



Atomic detectives: Using novel 3D software to monitor nuclear installations

The 3D Reconstructor and VideoZoom are advanced software systems that allow independent inspectors of nuclear sites, working under the auspices of the International Atomic Energy Agency and EURATOM, to detect the slightest unannounced modification of facilities at an installation that might compromise security.

The role of nuclear safeguards has evolved from the 'simple' verification of the correctness of a State's declaration, to the more complex challenge of ensuring that non-proliferation controls are respected. Inspections rely on cutting-edge scientific techniques and well trained nuclear experts or 'atomic detectives'. Announced and unannounced controls take place in uranium mines, at fuel fabrication plants, at enrichment facilities and nuclear waste sites, as well as at any other location where nuclear material is or may be present.

The 3D Reconstructor and VideoZoom were developed in the laboratories of the European Commission's in-house science service, the Joint Research Centre. Scientists have equally licensed agreements with external partners. This is leading to further applications in broad areas such as video-surveillance, civil engineering, preservation of architectural patrimony, and 3D visualisations.



Joint Research Centre (JRC)

– the European Commission's in-house science service

The essential breakthrough is that the 3D Reconstructor and VideoZoom technologies provide a scientific approach to policing nuclear sites that reduces the risk of human error. Using data taken from multiple camera angles inside buildings or of external roads and service areas, a complex 3D image is built up of a given location. This millimetre accuracy gives a much greater spatial view.

If a new building project, for example, did not follow the exact plans, the system would detect it. Similarly, if a single pipe inside a building were moved or had its diameter changed, inspectors would detect it. Because the information is recorded so quickly and accurately, it reduces the time an inspection team needs for basic controls and its adjustable resolution properties allow them to focus on a specific area in greater detail.

The pieces of the jig-saw can equally be brought together to give a complete 3D overview of an entire installation in a user-friendly, internet-compatible format. Scientists have recently developed specialised 3D glasses that combine with the software to give inspectors an on-the-spot comparison between the current and previously recorded 3D image so that anomalies are detected. VideoZoom is revolutionary insofar as it greatly increases the storage capacity of inspection cameras during image-based forensics.

Scientists were tasked with developing new tools that could cope with ever-larger image sets, while affording inspectors the option of filtering out irrelevant images without missing the relevant ones. VideoZoom creates pyramids of summary images built on an image stream. It then presents the summaries by layers of abstraction, with each layer giving more information which the reviewer can use to decide whether further investigation is needed. A reviewer can simply zoom out to see many images at once, or zoom in to see single images in greater detail.

Did you know?

The 3D Reconstructor technology has been used to perform a survey of two Glaciers of Mount Everest, the Lobuche and Chungri Nup glaciers, in the Himalaya Mountain chain. This will allow scientists to establish possible correlations between the behaviour of the glaciers and climate change effects.



Background

JRC scientists assist the European Commission's Directorate-General for Energy in fulfilling its verification obligations under the EURATOM Treaty on the uses of nuclear material for declared, peaceful purposes. They monitor safeguards compliance of 80% of the world's reprocessed nuclear fuel, operate onsite laboratories at the Sellafield (UK) and La Hague (France) nuclear sites, and are a key provider of international training programmes for inspectors. They regularly invent new technologies around nuclear science that are then spun-off in other fields. A recent example includes robotic technology used to remotely handle spent nuclear fuel elements that has been successfully adapted to the health field for remote telesurgery.

The multidisciplinary nature of research carried out at the JRC means that experts with a proven track record in an area such as nuclear science can interact with, and profit from, the knowledge and inventions of colleagues. This way a good idea is more readily exploited and turned into end products and jobs. The 3D Reconstructor and VideoZoom exemplify this. Commercial partnerships are already underway with applications in architectural surveying and heritage, engineering forensics, entertainment and TV production, virtual reality (virtual studios, computer games, content-related applications e.g. CD-ROMS), social tele-presence, e-commerce and the evaluation of natural disasters.