The theatre of crime

Picture: Macauley Institute

Virtual reality technology can help forensic scientists and investigators solve major crime investigations. Damian Small looks at a virtual crime scene theatre being developed to do just that.

The virtual crime scene theatre is an effective way of aiding communication between investigative experts says Professor David Miller of the Macaulay Institute. It is a curved screen with three projectors and has an immersive aspect. It measures six by two by five metres and the model of the scene is compiled as a computer representation using software similar to that architects might use.

"We are looking at what you'd need to capture from a scene to then help communication and discussion between experts so they can send a message to a third party, such as lawyers, a jury and other key stakeholders," said Prof Miller.

The thinking behind the theatre is to produce a "physical environment where group discussions are 'immersed' in the crime scene", he explained.

Prof Miller said there are clear benefits to modelling a crime scene. It may eventually become possible to recreate scenes from a 'cold case' through the theatre. "If enough information is available to develop a model of a scene, it means it can be re-created." This is important considering it "may not have been possible to have got all the relevant skills to visit the actual scene, or may have been impossible to get all the relevant experts in the same room at the same time discussing the scene from their perspectives".

There is a demonstration model of the theatre currently in use, which depicts a scene from a hotel room with a body. This model is used to demonstrate important information such as the routes in and out of the scene, interpretation of the evidence, what information to record at the scene and also how to replicate the scene.

With the ability to database crime scenes in a three-dimensional format, this would no doubt prove to be a valuable resource should a crime scene become a 'cold case' over time. As Prof Miller explains, the databasing helps to learn what to record.

Being 'immersed' in the theatre means one can open doors, pull up a print from an object in the room, move around and view angles you wouldn't have been able to achieve otherwise. "The databasing means we can re-create the scene with current information that can be used in the future," said Prof Miller.

Researchers are in discussion with the relevant communities about the

development of the virtual crime theatre. Opinions from the investigation community are important. "If they see value in this technology, should we be pushing for something that can be used in the next month or is it something we should develop so that we could use it for particular cases sometime in the future?" asks Prof Miller.

The team is also currently considering how sophisticated a computer model will be used in the virtual theatre. For example, will the virtual crime scene be manageable so that virtually, different scenarios can be viewed in a number of different ways?

The use of similar three-dimensional computer modelling has been used before, for example in assessing the potential scenarios of fire spread within a building.

The virtual theatre is not yet a commercial product. Prof Miller and his team are still developing the methods and the content based on the up-and-running prototype.

Networking for the future

The virtual crime scene theatre is an example of the wider aims of the Geoforensics and Information Management for Crime Investigation (GIMI) network. As Prof Miller explains: "The emphasis is on there being a network where people can exchange current thinking and knowledge, and that's a key aspect behind the virtual crime theatre.

"Getting people together that have related interest is key to the network. People from a variety of different angles within forensic trial and investigation professions, which is mirrored by the cross-range of disciplines within the network's research community."

The result of the collaboration is that the GIMI network is currently exploring and utilising the benefits of a range of tools and methods such as: soil fingerprinting – the SoilFit project (PP, 13/07/2006), interpretation of ground measurement imagery, non-invasive soil interpretation technology, identifying the origin of soil samples and methods for communicating results to a range of different disciplines.

The network is structured specifically to deliver innovative solutions to the challenges in the field of forensic investigation. Doctor Lorna Dawson from the Macaulay Institute, Coordinator of the GIMI network, discusses how the expertise of over 40 scientists and forensic professionals from five countries is drawn together under the umbrella of GIMI.

"The network consists of four core discussion groups: forensics, analytical, instrumentation and communication.

"Forensic experts have experience working in direct case work and represent the end users such as the National Centre for Policing Excellence (NCPE), the Forensic Science Service (FSS), police laboratories, legal institutions as well as private companies offering forensic analysis.

"An analytical methodology group has a remit to assess and develop new ways of measuring both soil and vegetation and evidence of anything buried under the ground. For example, there are gases, which are emitted from the ground that could indicate the presence of something such as a buried body."

Pointing out the international make up of GIMI, Dr Dawson described how a member from the internationally renowned 'Body Farm' in America is contributing to the network. "An expert from there, Dr Arpad Vass, is working with the network to study areas such as fatty acids present in soil, which could indicate the breakdown product of there having been something buried there," said Dr Dawson.

Some of the research currently being practiced by network members involves the conducting of geological surveys. Dr Dawson said: "The British Geological Survey at Keyworth have developed a mobile lab with the task of taking samples of gas at the scene of a crime. This saves time, as the sample doesn't need to be sent to a laboratory.

There is also the analytical procedure conducting work such as the SoilFit project, which aims to establish an instrumental soil database to help solve crime cases both nationally and internationally. Dr Dawson added: "This part of the network also includes the development of new combined analytical methods such as soil DNA, FTIR and XRD characterisation, which utilises only minute traces of soil which means that a tiny amount of a sample can be characterised."

Diffraction characterises the range of minerals in a soil sample, to learn what material the sample has derived from. This localises the sample, geographically fixing the sample to the most likely of areas on a map. In addition, as well as pollen profiling, which is a well recognised approach pioneered by one of the GIMI members, Patricia Wiltshire of the University of Aberdeen, DNA wax marker and FTIR characterisation can help further determine the vegetation and soil organic matter at a site.

Overall, Dr Dawson is responsible for coordinating the analytical methodologies carried out by the network.

"Some members of the network are tasked with putting into practice some of the methods that we as researchers are developing. That's what makes the network so beneficial; the whole network has research scientists, research practitioners, forensic practitioners and it also has the actual police and law enforcement advisors. We have the whole gambit from end user stake holder through to the people doing the research in the laboratories that can feed back which are the most appropriate analytical methods to use."

Within the network are three 'pockets'. These are, analytical analysis: getting analytical methodologies to work on appropriate samples and getting it to work at the crime scene. There is instrumentation development: developing technology such as ground penetrating radar, which was originally applied to the Fred West case for example. Then, with the communication group, it is brought together either recreating the crime scene for interpretation later or recording and helping identify where at a crime scene something has happened.

Ground penetrating radar has limitations in the UK where wet soils are present such as much of the moorland areas. So, part of the instrumentation group's remit is to review existing and come up with new methods. Increasing the wavelength is one approach, and Dr Iain Woodhouse, a geo-forensic scientist at Edinburgh University is attempting to extend the wave length rather than just using the radar part of the spectrum to develop the technique so that so it can be used in a wider range of situations.

"We are looking at airborne imaging radar - an imaging technique from an airborne platform, which looks at the surface with the technical advantage of using longer wavelengths to see through foliage.

"It is based on a Japanese satellite launched last year and although it is largely the military that are interested in this type of technology in the search for vehicles over a large area, part of my role is to see whether such a product is suitable to end users within law enforcement agencies; could it function in the front line of investigating crime and what benefits would it bring? It may impact on criminal cases where a vehicle must be located across a similarly wide search area, for example."

Unmanned Air Vehicles (UAVs) and light aircraft that can carry radar systems for example are an up and coming technology, said Dr Woodhouse. "After narrowing a search area down reasonably well and you need to look at it in high resolution then a UAV or light aircraft could accomplish this.

"My remit is to look for techniques that haven't yet been considered or any new technologies that are going to appear in the future that may be relevant to forensics. The network can explore such technologies whilst they are being developed. One such product for example is called Lidar (light detection and ranging), which uses laser to give high precision information of the ground."

Joanne Ashworth, head of physical evidence at the National Centre for Policing Excellence (NCPE), works with the network representing police user requirements to ensure that any product developed is fit for the purpose and can be implemented into policing.

Regarding the nature of Dr Woodhouse's research, she said: "The NCPE are generally consulted on the high end of crime and in particular the more difficult cases; we see a reasonable proportion of cases where people are missing and presumed murdered. These cases are the most difficult to prove particularly as it is the actual body that is the crime scene and potentially holds a wealth of scientific evidence.

"Therefore, to employ methods and joined up thinking to locate that body is extremely useful, particularly as the methods proposed are non-invasive and therefore allows bodies and other evidence such as buried arms caches for example to be recovered in controlled conditions to preserve as much forensic evidence as possible."

Dr Dawson added that ultimately, at the end of the next three-years, the network will be integrated so that "if a case is brought to the group's attention, with a tiny amount of soil evidence for example, we can scale that up from the analysis through a study of the chemical, physical and biological methods, and through geographic information systems it can be 'plugged' into a database to find out where it is most likely that the physical evidence has come from and highlight a range of areas where it is likely that a missing object or body is. Then, through the work of the instrumentation group we will have a remote searching ability; we can make it non-invasive, without destroying valuable evidence."

One development Dr Dawson is involved in is the development of an urban soil database. Her team is hoping to get forensic science departments across the UK this year to sample, as one large exercise, urban soils across their city. "This will enable us to get a more forensically realistic and localised picture, helping the police forces in those particular cities," she said.

Dr Dawson has recently finished a project that utilised plant biomarkers to characterise six different urban gardens in Aberdeen. "You could actually identify which garden we had been in. We now have analysis down to the level that it can identify individual gardens, which could impact on volume crime such as burglaries."

Another recent initiative involved the use of infra red analysis. "We showed that you could actually analyse a tiny trace on the knee of a jean, and that the spectrum from the clay found there matched exactly the spectrum from where the person had kneeled. You could identify a scene of a crime by what was left on the clothing. We are trying to get down to the precision of the analytical methods such that we can test whether samples are representative of a scene or not," she said.

Describing her analytical methodology, Dr Dawson said: "We characterise organic matters in the soil using plant biomarkers, which gives a signature of what vegetation has gone into that soil over its history, thus producing a 'fingerprint' of a chronological information sheet of what is likely to have been deposited there."

This provides information as to where the most likely search should be carried out, such as a grass signature that would demand a search in grass parks for example. It allows you, through studying the organic matter in a sample, to learn what is currently growing in an area.

She added: "We have developed a layering GIS idea: you identify the soil from characteristics such as mineralogy, which tells you what bed rock it came from, then with the soil organic matter you are able to determine what is currently growing there such as granite bedrock with a grass paddock above."

Her work is part of the start-to-end tactics harboured by the network that will help the phases in an investigation. "We are helping to develop methods that can locate something, and when we develop the probability of the science behind the methods, we'll be able to give information that can help at the evidential stage of an investigation."

Speaking of the network's value, Ms Ashworth added: "Historically, policing has relied on approaching individuals to carry out specific pieces of work, which doesn't always provide the most effective and appropriate answers to policing issues. The network provides more joined up thinking and the opportunity to deliver a combined service with complimentary technology and expertise.

Picture: Macauley Institute

The GIMI network.