CAMA Change Detection with Light Detection and Ranging

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Appraisal data stored in computer-assisted mass appraisal (CAMA) systems have been successfully analyzed for change by utilizing light detection and ranging (lidar). Spatial information derived from lidar data is used to create a structure footprint. Injecting the scale-accurate sketch vectors from CAMA into the lidar-derived structure footprint allows a direct comparison of the sketch with the footprint. This comparison process for detecting change in the CAMA data is highly automated, and various degrees of change classification allow more efficient follow-on desktop reviews and field checks by assessors.

The IAAO Desktop Review

With the correct tools, the CAMA database can be analyzed for change. In the IAAO *Standard on Mass Appraisal of Real Property* (2006), Section 3.3.5 states that, as an "alternative to periodic on-site inspections, jurisdictions may employ a set of digital image technology tools to replace routine cyclical field inspection with a computer-assisted office review." The intent of the IAAO standard is to allow the use of high-resolution imagery to assess property grade, effective age, and condition. The imagery includes orthophotography, oblique imagery, and street-view images. Thus, the IAAO is endorsing the use of these technologies to perform change detection from the office as part of a desktop review.

Change detection is not new to the assessor. The old-fashioned, but reliable, approach is to go into the field with the property record, the property sketch, and a street-view photograph. On a cyclical schedule, the community is canvassed for updates and corrections. The task of the assessor is simplified if the review can be performed from the office. However, there will always be the need to visit the field to validate the office review, to measure new structures, and to reconcile ambiguous information.

There are a number of issues affecting the desktop review. The obvious one is the amount of interpretation and skill

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required to analyze imagery for change. More subtle issues also are involved in understanding the limitations of image interpretation, as well as the vocabulary for quantifying any change found.

Traditionally the *stare-and-compare* process is how imagery is studied for change. But stare-and-compare is time-consuming and error prone due to *occlusion* and *change blindness*. Change blindness is a condition of fatigue in which the eyes and brain can longer find differences in images. Occlusion describes how a closer object blocks or masks the view of an object further away. Occlusions in imagery are most commonly caused by trees and shadows obscuring the view of the structure to be seen and measured. Even street-view images can have occlusions due to parked cars and vans, hedges, trees, fences, and neighboring homes. Obliques have the advantage of multiple views and being able to see under the occluding roof eaves, but features can still be obscured by trees and shadows.

Lidar

Overcoming these image analysis problems is a set of quantitative tools that perform change detection utilizing data from an airborne laser scanner called lidar. Lidar stands for **Li**ght **D**etection **a**nd **R**anging. This airborne laser scanner is capable of collecting millions and millions of ground measurements. As a plane flies overhead, an infrared laser sensor continuously sweeps the land and maps the terrain. Lidar is now the preferred tool for preparing detailed surface elevation models. In the past five years, lidar technology has matured, eliminating the skepticism that met the technology when it was first introduced. Today, there are industry-standard approaches (FEMA 2003) for collecting lidar, but the technology is only at the frontier of its capability.

Lidar Basics

The lidar sensor utilizes a pulsed infrared laser. The laser pulse is bounced off the ground. The range from the sensor to the ground is computed by measuring the reflected time of flight. The time of flight is calculated with a very accurate clock. Pulse time measurements are converted to ranges using the formula

$$R = (T*C)/2,$$

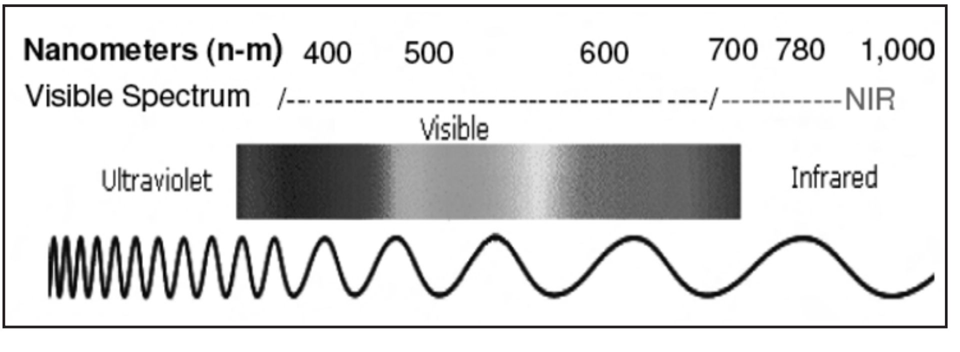
where R is the range, T is the time of flight, and C is the speed of light.

Figure 1 shows the relative wavelength of the infrared beam compared to the visible spectrum. Research is being conducted on using other frequencies, such as ultraviolet, to penetrate water to depths of 25 meters to be able to map the floors of water reservoirs and coral reefs. The military already uses the higher microwave frequencies to see through clouds and vegetation and—rumor has it—even through building walls (with the use of a substantial amount of power).

Lidar Pulses

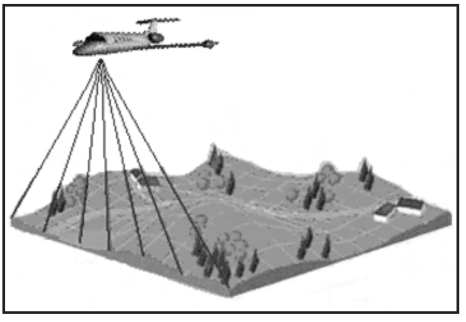
The pulses from the lidar are generated by a spinning mirror "sweeping" the infrared beam across the ground. The

Figure 1. Wavelengths of the visible and near-infrared spectrum



sweep is perpendicular to the aircraft's flight path, as shown in figure 2. The lidar sensor emits several thousand pulses each second. For example, a 100-kHz sensor can produce 100,000 pulses per second. A typical county can have from several million to a billion or more lidar measurements.

Figure 2. How lidar pulses from an airplane scan the ground



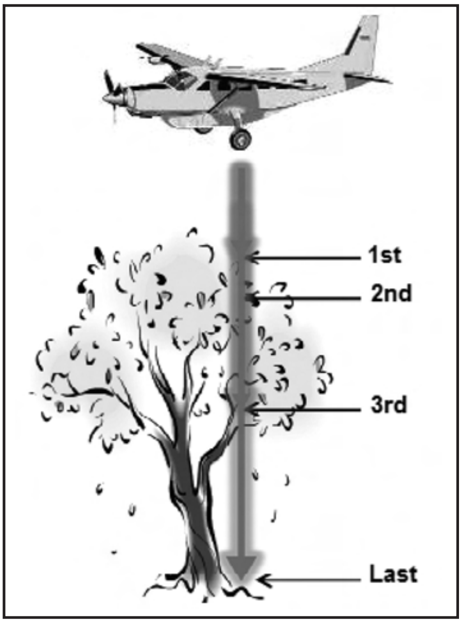
As the laser pulse leaves the sensor on the aircraft, its width is about 0.1 cm (half an inch). The beam spreads as the pulse flies to the ground. The amount of spread is proportional to the distance between the sensor and the ground. Thus, an aircraft flying 1,000 meters above the ground can have a pulse spread about 0.25 meters. Flying 2,000 meters above the ground doubles the spread to half a meter.

Not all the pulses strike the ground; some are reflected from buildings, cars, trees, and the like. Some pulses never return, being absorbed by the surface of a feature such as still, clear water.

Lidar Returns

Portions of the spreading laser pulse may strike a portion of a feature and bounce back to the sensor, which is called a *return*. Another portion of the same laser pulse may strike the ground slightly later, and this is called a *last return*. These multiple returns represent variable and permeable features being scanned by the laser. For example, the first return from the pulse could be the crown of a tree, the second return a branch of the tree, a third return the fender of a car parked under the tree, and the last return the curb (see figure 3).

Figure 3. Multiple returns per lidar pulse



It is not unusual for most pulses to have more than one return. Many lidar sensors can track five returns per pulse. Future lidar sensors might be able to detect an infinite number of returns, but these sensors would track the changed waveform of the reflected pulse, rather than the actual return.

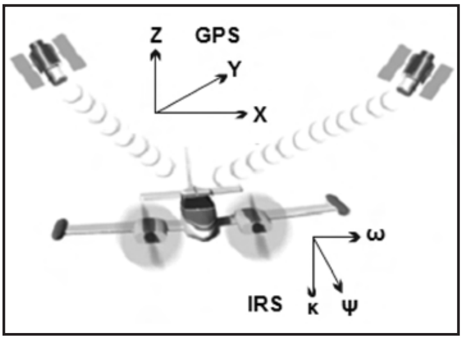
Lidar Coordinates

The lidar sensor measures both the distance and the angle of the return. The distance is computed from the laser pulse's time of flight. The angle is captured from the position of the spinning mirror that sweeps the laser across the ground. Additional methods are used to refine every return's angle and distance measurements into an accurate x-y-z coordinate of the ground strike.

On board the aircraft are two more sensors: the airborne global positioning system (GPS) and the inertial reference system (IRS). The GPS is used to initialize the IRS, which keeps track of the aircraft's flight path, including its crab, tilt, and yaw. Sometimes the IRS is called an inertial navigation system (INS), an inertial positioning system, or an inertial measurement unit.

With the GPS and IRS, the aircraft flies a planned route of travel. This flight path defines the strips of lidar data to be collected. Flight paths are planned and followed to ensure that no ground is missed in the aerial scanning (see figure 4).

Figure 4. GPS and IRS determine the aircraft's orientation



Each swath of lidar data is "stitched" together via a process called analytic triangulation (AT). The AT is a mathematical model that yields a complete blanket of laser returns from all of the swaths by tiling the swaths together.

This blanket of lidar data is then "tied" to the ground with traditional ground survey control. Thus, traditional survey/photogrammetry techniques are used to ensure the accuracy of all the lidar data collected on a project.

Lidar Accuracy

In general, each lidar return is about 1-foot accurate in the horizontal x-y coordinates and about 6-inch accurate in the vertical a coordinate. Note that these accuracies are expressed as standard deviations from a known value, as all map accuracies are.

Horizontal accuracy is generally worse because of the geometry involved with the sensor, that is, the perspective error caused by the angle of the pulses and the ground sloping away from the pulses.

Important to a lidar project is the *error budget*, which determines the accuracy of the lidar data being delivered. Part of this error budget includes the sample rate of the sensor and spacing of scan lines. This error budget also factors in the error from the scan pattern, sensor response times (latency), sensor (thermal) noise, and atmospheric error (fog, humidity, temperature, and refraction). Because of atmospheric error, lidar missions are usually flown at night.

The greatest source of error is not the lidar sensor but the GPS and INS on the aircraft. The exact position of the aircraft needs to be known to calculate the x-y-z coordinate for every return. Any drift in the GPS calculations or the INS adds error to the return's ground coordinate. Thus, wind direction and speed can affect the aircraft's orientation.

Attention to the vertical datum is important to the final accuracy of the vertical coordinate and, to some degree, the horizontal coordinates. Elevations are mapped either in relation to an imaginary curved surface of the earth called an ellipsoid or against an imaginary flat surface called a vertical datum.

In general, NAD83 (North American Datum 1983) is sufficient for the horizontal coordinate component. To define the vertical coordinate, however, a local orthometric (as opposed to an ellipsoidal) vertical reference or datum should be used. Typical vertical reference systems are the NAVD88 (North American Vertical Datum 1988) and the ITRF (International Terrestrial Reference System). Note that each state and community may also have its own local vertical datum.

Another coordinate complication is that the equipment and techniques used for the survey control, GPS, INS, and final lidar point cloud could all have different coordinate systems and datums. Incorrect use of these systems and their translations could result in several meters of error.

Accurate survey ground control, a

robust analytic triangulation model, and data densification with overlap and cross flights are important in the final accuracy of millions of lidar returns. In general, the final resulting cloud of points yields accuracies better than 15 cm, with precisions better than 2 cm.

Lidar Density

Lidar vendors say they fly their missions “low and slow” to create denser point clouds or “high and fast” to generate less dense but more economical data. The density of the lidar returns determines the resolution of the features that can be mapped. Smaller features require more dense data for their resolution.

Point density is dependent on the lidar sensor and aircraft altitude and speed. Another aspect of density is the amount of side lap in each flight line. A third way of collecting more dense data is to have cross flights perpendicular to the first flight paths.

Many users may want their data processed to thin the data or aggregate them into a smaller mapping data set. When data are thinned or aggregated, important details are lost. This loss of information may not seem important to lidar data users in a flood-control district or when the data is used in orthophoto production. Discarding the data, however, can prevent the lidar from being used in future change detection processes.

Lidar Data Sets

There are several lidar data sets. They include buzz words of DTM (digital terrain model), DEM (digital elevation model), DSM (digital surface model), TIN (triangulated irregular network), bare earth, and intensity. All these data sets are typically available in digital file formats such as the binary (LAS) format and ASCII (xyz) format.

There are also various levels of lidar products and amounts of value added that can be performed. Of course, the more value added, the longer and more expensive the delivery (table 1).

Table 1. Lidar data deliverables

Detail	Use and Description
All points	A raw point cloud of georeferenced returns, with no filtering.
Filtered	Morphologic filtering to create bare earth data and limited classifications.
Cleaned	Manual editing to clean data for use as a DTM and later processing.
Feature extraction	Automated and manual data classification with specific data extracts, such as mass points and break lines.
Fused	Refined data are “joined” with other GIS data, imagery, and hyperspectral imagery to generate new data sets.
DEM	Bare earth lidar data are aggregated to create a grid elevation model.

Raw Lidar Data

After lidar data are georeferenced, they are available in both binary (LAS) and ASCII (x-y-z) files. The binary file is much more compact than the ASCII, but a lidar program is needed to read the data. The LAS file also contains more information on each of the data points, such as the intensity of the return, angle of the pulse, and number of returns for the pulse.

The ASCII file is more simply opened with a word processor or spreadsheet program. Figure 5 is a sample of the raw file in ASCII format, with comma delimiters. The first field is the easting (x-coordinate), the northing (y-coordinate), and then the elevation (z-coordinate).

These ASCII data sets can contain over a billion coordinates. Files of this size

Figure 5. ASCII lidar data

```
2100044.620,244572.930,804.710
2100039.430,244572.810,805.140
2100028.970,244572.530,807.500
2100012.130,244572.200,816.790
2100007.050,244572.050,816.920
2100001.760,244571.950,817.900
2100003.960,244577.360,816.750
2100020.340,244577.670,806.680
2100030.410,244577.930,805.400
```

range from hundreds of megabytes to many gigabytes.

The same data in figure 5 can be geographically represented as a map showing each of the x- and y-coordinates. When these geographic data are rendered to visualize the z-coordinate, the result is called a *point cloud* (see figure 6)

Figure 6. Lidar Processing

One significant issue with lidar is the amount of effort that goes into the processing of the data to create derivative products. This processing is measured in both computer and human processing time.

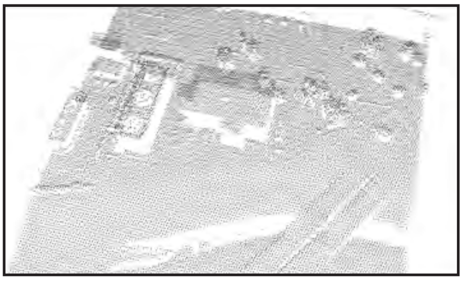
One of the initial post-processing steps is the removal of excess data. Sometimes called noise, these excess data are simply unwanted data not needed in the users' end application. Much research has gone into removing redundant information or thinning data. The motive for data thinning is to improve issues with data storage and to boost computational efficiencies of software that use the lidar data.

This post-processing can be completed with specialized software filters, but generally a person supervises the removal of the unwanted data. Eliminating these unwanted data can reduce file sizes by half, from many gigabytes to just a few.

A type of filter used to classify and remove data is the morphologic filter, which considers the patterns and texture created by a cluster of points in the cloud. For example, if the points indicate a smooth, sloping surface, then they are assumed to be a roof. If the points are random, then the feature may be trees or shrubs. This form of filtering is of course an intense area of research by academics and the military.

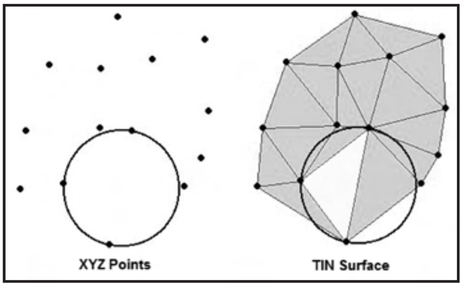
When the vegetation, cars, and other transient objects are removed, leaving structures and the ground, the resulting file is called a DSM (digital surface model). The cleaned DSM is useful for three-dimensional visualization, of such features as buildings and even sloping roofs (see figure 7).

Figure 7. Oblique view of lidar point cloud



When the DSM is rendered as triangular polygons with each polygon creating an abstract surface, a TIN (triangulated irregular network) is created (figure 8). The TIN is useful in visualization by creating relief maps and modeling views of outbuildings. TIN models are the most common format for processing lidar data within a geographic information system (GIS).

Figure 8. Lidar ground points and TIN model



The bare earth model is a DSM with all vegetation and man-made structures removed. Examples of man-made structure are vehicles, bridges, dams, homes, buildings, rail cars, garages, and so on. The bare earth model is used by surveyors, engineers, and public works officials in planning infrastructure development.

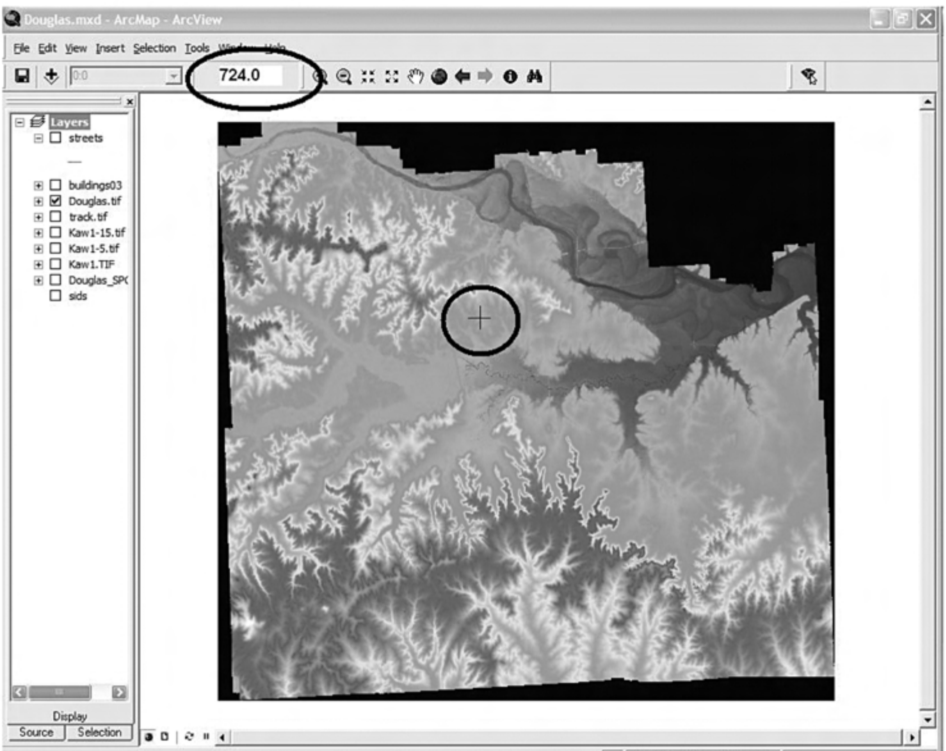
When structures are removed and photogrammetry control features called *mass points* and *break lines* are added, the DSM is called a DTM (digital terrain model). The DTM is used in the generation of very accurate ortho imagery, sometimes called *true* orthophotography. Some oblique products also *register* each oblique image to the DTM, ensuring very accurate vertical, horizontal, area, and façade measurements.

The DTM is also usually viewed as a TIN or in a simpler data extract known as the DEM (digital elevation model). The DEM is a method of averaging data and reducing the data content to create a very simple visualization product. The DEM is actually a grid into which several or even hundreds of lidar elevations are averaged. The averaged elevations are coded into each grid cell. Sometimes the DEM is created as a georeferenced raster file to improve file portability for use in other applications.

An example of the size savings was a DEM project in Douglas County, Kansas. The resulting raster file sampled 590 sets of lidar data of more than 21 gigabytes into a single image of only 200 megabytes (see figure 9). Lidar Logic was able to embed the elevation data directly into the raster file using a proprietary process. This compressed image also preserved the elevation data in the visual rendering, so the user could intuitively see changes in the elevation. With a custom tool created in ArcView, users also could see the elevation value as they moved their mouse cursor. Of course, this single image could be further compressed to only 10 megabytes, yielding a 2,000:1 compression, though there would be the typical loss of image quality.

Note that the DEM is an isotropic model, implying the size of every cell has the same area and shape, whereas the TIN is an anisotropic model and each triangle is a different size and different shape. This has implications for future data processing if detailed features are to be extracted.

Figure 9. Lidar elevation data



DEMs and TINs are often used in hydrologic and hydraulic models to determine flood risks. However, these models are limited because of the density of the lidar ground strikes and should be augmented with break lines to yield accurate and reliable models.

Lidar Ambiguity

Understanding the traditional approaches to lidar data processing helps explain how the data can be processed for CAMA change detection. This approach also considers how to manage ambiguity in an image, such as the examples in the following figures.

Users can easily visualize the features in the lidar data. Looking at trees and structures in lidar point clouds makes the user aware of how these features are depicted with lidar. Surfaces of roofs can also be easily visualized (see figure 10). Part of the visualization process is how the brain comprehends the features and automatically fills in missing information.

Closer inspection of the point cloud, however, causes the brain to see "gaps" in the data, causing uncertainty in what was previously a clear image of features. This process is similar to how the brain comprehends optical illusions. At first glance, an image may appear one way, but with a closer look, the image changes (figure 11).

A practical example is the edge of the roof in the cloud of points (figure 12). Note how at first glance the edge of the roof is clearly seen. But upon closer study, the roof appears ragged and poorly defined, especially in zooming in for more detailed study.

Figure 10. Oblique close-up view of lidar point cloud

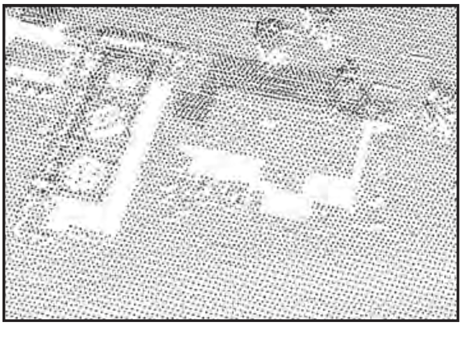
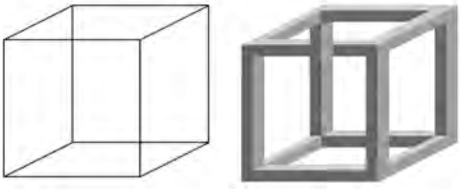


Figure 11. Ambiguous feature, "The Necker Cube"



To overcome these fundamental limitations of the lidar data, several automated approaches were developed to make use of the noise and incomplete data. Understanding the mathematics of noise, the mind, perception, and data incompleteness helps understand how to better extract features using rules of data sampling and resolution. The result is the lidar mask.

Lidar Mask

The goal of the mask is to identify features (structures) as part of the foreground while obscuring features (noise) in the background. This foreground/background processing of the data uses several concepts related to human cognition on reducing unwanted information into the background while preserving features of interest.

The lidar mask is a tool used to better define the edges of foreground features

Figure 12. Magnified view of building in lidar point cloud

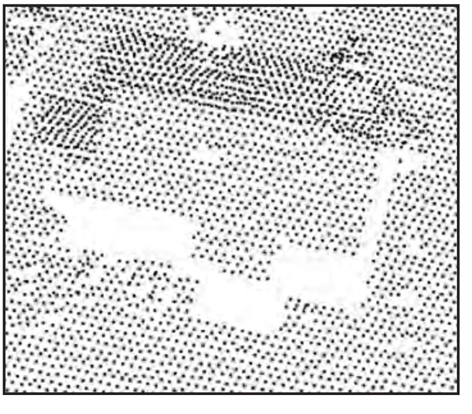
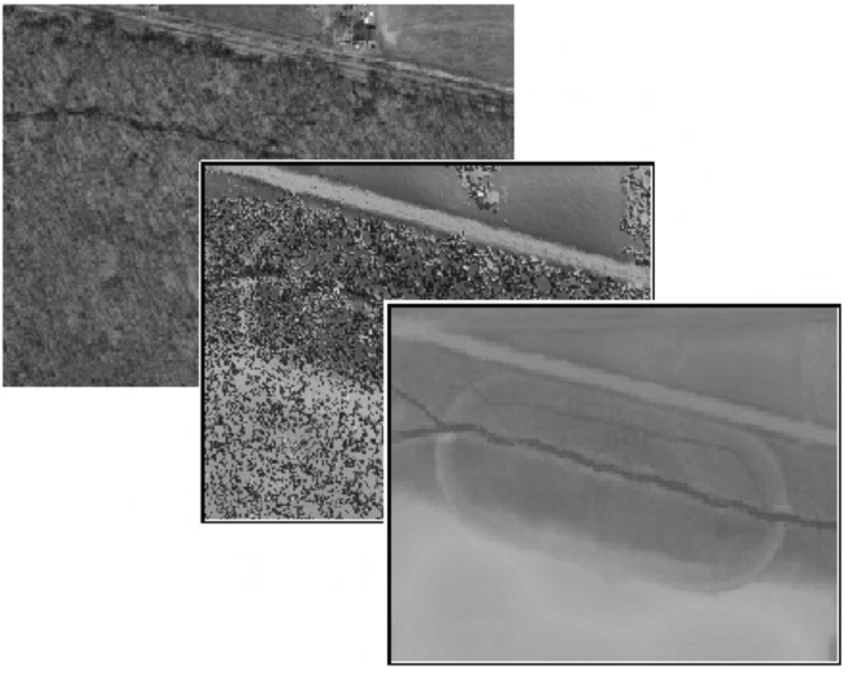


Figure 13. Aerial photo of trees, lidar with vegetation, and lidar bare earth



and to block the view of other unnecessary background information. The mask is used primarily to assist in the determination of feature breaks and later to locate their edges.

The first process of lidar masking is filtering out trees and other vegetation. The trees and vegetation are considered noise and are removed from the lidar data. However, this noise also is used in part to assist in determining features or parts of features that are obscured visually by the noise. The resulting lidar data set is the surface of the ground. This proprietary process is specifically designed to eliminate the change detection problem with vegetative and shadow occlusion of aerial photography. Notice how in figure 13 the trees can be seen in the ortho and in the raw lidar file, but are removed from the final lidar image.

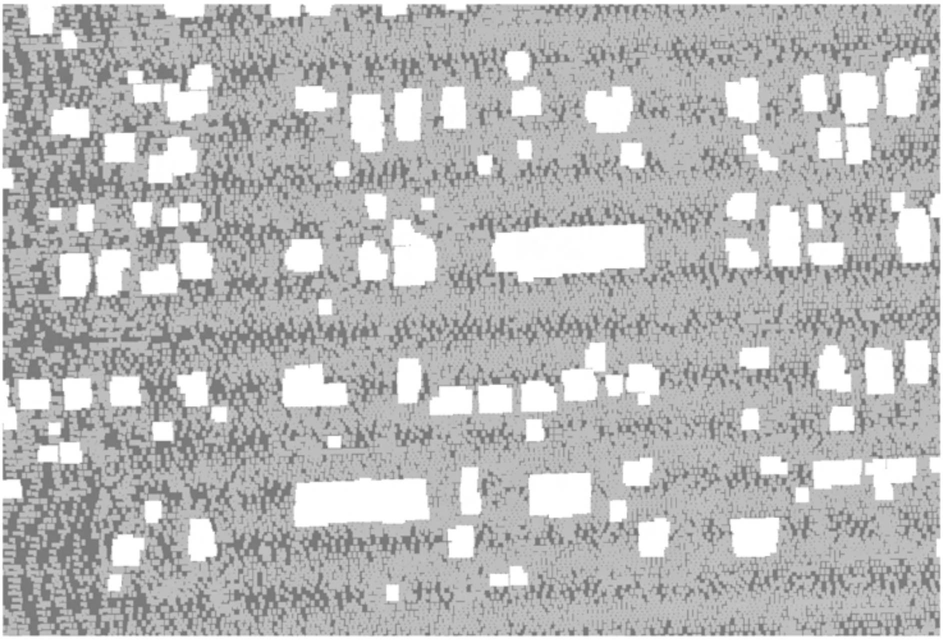
The second foreground/background processing component is the *dialing-in* of features that can be resolved (see figure 14). The size of features that can be resolved is dependent on the density of the lidar returns. In general, features of about 4 by 4 meters can be resolved from lidar data collected according to FEMA specifications. Smaller features can be resolved better with denser lidar data.

Part of the dialing-in process is also used to remove other ground clutter. For example, parked cars are about the same dimension as backyard storage sheds. It is easy to remove both the parked cars and the small outbuildings, but the programming logic required to drop only parked cars and not sheds is much more rigorous.

Sketch Change Detection

The lidar masking filters are very important in preparing the final mask for the assessor. The information in the lidar mask includes homes, buildings, and other man-made features relevant to an assessor, such as gazebos and aboveground swimming pools. This filtering or masking of the background helps eliminate the noise that could interfere with later automated change detection in the CAMA sketch as well as in the final manual desktop review.

Figure 14. Resolving a lidar mask from point cloud



Change Detection Inputs

There are three important inputs in the CAMA sketch change detection process: the lidar mask, the sketch vectors from CAMA, and the digital parcel fabric.

The sketch in CAMA must be digital and retrievable in some nonproprietary format. If sketches are drawings on a property card, then the property card must first be digitized. Figure 15 shows a sketch from an IBM AS/400™ in an IBM DB2™ database. The sketch vector data were exported into an ASCII file.

The sketches are all then converted into a set of digital scale-accurate polygons. In the case of this demonstration area (figure 16), the polygons were created as an ESRI Shapefile™.

The parcel fabric should be a single shapefile. Its coordinate system should be the same as the lidar data. If not, it is easier to re-project the parcels into the same coordinate system and vertical datum as the lidar. Finally the parcel data need unique parcel identifiers linking the sketch from CAMA.

Sketch Georeferencing and Analysis

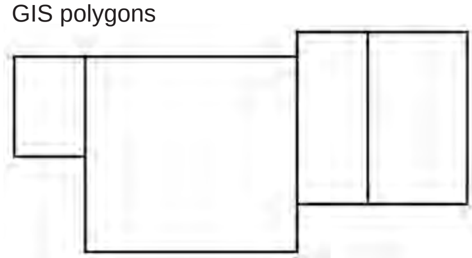
The mask is an efficient tool in the automated georeferencing of the CAMA sketch. The mask represents the structure as a void in the background data. Based on the geometry of the sketch, software automatically determines the best fit of the sketch into the void in the mask.

Unlike the lidar products discussed above, the CAMA sketch is fused to the appropriate void in the lidar mask. This

Figure 15. Sketch vectors in CAMA

```
                E     +-10-+--14--+
 +-10-+-------3010-2--+     I      I
14    I              17  D I      I
 I  B I               I   23   C  I
 I   26               I    I     23
 +10--+       *      26-10-+      I
      I               I  A 6      I
      I               +10--+-14---+
      I               I
      +-----30F-------1
```

Figure 16. Sketch vectors rendered as GIS polygons



fusing process creates new value-added information: the georeferencing of the sketch from CAMA and the analysis of fit.

The change detection process is a quantitative measure of a qualitative fit. This means the wellness of fit is graded by the analysis software as each sketch from CAMA is fit and compared to the corresponding parcel void of the lidar mask.

Figure 17 shows the lidar mask with voids as transparent, thus representing the missing elevation data. The parcel fabric is the bold line and the sketch before georeferencing is the fine outline. Note that the mask color represents the elevation data. Thus, the elevation for each sketch can be automatically determined from the mask.

The actual software performing the change detection completes its task in an unglamorous, nonvisual, batch mode. The results are simply georeferenced sketches from CAMA and an attribute, or score, in the sketch database describing how well the sketch fits.

Figure 18 demonstrates how the sketch is moved and rotated to fit the void in the mask. Note how the sketch typically fits into the void. Where the sketch does not fit, it is graded and flagged for desktop review.

The void in the mask represents the rooftop of the structure. Therefore there is a certain percentage of overlap of the void into which the sketch will fit. The sketch georeferencing software anticipates the overlap. Thus, a georeferenced sketch should be slightly smaller than the mask void, and the geometry of the sketch and void in the mask should be similar.

Figure 17. Lidar mask with parcels and sketches

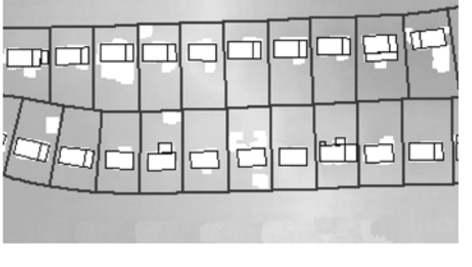
There is change if there is either too much or too little overlap between the sketch and the void. Also, if the geometry of the sketch and void are different, there is change. Four logical outcomes, or conditions, are possible with each comparison:

- *True positive*, change detected correctly.
- *False positive*, change detected incorrectly.
- *True negative*, no change detected correctly.
- *False negative*, no change detected incorrectly.

The software was developed primarily to achieve a true negative condition while minimizing the occurrence of a false negative condition. A true negative condition is also the one in which most of the human time would be spent if this process were done manually.

A true positive condition is easily determined, provided the change is the size of a deck or larger. A false positive condition, which is an incorrect change identified, is not necessarily a problem because this condition is flagged for desktop review and would be corrected during the review. A true negative con-

Figure 18. Lidar mask with georeferenced sketches



dition is the most common result of the analysis, which is to be expected. A false negative condition is the most problematic because it is not known when the condition of “no change” is incorrectly identified.

With respect to false negatives, the only solution for this condition is confidence in the performance of the software. On the first projects it was confirmed that a false negative condition does not appear to be a problem because of a 100 percent desktop review to evaluate the accuracy of the software. The world is infinitely variable, however, and software cannot handle all real-world exceptions.

In figure 19, note the voids in the mask where there is not a sketch. Some of these voids are outbuildings that are not sketched and not assessed.

Nevertheless, there are notable exceptions when there are no sketches to be georeferenced, and every assessor understands and appreciates these. Examples of missing sketches for mask voids are tax-exempt organizations, such as government offices, schools, and churches. Another exception is multistory building sketches, because georeferencing and testing CAMA fit can be done only on the ground floor.

Desktop Review

Analysis of the CAMA sketch is key to the desktop review. With lidar, the sketch is automatically georeferenced, analyzed for change, and *scored* with a quantitative value. The scoring includes values for missing outbuildings, missing decks, minor change, and major change. There are also scores for missing sketches, which may be voids in the mask for tax-exempt parcels. Another unusual score is for a void and sketch with the same dimensions but a different geometry, such as the example in figure 20.

With specific sketches now flagged and scored, the assessor can more efficiently perform the desktop review or, if necessary, go into the field to take

Figure 19. Lidar mask with exempt properties

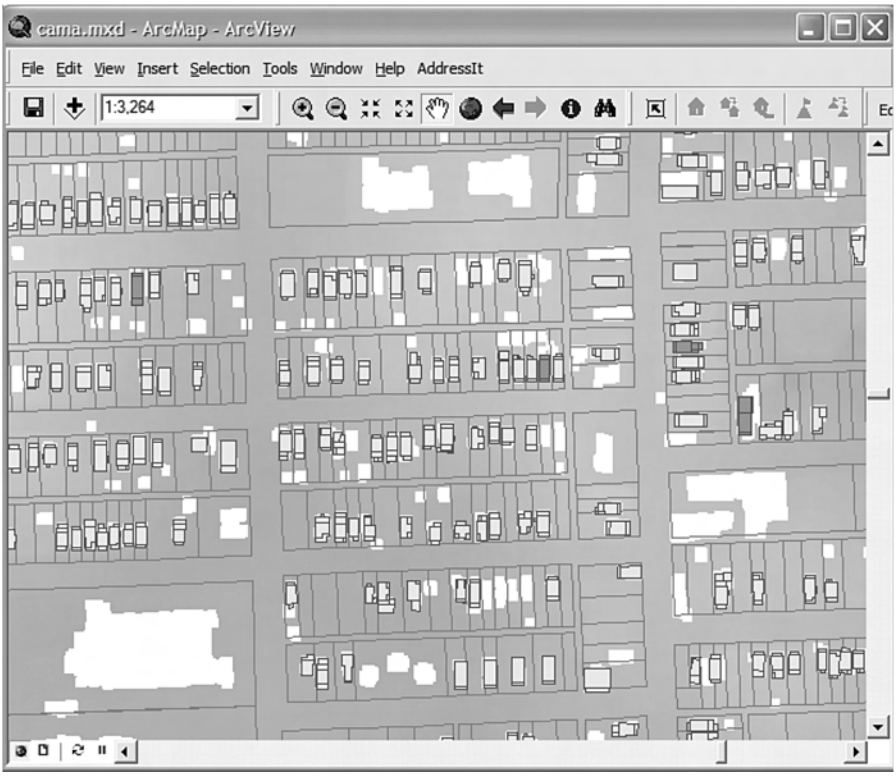
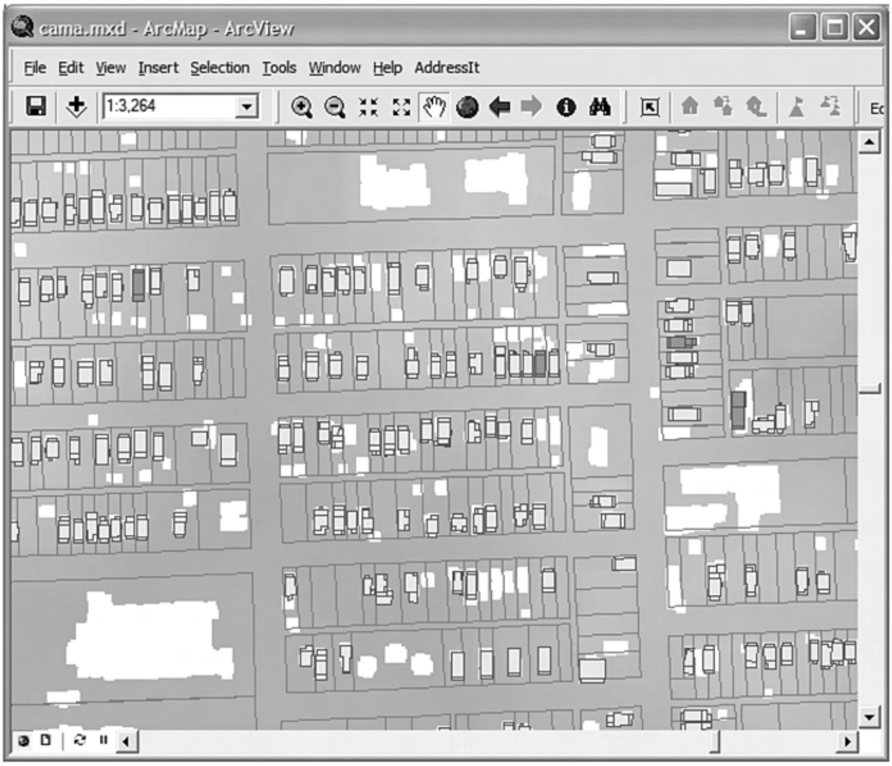


Figure 20. Bad sketch georeferenced to lidar mask



measurements and collect updated street-view images.

At the point of the desktop review, the lidar mask is no longer needed, but it is available as a GIS layer. The lidar mask is of value during the desktop review when it is rendered transparent so the user can see through it to the orthophoto underneath. The approach helps minimize the image background information containing yards, shrubs, trees, and other distractions. This allows the assessor to focus attention on the sketch being inspected.

Figure 21 is the same lidar mask as in figure 19, with the ortho toggled on.

Note there has been a fundamental change in the desktop review process. Because the sketch is being compared to lidar, the CAMA database is being analyzed for change. The comparison is not ortho to ortho, or oblique to oblique.

Determining the grade and condition of the change is another, separate task from the lidar. If obliques are available, then comparing the sketch with the obliques can provide information on the nature of new construction, grade, and perhaps even effective age and condition. Megapixel street-view imagery also is a very useful tool in the process (see figure 22). Unfortunately, in some cases, a field visit to the parcel is necessary to determine the change.

Summary

Lidar is now a proven tool for automating the fusion of many data sets, including the sketch from CAMA into real-world space. The lidar mask also enables a significant degree of automated change detection of the sketch against current lidar data.

Individuals conducting the review appraisal from the office can now perform their job more efficiently, achieve higher productivities, and be more confident that the changes they are identifying are correct.

Figure 21. Lidar mask with ortho in background

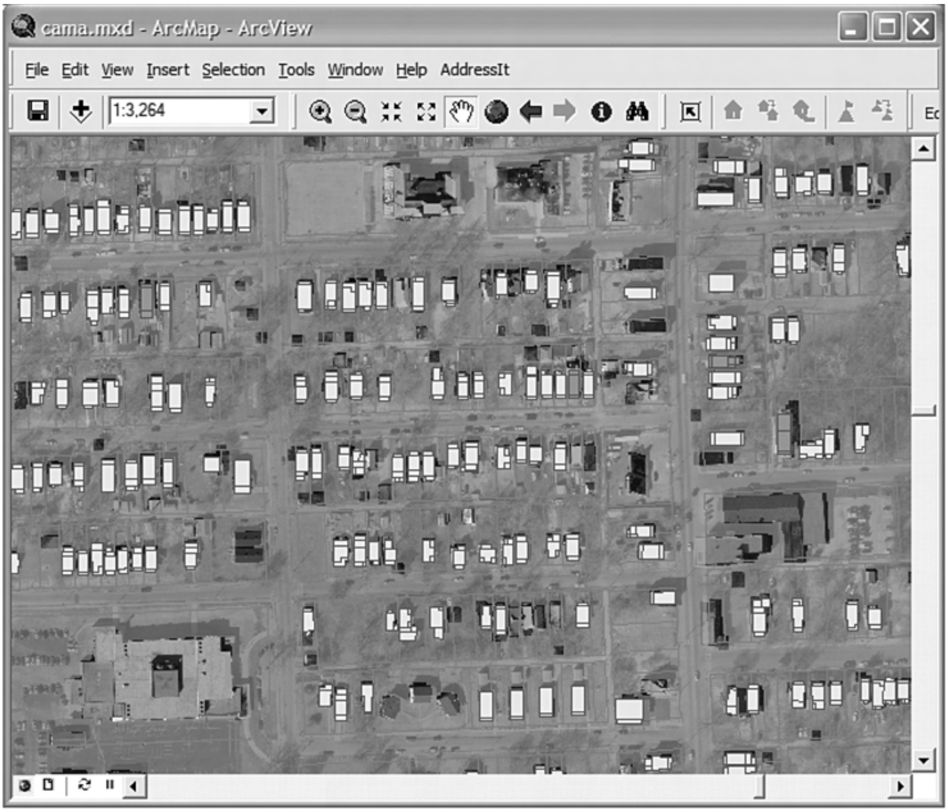


Figure 22. Obliques used in desktop review

The lidar mask approach to CAMA change detection is a proactive one. All communities have been vexed with having to continually bring their tax rolls up to date in a reactive process. With lidar, the assessor can now ratchet up CAMA valuations across the board, rather than in a piecemeal, cyclical approach.

The importance of lidar in the field of change detection will grow, especially in updating CAMA data. In communities with a reactive approach to database maintenance, the lidar mask is an effective tool for georeferencing the sketch in CAMA and for masking the ortho and oblique images to more easily and accurately determine changes.

Other uses of lidar are the determination of building elevations and flood plain mapping. This will lead to three-dimensional electronic sketches, including ceiling heights. Also, the CAMA data could become the nexus for a better determination of insurance loss claims during disaster recovery events.

On a final note, once a lidar baseline is created, change detection utilizing future lidar data will actually become a simpler process. In the future, change detection for CAMA sketch measurements will be possible in three dimensions, as well as from lidar or lidar data processing.

References

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