Collecting the evidence

Richard Auty reports on how the Metropolitan Police has been putting 3D Laser scanners to the test to speed and improve its investigation of serious road traffic accidents

Whenever a fatal accident occurs on Britain's roads, the aim of the Collision Scene Investigator is to collect - using the most efficient methodology - sufficient raw data at the scene to allow for thorough post-incident investigation.

A subsidiary but compelling factor to consider in today's economic climate is the impact of road closures both financially and operationally, on other road users and UK Business. With more than 12,000 call outs per year for Metropolitan Police Collisions Investigators, the financial impact of incidents on the capital's roads is a major concern.

Studying the options

In 2009, the Metropolitan Police Road Death Investigation Unit (RDIU) took the decision to review the potential of laser scanning and to compare it against the use of Total Station Robotic Theodolites. In particular, it was hoped to determine if the use of laser scanners at collision scenes could speed up survey times and indicate which type of laser scanner would be most suitable for data gathering.

The first stage was to establish the differences between Phase and Pulse scanners and which, if either, was more suitable. An open invitation was made to all the major suppliers to attend Hendon to demonstrate their equipment; the only requirements being that the unit had to be self-contained; no assembly other than putting the unit onto a tripod; no external batteries or GPS receiver; a laptop computer should not be required. and it must have an integral camera.

Testing times

To test the equipment, three scenes were set up and the scanning time was recorded; starting when the box was opened and stopped when the equipment put away.

Scene 1 – A complicated scene with multiple vehicles in close proximity
Scene 2 – A bend and junction with parked cars and a tunnel.
Scene 3 – An open section of road with two cars and transient data.

The analysis of the data identified some interesting differences. The phase scanners were reasonably fast but with a limited effective range. Examination of the scans showed that where individual scans were more than 20 metres apart it provided a diminished end product. Thus the phase scanners were quicker but required more scans, from more locations, to capture a complete scene. The phase scan also had 'interference' in the form of a wave pattern, caused by the phased nature of the scan, and resolving it required remedial work during processing.

The pulse scanner had a longer effective range of over 500 metres but to attain a reasonable density of points for the settings used, 80 metres was found to be a good distance between scanning positions. It provided good quality images with no interference and all the transient marks that the phase scanner recorded were also recorded by the pulse scanner. From this initial comparison, it was determined a pulse scanner was the preferred system for Collision Investigation.

Pilot study

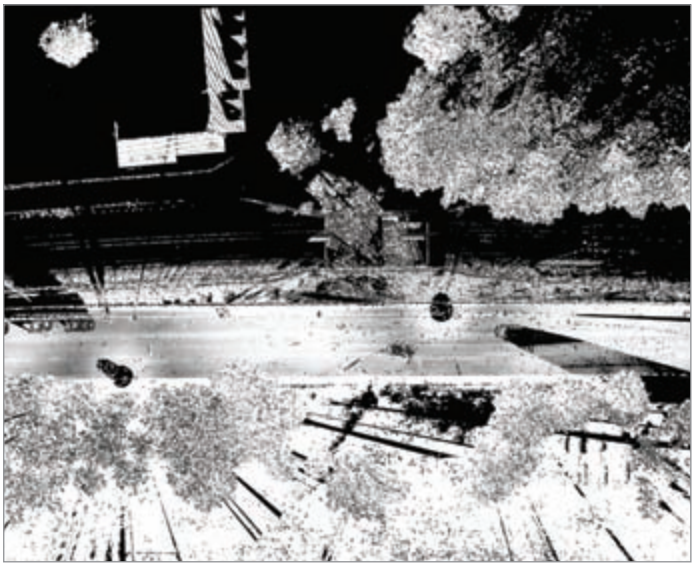
Following this initial testing, a six month pilot study was conducted to identify the potential

for time savings at scenes through the use of laser scanning technology and the possible extent of these gains. The pilot compared workflows and scene methodology in order to determine the best and most effective means of scene data capture. The primary objective of the study was to quantify the time savings achieved, if any, and identify any potential problems.

The previous test had identified two suitable pulse scanners for Collision Investigation. Scanner 1 was used by the Road Death Investigation Unit (RDIU) Northwest at Alperton (TDQ) and Scanner 2 was used by the RDIU Southwest at Hampton (TDT). The two remaining RDIU's, Northeast at Chadwell Heath (TDJ) and Southeast at Catford (TDP) would continue to use the Theodolite Total Station. Every callout from the four units was recorded and in total the laser scanners were deployed to 145 scenes and the Total Stations to 128 scenes.

Scan Quality: The quality of captured scans is determined by the spacing between individual points, both in the vertical and horizontal axis, at a set distance. Scanner 1 provided a standard spacing of 10mm horizontal and 10mm vertical whilst Scanner 2 was set at 7mm horizontal and 7mm vertical. These settings can be changed but the increase in point density does increase the capture time. The standard settings are therefore a compromise between speed of capture and a scan with sufficient detail to be of use.

Scan Speed: For the MPS, the speed of the scanning was paramount while ensuring that all the data were captured to allow the road to be re-opened in the shortest time possible. Scanner 2 provided in full daylight a colour scan in approximately 4½ minutes, with night scans taking about a minute longer at its standard 7x7x10 setting. Scanner 1 could provide, in full daylight, a colour scan in 15 minutes, with greyscale only at night or during low light levels, at its standard 10x10x10 setting.



Vertical scan of accident scene
The positioning and visibility of road signage is often an important factor in accident investigations

Results

During the pilot, every attendance at a collision scene was recorded in a set. No two scenes are the same and road closure times are affected by a number of factors such as the size and complexity of the incident and investigation. The results include delays incurred as a result of actions by third party organisations including body and vehicle recovery, repair and cleaning operations. The data cannot allow for these factors to be isolated within the total road closure time but as they occur at most if not all scenes, their inclusion is unlikely to be significant, particularly as the dataset was large.

TOTAL STATION SURVEYING	TDP	TDJ	Total
Number of call outs	68	60	128
Average survey time (minutes)	70	60	65

LASER SCANNING	TDP	TDJ	Total
Number of call outs	65	80	145
Average survey time (minutes)	59	31	45

While the two units using Total Station equipment showed similar survey times the two laser scanners provided significantly disparate results. The survey time for Scanner 1(TDQ) was within the time range of the units using the Total Stations, whereas Scanner 2(TDT), had a survey time about half that of either the Total Stations or Scanner 1. This time savings would also appear to have a direct impact on road closure times:

AVERAGE ROAD CLOSURE TIME (HRS:MIN)	
Total Station	4:25
TDT Laser Scanner	3:36

APPROXIMATE SCAN TIME 360° (MINUTES)	
Laser scanner TDQ	15
Laser scanner TDT	4½

The first comparison of the data should identify disparity between the two laser scanners. The speed of Scanner 2 to complete a full scan in colour is roughly twice as fast as Scanner 1 if the internal camera is not used, and more than three times faster if the internal camera is used to capture data to colour the scans. (Scanner 1 was unable to take photographs using the integral camera, used to colour the scan data, during low light conditions or at night). In addition Scanner 2 provided a greater level of point density and provided coloured scans both during the day and in low light conditions at night. There is no tangible difference between the processing times of data captured by the two devices.

Timely comparisons

When comparing the data capture times of the best performing laser scanner against the Total Station, an 'on scene' time saving in excess of fifty percent is evident. It can be assumed that this in turn, translates into a saving of over an hour of road closure time, per incident.

The total station can provide scaled line plan of the scene with minimal back office time, i.e. the time taken to process the raw data collected at the scene into meaningful information for presentation in court. The back office time is currently estimated at one hour to produce a basic 2D plan. It is currently taking CI's in the region of 1½ hours, including registration, to produce the same level of information from the laser scanned data, although it is hoped, with experience, this figure may reduce.

Added benefits

The magnitude of data collected by laser scanners in comparison with total station surveying has a number of additional benefits and the integrity of the data is indisputable. A total station survey relies on operator skill and an individual's interpretation of the scene including start and end of 'marks' and identification and positioning of evidence. This is also true when considering the use of scanners but, unlike a Total Station, the scan provides verification by capturing the whole scene with greater detail.

Once a scene has been cleared and the road reopened for normal use, there is no means of data verification or additional capture for traditional surveying methods. As an investigation develops it may be necessary to revisit a scene to provide clarification. The 'virtual' scenes, as collected by the laser scanners, have removed the need for these repeat site visits.

The quality of the laser scanned data is also much greater than required for most cases. It is possible to recreate the scene in high definition 3D with quality visuals for court use, simulations, animations and a fly through.

Conclusions

The pilot project has clearly shown that laser scanning technology can provide measurable and repeatable time savings when capturing raw data at a scene, with an average time saving of 50% when comparing the faster scanner to the Total Station. It also demonstrated that the 'survey time' saving can be directly translated into reduced road closure times.

If these time savings were to be extrapolated across the remaining scenes attended by the other units MPS RDIUs involved in this pilot, 199 in total, it would equate to a saving in survey time of about 100 hours. The MPS uses a rate for the economic cost of road closures of £100,000 per hour. Assuming the saving in survey time is directly transferable to a reduction in road closure, the use of laser scanning systems on these incidents alone would save an estimated £20,000,000. If this figure were to be extrapolated across all 1,200 incidents attended by the MPS CI's it would be in the region of £60,000,000 per annum.

Scanner 2 was a higher speed scanner, provided full colour scans in all light conditions at a higher intensity, is self levelling and has an in-built compass and GPS, but has a higher initial purchase price. If time was a factor, this scanner would provide a high level of data capture at a higher speed.

Richard Auty is the Senior Collision Investigator with the Metropolitan Police Road Death Investigation Unit (www.met.police.uk)

Note: *This article has been written as an overview of the potential time savings the use of laser scanning may provide. The make and model of the two devices trialled have been deliberately omitted in this article as prospective users should make their assessment of the available equipment in relation to their own individual requirements and budget. The Metropolitan Police does not recommend or endorse any particular system over the other.*
Further information can be sought on this project from the author by emailing Richard.auty@met.police.uk