Summer 6-27-2018

Drone Photography vs. Light Detection and Ranging (LiDAR) Data - Which Source is Best Utilized in 3-Dimensional Modeling Applications?

Austin Valentine
avalentine1@murraystate.edu

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By Austin Valentine Jr.

The concept of gaining additional vantage points, through aerial imaging, has been tossed around between Archaeologist and Anthropologist since the invention of the hot-air balloon. By the early 20th century, this ideology took a major step forward with the introduction of satellites. However, in the past decade, the scientific community has witnessed a massive evolutionary leap with the introduction of drone photography (Valentine, 2018).

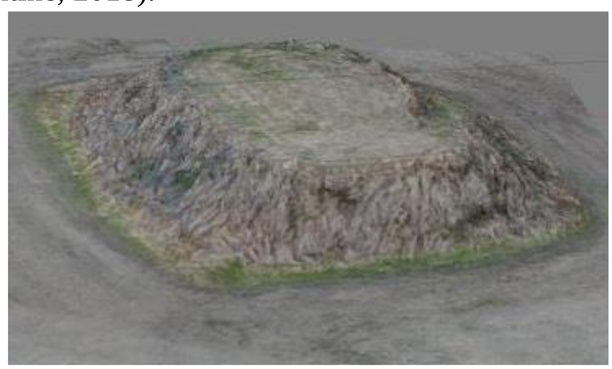

Fig. 1.1 – Textured 3-D model created by Austin Valentine Jr. using drone photography

Over the past two years I have authored a number of technical papers focusing on the utilization of computer technology in the fields of Archaeology and Anthropology. Most recently I have focused my research on 3-dimensional modeling of the Kincaid Mounds archaeological site in Massac County, Illinois as seen in figure 1.1. However, I have yet to explain why I chose drone photography over Light Detection and Ranging (LiDAR) data, which may be available free online through state geospatial data sites or the United States Geological Survey's (USGS) Earth Explorer site.

When I decided to take on the task of creating a 3-dimensional model of the Kincaid Mounds site, I was faced with two main choices of imaging sources. I had to decide on either modeling through LiDAR data or photography taken from aerial drones. I based my final decision on factors such as; availability, affordability, resolution, data storage, and additional uses.

For the LiDAR data portion of my comparison I turned to the Illinois Geospatial Data Clearinghouse at the University of Illinois Urbana-Champaign's website https://clearinghouse.isgs.illinois.edu/data. At this site I was able to locate and download the necessary data, free of charge, and use specialized computer software to create a topographical image as seen in figure 1.2. This particular data, which was collected in 2012 consist of thousands of points containing elevation data as depicted in figure 1.3. The data is reflected in feet above sea level, which allows us to create a 3-dimensional profile as seen in figure 1.4.

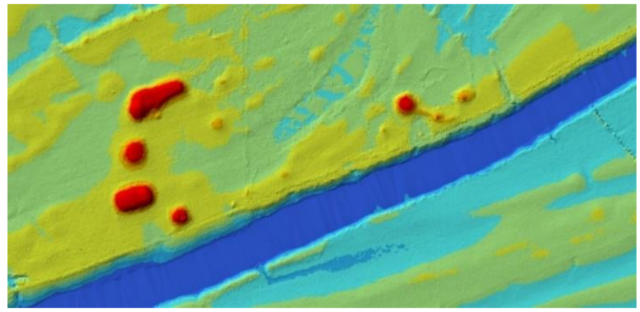

Fig. 1.2 – Image created by LiDAR data from the Illinois Geospatial Data Clearinghouse (Illinois State Geological Survey

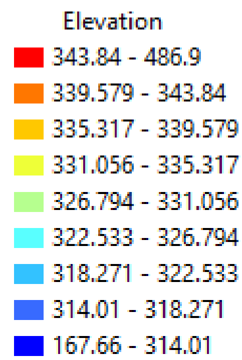

Fig. 1.3 – Corresponding elevation data for figure 1.2

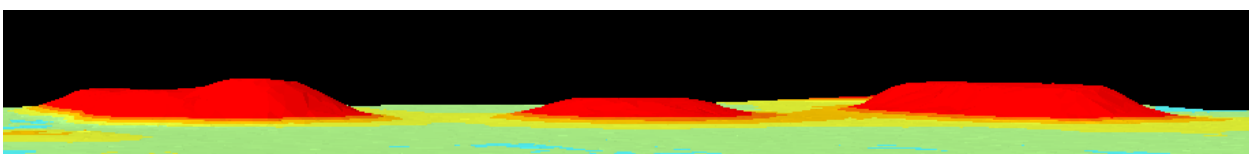

Fig. 1.4 – 3-D profile of LiDAR data downloaded form the Illinois Geospatial Data Clearinghouse displayed in ArcMap v10.5.1 *(Illinois State Geological Survey, 2015)*.

However, sometimes this is not the case. In some instances, the necessary data may not be available for analysis, and hiring a company to collect such LiDAR data can cost thousands of dollars. Also, to view this particular type of data one must purchase or have access to costly computer software.

For this particular application I chose to use ESRI's ArcMap v.10.5.1, which has a standard version price of $3,000.00 (ESRI, 2018). The ArcMap software allows the user access to a number of powerful analysis tools to conduct statistical calculations and site measurements from the comfort of one's computer chair. However, the user is limited to the tools provided by such analysis software.

For the drone portion of my comparison, I chose the DJI Phantom 4 Advanced Aerial Quadcopter. This device is equipped with a 20-megapixel resolution camera that is capable of taking both images and video. The device, which has an approximate flight time of 30 minutes, has a current price tag of $1,199.00 at the DJI online store (DJI, 2018). This device also requires a display, which in this case I utilized an Apple iPhone 7 Plus accompanied with a drone mapping app called Pix4D.

Fig. 1.5 – Pix4D aerial mapping for DJI drones operating on Apple IOS.

This method of modeling requires a physical trip to the site in order to collect the images necessary for 3-dimensional mapping. This particular app allows the user to specify a grid-style flight pattern over the locations of interest, as seen in figure 1.5. Once the flight pattern is established, the user initiates the flight plan and the application automatically conducts the mission taking the necessary photographs to complete the project (Valentine, 2018).

Once completed the drone memory card will contain a photograph for each of the black dots as seen in figure 1.5. Each photograph, which is taken at a slight angle, is georeferenced by the phone attached to DJI device. Once these images are downloaded they can then be compiled into a 3-dimensional model and textured, as seen above in figure 1.1, using a variety of software packages. My particular software package of choice is AGI-Soft Photoscan Standard Edition, which carries a $179.00 price tag (Agisoft, 2018). Thus, creating a more eye-appealing 3-dimensional model than the one depicted in figure 1.4.

Based on the following information provided, I can summarize the components of the decision-making process through the following table:

	LiDAR Data	Drone Photography
Availability	LiDAR Data may or may not exist for a particular area.	Data can be collected most places but can be restricted due to air traffic, no-fly zones, or drone laws. Also requires travel to and from a site.
Affordability	Initial software cost involved in data analysis and processing of $3,000. Additional data cost may be incurred.	Both initial software cost and equipment cost of approximately $1,379. Device also requires access to a phone or internet capable display device.
Resolution	Data is collected in the form of points, which yield a georeferenced data with corresponding elevation information.	Camera resolution depends on the brand of drone. Devices are capable of both photography and video.
Data storage requirements	LiDAR data files are large and can easily exceed 1GB storage.	Image files are large and can easily exceed 1GB storage for a single project.
Additional Notes	Data is easy to work with and can produce .OBJ files that can be printed by a 3-D printer. LiDAR also has the ability to display physical structures covered by trees and vegetation which cannot be seen by aerial photographs or the naked eye.	Images are easy to work with and can produce .OBJ files that can be printed by a 3-D printer. The device also allows the user to utilize individual photographs or take video for other applications. Due to cell phone GPS accuracy, Georeferenced data points may not have the accuracy that is present with LiDAR data. Also, battery life may limit the number of photographs or time spent onsite.

In conclusion, the utilization of drone photography presents researchers with far greater cost-efficient opportunities by allowing them more flexibility. Thus, providing a greater variety of applications but at the cost of decreased georeferencing accuracy and the possibility of missing unseen objects. Whereas, LiDAR data is a more accurate form of 3-dimensional modeling.

LiDAR transmissions have the ability to penetrate vegetative canopies revealing a number of unseen structural formations. Despite the larger degree of accuracy associated with LiDAR, there are many instances where LiDAR data simply does not exist or must be compiled from multiple sources to cover a desired area of interest. Thus, proving that both drone photography and LiDAR have valid applications which are contingent on researcher's desired results.

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