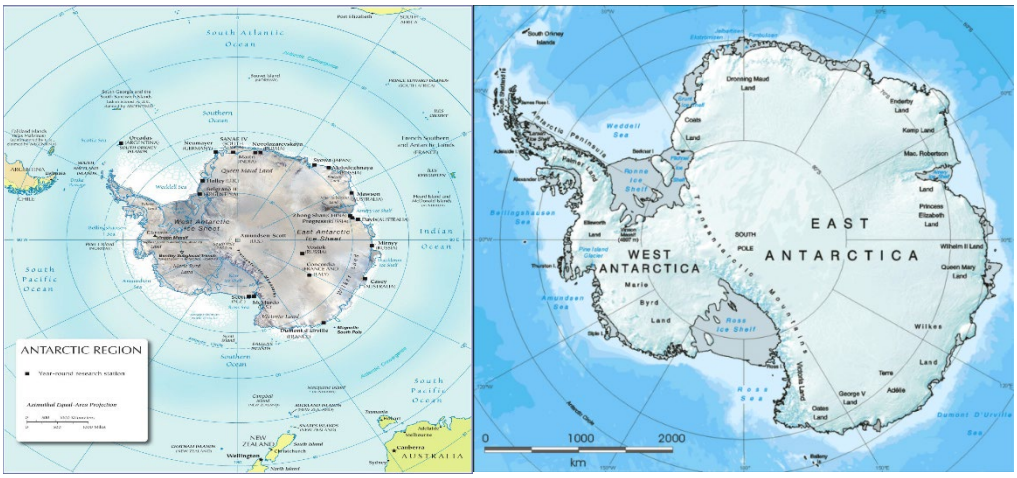


- A low poly hut was chosen to display research stations. Low poly was once again chosen to keep the application light weight and to ensure uniformity.

- A slider will be used to show the erosion of Antarctica's ice over a set number of years. This is to be used in interaction 1.



- Red 3D pins will be utilized on the map to show key locations and areas of interest. This is to be used in interaction 2.



- 2 Maps of Antartica will be used via Vuforia, for the application to run correctly. More maps could be added later. These two maps are current image targets.

- Ice Extent models will be programmatically generated from monthly GIS data of Ice Extents supplied by the National Snow and Ice Data Center.
- Antartica 3D Model – Will be programmatically generated in Unity from the Reference Elevation Model of Antarctica.

7. **Conclusion**

The application's design is to provide an engaging and novel experience to students using the software. It is designed to provide information quickly in a fun and interactive way. This will educate the user of the current Antarctic state and encourage them to seek out more knowledge, or to pursue a career in the maintenance and preservation of the Antarctic.
This project not only educates users about climate change, but also showcases the potential use of AR as an educational tool.

8. **References**

3DModels
Low Poly seal - https://sketchfab.com/3d-models/low-poly-seal-349887b87b9540319ef502edfc998412

Low poly penguin - https://sketchfab.com/3d-models/low-poly-penguin-8a27f42a0b1646d6b210db9ab668c54f

Low poly seagull - https://sketchfab.com/3d-models/flying-seagull-07dde3ea7d9048588d3c4edfd37ac20d

Low poly HUT - https://sketchfab.com/3d-models/low-poly-sci-fi-lab-e84fd3405b34421095c70b0e09cc3111

2DArt

Red map Pins - https://sketchfab.com/3d-models/set-of-map-pin-dc052c20722643bbaeff00ba4eacf02b

Unity Slider - https://docs.unity3d.com/Packages/com.unity.ugui@1.0/manual/script-Slider.html

2 Maps of Antarctica -
https://www.mappi.net/continent_antarctica.php

https://www.reddit.com/r/MapPorn/comments/hdlcuh/map_of_antarctica_why_is_there_an_east_and_west/

Technical References:
The following resources were used while learning about the GIS data format ice extents are stored in and producing a 2D/3D mesh from the stored poly shape date.
https://github.com/NetTopologySuite/NetTopologySuite.IO.Esri
https://github.com/DotSpatial/DotSpatial?tab=readme-ov-file
https://github.com/EIdeallab/ShpLoader
https://github.com/artyredd/UnityShapefileAsync
https://github.com/CharlotteAndre/ShapeFileForUnity
https://github.com/speps/LibTessDotNet
https://nsidc.org/data/seaice_index/data-and-image-archive
https://developers.arcgis.com/unity/

Elevation data for height map generation
https://portal.opentopography.org/datasetMetadata?otCollectionID=OT.082023.3031.1
https://owengoss.medium.com/using-real-world-elevation-data-in-unity-6b2a960401af