Drones, Phones, and Stones: Initial Testing of a Role-Based, Computer-Supported Approach to Collaborative Cemetery Indexing

JACOB RUBINSTEIN and DON ENGEL, University of Maryland, Baltimore County, USA

After project organizers used a drone to create a high-resolution aerial map of a historic cemetery, sets of volunteers served in four distinct, interdependent roles to photograph, research, restore, and geospatially index the cemetery's many unrecorded interments. Here, we share observations from our initial tests of this approach, which included a visit of volunteers for synchronous on-site work. We explore the differences in volunteer behavior and performance relative to organizer expectations and how the interdependence of the four roles is impacted by these differences.

CCS Concepts: • **Human-centered computing → Collaborative and social computing systems and tools**; **Computer supported cooperative work**; **Geographic visualization**; • **Applied computing → Archaeology**.

Additional Key Words and Phrases: mapping, role-based collaboration, cemetery preservation, drones

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1 INTRODUCTION

Historic cemeteries often face difficulties retaining and maintaining burial records which can date back hundreds of years. Factors such as erosion, overgrowth, and toppling/sinking can cause a loss of information which may become nearly impossible to recover. Partial records can sometimes be used to reconstruct information with reasonable certainty. By searching public documents such as death certificates or obituaries, data such as full names, dates of birth, age at death, and cemetery addresses may help reconstitute a cemetery's lost files. However, these connections can be difficult to verify, and expertise is required to locate and interpret resources and records.

The task of maintaining and restoring historic cemetery records becomes increasingly difficult with the passing of time. As paper records decay and the stones erode, the less information available to link individuals to their place of rest. We have developed a computer-supported collaborative workflow technology which facilitates cemetery mapping and the recovery of burial information, inspired by earlier research on collaborative mapping [1–4]. This workflow delineates roles requiring various levels of expertise which can be preformed asynchronously with minimal interaction between roles, or synchronously with volunteers in different roles collaborating to complete their tasks. Here, we share our experience working with project volunteers and our analysis of volunteer behavior relative to our initial expectations.

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2 APPROACH

After evaluating about 10 possible cemeteries in our metropolitan region through site visits and cemeterian interviews, a site 2.0 miles from our university campus was selected based on its lack of records, willingness to partner on our project, and proximity to prospective volunteers from our university community. In addition to recruiting from the university community in general, The cemetery's religious affiliation enabled us to attempt recruitment from similarly aligned religious congregations; genealogical societies; and community and student organizations. The resolution of existing aerial maps proved insufficient for resolving individual graves, let alone uniquely identifying them, so we joined a growing trend in cultural heritage preservation [5–7] by flying a consumer-grade drone on a pre-programmed flight to capture the scene, converting the photos from that flight into an aerial map with 0.95 cm ground sampling distance. We developed a web-based application to use this map as a foundation to support volunteer collaboration.

Volunteers were invited to sign up for any subset of four roles discussed in the sections below: **photography**, **mapping/indexing**, **research**, and **restoration**. We anticipated that research and mapping/indexing work would be done asynchronously and remotely, while photography and restoration work necessitated being on-site at the cemetery. We intended for on-site work to be both synchronous (i.e., group visit) and asynchronous. In the interest of scalability, volunteers were encouraged to bring their own supplies when possible, such as camera phones and yard tools, and were asked to inform the organizers if they would need supplies which they could not bring.

3 VOLUNTEER ROLES

Fig. 1. Sunken stone before (a) and after (b) after restoration. Photo showing context (c) and close-up (d). Our mapping tool (e).

Photography volunteers take pictures of gravestones from various angles using simple point-and-shoot cameras (e.g., smartphones). To determine which gravestones have been photographed and which have not, volunteers check our web application and use the aerial view to identify stones lacking annotations. The aerial view of the cemetery allows volunteers to identify large unphotographed sections as well as individual stones or objects that had been skipped.Two categories of photographs are collected in this way: close-up detailed images which capture detail and information on the stone (Fig. 1c), and wide-view contextual photos including landmarks around the stone and the position relative to other nearby stones (Fig. 1d). Photographers are instructed to check all sides of each stone, as some stones have inscriptions on the back for separate burials or as additional information for a single burial. Close-up images are used to capture a detailed view of inscriptions, while the contextual photos are used by mapping/indexing volunteers to identify a stone's location.

Mapping/Indexing volunteers update the web-based map (Fig. 1e) with marks indicating indexed gravestones; non-gravestone items in the aerial view which are appear similar to gravestones from overhead (e.g. family section markers and small stone benches); and points of interest which require followup work from research or restoration volunteers. They give each marks a text label to explain what it is and a categorization which determines the mark's color. Indexed gravestone marks are linked to entries on findagrave.com, a third-party website where images are posted along with information transcribed from the gravestone. Non-gravestone marks are given a descriptive label. Points requiring further work are labeled with a brief description of their status and optionally linked to a Google Drive folder created in lieu of a findagrave.com entry, because such entries require indexable information (readable names, years, etc). One of our longer-term goals in this project is to determine whether a detailed overhead view with ground-based mobile phone photos (including both close-up photos and contextualizing photos with landmarks in the background) is sufficient for mapping volunteers to reliably place marks on a map.

Research volunteers use external references to answer questions which a gravestone cannot, but which must be resolved for indexing to take place. The most often "research" case is a stone which is only partially readable. Less often, some stones are ambiguous in their meaning, with an individual stone showing two names, e.g. Jeremy Paul, within a "Smith" family section, meaning this is either a "Jeremy Paul" full name buried amongst the Smith family, or the full name is "Jeremy Paul Smith." Cross-referencing (partial) dates with (partial) names can yield prospective matches in public records such as obituaries and death certificates. For deaths which occurred in our municipal area, the death certificates indicate the name and address of the decedent's cemetery, which allows for high-confidence matches in some cases. Similarly, obituaries often mention close relatives, who may be buried in adjacent plots. Some inscriptions are entirely in another language or alphabet (in the case of our site, Hebrew and Yiddish are the most common languages after English), and other dating systems (e.g. the Hebrew calendar) are used in lieu of the Gregorian calendar. In these cases, researchers also applied linguistic and cultural knowledge to produce a preliminary translation or transliteration which enabled further searches for English/Gregorian equivalents in public records.

Restoration volunteers use yard tools and various special reading techniques to make gravestone inscriptions readable. After photographers perform an initial capture of an area, some of the photos will show stones which are covered in vines, have fallen and become partially subsumed by the Earth (Fig. 1a, b), or which may be readable with the application of special techniques such as strategic lighting or wetting the stone's surface. After conducting their work, restoration volunteers provide additional photographs of a stone, in a more readable state, to mapping/indexing volunteers. The cemetery granted permission for restoration volunteers to remove vegetative overgrowth and dirt and to clean stones using water, but forbade moving stones or using abrasive solvents. While many of the stones which had fallen face-down cannot be identified until someone goes to the expense of righting them professionally, it is nonetheless possible to identify some. Mapping allows us to see which stones are neighbors to face-down stones. When older photos can be found of these neighboring stones, the face-down stones are sometimes in the background, upright, and readable.

4 GROUP VISIT TRIAL RUN

Before organizing a group visit to the cemetery, several individuals expressed a willingness to make individual trips but none came to fruition. Once a group visit date was set and recruitment was attempted at a larger scale, 18 volunteers signed up to participate in the project. Of these, 11 volunteered for photography, seven volunteered for mapping/indexing, 10 volunteered for restoration, and six volunteered for research. A total of 14 of the 18 volunteers showed interest in the group visit, with the remaining four having prior schedule conflicts. Of the 14 volunteers that signed up for the group visit, 10 joined us on the day with four as photography volunteers and six as restoration volunteers. This division of labor, based on volunteer preference, worked well. Neither the restoration nor the photography volunteers finished all available work, with each role group finished roughly a third of the work that was available to them.

Leading up to the visit, we shared with our volunteers detailed instructions of the responsibilities of their role as well as more general overviews of the other roles in order to provide greater context for their work. The nature of our collaborative workflow means that issues in one role, such as a lack of proper contextual photos of a gravestone, can cause issues for future volunteers in different roles, such as increased difficulty identifying the location of a stone to map it. We also hosted multiple presentations where we gave in-depth explanations of the entire process including photographs demonstrating each role's process and the various challenges each role might face.

On the date of the group visit we set up a table near the entrance of the cemetery before volunteers arrived with supplies and copies of the map used to identify stones which had not yet been photographed or restored. As our volunteers arrived, we sent photography volunteers to sections which had no map annotations and restoration volunteers to sections annotated as damaged or unclear on the map. Over the two hours of work that followed, we walked around the cemetery answering any questions our volunteers had and checking up on their progress.

From their arrival through their work for the day, users required more direction and hands-on training than we anticipated. It seems future attempts at scaling this work cannot rely on video training and written instructions, and will instead require that more experienced volunteers train newer volunteers. Similarly, we have had very limited success in getting asynchronous volunteer work for mapping/indexing and research. Several volunteers signed up for this role but have not yet followed through, except for one research volunteer who contributed significantly to translation efforts. It seems these role, too, might be best accomplished with in-person synchronous work, at least for the initial training of a first set of volunteers who may go on to train others.

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REFERENCES

[1] Muhammad A. Butt, Syed Amer Mahmood, and Syed Muhammad Hassan Raza. 2018. GeoWebEX: an open-source online system for synchronous collaboration on geographic information. *Applied Geomatics* 10, 2 (01 Jun 2018), 123–145. https://doi.org/10.1007/s12518-018-0204-8

[2] John Carroll, Helena Mentis, Gregorio Convertino, Mary Beth Rosson, Craig Ganoe, Hansa Sinha, and Dejin Zhao. 2007. Prototyping collaborative geospatial emergency planning. *Intelligent Human Computer Systems for Crisis Response and Management, ISCRAM 2007 Academic Proceedings Papers* (01 2007).

[3] Gregorio Convertino, Dejin Zhao, Craig H. Ganoe, John M. Carroll, and Mary Beth Rosson. 2007. A Role-Based Multiple View Approach to Distributed Geo-Collaboration. In *Human-Computer Interaction. HCI Applications and Services*, Julie A. Jacko (Ed.). Springer Berlin Heidelberg, Berlin, Heidelberg, 561–570.

[4] Jefferson Heard, Sidharth Thakur, Jessica Losego, and Ken Galluppi. 2014. Big Board: Teleconferencing Over Maps for Shared Situational Awareness. *Computer Supported Cooperative Work (CSCW)* 23, 1 (01 Feb 2014), 51–74. https://doi.org/10.1007/s10606-013-9191-9

[5] Dalton Lunga, Rohan Dhamdhere, Sarah Walters, Lauryn Bragg, Nikhil Makkar, and Marie Urban. 2022. Learning to Count Grave Sites for Cemetery Observation Models With Satellite Imagery. *IEEE Geoscience and Remote Sensing Letters* 19 (2022), 1–5. https://doi.org/10.1109/LGRS.2020.3022328

[6] Apostolos Papakonstantinou, Dimitris Kavroudakis, Yannis Kourtzellis, Michail Chtenellis, Vasilis Kopsachilis, Konstantinos Topouzelis, and Michail Vaitis. 2019. Mapping Cultural Heritage in Coastal Areas with UAS: The Case Study of Lesvos Island. *Heritage* 2, 2 (2019), 1404–1422. https://doi.org/10.3390/heritage2020089

[7] Lynne Rouse and Jan Krumnow. 2020. On the fly: Strategies for UAV-based archaeological survey in mountainous areas of Central Asia and their implications for landscape research. *Journal of Archaeological Science: Reports* 30 (04 2020), 102275. https://doi.org/10.1016/j.jasrep.2020.102275