Developing Pattern Recognition Software to Reconstruct Prehistoric Native American Pottery

NCPTT Grant
15Sept2016 to 15Sept2017
Project Deliverables

Narrative

SnowVision represents an innovative, collaborative effort to make accessible archaeological artifacts from the prehistoric Native American "Swift Creek" culture of the American Southeast. Swift Creek pottery was made from the 1st to the 8th century CE using a characteristic wooden paddle stamping technique. Original wooden paddles have been lost to time, but the carved paddle designs have been preserved as fragmentary and overlapping impressions on stamped pottery sherds. Painstaking human labor over the decades has resulted in the partial or complete reconstruction of hundreds of paddle designs from the pottery sherds on which they were impressed. The uniqueness of each design presents the rare opportunity to measure human social processes, such as residential mobility and interregional interaction, when sherd-to-design matches are discovered to occur, as they often do, across geographical space.

SnowVision, named after Swift Creek researcher Frankie Snow and the Computer Vision field, features unique, state of the art image matching software to study curve patterns from existing pottery fragments. With start-up funding from the National Center for Preservation Technology and Training (NCPTT), the University of South Carolina's (USC) project team developed a prototype of *SnowVision*. With NCPTT funding, Dr. Wang, who leads the Computer Vision part of the USC team, and his graduate students tested a series of curve matching metrics and then developed and refined a pattern decomposition algorithm, choosing the metrics and algorithm that performed best on our subject matter. Project code generated during the above grant period has been published on GitHub (https://github.com/*SnowVision*/*SnowVision*1.0) and documented in a peer-reviewed publication in the *Journal of Electronic Imaging* (Zhou et al. 2017; see also Yuhang et al. 2018). The success of this prototype greatly aided the USC team in securing additional funding from NSF to further refine the software.

Today, dozens of archaeological collections hold tens of thousands of Swift Creek sherds from sites in Georgia, South Carolina, Alabama, and Florida. Many of these collections have never been studied for Swift Creek designs and design matches. Digitizing the sherds using a 3D scanner is an essential part of the project, providing primary data for software development. To date, the team has completed the digitization (3D scanning) of 3,000 pottery sherds curated at Georgia Southern University's R. M. Bogan Archaeological Repository, a major repository of Swift Creek collections. These data have proven to be a critical component of the development of an automatic method to extract curves on sherds and to identify underlying designs on sherds with single and composite or "overstamped" patterns.

Current project goals include integrating the SnowVision software with a project website accessible to researchers and the public.

Zhou, Jun, Haozhou Yu, Karen Y. Smith, Colin Wilder, and Song Wang
2017 Identifying Designs from Incomplete, Fragmented Cultural Heritage Objects by Curve-Pattern Matching. *Journal of Electronic Imaging* 26(1). DOI10.1117/1.JEI.26.1.011022.

Lu, Yuhang, Jun Zhou, Jun Chen, Jing Wang, Karen Y. Smith, Colin Wilder, and Song Wang
2018 Curve-Structure Segmentation from Depth Maps: A CNN-based Approach and Its Application to Exploring Cultural Heritage Objects. Association for the Advancement of Artificial Intelligence (AAAI) Conference of Artificial Intelligence (in press).

Project Source Code

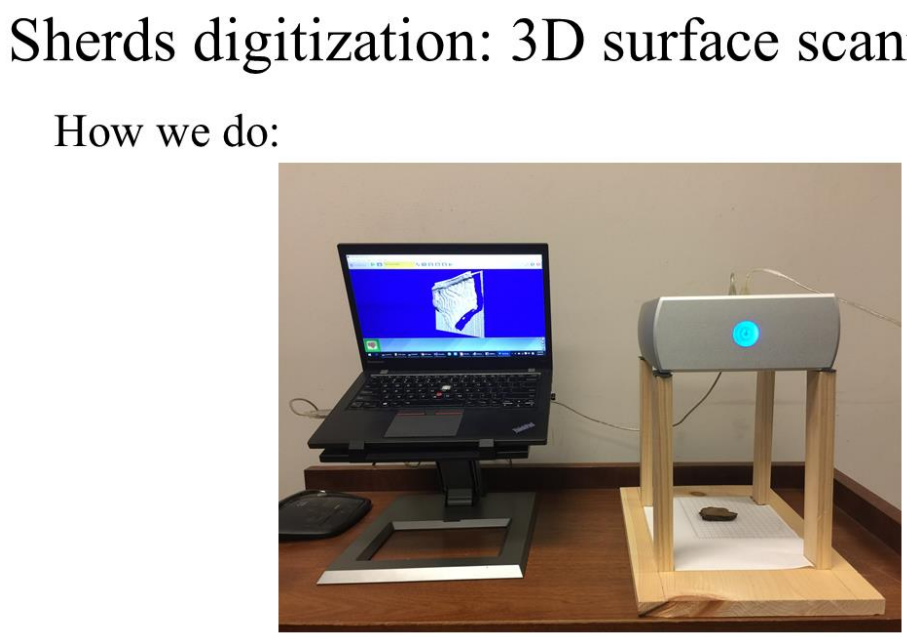
https://github.com/SnowVision/SnowVision1.0 -- for NCPTT Prototype

https://github.com/rudylyh/SnowVision – most recent work

Project in the News

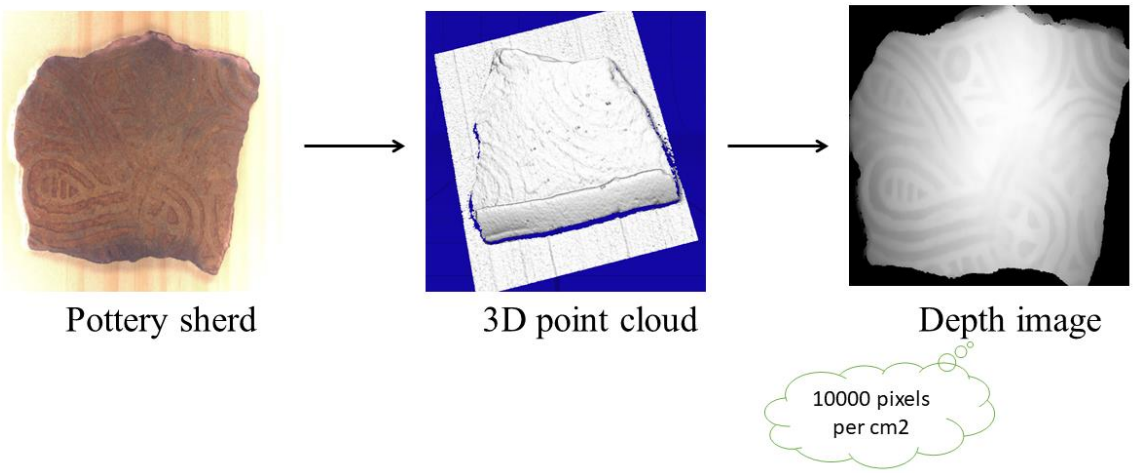
https://sc.edu/uofsc/posts/2017/06/computer_vision_to_match_prehistoric_pottery.php#.W18vJ7gpCUl

Project Images

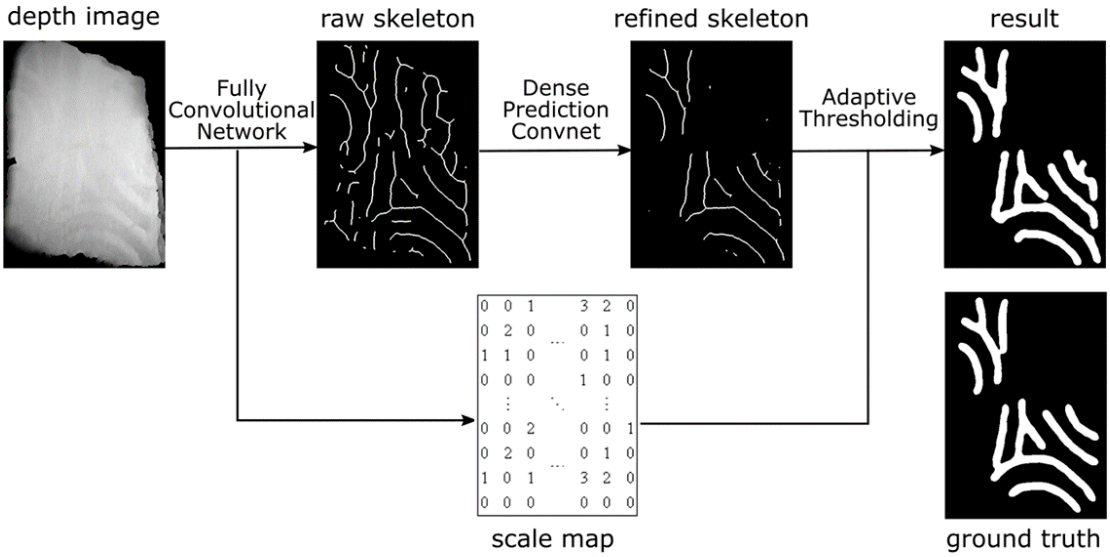


Sherds digitization: 3D surface scanning

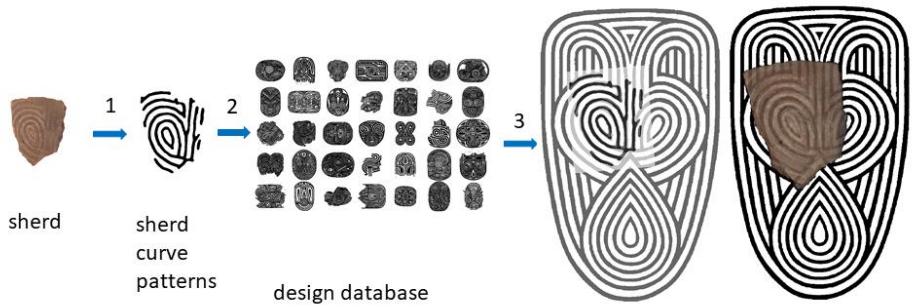
What we get:



Curve structure extraction by deep learning

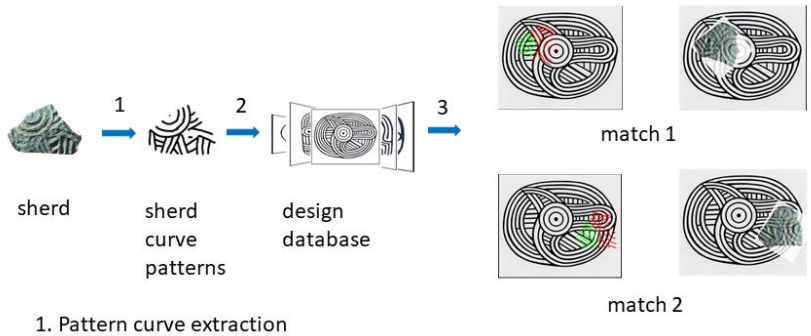


Non-composite sherd to design matching



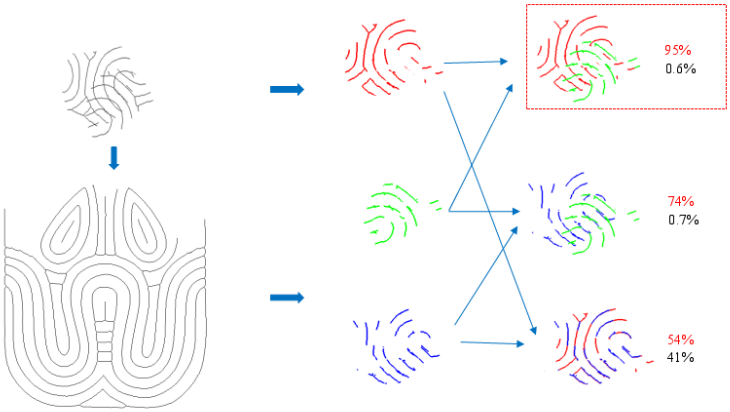
1. Pattern curve extraction
2. Matching sherd to each design in design database to find the best matched design
3. Matching result

Composite sherd to design matching



1. Pattern curve extraction
2. Matching sherd to each design in design database to find the best matched design
3. Matching result

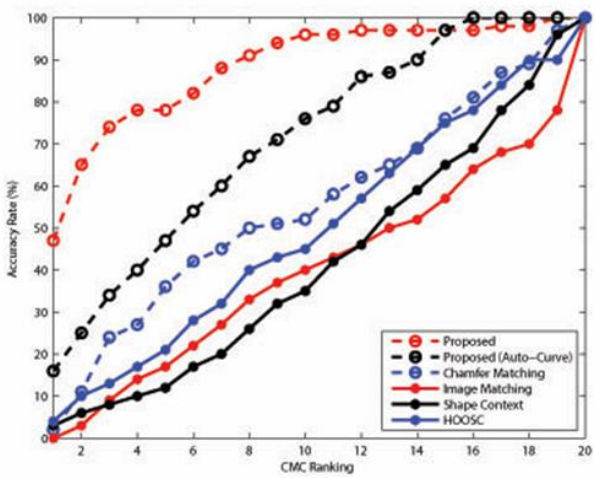
Composite pattern matching method



Matching a Sherd Pattern (top) to a Design Pattern (bottom)

Candidate Components

Combining Candidate Components (completeness scores shown in red and disjointness scores shown in black)



CMC curves of the proposed method and the four comparison methods. "Proposed (Auto-Curve)" indicates the performance of the proposed method on the sherd curve patterns extracted without manual refinement.