DEEPDIVE

Using AI, Machine Learning, and Virtual Reality to Explore Ancient Submerged Civilizations

Thomas Palazzolo, Wayne State University, United States of America
Ashley Lemke, University of Texas-Arlington, United States of America
Sarah Saad, Wayne State University, United States of America
Chencheng Zhang, Wayne State University, United States of America
Sri Padmi Jayanti, Wayne State University, United State of America
John O'Shea, University of Michigan, United State of America.
Robert G. Reynolds, Wayne State University, United States of America

Introduction

Submerged Prehistoric Archaeology is a sub-discipline of Archaeology that deals with the discovery of ancient submerged landscapes. In Europe alone over 3000 submerged ancient sites are recorded (Bailey et al, 2020). While there is an increased number of submerged sites in North America, the emphasis has on the study of shipwrecks and historical questions related to nautical issues (e.g., Faught 2002, 2004; Halligan et al. 2016). As a result, underwater Archaeology has not contributed much to Anthropological theory there, especially when it comes to broader theoretical issues (Bailey 2014). The goal of this study is to use Artificial Intelligence techniques, machine learning, and virtual reality to recreate an ancient submerged landscape. This landscape is then used as a vehicle for Archaeologists to test theories and validate hypotheses about ancient civilizations. Ultimately, the goal is to predict the location of new underwater sites that can be examined archaeologically.

The specific project, the Alpena-Amberly Land Bridge project is located in Lake Huron, one the Great Lakes in North America. Although submerged today, it was above water for around 2000 years, from 10,000 B.P. to 8,000 B.P. as a result of the Ice Age. It spans what is now Michigan in the United State and Canada. Logistically it was up to 8 miles wide at its widest point and over 80 miles long. Dr. John O'Shea, a curator for Michigan Underwater Archaeology at the University of Michigan-Ann Arbor speculated that it might be a pathway for the migration of caribou, North American reindeer during their Fall and Spring migrations. Up to that point most of the underwater Archaeology in the Great Lakes centered on historical shipwrecks. He saw this as an opportunity to perhaps identify ancient sites and civilizations that were currently out of reach of modern economic development (O'Shea et al. 2014). Early work identified material remains similar to what would expect from modern artic occupations, the area was sub-artic at the time. Although these were isolated remains there was a sense that more information can be obtained by looking at the area from a systems perspective.

The framework developed in the Land Bridge Project is an attempt to focus not only on the displaying of what's been found, but to enable the user to take part in actual, active research in an attempt to test theories about an ancient civilization in a systematic manner. The result of such a systematic study could result in the prediction of new finds as a result of testable hypotheses.

The Land Bridge Deepdive System: An AI Pipeline for Environmental Reconstruction and Hypothesis Testing in Unknown Environments

The Land Bridge was above the Lake Huron water level for about 2,000 years from 10,000 B.P. to

8,000 B.P.. The right insert in Figure 1 shows the location of the Land Bridge relative to the State of Michigan in the USA and Canada. The two cells on the bridge represent areas that are the focus of current exploration. They were selected due to their location relative to the widest part of the Land Bridge. It was assumed that this would be the area of largest herd congregation if it was used as a migration route for caribou. While the system described here was developed to utilize the data relative to these particular locations the framework is general enough for it to be used to support exploration in other unknown places.

Here, an AI pipeline was generated with the goal of reproducing the ancient environment to a sufficient degree to afford researchers the opportunity to test theories about the civilization that may have occupied the region. These theories might allow more general patterns of behavior to emerge, beyond just the location of a set of independent artifacts. Here, the goal was to identify similar high level patterns to Archaeologists, patterns that would help to contribute to aspects of Anthropological theory.

Figure 2 gives a component diagram of the current system, the Land Bridge Deep Dive System. The Data Component subsystem consists of information about the elevation of all 1 by 1 meter cells on the Land Bridge, over three trillion. This data set was acquired from North American Oceanographic and Atmospheric organization (NOAA).

The area selected from this database by the user is passed to the Graphical User Interface (GUI). A more detailed description of the GUI. This information is then given to the AI Pipeline component identified as the “AI Component” in the diagram by the user. The pipeline is used to “create the content” of the landscape in the following fashion:

1. **Water Level Selection**: Given the requested region the first phase of the pipeline, Timesim, identifies the cells in the region that are above water at that time.

2. **Height Map Generation**: This phase then computes the height of each of the identified cells in the region at the given level of granularity as well as their location and slope in each compass direction.

3. **Hydrology Map Generation**: Next, the waterloopElement generates information about the location of ponds, swamps, and rivers that are present in the location at that time.

4. **Vegetation Map Generation**: Given the location, water content, slope and sun angle the AI collection module predicts the cells potential vegetation.

5. **Caribou Path Planner:** This information is then given to the AnimalAttributes module that is used to predict caribou herd behavior during either Fall or Spring migrations.

6. **CACollection** is a module that is based upon the Cultural Algorithm (Reynolds 2017), a data intensive evolutionary algorithm. It is able to learn optimal combinations of herd priorities to maximize survivability of a herds as they move over the landscape.

7. **HuntingBlindCA** represents a set of rules developed by the Cultural Algorithm along with rules suggested by the user to predict the location of material remains of ancient hunters based upon features of their behavior.

8.Supporting Humans in the Learning Loop;There are two basic opportunities for users of the system to contribute to the learning process here. First is through the “GUI” and the second is through the “Display Component” of the system that provides the virtual reality experience. A screen shot of the Virtual World is given in Figure 3 below.

8.

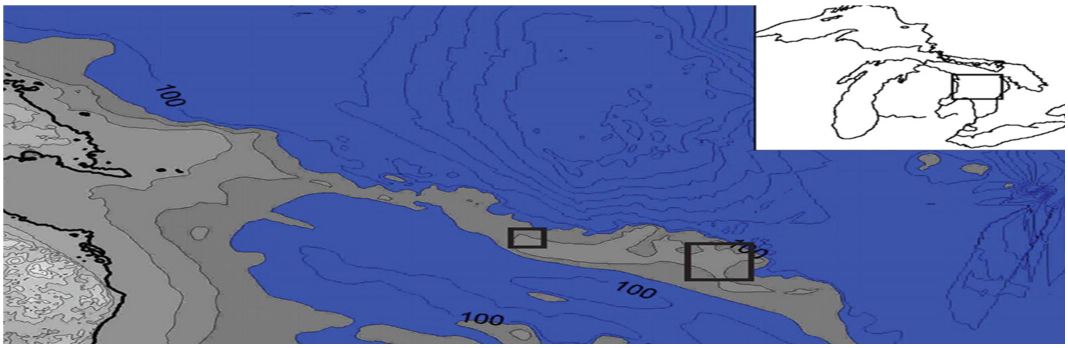

Figure 1 The location of the Alpena Amberley Land Bridge. The explored areas are denoted as squares on the map.

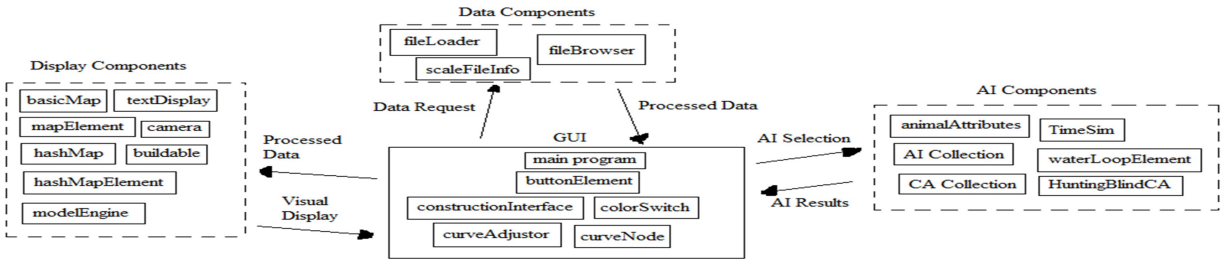

Figure 2: Basic Land Bridge Deep Dive System Configuration

Figure 3: A caribou herd moving along a precomputed path generated by a selected A algorithm.*

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