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GIS RESOURCES

GEOSPATIAL TECHNOLOGIES IN FORENSIC INVESTIGATIONS

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DRONE PHOTOGRAMMETRY TO DOCUMENT VITAL EVIDENCE OF FORENSIC INVESTING

FROM ALL SIDES - INTEGRATING LASER SCANNING AND UAV DATA GIVES INVESTIGATORS A NEW 3D VIEW

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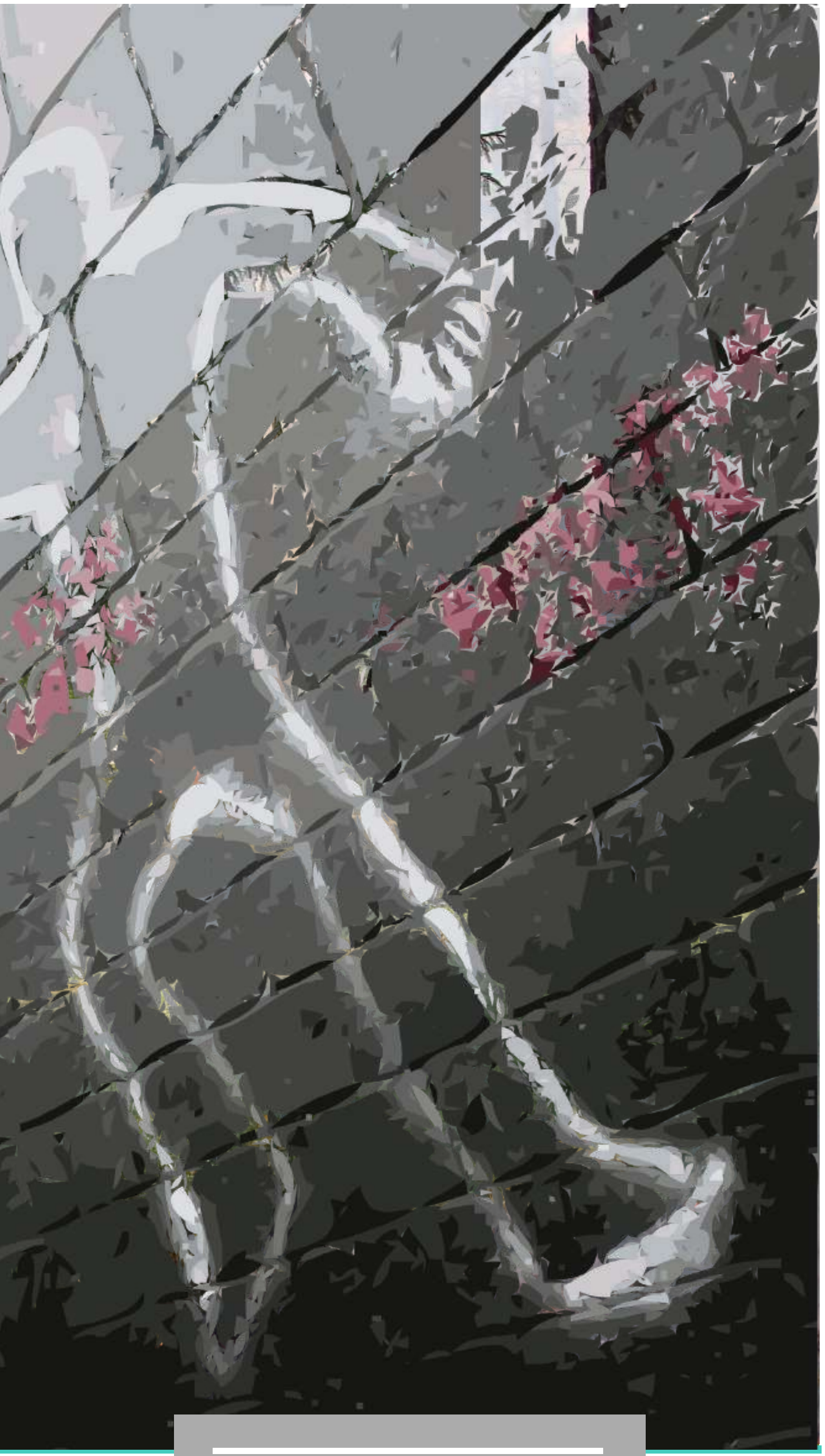

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editor's note

Geospatial Technology in Forensic investigations Surveying provided the basis for man to know 'what is where' and 'when'. The technology, if we can call it a technology during the early 19th century, was able to provide two very precious parameters – distance, which was deduced by determining angle and location on the earth, and time, which was obtained by observing the sun and the stars in the sky. This remarkable technology laid the foundation of what we know now as the Geospatial Technology. And Forensic investigations still want to determine 'what incident happened where' and 'when' in order to find the reason for the incident and who, if any or applicable, was responsible.

With the evolution of technologies, we now use sophisticated and easy to use equipments such as the digital survey technologies that include smartphones, tablets, digital cameras that are all integrated with the global positioning system (GPS) navigation systems that provide location and time of an incident. Sophisticated space based technologies now provide imagery that capture digital images over a small or wide area as a record of the spatial and spectral information of an incident. All this information is combined in sophisticated softwares that are run on powerful hardware that provide models to evaluate an incident or provide realistic scenarios for decision makers to establish the facts of the incident.

Forensic investigations have become have, over the years, evolved into their own specialised domains, such as, Forensic geography, Geoforensics or Forensic geosciences, Forensic mapping, Environmental forensics, Forensic GIS, Forensic Archaeology etc. By using sophisticated Geospatial technologies, data can be captured and analysed interactively by switching between different perspectives that can rotate around illustrations to throw up different theories as well as combined with statistics to provide better clarification and visualisation of an incident.

Up-to-date and detailed databases can be prepared to compare with similar incidents in the past. Forensic GIS and Geospatial Modelling of the different parameters, available in separate incidents, can provide investigators with as insight to a particular incident. Before and after scenarios can be generated to study different aspects of an incident and are especially useful in investigating the effects of natural disasters.

Geospatial technologies combined with imageries and modelling softwares are an established tool in the hands of a forensic investigator that aid him in the establishing facts of an incident in order to arrive at decisions and data that can be used by a court of law or an insurance agency or to improve upon a hypothesis in the scientific community or to help recover valued remains and artefacts etc.

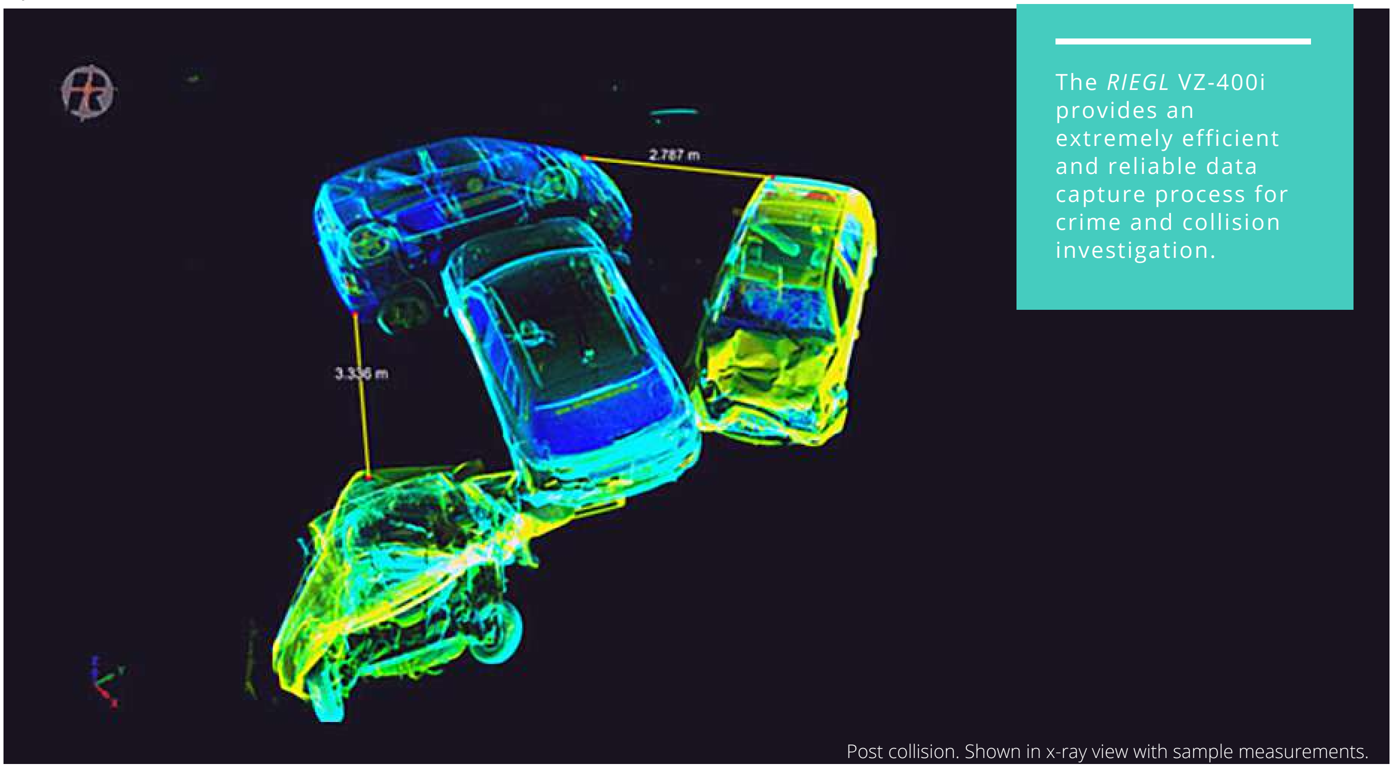
Geospatial technologies are now an essential component of digital forensics.

Ashok Prim
Editor

RIEGL LiDAR – SUPPORTING PUBLIC SAFETY AND FORENSIC INVESTIGATIONS FOR OVER 15 YEARS

RIEGL has supported Public Safety and Forensic Investigations for many years and continues to supply class leading technology (both hardware and software) for efficient recording of such scenes.

by David Foster



The *RIEGL* VZ-400i provides an extremely efficient and reliable data capture process for crime and collision investigation.

Post collision. Shown in x-ray view with sample measurements.

The value of LiDAR or 3D Laser Scanning for accurate documentation of crash and crime scenes has been discussed through numerous forums over the years. *RIEGL* has supported Public Safety and Forensic Investigations for many years and continues to supply class leading technology (both hardware and software) for efficient recording of such scenes. It may be useful to consider a little of the history before bringing the subject up to date with current practice with the latest scanners (VZ-400i and VZ-2000i), showing their leading operation and best performing fit for purpose testing.

Background

Documentation of crime and crash scenes over the years has traditionally been done with photography and sketches.

Some departments may have developed plan drawing teams, and these were certainly prevalent with

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Figure 1: ***RIEGL*** **LMS-Z420i. Contingency Planning (Courtesy: Metropolitan Police, London).**

Collision Investigation. Measurements taken with tape were time consuming, requiring many man hours to complete; clearly the more complex the scene the longer such measurements took. Setting out tapes in a datum line methodology (chain and offset) relied on keeping the tapes straight, and measurements offset at right angles, often in far from ideal conditions.

For crash investigators and reconstructionist, the need for such measurements, which were later drawn to produce scale plans, are crucial in determining key evidential matters such as point of impact and lengths of skid marks for example. Similarly, with crime scenes, locating key items of evidence assist in the investigation process and bringing offenders to justice.

Other areas which benefited from detailed plans related to pre-event security, contingency planning, and asset management, all of which required time consuming recording and processing to produce plans.

The move to recording scenes with total stations, then supplemented with GPS survey technology was a major boon. However, they were still time consuming, albeit faster than laying measuring tapes; even in Public Safety, time is money. Many resources are required in keeping a scene safe to work in, to preserve evidence and to redirect traffic around the road closure. This is also detracting from other duties which still need to be performed.

Laser scanning started to appear on the scene within Public Safety in the early 2000's. Initially costs were prohibitive, with operation slow and cumbersome requiring planning of associated resources (batteries!!).

However, the seed was sown; the benefit for producing an accurate 3D facsimile of a crash or crime scene was starting to be acknowledged. The ability to freeze the scene in time allowed investigators to return to the scene time and time again.

Deployment of 3D laser scanners also greatly assisted contingency planning and event security planners.

RIEGL's development of the VZ-400 series scanner provided a major breakthrough in adaptation of laser scanning for Public Safety – this scanner was much faster, smaller, portable, with self-contained power source and operated from the scanner itself with easy touch control panel on the body of the scanner. A large rollout program in the UK was based on the costs associated with sudden unexpected road closures, and these costs are significant. Reducing the length of time roads were closed saved money both to the general economy and to law enforcement agencies. Studies in a number of different jurisdictions indicate such costs, but also that deployment of the *RIEGL* VZ-400 was likely to and did provide for faster road re-opening times, whilst preserving the necessity to accurately document the crash scene.

Importantly, the software was developed alongside to ease back office processes; this had the advantage of leading to greater uptake and deployment of the VZ-400 to more crash scenes with the benefit to both the investigator and the motoring public/economy becoming increasingly apparent. Thus, the adoption of *RIEGL* VZ-400 scanners can be offset against the gains made; the high costs of road closures means monies saved with further reductions in road closure times pays for the initial capital outlay of the scanners many times over.

Additionally, the quality of engineering of the *RIEGL* VZ-400 and long-term reliability has proved that the scanner is not only long lived (original VZ-400s from the 2011/12 roll out are still widely use today), but that they offer an excellent return against any Best Value analysis.

The development of the current VZ-400i advanced on the success of the VZ-400 and added a variety of features from inception; during its life time the software and how the workflow from data capture through process to end deliverable has progressed, means the VZ-400i has cemented itself as the class leading LiDAR unit for Public Safety and Forensic Investigations.

Figure 2: Crime scene documentation - exercise.

Figure 3: Wet weather testing.

RIEGL **VZ-400i**

The VZ-400i is one of the most productive laser scanners available: very fast laser pulse speeds (1.2MHz) and measurements rates coupled with the ability to obtain imagery at the same time as scanning means scans obtained at the panorama_40 setting (40mdegs) are completed in 45 seconds. One-touch workflows make operation of the scanner incredibly easy. Automatic detection of position moves means that at each new position, the operator needs only press the START key to begin a new scan. The touch screen operation was developed in response to feedback from a broad customer base. These also informed the basis of the workflows with which the operator selects the scanning mode. It should be borne in mind, that the VZ-400i can also be customised - a workflow could be set for crash scene in daylight, rural crime scene at night as examples. Additionally, the ability to utilise user configurable scan patterns (variable scan densities, range modes etc) means that the scene can be captured in particularly good detail generally, but key items can be focused in high-detail scan windows.

The operator needs to understand what it is that is being captured, what the evidence in front of the scanner is, and why that data would need to be recorded. Using the *RIEGL* VZ-400i is an objective data capture process. The operator and any person involved in subsequent analysis of the data need also to be confident in the accuracy and reliability of the instrument, so that any data drawn down can be done with high confidence, and minimal measurement uncertainty.

Of course, in all this the capacity for *RIEGL*'s VZ-400i fast-scanning, easy workflows, simultaneous image capture (and ease of use in software) continues the ability to document such scenes very quickly, allowing closures to be opened sooner. Survey times can now be measured in minutes.

But what of the accuracy? In the UK a series of tests have been conducted to determine just how 'fit for purpose' the *RIEGL* VZ-400i is, including testing in wet conditions (Figure 3).

Working with the NPCC Specialist Capabilities Programme (SpecCap) a sequence of demanding test situations was created, with only the final extreme weather tests to be completed (CoVID-19 permitting) at the time of writing. In deployment the VZ-400i has been happily(?) used across wide temperature variations such as at -11oC / 12F in Latvia up to +45oC / 113F in Arizona. On-board sensors allow for variations in atmospheric conditions: this is an important consideration to allow for field conditions compared to laboratory results, in order to maintain accurate measurements.

Fit for Purpose

Figure 4: Collision Teams respond to incidents day/night, rain/shine.

The SpecCap tests were designed to be a process to determine a device's suitability for use – in these specific circumstance – for evidence capture at crash scenes. Levels of accuracy of the scanners and of registration were set, controlled scans performed at ground truth sites, and levels of performance determined in adverse weather conditions. For Law Enforcement Collision Investigators there is no planning to go out to survey when a crash occurs; each incident has to be responded to on demand. It was also a mandate that the device had to be capable of automatic registration without the use of targets. In such circumstances there is no requirement to tie to survey control.

The exercises detailed single station accuracy, which included targets as a mean of checking accuracy. Targets could not be used as part of the registration process. *RIEGL* uses reflector type targets which are fine scanned after the main scan has taken place. For the VZ-i series this process has been hugely streamlined and automated. However, it still adds time, both in setting out the targets and then conducting the fine scanning element. Where time is critical, steps taken to minimise time consumption are key. Again, the method validation process was to determine the parameters the VZ-400i could work at without targets. Standard deviation for a single scan in comparison to survey control was reported at better than 1mm. For multi-positions after registration, this was around 1mm – these figures married with initial tests which were processed and checked against numerous control measurements[1] by an independent body with the average error being better than 1mm (0.00088m).

Now for the real-world testing: the accuracy tests described above were conducted in a controlled environment with relatively short distances. How was the VZ-400i to perform in a variety of environments, without targets, and still register robustly to give accurate geo-referenced measurements, data that could be relied upon? Indications at this stage suggested we could extend scan position centres to as far as 40m and achieve the required accuracies.

The ground truth location was a police training facility in the UK. It involved urban street scenes, semi-urban areas and a rural featureless site. Each of the open areas had to extend for 300m minimum to replicate typical scenarios encountered by Collision Investigators across a wide variety of policing areas. The first scan project was completed with scan positions at 20m intervals at the semi-rural scene. Here, there are some buildings to one side of the road, but these were masked at intervals by trees. Opposite was a ditch and flat grass land. On-board registration was enabled.

The scan pattern was set to a prescribed resolution that the SpecCap defined (6mm @ 10m). This translates to 34mdegs (0.0034 degs) on the *RIEGL* VZ-400i. The workflow parameters were set up on the scanner ahead of time, so that this operation was selected as a defined process. The operator need only confirm that he/she will be using the correct workflow.

On board registration is completed, as implied, on board the scanner, without the need of a tablet or other device. This enabled real-time assessment of the registration process as the scans were being completed. The VZ-i Project Map app displays scan locations together with a streamlined version of the scanned data so that the operator can check each scan location relative to the previous as the registration is built up. Any gaps in data can easily be determined in the field at the time, reducing the need for return visits.

Figure 5 displays the results of this second scan project at the first – semi-urban – scene. Each scan position centre is at 40m, with each scan being completed in 61 seconds (including imagery). Registration was recorded with a standard deviation (3mm) that far exceeded the requirements of the test. The scene length was 320m between start and finish positions. Actual survey data extended for much further and control targets bracketed the 320m scene length. Similarly, on-board registration allowed the operator to analyse the registration in real time as scanning progressed.

Finally, a third examination was completed utilising the scanners capability to adjust the resolution of the scan; in this format the scan pattern was changed to read 50mdegs frames and 25mdegs lines. This has the effect of increasing the number of points on the horizontal surfaces, particularly useful for documenting relevant marks, gouges and debris on the road surface. For this scan pattern each scan is completed in 59 seconds.

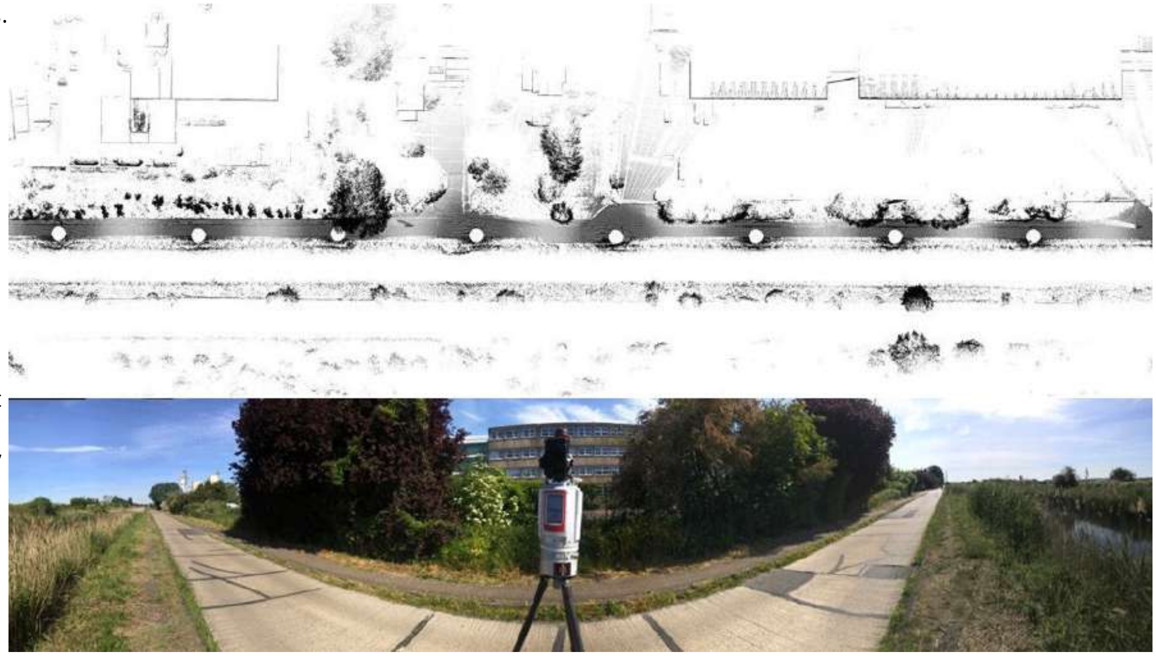

Figure 5: Ground truth location: semi-urban scene.

The next location was that of the rural featureless scene. Here the “roadway” was bordered on both sides by grass land with the grass being approximately 1m tall. There were occasional small trees and shrubs interspersed across the scene layout but the distances between each was large.

Figure 6 shows the results as we moved to the rural location. The same process was carried out: a 20m separation initial test then scans performed at 40m intervals over the 300m+ scene length, both at the 34mdegs and the 25/50mdegs settings (roadway).

Figure 6: Rural featureless scene, registered automatically without targets, 40m intervals.

Similar results were reported with regards to accuracy across the whole project. It was clear, and wholly as expected, that scanning at 20m makes for a better data set, however, what was revealed was the robust nature of the registration process both on-board the scanner and within the partner software RiSOLVE.[2] The combination of the *RIEGL* VZ-400i (with its numerous sensors as well as the scan data) and the algorithms relating to registration on board the scanner and mirrored in the software, makes for a compelling argument and a reliable data capture process.

Finally, similar tests were then carried out in an urban location with the added complication of one additional test: at one corner location (street junction), the scan positions had to be sited so that they could not see the targets for the adjacent / previous scan. Targets were carefully placed to control this sub-test to examine the registration in a real-world environment. For this scene, the scans were recorded at appropriate scan separations with the caveat of the sub-test. Not surprisingly, at both the 34mdegs and 25/50mdegs scan patterns, registration was completed successfully, again far exceeding the requirements of the overall test.

Incidentally, the same scenes were also scanned with the *RIEGL* VZ-400 which are still in widespread use across many Public Safety bodies. The results revealed that the scan separations in the rural and semi-rural areas should be reduced from the maximum 40m, but that the registration obtained was robust. This is reassuring to existing users as *RIEGL* continues to support those bodies with the VZ-400 instrument, allowing them to work with their current instrumentation.

Conclusion

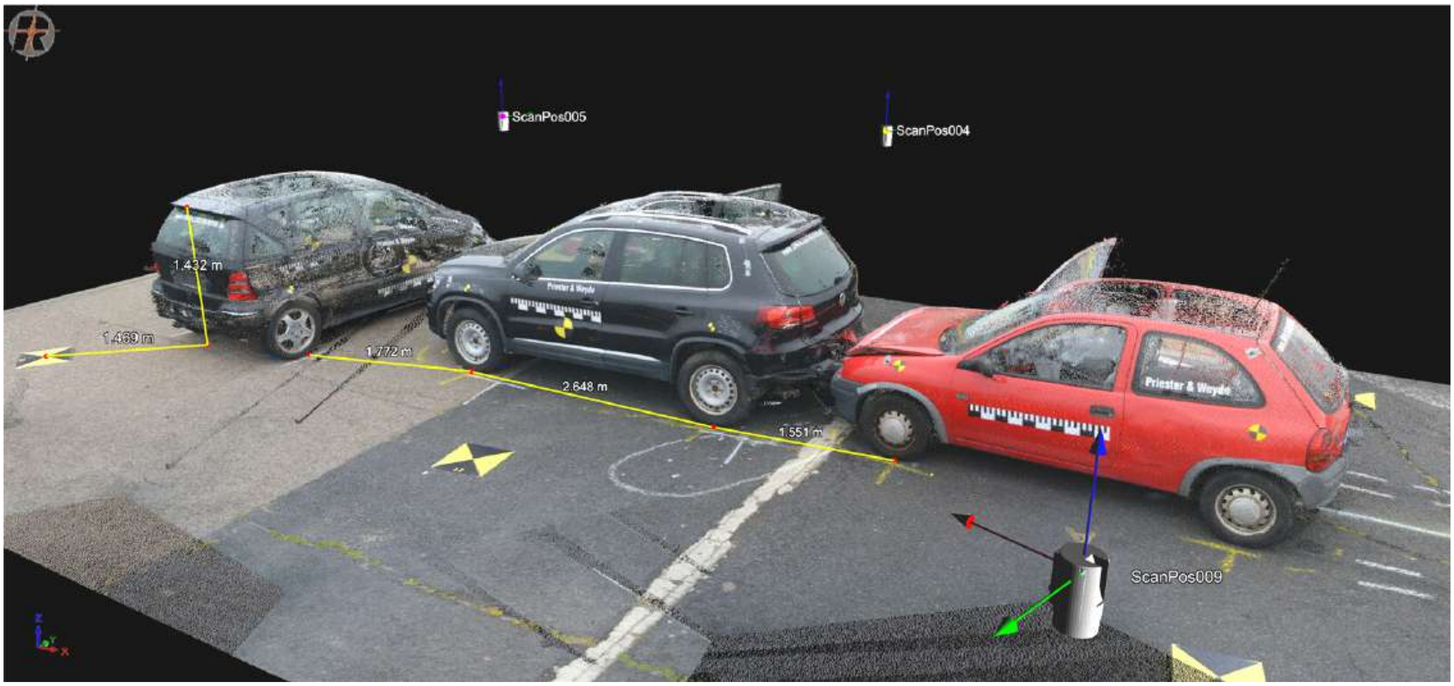

Figure 7: Post collision. Shown in colorized point cloud view with sample measurements.

The test provided for here mirrored, as far as is possible, real world environments to examine the capabilities of the *RIEGL* VZ-400i. The series of tests throughout are repeatable. *RIEGL* is very pleased with the performance of the VZ-400i and RiSOLVE software in meeting and indeed exceeding the requirements set by the SpecCap testing team to determine the "fit for purpose" nature of the scanner and methodology when being deployed.

We have demonstrated under challenging conditions, the ability to perform accurate scans which are registered automatically without targets in all 3 typical scenarios. It is important to observe that the scans were also registered on-board the scanner in real time, and that colour imagery to colourise the point clouds in the software, is obtained synchronous to the scanning operation.

Thus, the *RIEGL* VZ-400i provides an extremely efficient and reliable data capture process for crime and collision investigation. In achieving this, each scan is taking no more than 61s at the 6mm@10m resolution (panorama_34, 34mdegs) so providing for very rapid objective data capture. Fast scanning of this nature is a boost to road re-opening times, providing LiDAR data for professionals in subsequent investigations and reconstructions.

"*RIEGL* has been delighted to work with the NPCC SpecCap team through the series of examinations to date.", says Dave Foster, *RIEGL* Forensic Consultant, and continues, "We are proud to support the work of Forensic teams across the Public Safety arena, proving high quality data for investigators to conduct their analyses, reconstructions and conclusions."

Web: www.riegl.com

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For further information on how *RIEGL* laser scanning systems are deployed with Public Safety teams across the world and how they can be applied to your situation email: *info@riegl.co.uk*

Refernce

[1] Survey control to targets with Leica TS15i, both faces.

[2] RiSOLVE is a processing and registration only version of RiSCAN_Pro.

Author Bio

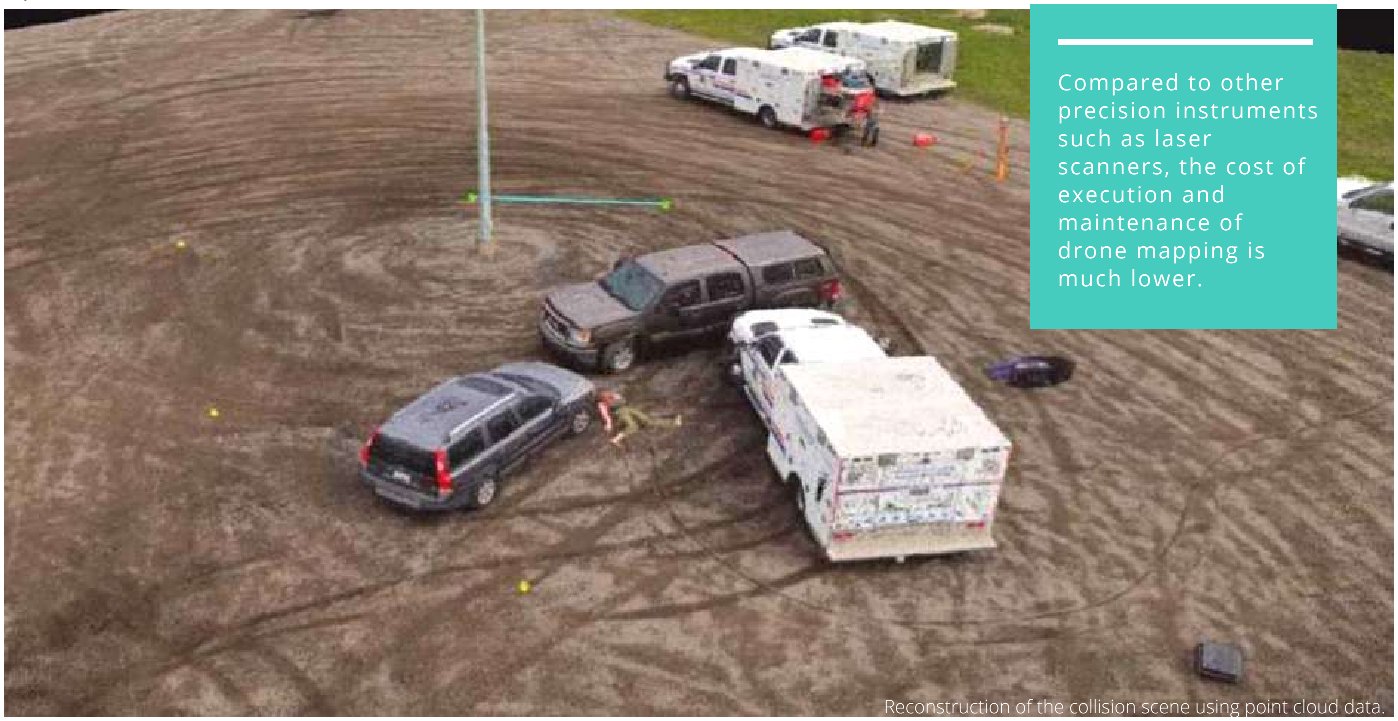
David Foster BSc MCSFS

After over 30 years with UK police, David retired to take up a position as a consultant. He had practiced in the field of Collision Investigation and Reconstruction for over 16 years, leading a small team of dedicated investigators. He was an early adopter of LiDAR to complete objective scene data capture. Having gained many years of user experience, Dave now leads for *RIEGL* for Public Safety and Forensic Investigations, working with *RIEGL* with their development of hardware, software and workflows to share; As a result, Dave and *RIEGL* have worked with a wide variety of clients to achieve the best solutions for their needs with a number of ongoing projects to develop client solutions and enhance *RIEGL*'s position as Innovators in 3D, providing LiDAR for Professionals.

DRONE PHOTOGRAMMETRY TO DOCUMENT VITAL EVIDENCE OF FORENSIC INVESTING

Using drones and Pix4Dmapper to reconstruct accident and crime scenes provides an immediate response, saves time and expense and offers highly accurate outputs.

by Pix4D



Reconstruction of the collision scene using point cloud data.

> Compared to other precision instruments such as laser scanners, the cost of execution and maintenance of drone mapping is much lower.

Over the last few decades, forensic investigators as embrace the geospatial technologies in decoding the crucial puzzles in forensic investigations. The latest developments in Geospatial technologies have given the capability to recreate the entire after collision or crime scene as-is in 3D. The 3D modelling helps in the visualization – what exactly happened, analysing – how it could happen, to collect vital evidence for forensic investigation, documentation and to ensure justice.

Geospalial technologies have unique capabilities which are ideally suited to collecting and analyzing spatial data. Traditional methods of investigation, such as pin maps, are largely unable to cope with volumes of multifaceted spatial information in any meaningful manner capable of assisting in identifying an offender or excluding possibilities. One of the most basic but crucial inputs in a forensic investigation the location and spatial correlation among various objects at the crime site. The use of geospatial technologies helps to support forensic investigations by storing data in correlations with spatial information and reproduce the entire scene to establish facts at any time. As a result, the concepts of

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location, place, and scale are intrinsically embedded within forensic investigations, analyses, and through the presentation of evidence, as are spatio-temporal relationships.[1]

It's been decades that photogrammetry has been used for generating 2D and 3D mapping outputs. Along with the surge of drone usage, acquiring geospatial data has become faster and easier, with drastically increased resolution.

Law enforcement agencies and forensic investigators can easily create a detailed 3D model of the crime scene with a drone, a mobile application - Pix4Dcapture, and an image processing software - Pix4Dmapper. Pix4Dcapture allows to choose the flight plans according to mapping targets, and it automatically controls the drone and triggers the camera on-board referring to the requirement on overlaps, ground sampling distance, and many more.

Once the flight is completed, use the Pix4Dmapper desktop software to reconstruct the mapping outputs locally and experience more functionalities with a full 3D view in Pix4Dmapper Pro's raycloud – a unique, interactive interface displaying 2D image - 3D reconstruction correlations.[2]

Collision and Crime Scene Investigation with Drones

The Royal Canadian Mounted Police has started using Unmanned Aerial Vehicles to help them with their work on collision and crime scene investigations. It allows the investigations to be conducted under all weather conditions and provides broader views than the traditional procedures.

In an experimental project[3] which was organized by the Royal Canadian Mounted Police (RCMP) and Pix4D, using UAV models from Draganfly and Aeryon Labs. Two data sets of a made-up crime scene were acquired with quadcopters images of a staged car accident scene from low altitude. The ground sampling distance was less than 1 cm in order not to miss any details. A total of 225 images from Aeryon Labs and 212 images from Draganfly were obtained during the flights.

The full flight took less than thirty minutes including the pre-flight preparation. Eight yellow evidence markers were placed around the collision scene, indicating the location where all evidence was found.

A few on-site measurements were made by the police. GPS measurements of the object corners and the evidence markers were used as ground control points, and tape measurements between the markers were recorded for further assessment of the results.

The images were processed by Pix4Dmapper to reconstruct the 3D scene. Pix4Dmapper's total processing time was approximately two hours on a laptop with a core i7 and 8GB RAM. A densified point cloud, digital surface model (DSM) and orthomosaic were generated. Annotation and measurements were directly made in the software user interface.

The reconstructed results either exactly match or are within one centimeter accuracy when compared with traditional methods (tape measurements and laser scanner).

No-Light or Night-Time Crime Scene Documentation Using Drone

With drone technology and Pix4Dmapper photogrammetry software, a scene can be investigated and documented in as little as 20 minutes in the right conditions – but challenging conditions can slow things down, potentially allowing vital information to be lost.

Lighting is one of the biggest challenges facing public safety personnel. Low or no light can mean blurry or too-dark images which may require color correcting or even lose vital data. Adding light with flashlights or standard floodlights can cast harsh shadows.

To set the scene,[4] teams from FoxFury, Pix4D, Sundance Media Group (SMG), and the Nevada Drone Center of Excellence used actors, fake blood and bullet casings to create a realistic incident. The location did not have any lighting (or for that matter, any electricity to power floodlights). A lighting system from FoxFury Nomad Hi CRI was used to create a no/low-shadow environment with accurate colors. This system can be mounted to many different drones, including the DJI Phantom, Inspire 1, Inspire 2, Matrice 200 series, and produce daylight-like light even on the darkest nights.

Ground Control Points were laid into place on the perimeter of the scene,

Figure 1: Dummy was used to create the demo crime scene.

taking care to ensure no one stepped into the scene. These are used as tie-points during the 2D and 3D assembly of the data, using Pix4Dmapper. The GCP's for night capture are painted with Day-Glo paint colors for bright visibility and identification in the darkness of night.[5]

> "The images were then taken into the Sundance Media Group AVOC computers, where we assembled them as a low-resolution 2D file to verify all areas of the scene were adequately captured," said Sam Pepple, of Pix4D. "Once verification and confirmation are complete, the scene may be released to the rest of the CSI team for standard investigation. Following the low-resolution verification, a high-resolution image was processed and evaluated by the team."

Once the scene is captured, the rectified scene may be viewed internally or via secured online site by CSA, or Crime Scene Analysts, allowing measurements to be verified, retaken, or examined from a multitude of angles.

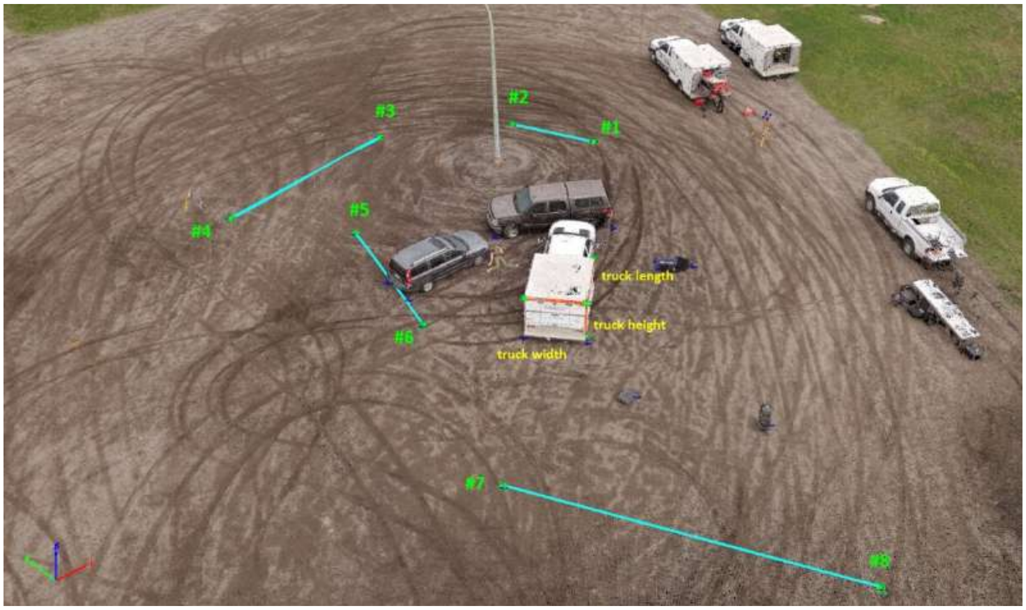

Figure 2: Reconstruction of the collision scene.

Figure 3: Processing images with Pix4D drone mapping software.

Figure 4: With specially-designed lights, drones can be used at night to capture images.

Case Closed

Using drones and Pix4Dmapper to reconstruct an accident and crime scenes provide an immediate response, saves time and expense and offers highly accurate outputs.

Generated results are available permanently and actual scenes are preserved in 3D and with detailed information within centimeter accuracy. Users can access files and make measurements anytime when required.

Another advantage of drones and drone mapping allows investigations to be conducted under all weather conditions and provides broader views than traditional procedures. Compared to other precision instruments such as laser scanners, the cost of execution and maintenance of drone mapping is much lower.

- Applies to all conditions.
- Efficient and time saving, immediate response.
- Permanent preservation of data and reconstructed scene.
- High accuracy for measurements Views from all angles, no missing details.
- Easy to operate and maintain, less training needed.
- Both outdoor and indoor reconstruction, seamless merging.

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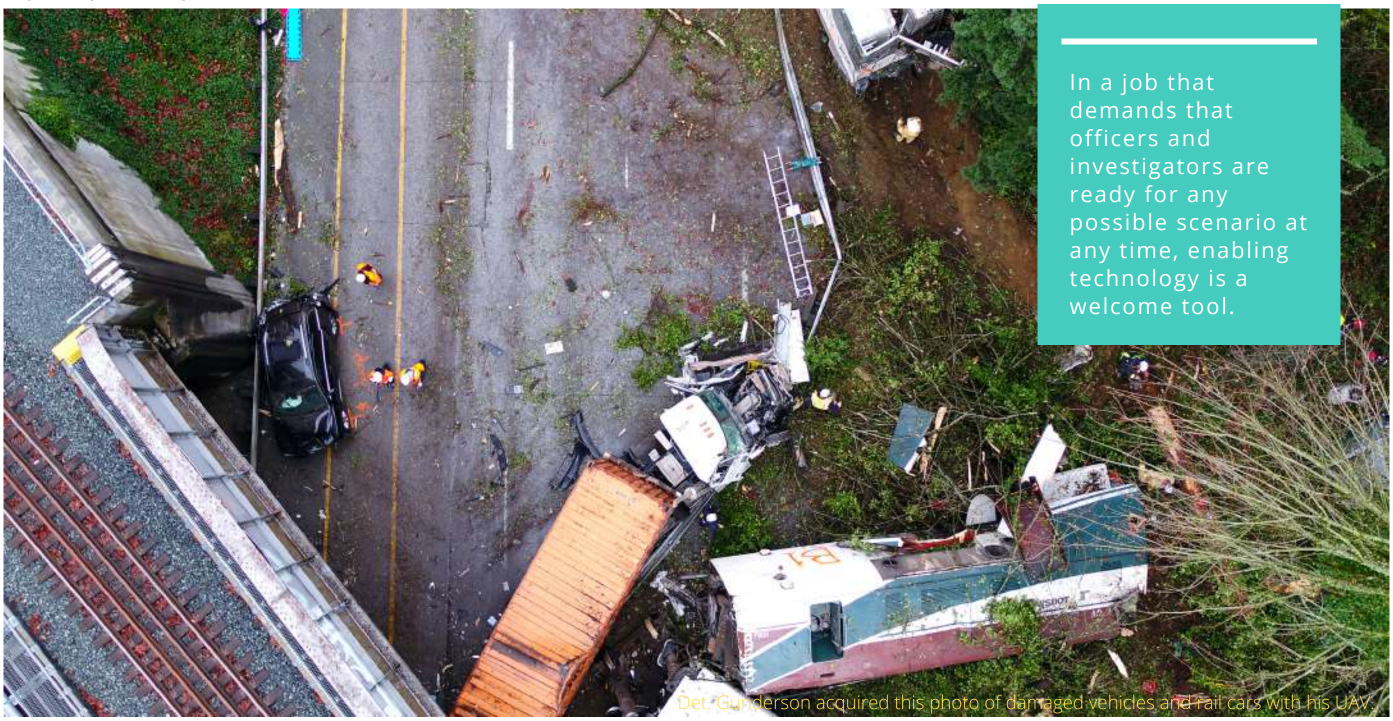
FROM ALL SIDES - INTEGRATING LASER SCANNING AND UAV DATA GIVES INVESTIGATORS A NEW 3D VIEW

Laser scanning and UAV have their strengths and benefits in the field. But the ability to seamlessly combine the two different data sources into one point cloud gives a complete 3D view from all sides of a crime scene.

by Mary Jo Wagner



In a job that demands that officers and investigators are ready for any possible scenario at any time, enabling technology is a welcome tool.

Det. Gunderson acquired this photo of damaged vehicles and rail cars with his UAV.

No one would dispute that courage is at the core of any police officer. It takes a certain braveness to dress for a job in which every day is a mystery people could go missing, be hurt, be fatally wounded and one's own life could be at risk of injury or worse.

For detective Eric Gunderson of the Washington State Patrol (WSP), that fearlessness extends to his department's adoption and use of technology, where they regularly move beyond spec sheets to discover new and innovative ways to make technology work for them. For example, they once hung a Trimble TX5 laser scanner upside down through a sunroof to scan the inside of a car.

This level of comfort with advanced technological tools has come from years of asking "What if," and a willingness from the chief down to embrace technology that can benefit both the WSP and the people it serves.

Laser scanners are now as common as radios for each of the WSP's 15 detective units across the state the scanners have been in the field for

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the past four years. And in 2017, they began adding Unmanned Aerial Vehicles (UAV) to their arsenal of technology.

“Whenever we acquire new equipment, my captain always says, ‘This technology is another tool in your toolbox," says Gunderson, the WSP's technology liason based in Tacoma. “So, if you need a Phillips [screwdriver], you've got one. If you need a flat head, you've got one. No one tool will solve all your needs. It’s important to get comfortable with many different tools both in the field and back in the office.”

Indeed, Gunderson’s penchant for experimentation has been key to becoming at ease with technology. Case in point: soon after acquiring their first UAV, Gunderson used Trimble RealWorks Forensics software to test the possibility of merging scan and UAV data of the same scene into one, integrated point cloud. It was not only a success, the integrated forensics view has become a formidable tool for accident reconstruction cases, which make up 65 percent of their responses.

“Individually, both laser scanning and UAV have their strengths and benefits in the field,” says Gunderson. “But the ability to seamlessly combine the two different data sources into one point cloud gives us a complete 3D view from all sides of a crime scene. That is an additional and powerful forensics tool. The technological versatility we have makes us confident that we’ll be able to respond to any incident and investigate it thoroughly.”

And it’s a good thing, too. Because it was that same level of comfort with technology that gave WSP responders the confidence to answer the call to the 2017 DuPont train derailment outside Tacoma, Wash an accident so unpredictable and so massive that no training drill could have adequately prepared them. It not only put the WSP to the test, it provided the opportunity for Gunderson to push the limits of the integrated scanning/UAV point cloud approach and display it on a national scale.

Responding from All Sides

On the crisp early morning of December 18, 2017, an Amtrak passenger train was making its inaugural run between Tacoma and Portland, Oregon. As it neared a curve leading to an Interstate-5 overpass near DuPont, the train was traveling at 78 mph–50 mph over the speed limit and the lead locomotive, along with 11 of its 14 rail cars, derailed. It was 7:33 a.m. and I-5 was already teeming with commuters. The lead locomotive and three rail cars landed on I-5, causing a 14-vehicle pile-up. Three of the 77 passengers onboard the train were killed, and 62 passengers and 6 crew members were injured. The initial damage was estimated to be $40 million.

“Where this happened couldn’t have been a worse spot as far as impact to the region,” says Gunderson. “I-5 is the major artery between Tacoma, Olympia, Portland and Seattle. With Puget Sound to the west, the Nisqually River to the south and a military base to the east, your only driving option is I-5.”

WSP troopers were on scene within five minutes of the crash. By 8:30 a.m. the scene was swarming with hundreds of troopers, detectives, firefighters and paramedics, all of whom had one thing on their mind: rescue.

“For that kind of incident, the last thing you’re thinking of is preserving evidence,” says Gunderson. "If I need to move a train or car to get someone out, that’s what’s going to happen."

Figure 1: The as-found scene of the Dupont train incident where 11 of 14 rail cars of an Amtrak derailed, killing three people and injuring 62 passengers and 6 crew members.

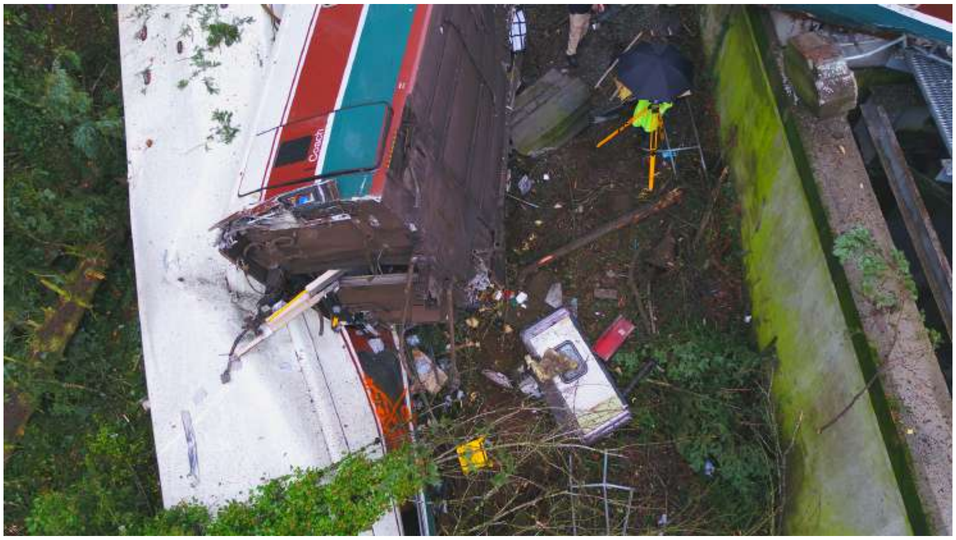

Figure 2: A TX5 stands protected by the elements as it scans the mangled rail car in front of it.

So our first hour was consumed by all lifesaving first. But once we cleared the scene, everything began to slow down and we could start investigating. Then we owned the scene.

Working in collaboration with the National Transportation Safety Board (NTSB), the lead investigating organization, Gunderson led the accident reconstruction phase, bringing in four Trimble TX5 scanners and one DJI Matrice 200 UAV. Although he had been successfully using Trimble RealWorks Forensics to merge scan and UAV data into point clouds, he had never applied the approach to an incident of this magnitude.

Teams of WSP collision investigation detectives first walked through the debris-riddled scene, taking photographs, painting the footprints of important objects such as cars and tire marks, and documenting them. In parallel, he dispatched two teams per each of the four TX5 scanners and split them into two groups, one to work on the overpass section and one to manage the roadway section.

Setting up on each end of the tracks, the railway teams methodically moved towards each other, scanning all four sides of the individual rail cars and any strewn debris, and recording each object as it was found. The ground crew followed the same process. Starting at each end of the I-5 scene, the teams collected data points of the rail cars, vehicles, roadway, tire marks, paint marks, and anything that laid within the boundaries of the accident. In total, the four teams collected 82 scans and more than one billion data points in five hours.

"What's awesome about scanning is that it ensures you don't miss anything," says Gunderson. "At the accident scene, you only get one shot to get what you need. You can't put the trains back where they used to be, so you need to be right the first time. Scanning captures everything incredibly quickly and often captures something you didn't know you'd need."

Figure 3: While the teams were scanning the tracks and roadway, Gunderson flew the scene with the UAV and collected 682 photos with the unit's 20MP camera.

Figure 4: Wreckage from the Dupont train derailment captured by a Trimble TX5 laser scanner. In total, four teams collected 82 scans and more than one billion data points in five hours.

While the teams were scanning the tracks and roadway, Gunderson flew the 920-ft-long by 340-ft-wide scene with the UAV. After a 10-minute set-up, he flew an overall pass at 200 ft at roughly 70 percent front lap and 50 percent side lap to establish a base. He flew a second pass at 100 ft and a final flight at altitudes between 15 ft and 50 ft to acquire some oblique photos. In 89 minutes, Gunderson collected 682 photos with the unit's 20MP camera.

"I could've handled the accident with just one technology, but given its scale, I wanted to have data redundancy," says Gunderson. "The drone would provide different view angles since the scanner can't get the top of the train. In addition, with the volumes of data I'd collect, it would be a great opportunity to test how well I could merge the two massive datasets together."

By 2:00 that afternoon, Gunderson was able to pack up the gear and head back to the office to process the data.

For efficiency, Gunderson loaded

the UAV photos into their photogrammetry software for batch processing overnight, so when he returned to the office the next morning, the data would be ready.

Creating a Complete 3D picture

Preparing the 3D point cloud began by importing the 82 scans into the RealWorks software, which allows investigators to quickly register, segment and classify 3D laser scan data for analysis and reconstruction. As there was data from four different scanners, Gunderson had to first group and register, or stitch together, all scans from each scanner to produce four scan-data groups. Then he merged each of the four groups to create one overall point cloud.

Since teams were collecting data during the active accident investigation, the scanners also captured the hundreds of responders working the scene, which resulted in superfluous or "parasite" points. RealWorks provides automated clean-up tools to help clear unneeded points. With the automatic classification feature, he moved irrelevant objects into designated layers and removed the parasite measurements from the finished point cloud.

"RealWorks' ground extraction tool is excellent," says Gunderson. "I can separate the ground from another layer, and then cut out the parasite points like the police cars, fire trucks, and people walking around so I can produce the clearest model possible. Being able to almost freeze the scene gives us more confidence when investigating after the fact."

With the laser scan point cloud complete, Gunderson focused on importing the processed UAV point cloud into the RealWorks point cloud. Once imported, he used the automated extraction tool to clean up and remove any superfluous points and then combined the dataset with the master point cloud to produce the final 3D model of the train derailment

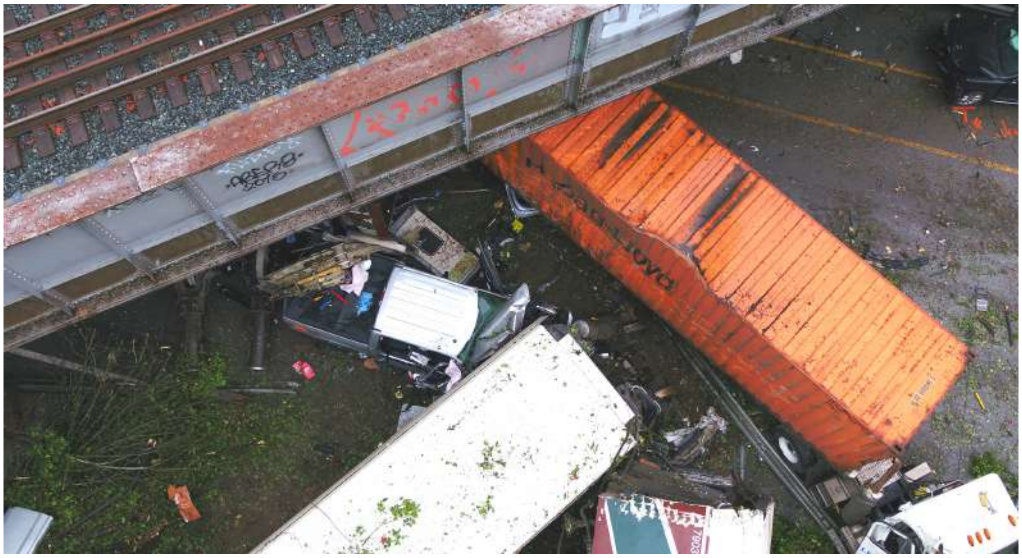

Figure 5: WSP troopers were on scene within five minutes of the crash. Search and rescue consumed the hundreds of troopers, detectives, firefighters and paramedics for the first two hours.

The two came together perfectly, he says, "Integrating UAV data into RealWorks is nearly seamless because the software views the data as a LAS (laser scan) file," says Gunderson. "Pairing the tops of the train cars from the UAV data with the scanning data of the cars gives us a complete view of the incident scene, and one we wouldn't have if we had just used one technology. You can spin the model, rotate it, move along any axis, measure anything and zoom in. It's just like being there."

In total, it took Gunderson about nine hours to create the finished incident model. In less than 36 hours after the initial derailment, he was able to provide a 3D view of the entire accident scene and any object in it.

That afternoon he presented the NTSB with the 3D data and "walked" the officials through the point cloud, demonstrating its visual content and its capabilities.

"They were wowed by the model," says Gunderson. "I don't think they'd ever seen something like this before and as I moved through the scene, they could immediately see the benefits of the detail, accuracy and interaction the point cloud provides for their investigation. They can now revisit the scene from their desktops anytime they need to find evidence or verify details, and they may even find something new to aid the analysis."

The NTSB is expected to issue its final report on the accident in 2019.

Value for Money

The final point cloud result of the DuPont train derailment not only demonstrated the success of Gunderson's multi-pronged approach on a large scale, it helped cement these technologies as core data sources for the WSP.

"The benefits of the laser scanner and the UAV are unparalleled, both individually and together," says Gunderson. "I can't fly the UAV in a house, but I can definitely scan it. But if I have a mile-long accident scene, I can fly that in five minutes, and I can supplement with the scanner. I can capture great scanning data at each end of the scene and then connect the two in RealWorks. Having these choices allows us to tackle any scene."

Last summer, the department upgraded their scanners and acquired three Trimble TX6 laser scanners. The new units give them 500,000 points per second, better intensity detail, which makes objects stand out more clearly, faster scanning and the ability to scan in the rain–an important feature for the Pacific Northwest.

They also launched a UAV pilot program last July and outfitted 15 collision technology specialists across the state with smaller UAV units. The aim was to assess whether the technology could help them map straightforward accident scenes more efficiently and accurately. Soon after the pilot began, a team responded to a one-car pedestrian accident on I-5. Prior to the UAV, they would have worked the scene for a few hours with traditional baseline methods. Using the UAV, they cleared the scene in 18 minutes.

"Someone from the state DOT (Department of Transportation) once told me that any time the I-5 is shutdown, the cost to the region is about $350-$400 a minute," says Gunderson. "That adds up to a big number really quickly."

Based on the success of the pilot, the WSP is adding 75 more smaller UAVs to its force this summer and more than 50 WSP detectives have been issued the smaller UAVs–each criminal investigation division has a Matrice UAV.

It's clear the WSP's commitment to asking "What if" and investing in technological choices is not abating. In a job that demands that officers and investigators are ready for any possible scenario at any time, enabling technology is a welcome tool.

"Pushing the envelope with our technology is having a huge impact," says Gunderson. "It's almost unmeasurable to account for what we capture and the impact that data has on the people we serve. We could never have trained for an incident like the derailment. But when it happened, we didn't hesitate to respond because we knew we had the technology and tools we needed. You're going to have victims who want answers and investigators who have to give those answers. Our ability to provide information that will help people find the answers feels really good. And that's real value for money."

Figure 5: The aerial view of the train incident provides just a small sample of the strewn debris.

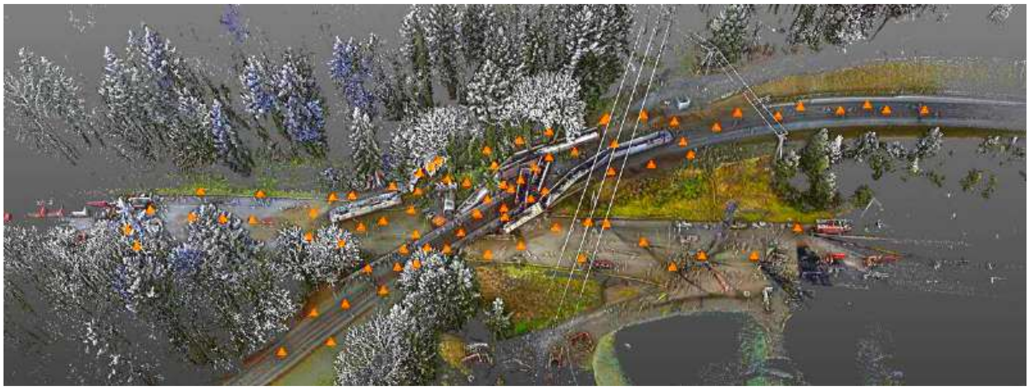

Figure 6: Gunderson integrated scanning data and UAV photos into Trimble's RealWorks software to create a 3D point cloud of the incident scene. In this view, orange markers indicate the location of each of the 82 set ups taken with the Trimble TX5.

Figure 7: Det. Gunderson operates the WSP's Matrice 200 UAV.

FLOOD MODELLING USING OPEN SOURCE SOFTWARE

A new methodology for flood modelling using open source software has been presented. The geographical information system software QGIS has been applied to a LiDAR image to produce a 3D file in stereolithography format.

by Dr Thomas J Scanlon

Roughness zones for different Manning-Strickler coefficients in test CASE 4.

> The availability of highly computational technologies means that effective open source flood modelling software is now accessible for the wider academic, industrial and citizen science communities.

The study presents a methodology for flood modelling using entirely free-to-download, open-source software. The procedure encompasses three stages of pre-processing, solving and post-processing. In the pre-processing stage the geographic information system software QGIS is used to process a LiDAR image into a stereolithography file. This file is then used to generate a digital elevation map using the open-source computational fluid dynamics code OpenFOAM. The shallow water equations are solved within the framework of OpenFOAM using a solver called shallowFoam and post-processed using Paraview. Results are presented for four test cases of increasing complexity and the outcomes show that the methodology produces very satisfactory agreement when compared with commercial flood models

Introduction

Given the now established link between extreme weather events and climate change (Blöschl 2019, Robins 2019) an increasing likelihood of severe flooding exists world-wide. A significant number of inundation events have occurred over the last 20 years in the UK with current flood

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damage costs estimated at around £1.3 billion each year (ECIU 2019). This is in addition to the human psychological damage where 1 in 6 properties in the UK are exposed to significant flooding risk (CCRA 2012). Although technical and economic barriers mean that the complete elimination of flood risk is impractical, comprehensive flood management plans must be employed to mitigate such adverse weather events. These strategies can be informed by appropriate flood modelling techniques and this is the focus of this paper.

Several commercial flood models are available (MIKE 2019, TUFLOW 2019, ISIS 2019, SOBEK 2019, INFOWORKS_ICM 2019) and in 2013 such codes were invited by the UK government Department of Environment, Food and Rural Affairs (DEFRA) to take part in a series of flood modelling exercises (DEFRA 2013). The goal of this project was to generate a series of benchmark cases for flood modelling and gauge the performance of each code with a view to establishing best practice when applied to flooding events. Among the codes tested in the DEFRA exercise was the open source code ANUGA (ANUGA 2019) developed by the Australian National University and Geoscience Australia. The code performed well in comparison with its commercial counterparts, however, it was only applied to a select number of benchmark cases. shallowFoam (Mintgen 2017) is the open source flood model solver used in this paper and represents an alternative code to ANUGA. The code has been released open source via the software repository GitHub (shallowFoam 2019). Developed within the framework of the open source computational fluid dynamics (CFD) solver OpenFOAM (OpenFOAM 2019), shallowFoam solves the shallow water equations (SWE) in a finite volume meshing environment. With an estimated user base of 10,000 (OpenORG 2019), OpenFOAM is a parallelised CFD code widely employed in the academic and industrial communities. shallowFoam has been successfully applied to the case of a dam break (Zeng et al 2017), however, this work necessitated the use of radial basis functions in the generation of the digital elevation map (DEM). In the paper that we present, use is made exclusively of free-to-download software in the generation of the DEM and does not rely on any external mathematical manipulation.

shallowFoam Solver

The shallowFoam solver solves the 2D (x, y), depth-averaged, shallow water equations (SWE) according to the coordinate system shown in Figure 1. Here, h is the flow depth (m), z_b is the bottom surface level (m) and z_w is the water level (m).

The SWE correspond to transport equations for the conservation of mass and momentum according to equation 1.

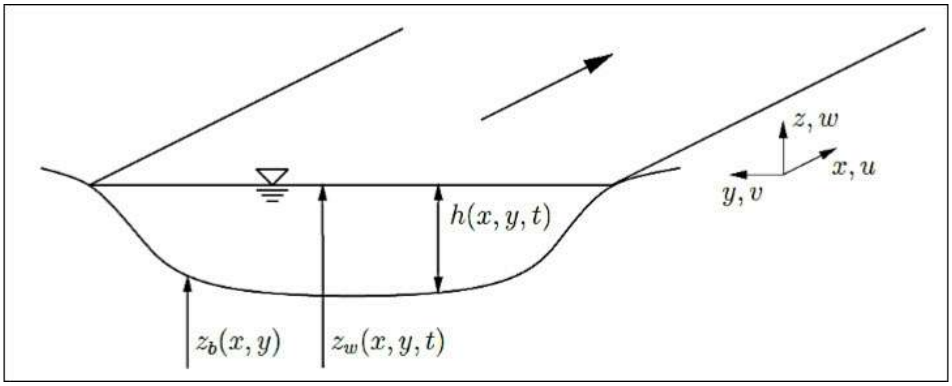

Figure 1: Coordinate system and variables for the shallow water equations (Mintgen 2017).

Equation 1

$$\frac{\partial h}{\partial t} + \frac{\partial q_i}{\partial x_i} = 0 \qquad (i = 1, 2), \qquad (1)$$

and,

$$\frac{\partial q_i}{\partial t} + \bar{u}_j \frac{\partial q_i}{\partial x_j} = -\frac{g}{2}\frac{\partial h^2}{\partial x_i} - gh\frac{\partial z_b}{\partial x_i} - \frac{\tau_{bi}}{\rho} + \frac{\partial}{\partial x_j}\left[v_t\left(\frac{\partial q_i}{\partial x_j} + \frac{\partial q_j}{\partial x_i}\right)\right] \quad (i = 1, 2), \qquad (2)$$

respectively. $q_i = h\bar{u}_i$ has been introduced as the specific discharge (m^2s^{-1}), g is the gravitational acceleration (ms^{-2}) and the bottom surface shear stress τ_{bi} is modelled using:

$$\frac{\tau_{bi}}{\rho} = \frac{n^2 g}{h^{\frac{1}{3}}}\bar{u}_i|\bar{\boldsymbol{u}}| \ , \qquad (3)$$

where $|\bar{\boldsymbol{u}}|$ is the velocity vector magnitude and n is Manning's roughness coefficient. Turbulence closure is via a depth-averaged parabolic eddy viscosity model where the turbulent viscosity v_t is set as:

$$v_t = \frac{\kappa}{6}u^* h \ , \qquad (4)$$

with the von-Kármán constant κ = 0.41 and the shear velocity u^* calculated by:

$$u^* = \sqrt{\frac{\tau_b}{\rho}} \qquad (5)$$

Methodology

This section will present the general methodology for setting up, running and post-processing a flood model case. The case presented here is CASE 2, one of the four test cases considered in this paper. All other cases follow the same methodology. CASE 2 is one of the DEFRA benchmark cases and considers a dam burst scenario into a valley of approximately 17 km in length. Figure 2 shows the LiDAR image of the valley and corresponding shape file outlined in light blue which outlines to the computational domain. The ground slope is shown as an altitude-distance graph along the valley centre-line in green and sampling points are shown as numbered crosses. Inlet flow conditions are supplied at the red line in the upper valley as hydrograph as shown in Figure 3.

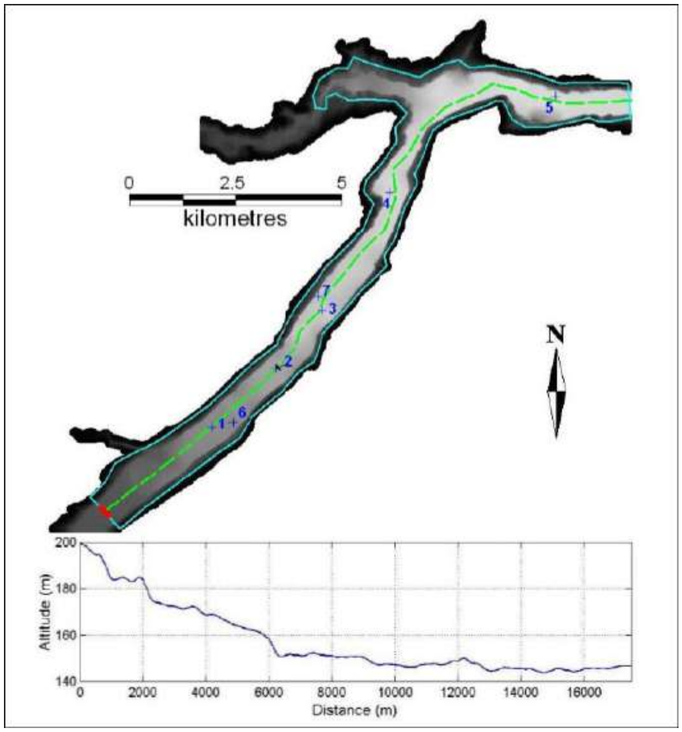

Figure 2: LiDAR image of the valley benchmark case and height-distance graph along centreline.

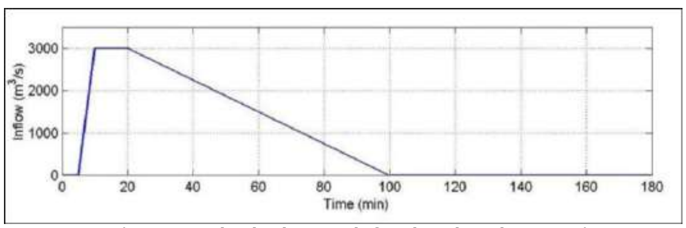

Figure 3: Inlet hydrograph for dam break scenario.

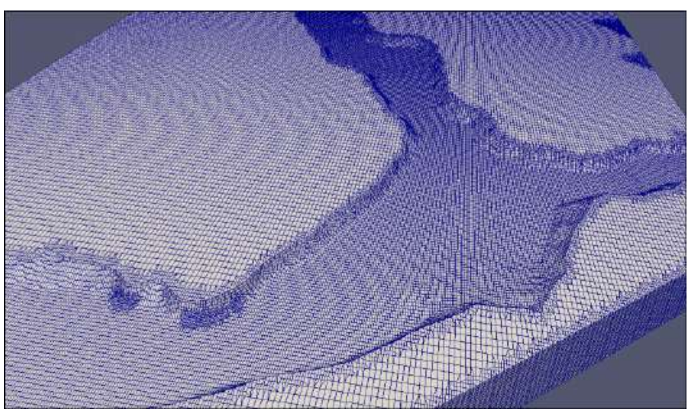

Figure 4: 3D snappyHexMesh showing the lower valley zone.

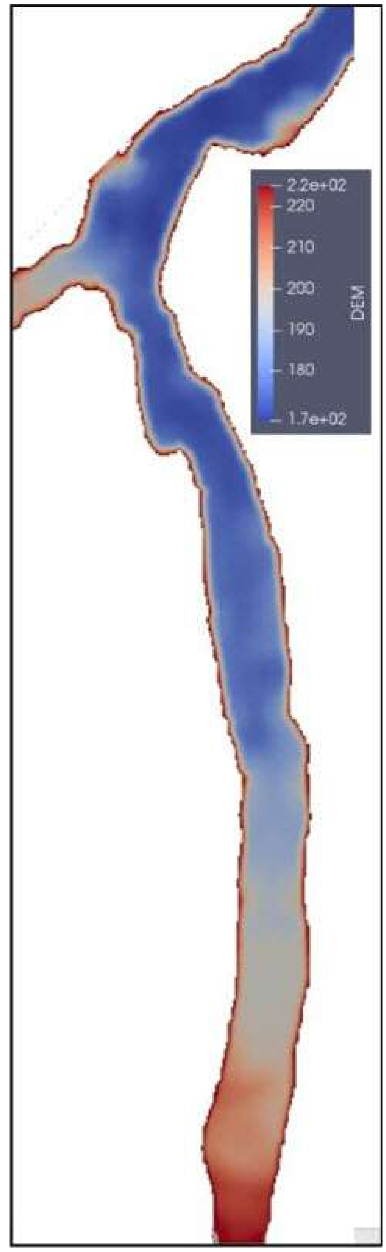

Figure 5: Valley DEM generated using OpenFOAM utility Test-WallDist.

The first step in the methodology is to create the digital elevation map (DEM). The open source geographical information system (GIS) software QGIS (QGIS 2019) is used to process the LiDAR .asc file supplied as part of the DEFRA benchmark case. A QGIS plug-in called DEMto3D is employed to generate a stereolithography (STL) file and this STL file is brought into OpenFOAM to generate a 3D computational mesh using the OpenFOAM meshing utility *snappyHexMesh*. The result of this meshing is shown in Figure 4. The height to the cell face centres from a bottom reference plane is then calculated with a new OpenFOAM utility called *Test-wallDist*. The resulting DEM is shown in Figure 5.

Following the generation of the DEM a new 2D mesh is created which covers the same computational area as the 3D one. The 2D mesh is generated using the combined OpenFOAM utilities *blockMesh*, which creates an orthogonal, structured mesh and *snappyHexMesh*, which creates an unstructured polyhedral mesh. The OpenFOAM utility *extrudeMesh* is then employed generate a 2D mesh with *"empty"* patch types at the top and bottom surfaces. Such *"empty"* patches are necessary to force the OpenFOAM solution to be two-dimensional in nature. It is also at this stage that additional STL files may be incorporated into the 2D model to provide, for example,zones of different surface roughness for rivers, woodland, grassland, buildings etc. – see CASE 4 for an example of this. Finally, the digital elevations are mapped from the 3D solution on to the 2D mesh using the OpenFOAM utility *mapFields*. The solver *shallowFoam* is then ready to be run, taking advantage of OpenFOAM's unlimited parallel processing capability. Post-processing is via the open source visualisation application Paraview which is supplied with OpenFOAM.

Results and Discussion

Case 1

Test CASE 1 consists of a sloping topography with two depressions separated by an obstruction as shown in Figure 6, and of width 100m. A time-varying inflow discharge is applied as an upstream boundary condition at the left-hand side, causing a flood wave to travel down the 1:200 slope. While the total inflow volume is just sufficient to fill the left-hand side depression at X = 150m, some of this volume is expected to over-top the obstruction because of momentum conservation. The objective of the test is to assess the code's ability to conserve momentum over an obstruction in the topography and settle in the depression on the right-hand side at X = 250m.

Figures 7-9 show that the *shallowFoam* results for water level and velocity are in satisfactory concurrence with the results produced by the commercial codes MIKE_FLOOD and TUFLOW and the open source code ANUGA. This gave confidence in the *shallowFoam* code and DEM methodology to proceed to the more challenging test CASE 2.

This *shallowFoam* case was run on a single Intel Core i7-7820HK CPU @2.90 GHz. A computational mesh of 1200 cells was used, a time-step size of 1 s employed and the computational time to complete the run was 10 s.

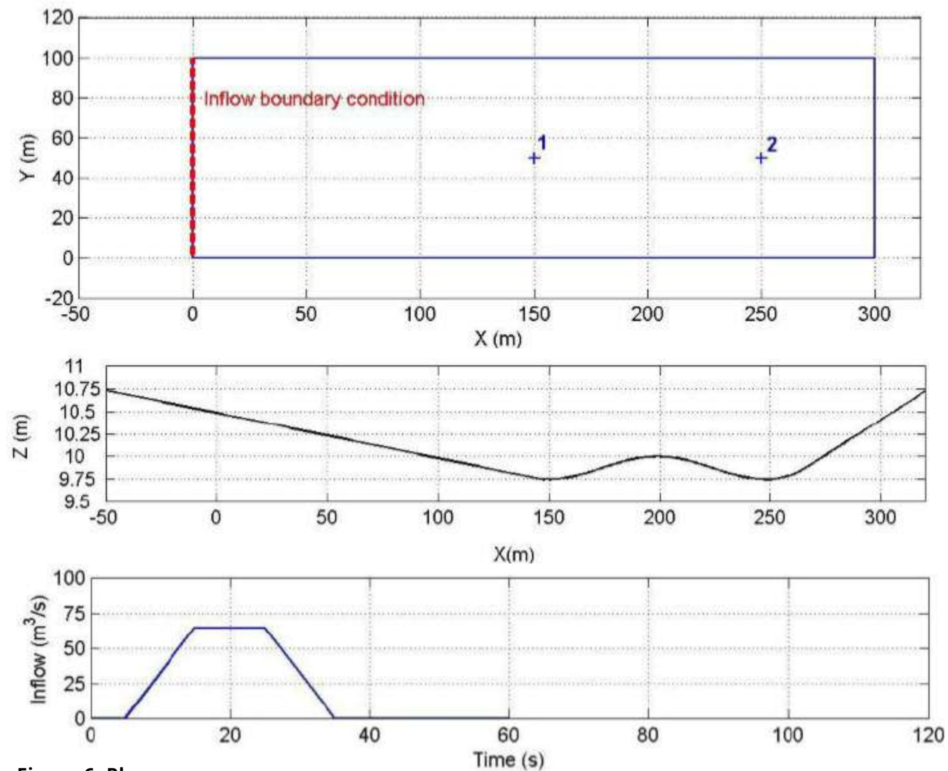

Figure 6: Plan view, elevation and inlet hydrograph for test CASE 1.

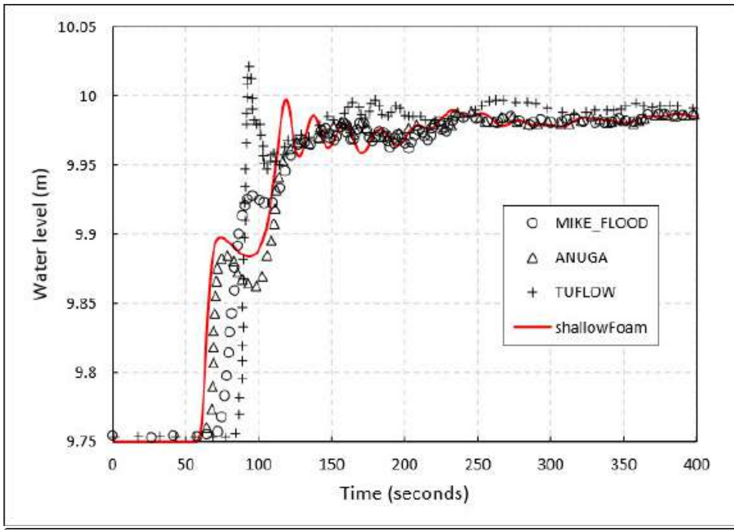

Figure 7: Water level versus time for point 1 in test CASE 1 (see Figure 6 for point locations).

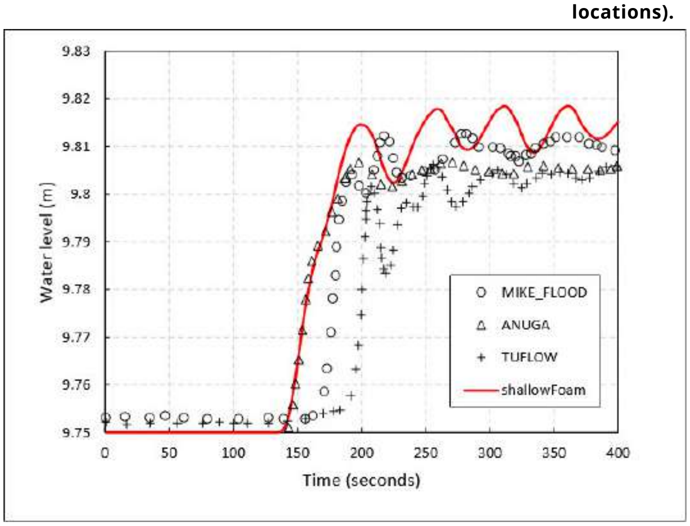

Figure 8: Water level versus time for point 2 in test CASE 1 (see Figure 6 for point locations).

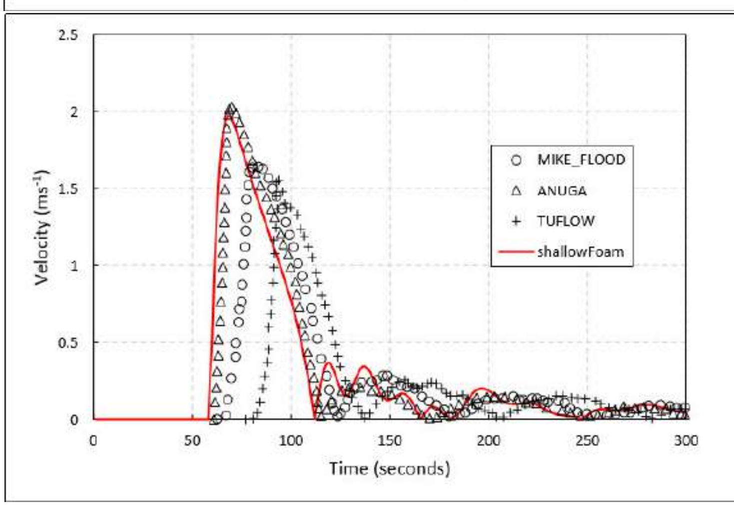

Figure 9: Water velocity versus time for point 1 in test CASE 1 (see Figure 6 for point locations).

Case 2

The geometry and boundary conditions for test CASE 2 valley dam break were outlined in the section on Methodology. Figures 10-11 for water level and velocity, respectively, show a very reasonable agreement between the shallowFoam model and the other flood codes. A total simulation time of 30 hours was modelled in this case and Figure 12 shown contours of wetted area after 2 hours.

This *shallowFoam* case was run in parallel using 3 Intel Core i7-7820HK CPUs @2.90 GHz. A computational mesh of 246,000 cells was used, a time-step of 1 s employed and the computational time to complete the run was 2.7 hours.

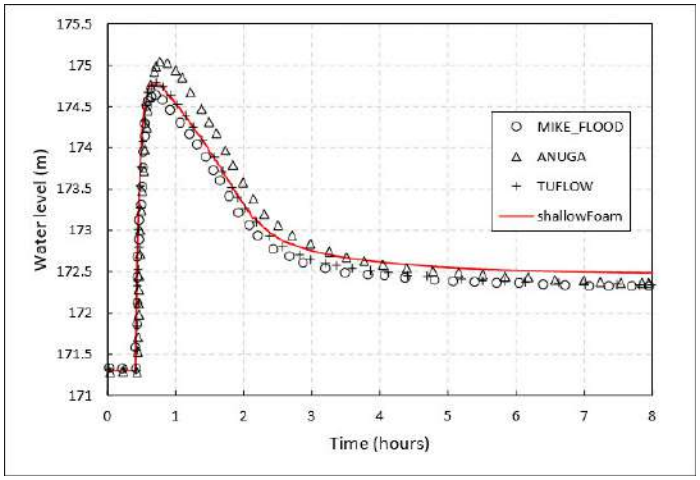

Figure 10: Water level versus time for point 1 in test CASE 2 (see Figure 2 for point locations).

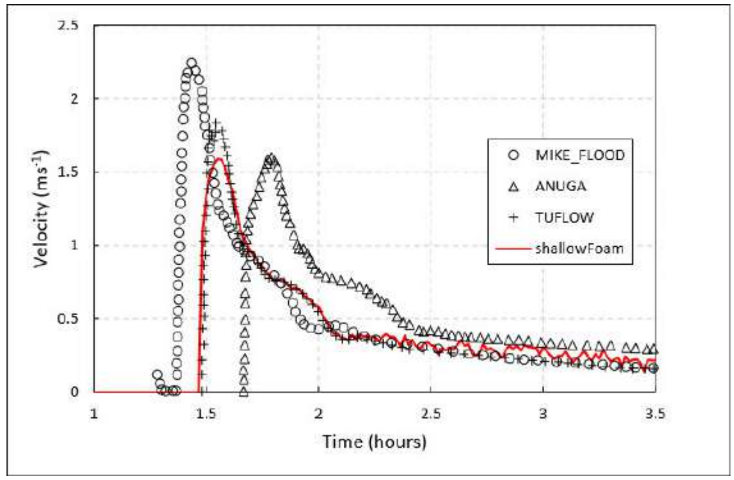

Figure 11: Water velocity versus time for point 4 in test CASE 2 (see Figure 2 for point locations).

Case 3

In this river and floodplain modelling test case the site to be modelled is approximately 7 km long by 0.75 to 1.75 km wide (see Figures 13-14), and consists of a set of three distinct floodplains FP1, FP2 and FP3 in the vicinity of the village of Upton-upon-Severn, England. In the test, the River Severn that flows through the site is modelled for a total distance of ~20km. Boundary conditions are a hypothetical inflow hydrograph (DEFRA 2013). The objective of the test is to assess the package's ability to simulate fluvial flooding in a relatively large river, with floodplain flooding taking place as the result of river bank overtopping.

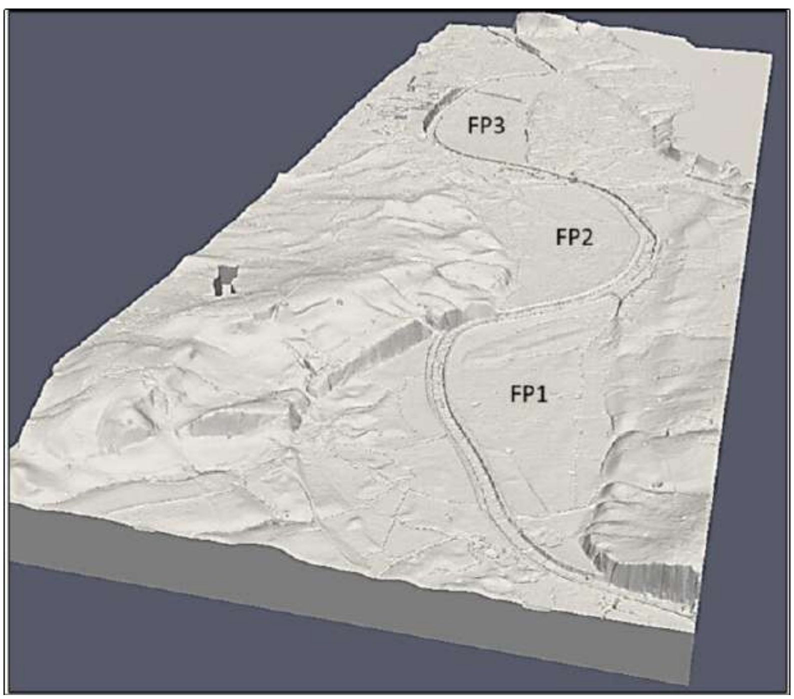

Figure 13: 3D STL file generated by the QGIS plugin DEMto3D showing floodplain regions FP1, FP2 and FP3.

It is evident that there is a relatively wide variation in the range of results for the codes tested in this complex benchmark case. The *shallowFoam* results, both qualitatively and quantitatively, appear to be in reasonable agreement across the spectrum of data presented with peak water levels and velocities corresponding well with the commercial codes as shown in Figures 15-17.

This shallowFoam case was run in parallel using 3 Intel Core i7-7820HK CPUs @2.90 GHz. A computational mesh of 244,000 cells was used, a time-step of 1 s employed cells and the computational time to complete the run was 5.05 hours.

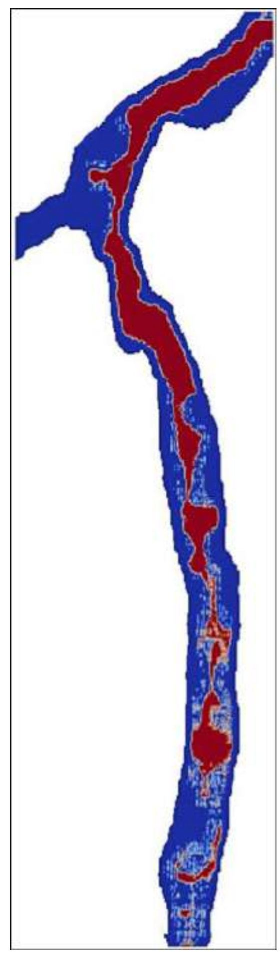

Figure 12: Contours of wetted area (red) for the shallowFoam simulation of test CASE 2 after a duration of 2 hours.

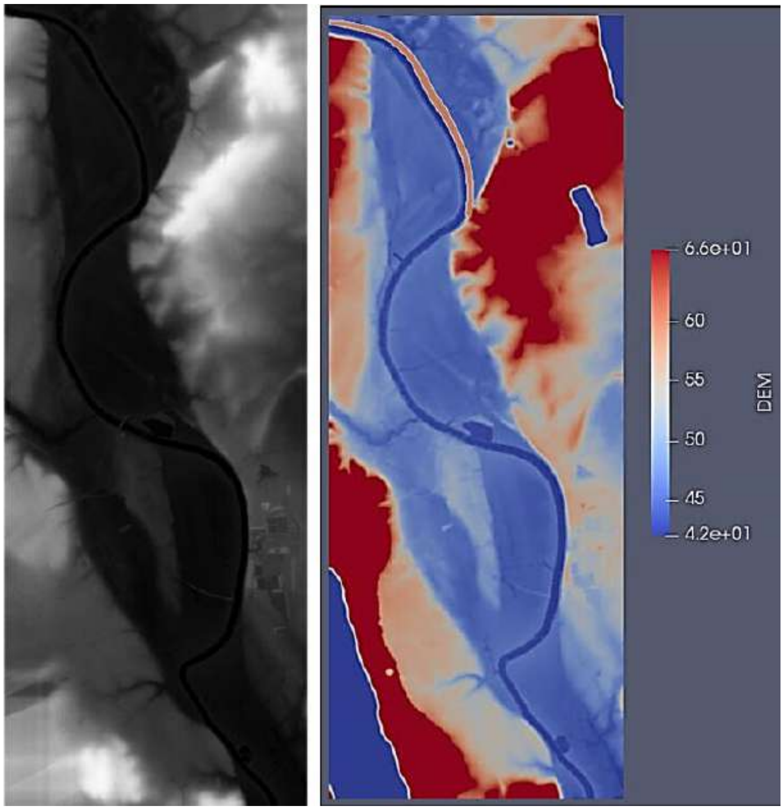

Figure 14: LiDAR image (left) and DEM generated using OpenFOAM utility Test-WallDist.

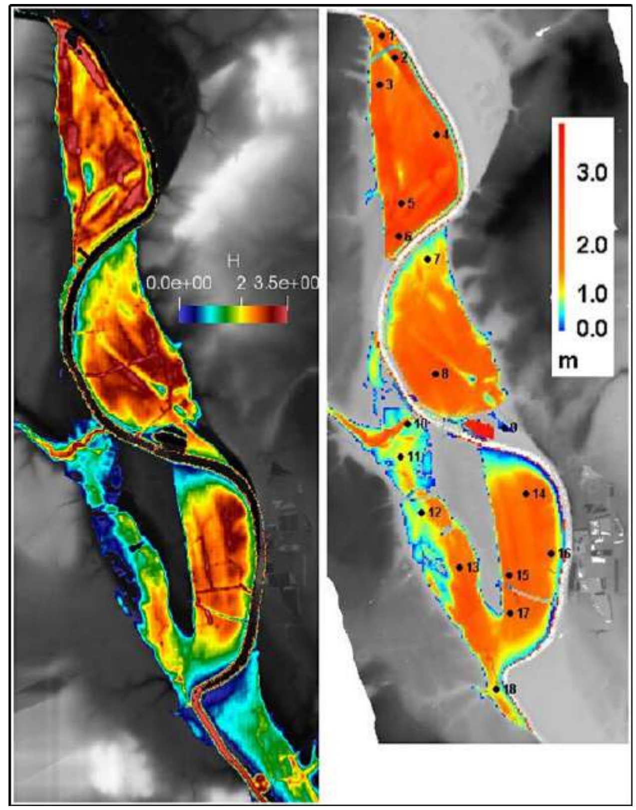

Figure 15 Peak water depths predicted by shallowFoam (left) and the commercial code ISIS-FAST (right). Sampling points P11 and P17 in floodplain FP3 are indicated on the right-hand.

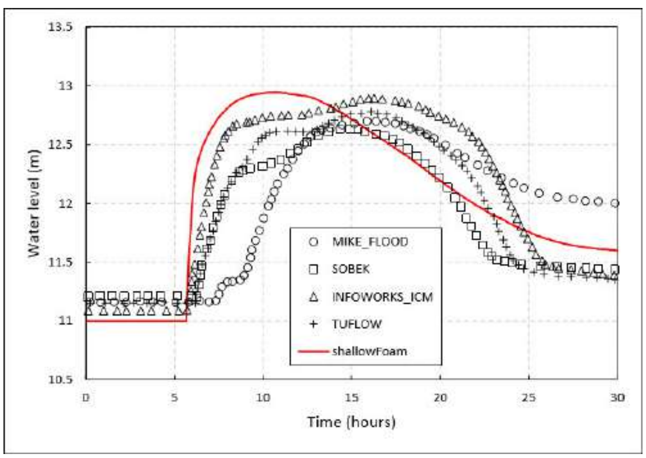

Figure 16: Water level versus time for point 11 in test CASE 3 (see Figure 15 for point locations).

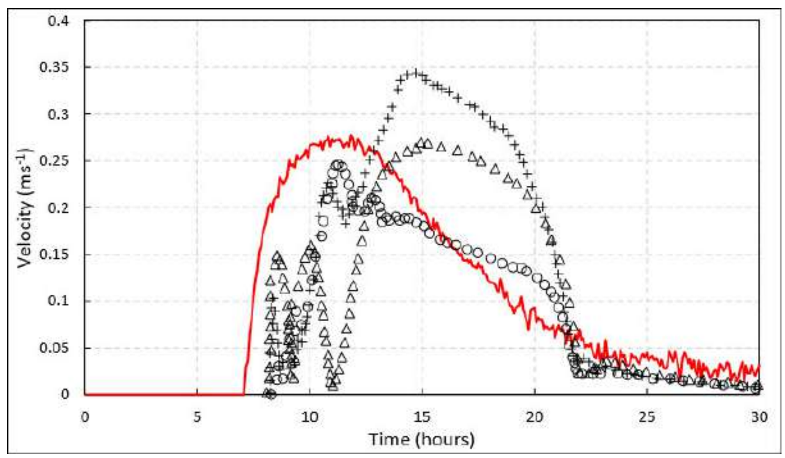

Figure 17: Water velocity versus time for point 17 in test CASE 3 (see Figure 15 for point locations).

Case 4

CASE 4 is a practical example of how the methodology presented in this paper may be used to mitigate a flooding issue. In January 2015 storm Frank caused severe flooding and damage in the town of Ballater, Scotland (FRANK 2019). The methodology has been applied to, firstly, model the flood as it occurred and suggest an possible flood defence solution. Storm Frank hydrograph inputs for the rivers Gairn/Dee and the river Muick were included as inlet boundary conditions in the model and the shallowFoam code was run for a simulation period of 24-hours.

Figure 18 shows the extent of the computational domain and the proposed flood defence solution in red. Sampling points around the flood barrier are indicated by points P8 to P16. These points are used to extract the water level in front of the flood defence to give the necessary barrier height to counteract flooding during such a storm.

As discussed in the section on Methodology, different roughness parameters in terms of Manning-Strickler coefficients may be introduced into the model and these roughness zones are shown in Figure 19.

Figure 20 shows the excessive inundation occurring at the time of the peak river flow rate, while Figure 21 shows the mitigation of this by using the flood barrier protection. The results from test CASE 4 show that the methodology described in the paper can be applied to a practical situation and propose solutions for flood mitigation in a complex topography.

This *shallowFoam* case was run in parallel using 3 Intel Core i7-7820HK CPUs @2.90 GHz. A computational mesh of 176,000 cells was used, a time-step of 1 s employed and the computational time to complete the run was 1.92 hours.

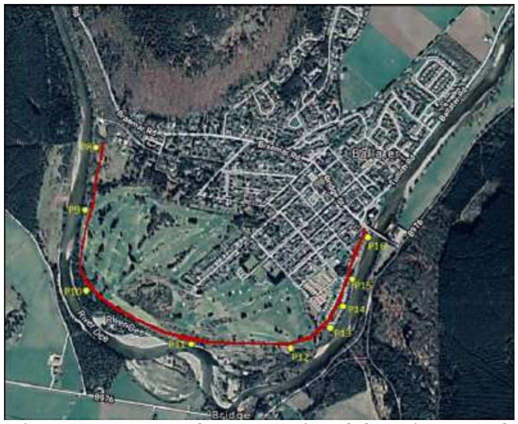

Figure 18: Extent of computational domain around the town of Ballater in test CASE 4. Proposed flood defence barrier (red) and probe sampling points are also highlighted.

Figure 19: Roughness zones for different Manning-Strickler coefficients in test CASE 4.

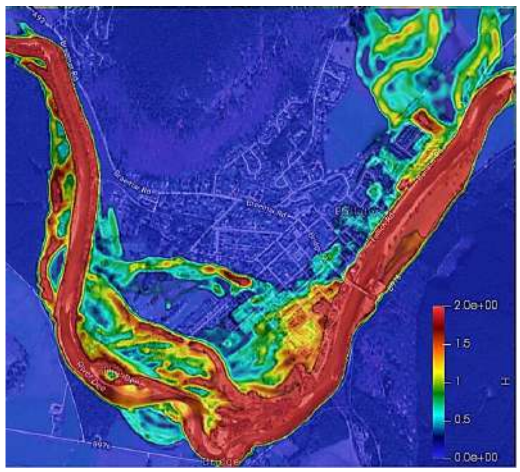

Figure 20: Contours of water height (m) at the time of maximum river flow rate (12 hours) with no flood defence.

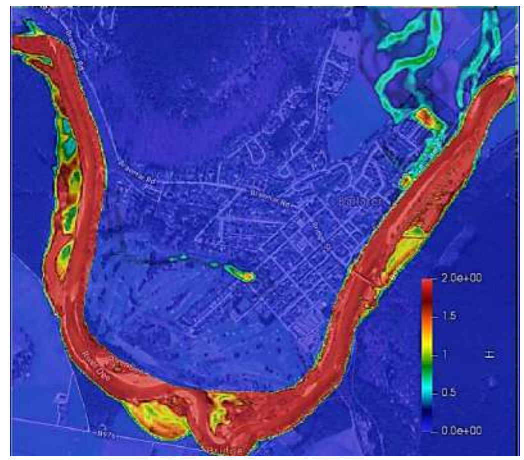

Figure 21: Contours of water height (m) at the time of maximum river flow rate (12 hours) with flood defence in place.

Conclusions

A new methodology for flood modelling using exclusively free-to-download, open source software has been presented. The geographical information system software QGIS has been applied to a LiDAR image to produce a 3D file in stereolithography format. This file was then converted to a digital elevation model in the computational fluid dynamics package OpenFOAM.

Finally, the shallow water equations were solved within the framework of OpenFOAM using the flood model *shallowFoam* to produce maps of water height and velocity. In comparison with benchmark results for a range of commercial codes, the *shallowFoam* solutions compared well and produced satisfactory results for key flooding parameters. The final test case showed how the methodology could be applied to a practical flooding problem with mitigation measures successfully implemented. Future work will include incorporation of 1D-2D links for features such as culverts and sluice gates and the implementation of a shock capturing scheme for supercritical flows. The availability of such computational technologies means that effective open source flood modelling software is now accessible for the wider academic, industrial and citizen science communities.

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BUSINESS

March 16, 2020 - June 15, 2020

Avineon Completes Acquisition of Two Springs Consulting

Anand Subramani President of Commercial Systems at Avineon®, has announced the acquisition of Two Springs Consulting LLC (Two Springs). As a provider of professional GIS services for more than a decade, Two Springs supports public utilities and local governments with a wealth of experience in all aspects of GIS implementation and enhancement.Two Springs, a well-established professional services organization located in Seneca, South Carolina, is known for serving multiple clients throughout the state with exceptional quality services. The addition of the Two Springs team complements Avineon's current professional services offering and fits with Avineon's culture to provide reliable, value-based solutions to all of its customers. Avineon offers geospatial products and services to Esri clients in numerous industries, including electric, gas, water, and telecommunication utilities, as well as local, state, and federal government agencies.

Centrik and Flock Sign Strategic Alliance to Deliver Data-Driven Reduced Risk Operations for The Drone Sector

Operational management system supplier Centrik and specialist drone and eVTOL insurance provider Flock have formed a strategic alliance to raise safety standards and reduce risk in commercial drone operations. The move means a commercial UAS operator who used Centrik to manage its operations can now automatically align insurance costs with their actual exposure to risk. Flock's connected insurance offering allows operators to purchase a single policy that scales with their business offering flexible liability limits for individual jobs. Every month UAV operators are billed based on number of flights undertaken and the level of risk they are exposed to. This data is securely analysed by Flock's risk intelligence engine with a direct integration into Centrik's platform.

Maptitude 2020 U.S. School Districts Data Available as KML, GeoJSON, Shapefile

The Maptitude 2020 U.S. School Districts Data is available and includes three nationwide map layers of elementary, secondary, and unified school districts. These districts are packed with information that is essential for analyzing school districts. Explore locations by income, population and income growth, daytime population, age, race, gender, ethnicity, buying power, occupation, employment status, housing characteristics, citizenship counts, and more. Also included are 2014-15 statistics on the number of teachers, number of students by race (American Indian, Asian, Hispanic, Black, White, Hawaiian, Multiple races), NCES Local Education Agency ID (LEAID), State Education Agency ID, and school district name, address, phone number, and lowest and highest grades.

USGIF Publishes 2020 State and Future of GEOINT

The United States Geospatial Intelligence Foundation (USGIF) has published its annual State and Future of GEOINT Report, a collection of articles intended for use by all GEOINT practitioners. This unclassified document contains a series of concise descriptions of problems, achievements, and emerging issues and technologies as a guide to better understand the global GEOINT mission — whether you work in the public, commercial, federal, civilian, defense, intelligence, or national security space. The report offers insights about the state and potential of our community and its tradecraft; through the lens of people, process, technology, and data. This year's report demonstrates the power of collaboration across academia, industry, and government to make informed statements about the possible.

USGIF Announces 2020 Achievement Award Winners

The USGIF Awards Program annually recognizes the exceptional work of the geospatial intelligence tradecraft's brightest minds and organizations pushing the community forward. Award winners are nominated by their colleagues and selected by the USGIF Awards Subcommittee. Click to learn more about award recipients.

Joint Scientific Article on LiDAR for Bathymetry of Very Shallow Waters, under the Leadership of RIEGL, wins ISPRS Best Paper of 2019!

In coopertaion with the Vienna University of technology and the University of Stuttgart, Roland Schwarz and Martin Pfennigbauer from *RIEGL* Research succeeded in issuing a new and innovative contribution to topographic underwater mapping with the SVB algorithm (surface, volume and bottom) presented in their article. A considerable advantage of their method is that it relies only on a single laser wavelength. The jurors were impressed with the detailed modeling of the return waveform, the clarity of the explanation, the convincing experimental results, and the potential for broader applicability of the method. The full scientific paper is available under the following link: https://doi.org/10.1016/j.isprsjprs.2019.02.002

PARSEC Business Accelerator Boosts EO Enterprises

Harnessing the power of Big EO Data requires efficient handling of the volume, velocity, variety, and veracity of multi-modal EO data, such as the Copernicus Sentinels. SMEs entering the EO market require expensive experts top-skilled in IT and remote sensing alike, which distracts precious resources from the core business. These barriers make it difficult for SMEs gaining ground in the market.This is where PARSEC comes to help. This European funded project will effectively support SMEs in addressing these challenges through both business development support, financial support, and a massively scalable EO datacube service. PARSEC's unique Big Data toolbox at its heart is powered by rasdaman, the European pioneer and world leading datacube analytics engine. With rasdaman's federation capabilities, several DIASs as well as a series of further, often specialized data centers get integrated into one common information space available to all PARSEC supported SMEs. Currently, PARSEC has available over 7 Petabyte of Sentinel datacubes on Mundi alone, and they grow by the day.

Leveraging Geospatial Technology to Effectively Map Spread of COVID-19 to Minimize Its Impact on Business

Transerve Technologies' through its offering 'Transerve Online Stack (TOS)' has come up with a solution to map COVID-19 density zones using geospatial technology. This advanced solution works on Predictive Analysis and uses layers of geospatial data to track, monitor, analyze and visually represent them into data stacks. These data stacks will help in route optimization in COVID positive zones that can further assist businesses in making statistically driven decisions. TOS is emerging to be a very effective tool for governments and corporates. TOS has been maintaining a Corona timeline and created interactive digital maps of all the districts in India, and colour coded them to map all the Covid19 related information.

Esri Donates Free Software to GEO BON Grant Recipients

Esri, the global leader in location intelligence, has announced that it will be making its software available to recipients of EBVs on the Cloud, a grant program from Microsoft and the Group on Earth Observations Biodiversity Observation Network (GEO BON).Grant recipients will receive complimentary access to Esri's ArcGIS platform. The program will support projects that strengthen efforts to monitor Earth's biodiversity and create data referred to as Essential Biodiversity Variables (EBVs) and relevant indicators of change derived from this data. Grantees will retain all intellectual property for the products developed over the course of the projects they complete.

Esri Provides Free COVID-19 Resources to Nonprofits

Esri, the global leader in location intelligence, announced it will provide a COVID-19 Response Package for free to all nonprofit organizations responding to the pandemic. This package includes data, templates, and solutions that are accessible through Esri's Disaster Response Program (DRP). By mapping data with capabilities such as spatial analysis, Esri's software allows organizations to track where COVID-19 cases are spreading, and through predictive modeling determine where additional capacity will be needed.

TDC Joins Trimble's GIS Business Partner Program to Empower Mobile GPS Workflows

Trimble has announced that TDC Group, Inc. has joined Trimble's GIS Business Partner Program. As part of the program, TDC has implemented the Trimble Precision SDK (Software Developer Kit) to integrate high-accuracy positioning capabilities in its Freeance mobile software applications running on tablets and smartphones using Trimble GNSS receivers. Freeance provides field crews with simple yet powerful and configurable location-based mobile apps to manage data collection and inspection activities across utility and public works organizations. By adding the Trimble® R1 and R2 receivers to the Freeance workflows, users are empowered with real-time access to high-quality, reliable data.

Trimble Introduces Tekla 2020 Structural BIM Software Solutions

Trimble has introduced latest versions of its Tekla software solutions for advanced Building Information Modeling (BIM), structural engineering and steel fabrication management—Tekla Structures 2020, Tekla Structural Designer 2020, Tekla Tedds 2020 and Tekla PowerFab 2020. Tekla software is at the heart of design and construction workflows building on the free flow of information, constructible models and improved collaboration. Tekla Structures supports the Constructible Process to transform the entire design, build and operate lifecycle.

Leica Geosystems Announces Latest Version of Public Safety Software

Leica Geosystems, a Hexagon company, has announced the latest version of Leica Map360 crash and crime scene diagramming and reconstruction software, bringing three editions to meet specific customer needs based on the technology used to measure and collect any scene. With 2D intuitive workflows, Map360 Sketch offers a program designed to create basic diagrams, floorplans, and reports from manual measurements, imported points, or UAV imagery.

Planon and Leica Geosystems Announce Global Partnership

Planon and Leica Geosystems, a Hexagon company, have announced a global partnership to integrate Planon's software for real estate, space, and asset management and Leica Geosystems' reality capture, cloud-based visualisation and collaboration solutions to accelerate digital transformation in the building industry. Building Information Modelling (BIM) is well-established to support the construction and operations of new buildings, but for existing buildings without such models, providing these has been a challenge for years. Planon and Leica Geosystems have released a solution to address this challenge by providing digital twins for existing buildings that can be created without significant investment and seamlessly integrated with any Planon software solution.

SimActive Introduces Cloud Sharing and Reflectance Calibration with New Version 8.5

SimActive Inc. announces the release of Correlator3D version 8.5. The new version allows users to share and visualize projects in the cloud. It also features new tools for the calibration and processing of multispectral imagery. This new version brings advantages to customers having data exploitation requirements such as online viewing, and to users processing imagery from highly sophisticated sensors.

Blue Marble Geographics Announces the Release of Geographic Calculator 2020

Blue Marble Geographics® has announced the release of the 2020 version of Geographic Calculator - the leading geodetic toolkit for accurate coordinate conversion and datum transformation. The 2020 version of Geographic Calculator comes with many new features and improvements, including a new Remote Desktop Protocol - enabled Single-User Floating license option for customers who need to access Geographic Calculator from another computer. Other important features are new magnetic declination models including World Magnetic Model 2020 and IGRF13 as well as support for converting lidar using local best-fit engineering coordinate systems.

GIS & EO

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RedTail LiDAR Systems Supports Wounded Veterans Through Stream Restoration

The adoption of drone-based 3D LiDAR mapping technology is an important advancement in the field of stream restoration and monitoring. Compared to traditional surveying and monitoring methods, the use of drone-based LiDAR allows for the rapid inspection and monitoring of miles of stream corridor in very short time periods, providing precise, accurate and consistent data.The high-resolution images (point clouds) produced by the LiDAR system can be used in all aspects of stream restoration projects.

India Geospatial Stack to Enable Scientific Mapping of Resources

With a vision to create a new paradigm for governance and development with special emphasis on reducing disparity, expediting growth and also bringing forth demographic dividends that are unique – India Geospatial Stack would enable the scientific mapping of resources, the disparities present and also meet the aspirations of beneficiaries, society – especially the disadvantaged. The building of India Geospatial Stack will be divided into two phases ideally-firstly there would be the need to design a land information system that would serve local conditions and land practices and then go on to design the core implementation phase which would involve data creation, spatial publishing and integration.

University of Maine at Machias to offer new Degree in Environmental Geographic Information Science

Beginning in fall 2020, the University of Maine at Machias will be the only public university in Maine to offer a four-year degree program in geographic information systems (GIS) The bachelor's degree in environmental geographic information science replaces UMM's major in environmental studies. For more information about the new program, visit *machias.edu/environment.*

Get More from Imagery Using 30 New Features Released to Geomatica Banff

PCI Geomatics is the developer of Geomatica, a leading software remote sensing, digital photogrammetry, geospatial analysis, map production, mosaicking and more.Geomatica Banff introduces automation for object-based image analysis. Automation is available in Focus from the Object Analyst or can be implemented as a chained workflow with individual algorithms (and Python). Building training data can be from multiple locations and deployed to classify and extract features of temporally overlapping imagery or data sets covering various geographic areas. Now just train data sets once and classify consistently over-and-over again.

Estonian Railways Selects Hexagon to Automate and Digitize Operations

Estonian Railways Ltd., a state-owned company responsible for Estonia's railway administration, has selected Hexagon's Geospatial division to implement a transportation system that will automate and digitize the railway's infrastructure maintenance, construction and traffic management processes. The combined asset management system and GIS platform will support the company's more than 700 employees to efficiently manage assets and workflows. Powered by Hexagon's GeoTrAMS, a web-based system for tram and light-rail infrastructure, and GeoMedia, a flexible GIS management platform, Estonia Railway will be able to visualize assets on a map while integrating with other companies and external systems.

SimActive Used to Determine Solar Potential from Satellite Imagery

SimActive has announced that his Correlator3D™ product is used by Dutch company NEO B.V. to assess solar potential in multiple cities. Digital surface models (DSMs) are generated from WorldView and GeoEye satellite stereo images and serve to calculate solar panel capacity. DSMs covering hundreds of square kilometres are quickly generated by the software. Key metrics to estimate solar potential are then derived, including roof orientation, pitch and shaded areas.

HERE and Flynex Map German Airspace for Autonomous Drones

HERE Technologies, a location data and technology platform, and FlyNex, a startup specialized in drone flight planning, are mapping German airspace in 3D. The "DaViLus" (Data Visualization of the Airspace structure) mapping project is supported by the German Ministry for Transport and Digital Infrastructure. The results are available free of charge at *https://davilus.flynex.de*. This map relies on location data from HERE. With its highly accurate 3D object data in the lower airspace, HERE is best positioned to power the development of a map that enables unmanned aircraft, such as drones, to safely maneuver cityscapes.

SimActive Involved in the Mapping of a UNESCO Archeological Site

SimActive has announced that his Correlator3D™ product is used to map the UNESCO World Heritage Site of Halin in Myanmar. The archaeological project involved the deployment of drones to gather data necessary to prepare orthophoto maps and digital elevation models. The goal is to find new features as well as to assess the state of the known ones. These include monumental walls, dams and digging canals many of which are still visible in the landscape. The resulting geospatial data also allow to check if modern constructions or farming are not causing any damage.

Indian Space-tech Startup - Pixxel Prepares to Launch 24 Satellite

Pixxel founder and CEO Awais Ahmed said that they were planning to launch the satellite next month but had to push their plans to November due to coronavirus. They are planning to launch the second satellite by July 2021. The small satellite will go in a Russian launch vehicle and will focus on high clarity satellite imagery. It would be helpful for governments and private organisations in collecting AI-powered analytical data related to agriculture, climate, spread of crop pests and diseases, defence monitoring, and mining in order to find illegal operations, monitor oil and gas pipelines, natural disasters, forest fire etc.

PRODUCT LAUNCH

March 16, 2020 - June 15, 2020

Pix4D Announces A New Generation of Tools for Photogrammetry, Drone Mapping and Analytics

Photogrammetry leader Pix4D has announced the commercial release of next generation software addressing the morden-day professional challenges. Developed in close collaboration with customers and partners, Pix4Dsurvey, Pix4Dmatic, Pix4Dinspect, and Pix4Dscan will contribute to revolutionizing the way professional customers operate and deliver their services.

Trimble Business Center (TBC) v5.3 is Now Available, So What's New in TBC v5.30?

Trimble has announced the release of version 5.30 of Trimble Business Center (TBC) office software that enables surveyors and geospatial professionals to simplify the creation of cadastral, GIS, infrastructure inspection and tunnelling deliverables. TBC is a leading software solution to provide users with the capability to efficiently edit, process, and adjust geospatial data and create deliverables with confidence.This latest release features for CAD and drafting, surfaces, tunnels and corridors, mobile mapping and working with field data.

Trimble Geospatial Announces Release of New Version of Trimble Access

Trimble has announced that its Trimble Access™ 2020 field software is now available on the Trimble® TDC600 rugged mobile device powered by Android. This combination offers surveyors the ability to leverage their familiar workflows and survey instruments while using an Android OS platform. For surveyors looking to use a smart-phone style mobile device to collect data in the field, the Trimble TDC600 running Trimble Access 2020 provides an optimal solution with its lightweight, rugged design. It is also ideal for surveyors looking for a lower-cost platform with the new Trimble Access software and workflows. For more information on Trimble Access 2020 visit: Trimble Access.

Touch GIS App Introduces Digital Clinometer Tool for Geologist

Touch GIS has introduced a digital clinometer tool to assist field geologist in recording strike & dip readings. Version 1.3 of the app also features a new 'Attitude' attribute type, which makes it easy to record and display these readings on the map. As more and more field work is being done on mobile devices, it's important to integrate them onto a single platform for collecting and sharing field data. Touch GIS has a mission to provide the most robust data collection feature set for mobile field mapping. The app is available for free to download on the App Store: https://apps.apple.com/app/apple-store/id1469504766?pt=120189314&ct=Version%201.3&mt=8

Hexagon Geospatial Releases M.App X 2020 Update 1 – Cloud-based Enterprise Solution for Imagery Intelligence

Hexagon Geospatial has recently released M.App X 2020 Update 1 with great new features. The major version of M.App X 2020 was released late in January 2020. For defence and intelligence organizations, M.App X is a tool that makes imagery easier to interpret, create intuitive maps for actionable information and centralize geospatial data for instant access across an organization. M.App X is powered by Hexagon's LuciadRIA mapping engine, a high-performance browser solution to improve hardware performance and support 2D and 3D displays of the same map. Customers can now download the new version of the software.

GEO EVENTS

June 22-24, 2020
GeoIgnite 2020
Ottawa, Ontario, Canada
https://2020.geoignite.ca/

July 13-16, 2020
Esri User Conference
Virtual
https://bit.ly/2Wfrp5W

September 15-17, 2020
Commercial UAV Expo Americas
Virtual
https://www.expouav.com/

October 13-15, 2020
InterGeo 2020
Berlin
https://www.intergeo.de/intergeo-en/

October 13-15, 2020
InterGeo 2020
Berlin
https://www.intergeo.de/intergeo-en/

November 23-24, 2020
Fair-Congress Geomática Andina 2020
Bogota Colombia
https://geo.sofexamericas.com/

April 23-25, 2021
GISTAM 2020
Prague, Czech Republic
http://www.gistam.org/

May 19-20, 2021
GEO Business
London, UK
https://www.geobusinessshow.com/

July 4-10, 2021
XXIV ISRPRS Congress
Nice, France
http://www.isprs2020-nice.com/