TECH, ETHICS AND THE DIGITAL CITIZEN

Cutting-edge tech provides endless possibilities for data collection through digital citizen science projects. But with big opportunities come big ethical challenges, cautions Estelle Clements

An alien-looking landscape stretches out in front of you. Keen to log as much geoscience information about it as possible, you take out a multifunctional handheld tool and start scanning the ground. No, it's not Star Trek; it's current reality—the technology is available now.

One such technology, common to many geoscientists, is LiDAR, or Light Detecting and Ranging, a remote sensing method that uses pulses of light to measure distance. By sending out an array of laser pulses, LiDAR yields rich information on the surfaces it contacts and can be used to build a picture of those surfaces. In the past, the creation of such an image required specialized technology, careful calibrations and maybe a plane or helicopter. Today, LiDAR can be found in household items such as robot vacuum cleaners.

With the company Apple recently announcing that its latest iPad features LiDAR with a 5-metre range, LiDAR stands to become an affordable and commonplace addition to the everyday complement of tools on our digital devices. It also hints at a future where digital citizen scientists can play a key role in contributing to geoscientific data collection and our understanding of the geological world—but only if we can first overcome a number of ethical obstacles.

Technological development

It's not just the presence of LiDAR on a commonplace device that will interest geoscientists. The LiDAR on Apple's iPad (an innovation that doubtless, other companies will reproduce) is integrated with the device's capacity to take photographs. The union of LiDAR with picture data enables photogrammetry, that is, the gauging of distance using photographs—another common technology familiar to many geoscientists.

Thus, enormous volumes of data are stored in the meta-data file associated with an image, such as time, date and location. This mass of information, which can easily be shared, provides incredible opportunities for geological research, including analysis of rock formations and structural features. Acquired over a period of time, such data could also be used to study changes in the Earth, such as ground movements and erosion, aiding geohazard assessments and contributing to land management, emergency planning and building developments.

Citizen science

Emerging technologies could be used by the public to positively impact geoscientific research in many ways. Citizens could build a profile of their local community, scanning and acquiring data that can be compiled for later analysis by geoscientists. Such participation from active digital citizens would be particularly useful in areas that have received little attention, perhaps because they are rural and difficult to reach, or because they are deemed insufficiently critical to receive the limited funding available for such data collection. Such an approach could identify geologically important issues or regions that were previously overlooked, including areas with potential archaeological and geoheritage value.

Programmes could be set up to harness the ability of local populations to contribute to a growing body of knowledge with relative ease. Apps and digital databases would allow citizen scientists to see where data are needed and how they might reliably contribute to longer-term projects, in which data must be collected at regular intervals over specified periods of time.

Such endeavours encourage people to collaborate and contribute to a body of knowledge for public good, foster a closer bond with the natural environment and geological world, and instigate public outreach and education, while inspiring young people to pursue the field of geoscience.

Exploitation potential

Before we rush off to harness new technologies and formulate strategies to broaden the scope of geoscience through input from digital citizen scientists, we also need to consider the potential issues that can arise. Large volumes of location-related data will be readily accessible, and when we grant an app access to our digital devices, they may collect other personal data from our device as well. The access and use of such data present a host of deeply significant ethical issues—particularly when government bodies or private corporations are involved.

For instance, individuals who are recording data from their local environments might travel for personal reasons to certain locations at regular intervals of time. This means their data are not only of scientific value, but also acutely private, and would have to be protected. Readily available data of this quantity and quality could also be commercially exploited and are vulnerable to potentially malign use by private and

third-party companies.

There are plenty of scenarios to consider. Photographs taken of friends on a hike, though not initially intended to assist geoscientists, might prove to be of value later, for example, if images are sought to assess changes in that area over time. Many people won't mind helping out and sharing their images if it means contributing to science, but citizens have to understand what they are giving away—not just photographs or LiDAR data, but personal information as well.

And there are more insidious threats to contemplate. If we upload LiDAR data and photographs to an internet-based cloud storage system, how can we be assured that the data will not be used to map out our homes, personal properties, private lives, time spent with friends, and daily activities?

Most people are aware that targeted advertising results from our internet searches. But companies don't only track where we go online, they also track where we go in the physical world, since we leave a similar, easy-to-follow data trail behind us. For example, you may allow an app to access the map function on your smart phone or tablet, so that it can direct you. However, the company that owns the app may then sell your information to third-party companies so that they can send you targeted advertising. Our location data could tell a company what our daily commute is like and what time we get home in the evening. The company may see that we're trying to lose weight by going to Weight Watchers, but that our resolve weakens and we head to the local ice cream parlour when we've had a challenging work commute. So, a company may advertise ice cream to us when traffic has been heavy or the trains are delayed, then advertise weight-loss products an hour later, when we feel vulnerable.

By knowing all our favourite private haunts, companies can tell what our religious beliefs are, our political leanings, our sexual orientation, even what our favourite food is. They might see that we rarely go to the gym, or that we're prone to drive instead of walk, and change our health insurance rate. With visual data, a construction company might see our damaged roof and target us with advertising. With technology that can map out what is inside our homes, the possibilities are endless. The decisions made based on the data collected by citizens should improve our lives, but could damage them as well.

Ethical framework

For geoscientists to benefit from technological advances and citizen science projects, they must instil confidence in participants, ensuring that any data offerings will not be exploited or used against them later. Geoscientists must be the guardians of good data use, insisting on an ethical code and demanding moral conduct from the corporations with which they work. Certainly, geoscientists cannot allow some of their most reliable and promising tools to be misused in nefarious ways.

The creation of a formal ethical framework that is specific to geoscientific data would be a major step in helping to ensure the responsible use of LiDAR and other data gathered from digital citizen scientists, and would encourage greater uptake in digital geoscience community projects. Similar frameworks already exist. For example, an unexpected outcome of the Covid-19 outbreak, and the focus on location-tracking apps to help prevent its spread, is the development of a set of ethical guidelines that describe the appropriate use of location data. Formulated by some of the world's best information ethicists, the guidelines include 16 questions to ascertain the ethical design of digital tracking and tracing systems, and provide a valuable starting place to create geoscientific-specific frameworks. We are just beginning to appreciate the challenges posed by cutting edge technologies, and it is essential that we address these challenges to safeguard a healthy scientific future.

The addition of LiDAR technology to Apple's latest products signals a move toward the broader inclusion of such technologies in the consumer marketplace. Significant ethical issues accompany this shift and must be addressed. We need to carefully consider how we understand, manage and apply these technologies in order to harness their full potential. The technologies are young, but the possibilities—both good and bad—are endless. We must consider from the outset how to ensure the outcomes for geoscience and citizen geoscientists are good. A tremendous potential for scientific advances exists, but it requires a positive vision and a well-considered ethical strategy.

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