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Improving Mobile Positioning Accuracy Within An Image-Based Hybrid Geocrowdsourcing System

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Abstract:

Geo-crowdsourced data (GcD), the collection of geospatial data from a multitude of public sources, has grown exponentially within the past fifteen years from a mostly theoretical idea proposed by academics to a giant industry providing an indispensable service to commercial and government interest alike. This growth is largely attributable to what Goodchild (2007) coined as “Volunteered Geographical Information” (VGI), a subset of GcD that requires an intentional act of public contribution, as well as the advent of the smartphone. This is reflected by the sheer amount of applications that rely on GcD to provide directions, up-to-date traffic notifications and the operational statuses of public facilities and businesses.

Despite the monumental growth and advances of GcD over the past decade, deficiencies within this field of geospatial information systems (GIS) continue to persist. Poor positional accuracy and a lack of robust feature attribution remains a problem and continues to be a major stumbling block for wider acceptance within the wider GIS industry. The lack of positional accuracy can be more severe in some applications over others, especially ones where the data contributor is moving and the application is dependent on accurate positioning as opposed to reporting applications where general location is sufficient when accompanied by additional information. The former issue stems partly from the effort to make VGI platforms more accessible to users with no prior GIS experience. Recent technological advancements such as machine learning algorithms can recognize patterns in satellite imagery to fill in the attribution gaps in the data created by geospatial novices. Solutions for improving positional accuracy are not as clear. The aim of this paper is to find out if the advancements in mobile positioning hardware, the Global Positioning System (GPS), and interfaces for geo-crowdsourcing applications/programs over the past five years will address the positional accuracy. Improving positional accuracy within geo-crowdsourced data would not only encourage wider usage among the GIS field, but could prove essential for emergency response, military mobility, and mitigating the threat of terrorism.

In 2018, Williams conducted research to find a correlation between the number of VGI contributors and the level of positional accuracy of data points contributed to the George Mason University Geocrowdsourcing Testbed (GMU-GcT). The GMU-GcT was a crowdsourcing system developed by GMU’s Geography and Geoinformation Science (GGS) department designed to facilitate the gathering, validation, quality assessment, and publication of transient obstacle data to assist persons with blindness, visual impairment, and/or mobility impairment (Rice et al., 2018). A mobile-phone, image-based ground truth data contribution tool from the GMU-GcT was developed and distributed to student volunteers at GMU who would then contribute information regarding pre-defined locations throughout the university campus. Results showed that the positional accuracy attribution of the data contributions to the GMU-GcT improved with additional contributors, eventually reaching a level similar to previously-studied accuracy thresholds that were accomplished with a significantly more detailed and heavily moderated data contribution workflow. Under-moderated reports from a single contributor averaged 8.55m in positional error. When the number of contributors increased, positional error of reports for the same item dropped to 3.89m at n=20 (Williams, 2018). The most common positional error threshold for geo-crowdsourced data, referred to in previous works as the Haklay distance (~6.0 meters, from Haklay 2010) was reached when the number of contributors was increased to just two. Once the number of contributors was increased to four, the decreases in positional error rate stayed fairly constant.

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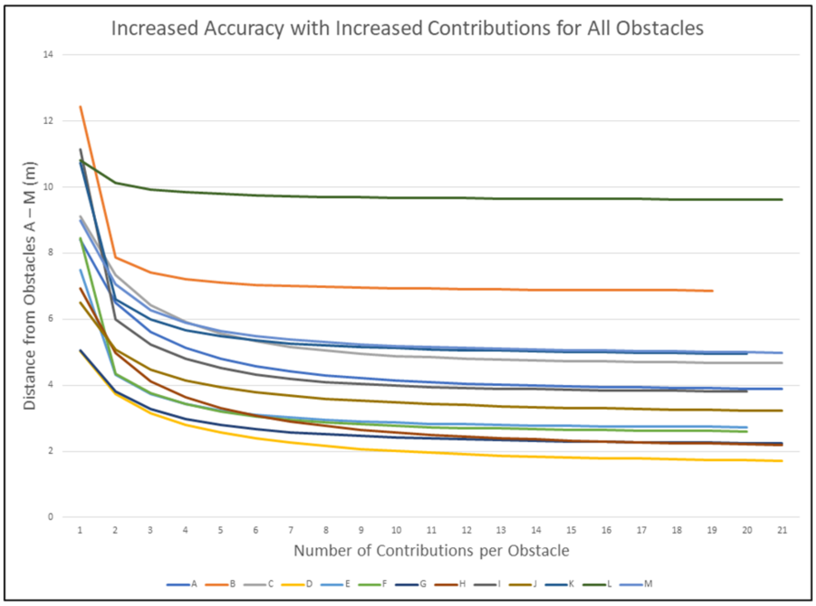

Figure 1: Results from Williams (2018) original experiment show positional accuracy plateaus after four contributors

The results captured in this new study were compared to Williams' study from four years ago in order to get a better perspective on advancement in Global Positioning System (GPS) technology in current smartphones. In this study, data were collected using Esri's ArcGIS Field Maps application instead of the in-house solution from the prior study, demonstrating that the growing popularity of GcD resulted in the development of specialty applications that did not exist five years ago. To address the potential for inconsistencies in attribution contained within crowdsourced features as outlined by Foody et al. (2015), instructions for data-gathering were written as user-friendly as possible, attribution fields were kept to a necessary minimum, and volunteers were able to choose location description attributes from a hard-coded drop-down list. The data points collected within the vicinity of a target were used to generate a polygon. Additionally, the polygons were generated from combining device positions as well as the orientation vectors from the electronic compass. From those points, a centroid was calculated. The resulting centroid approximated the location of the target. Lastly, the data attribution fields from the new data collections were analysed to see if there was improvement over the original 2018 data. Fundamentally, clearing the hurdle of positional accuracy issues will further accelerate the adoption of GcD within the greater GIS industry and greatly benefit first responders and humanitarian efforts.

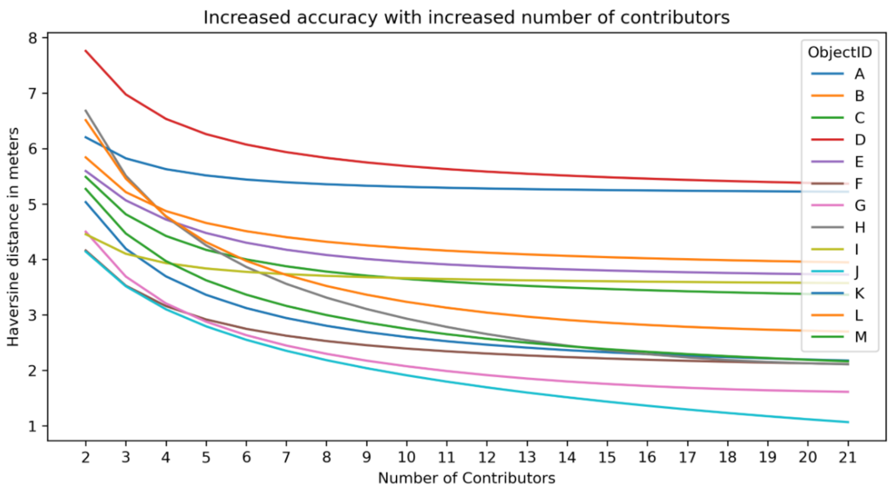

Figure 2: Preliminary results from the new experiment from 2023 shows positional accuracy for each data point plateaus after five contributors

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