ForLab Final Report: Context and objectives

Usually the post blast scenario of an IED attack consists of a wide area covered by very small debris of the explosion. Every detail may be of importance for the identification of the terrorist group responsible for the attack, the person who emplaced the explosive or even the person that assembled the IED. However, differentiating general debris from “clue evidences” is a hard process that, today cannot be performed in the field and therefore a huge number of samples are collected in field and sent to a distant laboratory to perform a deep analysis to determine its relevance. As the relevance of the evidences is unknown to the investigators, they trend to collect larger amount of evidences (to ensure the success) thus generating a huge amount of work for the laboratories.

Any knowledge about the author of the attack or the procedures they used can be of vital importance to prevent new attacks. Comparison of the characteristics of the attack with previous incidents may also help and the fast exploitation of this information may dramatically improve the results.

The quality of analysis depends on the quality of recognition, documentation, collection and preservation of the evidence. So, the current needs of the end users include sample detection, identification, capture of the scene and a kit suitable for semi-automatic crime scene reconstruction supported by a positioning system.

ForLab is a novel systematic methodology which fulfils the end user demands by:

- On site detection, identification and analysis of evidences, providing the investigator with objective criteria for the selection of the samples.
- Producing a real time 3D recreation of the scene including the localization of the evidences
- Making all relevant information of the scene readily available in a Command and Control Centre to the expert leading the investigation, and making this information also available to the investigators.

The final goal is to optimize the evidence collection and to reduce the time and resources in the laboratory, while preserving the chain of custody so as to minimize the time required to identify the responsible for the attack.

The on-site detection, identification, analysis of evidences in real time will let the investigator to pre-evaluate the evidences and to decide which of them must be collected. The optical spectroscopies are good candidates to screening post-blast IED evidences due to their capability to analyze different types of evidences in few seconds and to operate in field. Often, the fragments of the triggering electronics of the IED are the most valuable evidences for the identification of the authors, NLJD has the necessary characteristics for the easy localisation of those fragments.

The following technologies have been developed in ForLab:

LIBS (Laser Induced Breakdown Spectroscopy): LIBS is a very sensitive technique that provides information on the elemental composition of the analytes, and has demonstrated its capability to identify tenths of nanograms of explosives over a surface in just a few seconds.

RAMAN spectroscopy: This technology measures directly the characteristic vibrational spectrum of the sample under investigation. This molecular specific fingerprint allows direct identification of the substance under investigation.

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Laser-induced fluorescence (**LIF**) is one of the most sensitive detection schemes. The fluorescence is the light spontaneously emitted due to transitions from excited singlet states to various vibrational levels of the electronic ground state. The experimental measure of the fluorescence emitted by matter carries information about both the photophysical properties of the molecule and the chemical and physical nature of its micro surroundings. In general terms the LIF is not compound specific; however the additional capability of active reflectance measurements represents a significant step forward in the identification and precise localization of debris dispersed all around the crime scene.

NLJD: This technology is based on the intrinsic property of non linear junctions such as those contained in semi-conductors, to radiate different harmonics, when radiated at a given frequency. It provides the ability to detect electronics, even if switched off or in sleeping mode.

In addition, this tools will integrated into the ForLab system providing additional tools for management of the information acquired from the scene.

3D modelling technology has been developed to allow the fast generation of a 3D model of the scene providing a real time dynamic overview of the scene.

Non GPS based localization technology capable of work in indoor and outdoor scenarios has been developed to provide the accurate localization (10 cm) of the evidences within the 3D model of the scene.

A secure wireless communication network ensures the reliable transmission of the information to the Command a Control centre where the data received from the different sensors is received and presented to the operator in a comprehensible way.

Al the evidences collected are **registered using a Tablet PC** integrated into the ForLab network that allows the generation of an evidence report that is transmitted to the command centre, **ensuring the preservation of the chain of custody**.

FORLAB components will be deployed into the scene of the explosion of an IED as follows:

The first elements to be deployed will be the communication network and the 3D scene recreation tool that will make a 3D model of the scene available at the Command and Control Centre in just about 30 minutes. Initially a low resolution model is acquired and transmitted to the command and control centre that will decide if it is necessary to increase the level of detail of the complete scene or a priority area.

The second element to be deployed will be the LIF analysis tool that will start a scan of the scene from a fixed point scanning an area (up to 30 m. from the sensor), looking for potential evidences. LIF images of the scene highlighting the presence of plastics, and polymeric debris transmitted to the command and control centre and combined with the 3D view of the scene in just about 15 minutes.

Finally, the screening technologies (LIBS, RAMAN and NLJD) will be deployed:

NLJD will help the technicians performing a visual inspection of the scene to localize hidden debris of electronic devices. The localization of those debris will be clearly identified in the 3D model at the Command and Control Centre.

LIBS and Raman will be used to get an chemical analysis of the samples identified by the investigators. The automated recognition software of the sensor will provide the investigation with an immediate objective indication of the presence of explosive traces on the selected sample.

Every time the investigator decides to collect a sample, a report of the evidence is created in a Tablet PC (including pictures, localization, time of collection, etc), digitally signed (to ensure the integrity and the authoring) and sent to the command and control centre.

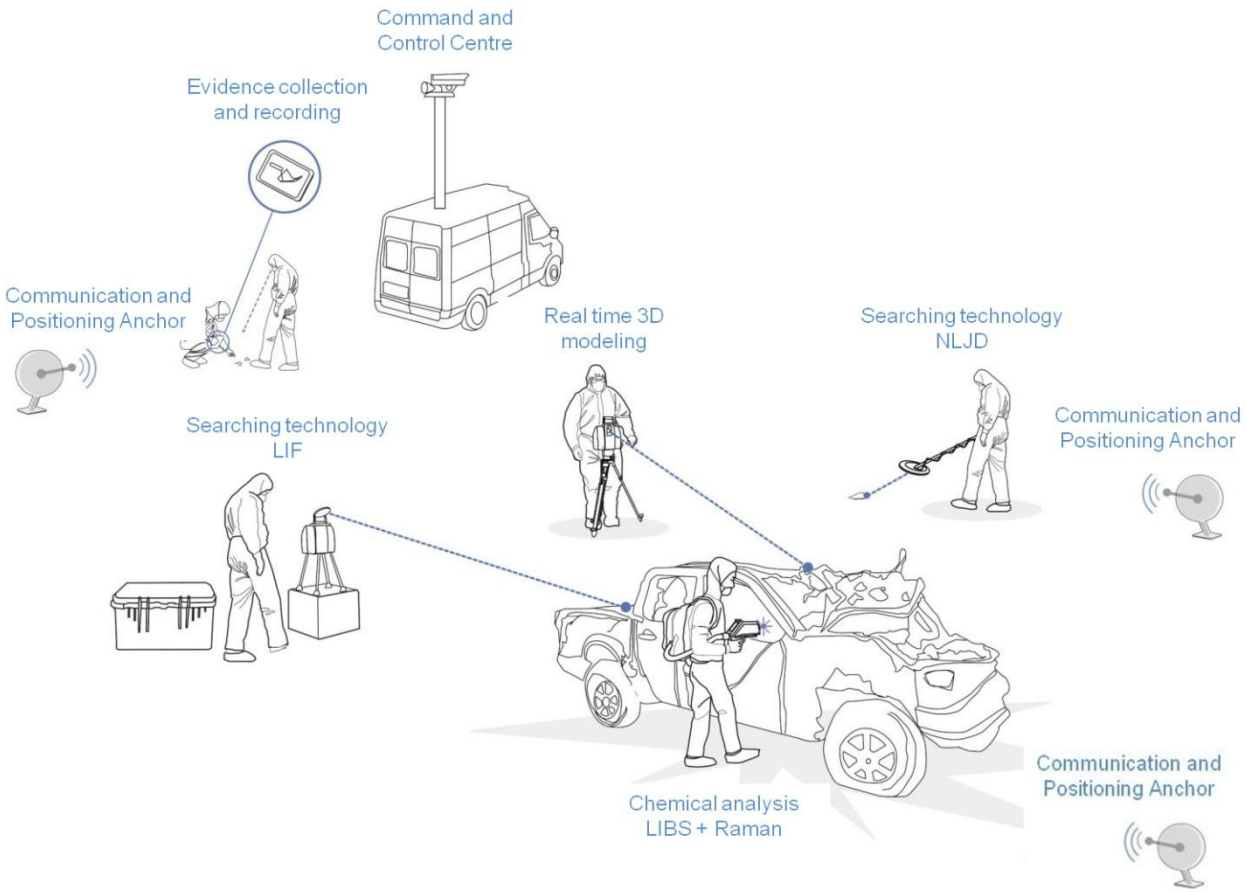

Figure 1 Operational diagram of the FORLAB

The command and control centre may be physically located near the explosion scene or may be located at a distant place. This gives the ForLab system the major advantage of allowing highly qualified investigators to follow the investigation from the command and control centre and to direct investigators in the scene to do sampling in specific areas of higher relevance or to instruct them to perform some specific tests on particular samples.

ForLab will provide end users with:

- 3D scene recreation for improved understanding of the scene during investigation and for later recreation of the scene for further investigations

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- Four quick and portable screening tools to detect and identify forensic evidences in field
- Automated sample localization in the scenario
- A command and control centre where the evidence information can be processed in almost real time and depicted in the 3D scenario
- Possibility to recreate the events registered by the Command and control centre during the investigation for training proposes or to review the steps of the investigation.

FORLAB project is addressing the topic SEC 2010.1.3-2 *"Forensic Analysis of an explosion or an unexploded IED".* It relates to the problem of evidence collection in the post-blast scene, providing the investigators with a new tool compatible with the exiting procedures for this kind of investigations.

The main focus of the project has been.

- Provide the investigators an objective criteria of evaluation of samples to reduce the number of evidences to be collected and sent to the reference laboratory.
- Improve the capability of recreating the scenario to help on the real time identification of areas of higher interest and helping on the recreation of the scene for later investigations.
- Make the information on the investigation available to the investigators in real time and in a comprehensive way.

The involvement of end user was also a major objective since the beginning of the project. This objective was supported by the presence of the security forces of four European countries as members of the consortium that have largely influenced the final results of the project.