



LASER TECHNOLOGIES FOR ON-SITE SURVEILLANCE

JOÃO G.M. GONÇALVES¹, VÍTOR SEQUEIRA¹, JULIAN WHICHELLO²

¹ European Commission - Joint Research Centre, ISIS-RIT, Ispra, ITALY

² International Atomic Energy Agency, Vienna, Austria

Surveillance techniques are based on the detection of changes. These changes can be caused by moving objects or people, or by modifications made to the environment itself. Visual surveillance uses optical means, e.g., the analysis of an image acquired by a surveillance camera. These techniques are effective in detecting objects moving within the surveyed area. There are situations, however, where optical surveillance may prove to be unreliable. In some cases, the changes in the image are too small to be properly detected with scene change detectors. In other cases, alarms are generated without objects (or people) moving. These false alarms may be caused by changes in illumination, e.g., a faulty lamp or spurious reflections in places near water pools. Further, the absence of illumination during a blackout (whether it is caused by accident or on purpose) prevents cameras from their surveillance operation. There are high security installations for which it is necessary to introduce reliable, independent and effective sensors that can keep the surveillance work even during a blackout.

Laser range scanners are electronic instruments measuring the distance from the instrument itself to the outside world along a specific direction. The type of the instrument to use depends on the range of distances to measure. Indeed, whereas for large distances (e.g. between 1 and 200m) it is possible to use time-of-flight instruments, for short distances (e.g., from a few centimetres to about 1.5m) a triangulation laser striping system is used. The deflection of the laser beam (e.g., using rotating mirrors) enables the acquisition of the distance profiles (or matrices) of the surrounding premises in a very short time.

The comparison of an acquired profile, or matrix, of distance measurements with a reference is most effective for real-time detection of small changes in the environment. Laser range systems have unique characteristics (see Table 1), which make them effective in Safeguards applications. Simple and efficient alarm detection algorithms make laser range systems a natural complement to already installed surveillance systems.

In a typical application the laser scanner is installed facing a Safeguards relevant area. After setting-up the scanning parameters, i.e., scanning angle (both vertical and horizontal) and spatial resolution, a first scan (i.e., a matrix of distances) is acquired and used as reference. In routine operation the instrument would keep measuring the distances in the surveyed area, and signalling changes to any local surveillance supervisory system.

- Self-illumination: the instrument does not depend on external illumination;
- Independence of ambient lighting: the instrument works well both in dark and illuminated conditions;
- High accuracy distance measurements: typically about 1 cm for a 100 m range; Short range scanners: better than 0.5 mm for a 1,5 m range.

- Fast data acquisition: typically more than 10,000 range measurements per second;
- Measurement of the distance of an object, its size, speed and direction of motion: this information can be most useful for distinguishing normal moves from security (or safety) related ones;
- Stand-alone operation: the instrument may be designed to work on its own, with no requirement to be connected to a host computer;
- Wide scanning angle, typically, 360° by 90° .
- High spatial resolution, i.e., number of distance measurements per solid angle (typical: more than 10 samples per degree).
- Easy interfacing: typically RS232, Parallel port or Ethernet.

Table 1: List of characteristics of laser range scanners that are useful for Safeguards.

In summary, the paper reviews the main technologies of laser scanners, analyses the main specifications for easy equipment selection, and discusses how these technologies can be part of future safeguards surveillance systems.

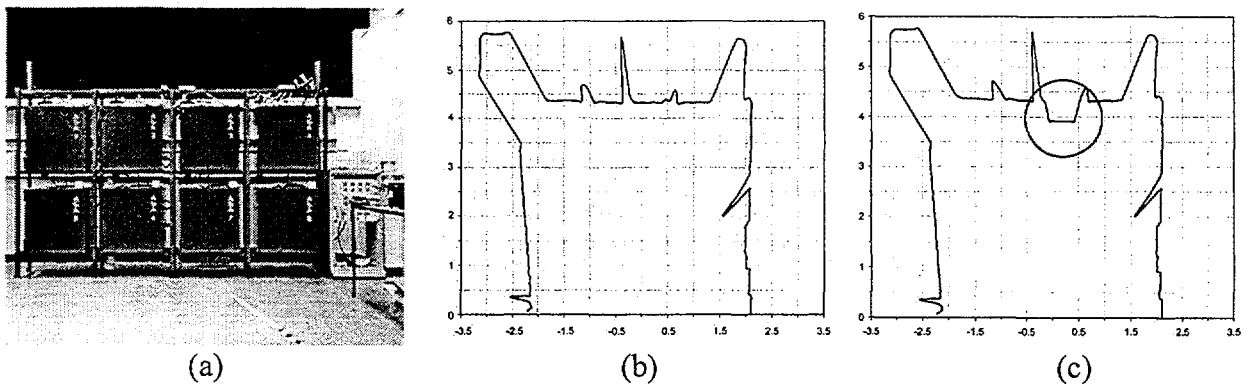


Figure 1: a) JRC mock-up storage area; distance profiles measured with a laser scanning system – a) Reference profile; b) Detection of a change in the environment.

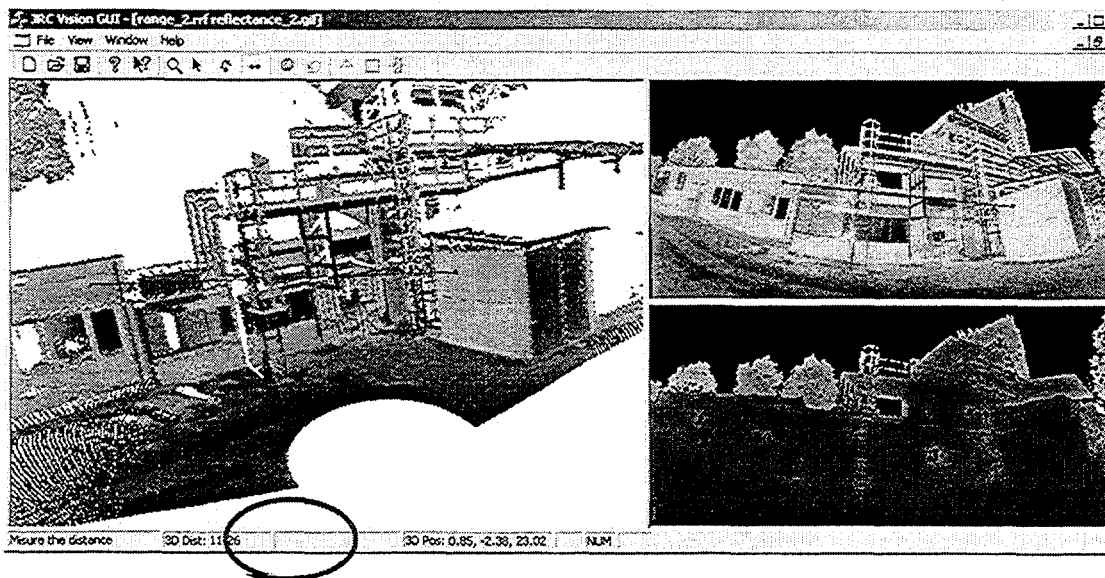


Figure 2: Laser range scan of a JRC industrial installation: left – cloud of 3D points; top right – infrared picture of the scanned area; bottom left – 2D grey level representation of the distance measurements (range image). The user can interactively select two points (red line) and the distance is immediately computed: 11.26 metres in this case (red circle).

Figure 3: Two range acquisition systems; a) time of flight laser range scanner (for large distances up to 200m); b) laser striping (triangulation based) range scanner (for short distances 5cm to 1.5m).

