Newsletter

N°2 January 2017

URBAN SEARCH AND RESCUE

Technological & Methodological Solutions for Integrated Wide Area Situation Awareness & Survivor Localisation to Support Search & Rescue Teams

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For more information

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You can also keep up with even more of what is happening at INACHUS project by following us on:

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Editorial

Dear reader,

I am pleased to present the second INACHUS Newsletter. Started in January 2015, INACHUS is a four year EU project, partially funded by the European Commission under the Seventh Framework Programme for Research and Technological Development (Grant Agreement no 607522). The project involves 20 partners from 9 EU member-states and two associated countries.

Urban Search and Rescue (USaR) crews face difficult working conditions and harsh environments. The INACHUS project seeks to establish an effective USaR operation framework to aid them; minimising the amount of time needed to locate victims, while also aiding rescuers in finding the safest and most effective way to reach those victims. Furthermore, it seeks to increase the overall efficiency of USaR operations, offering users rapid scene assessment through the use of sophisticated mapping hardware and software, coupled with increased situational awareness made possible by a Common Operational Picture tool integrating feedback from various inputs.

During the second year of the project the INACHUS system architecture was finalised and all the technical developments evolved based on the end users' needs. The first INACHUS Pilot Demonstration was successful, testing individual victim localisation solutions in realistic conditions.

Inside this newsletter, you will read about the work we have carried out over our second year, as well as details of the consortium's participation in conferences and other events related to the project's research field. Further information can be found on the project's official website.

I hope you enjoy the newsletter and invite you to keep in touch with the INACHUS project.

I wish you all a happy new year and enjoy reading our newsletter!

Angelos Amditis
INACHUS Project Coordinator
on behalf of the INACHUS Consortium

First field test

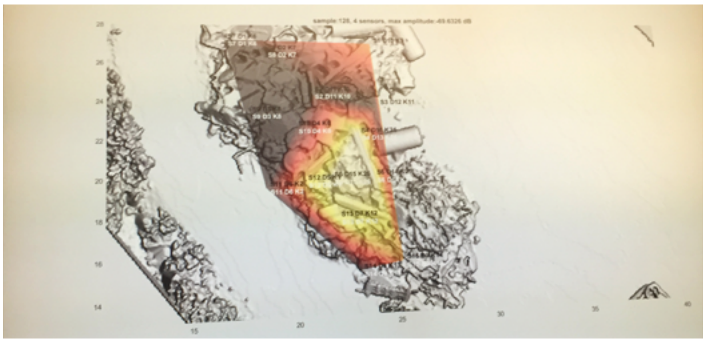
Pilot 1 in Sweden

The first Pilot of the INACHUS project was held at the Ågesta Training Center, near Stockholm, Sweden, on 15 June 2016, with the main goal of testing and getting feedback on the victim localisation tools.
Seven technical demonstrations were performed with end users from Sweden, The Netherlands and France, offering a great opportunity for hands on involvement, and to share INACHUS project developments with USaR specialists.

As a follow up to the Table-Top Exercise (TTE) in Toulouse, March 2016, where end users participated in a virtual USaR scenario employing the whole INACHUS platform, the first Pilot was an opportunity to evaluate the victim localisation tool prototypes in a realistic USaR environment, a rubble pile.

The INACHUS robot will integrate a video camera, an infrared camera, an electronic gas sensor, a Doppler radar, and a two-way communication system, in order to allow end users to communicate with the victim and collect information about the surroundings and possible rescue paths.

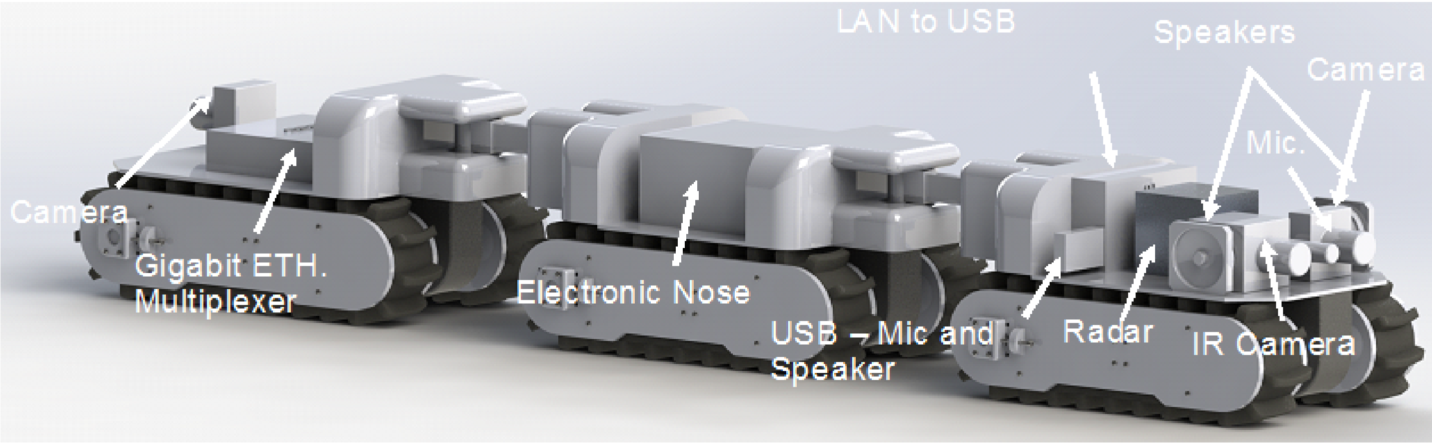
During the field test, only the first compartment (head of the robot) of the INACHUS robot was tested along with the sensors which are currently at an early stage of development. The different tools were tested under real conditions and end users were able to use them based on an operational scenario, and assess the robustness and the user friendliness of the interfaces as well as the accuracy and the effectiveness of the sensors.



The INACHUS robot operation is assisted by two high-technology tools. A **ground-based seismic sensor** to detect and locate even subtle noises from victims and a **mobile phone detector** to detect and locate victims' personal mobile devices through the rubble. These two tools were tested under operational scenarios, showing their adaptation capacity to specific USaR needs. A premature version of the ESS/COP (Emergency Support System / Common Operational Picture) interface developed in agreement with INSARAG guidelines was also demonstrated.

The field test was attended by 11 end users, who were very interested in the innovative approach offered by the INACHUS victim localisation tools. They were also appreciated of the functionality and ease of use of the interfaces. The first pilot was successful and gathered a lot of feedback from the end users that will guide future development of the INACHUS victim localisation tools. The next field test, Pilot 2, will be held Spring 2017, in France.

Victim localisation tools



INACHUS Robot

The INACHUS robot will integrate:

- Two **video cameras** assisted by powerful lights so end users can get a clear view of the unattainable parts of the rubble.
- An **infrared camera**, to detect possible living victims.
- An **electronic chemical nose**, to measure specific gases indicating the presence of a living human.
- A **robot radar**, to detect slight movements such as victim breathing.
- A **two-way audio communication system**, to allow end users to communicate with the victim and collect information.

These sensors, in addition to a real-time localising system, will help USaR teams to detect and locate trapped victims. The available prototype of the INACHUS robot was demonstrated during the first INACHUS Pilot. The robot head carrying LED lights and one video camera were tested together with a first version of the graphical user interface running on a wireless rugged tablet with joystick and buttons.

The snake-like shape is preferred due to the reduced cross-section area and therefore the ability to enter narrow spaces. The other two modules are necessary to carry the remaining sensors and communication hardware. The motorised joint mechanisms will extend the manoeuvrability of the robot enabling it, for instance, to climb small obstacles and 'look around'.

Robot head module

The final version of the head module will also include the infrared camera, the robot radar and the audio communication system.

The picture below illustrates a mock-up with the built and tested head module connected to two other modules. Each module has two tracks used to improve forward and backward movements. There are two other modules that are under development as well as the motorised joint mechanisms.

Victim localisation tools

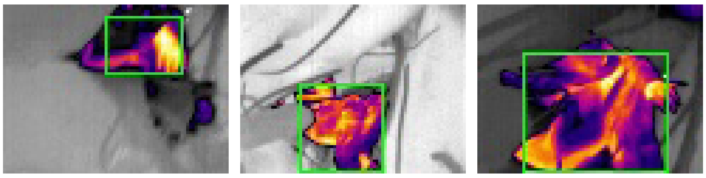
LWIR Camera in INACHUS Robot

INACHUS is improving on a more efficient survivor detection by developing a miniaturised Long Wave Infrared (LWIR) camera.

The main challenges of the LWIR development are the operational environment, which may be characterised by smoke, dust, rubble and extremely narrow spaces, as well as the very low resolution caused by the continuously moving LWIR camera.

To make up for those constraints and increase the reliability of the signal, the thermal information received by the LWIR camera is processed and research is carried out to implement specific features for detecting body parts of partly hidden people (arms, etc., see pictures). Main advantages of this system are the real-time operation and the reduced cost of the LWIR sensor.

The developed methodologies have been evaluated in laboratory and in operational conditions during the first Pilot of INACHUS project, revealing the robustness, reliability and high performance of the developed device.



As observed during the field test, the sequences resulting from the LWIR camera are characterised by a complex visual environment for detection due to obstacles in front of the human body. Detection was accurate despite the difficulties with aforementioned visual conditions and the victims being covered by thick clothing.

Electronic Nose in INACHUS Robot

The assembled electronic nose sensor prototype (e-nose) is capable of detecting gases indicating the presence of live humans in confined spaces, and some additional gases as well that indicate a hazardous environment. The electronic nose which is part of the INACHUS robot sensor payload, is a small and portable gas detection and measurement sensor that works by sampling air. In the first Pilot, the electronic nose was tested as a standalone module and demonstrated to members of the end user community.

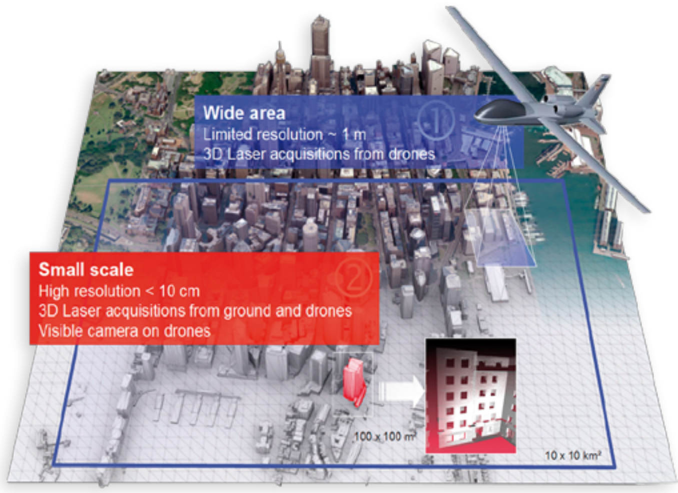
Pilot 1 was focused on validating the human presence detection capability of the system, a task that was successfully completed. The opportunity of demonstrating and discussing the user interface with end users was taken and valuable feedback was collected that greatly influenced its subsequent development.

Surveillance & mapping of disaster

Wide Area Surveillance Tools & 3D Mapping from Drones

The fast 3D modelling of collapsed buildings using images from Unmanned Aerial Vehicles (UAVs) can significantly help the USaR teams to determine the location of possible trapped victims and improve disaster response.

Two different techniques are studied to collect 3D data for disaster areas in the INACHUS project: 3D laser cameras (both airborne and ground-based) and 3D meshes from airborne cameras.



High-resolution and high-quality digital elevation/surface models (DEM/DSM) are fused from these two approaches (laser imagery and high-resolution images).

The images from the visual sensors are draped onto the 3D data, thereby enriching the 3D models and making them easier for a user to interpret.

One main motivation to use two complementary data acquisition techniques is that both UAV platforms can be deployed individually.

The subsequent data interpretation is possible by day and night (H24 operability) if only one of these techniques is available. If, however, both are available and fused, even better and more reliable analysis is possible.

Airborne observation

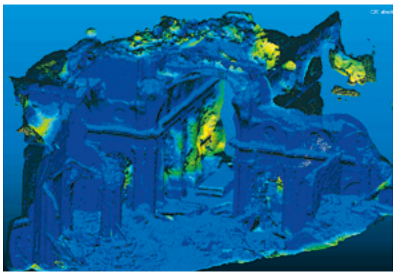
Airborne observation provides wide-area coverage while ground-based sensing produces dense high-accuracy data to complement the laser data from the UAV. Common experiments were organised in Toulouse, France, to illustrate the concepts and to display 3D data to end users. Partners and USaR professionals were involved on the setup and the discussions to share a common scenario.

The technical requirements played an important role to test and define the future strategies of airborne observation. These experiments contribute to validate the 3D data fusion algorithms.

First results are promising (https://youtu.be/xshcOtKFdWU). New experiments are planned to verify the robustness of our method on a real collapsed building, to be tested in Pilot 2 in 2017.

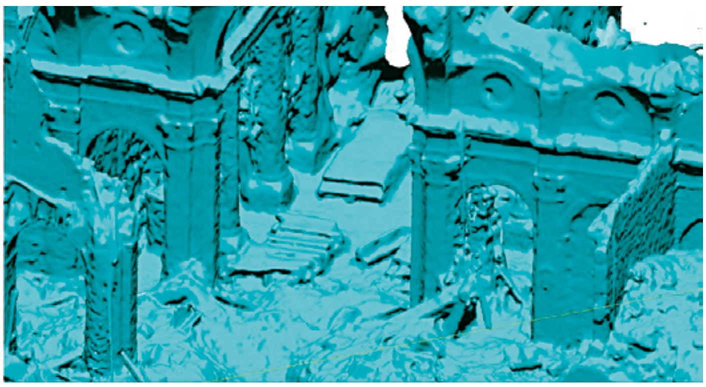
Surveillance & mapping of disaster

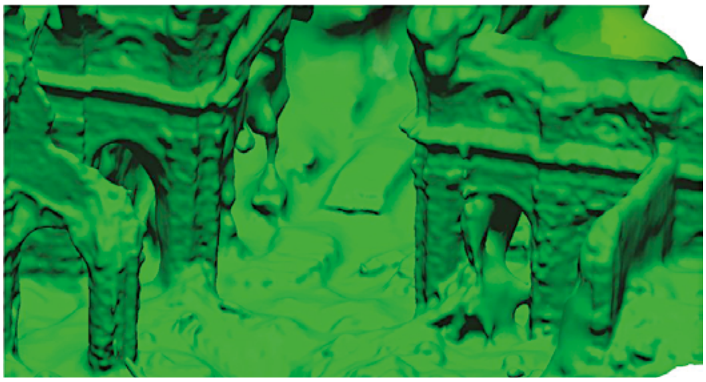
UAV-based 3D Modelling



Several experiments for the establishment of 3D modelling workflows for USaR purposes via real earthquake imagery were conducted and a thorough analysis on the parameters of the various modelling steps was made. UAV-image datasets of a small region in Mirabello, Italy, location of a destructive earthquake in 2012, were used.

Test performances were evaluated in terms of time required for the creation of 3D textured models and number of dense cloud points generated.





The similarity between the laser and image-based 3D model of a collapsed building and the collapse simulation model of the same building opens the opportunity to infer the location of several building elements inside a collapsed building.

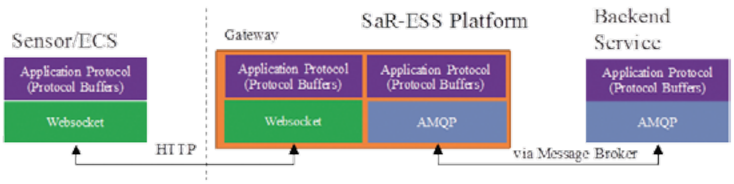
This is advantageous to infer, for example, the location of voids inside the structures or to estimate the overall stability, or of specific areas in the collapsed structure.

Framework & system

INACHUS Emergency Support System

Within the INACHUS framework, the Search and Rescue Emergency Support System (SaR-ESS) and more specifically, the Common Operational Picture (COP) are the link between end users and the entire system.

More technically, the Multisource Information Fusion Engine (MIFE) is a part of the SaR-ESS that provides a mediation layer between the entire information collection element and the back-end for track, target and tactical information such as mission and operational data from various sensors. It also allows information to be displayed.



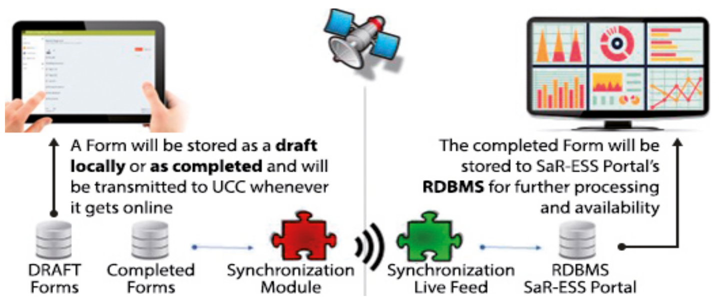
As part of the MIFE, the Data Fusion Mediation Server incorporates expert reasoning of the collected data using ontological models associated with intelligent algorithms that will act upon the gathered data to provide the end users with information on the location of survival spaces that most likely contain potential survivors, as well as potential rescue routes.

Within the SaR-ESS tool development, the consortium has been working towards providing a real-time communication server flexible enough to facilitate the communication from the field of operations to the SaR-ESS platform components.

In this way INACHUS will offer a real-time communication transport layer as well as a support of both peer-to-peer and client-server network topologies and an efficient message-exchange format that minimises the amount of consumed bandwidth.

In order to allow fast and operational communication of the end users with the SaR-ESS entity, INACHUS consortium is developing a mobile application for Android devices that facilitates data collection from the field of operations.

In addition, the consortium is developing a web application for the Urban Search and Rescue Coordination Cell (UCC) that can be used to improve the coordination capacity of the teams offering tools for better administration of the teams. Within the UCC, overall coordination of large-scale USaR responses is performed.



Both applications follow the INSARAG guidelines and early prototype versions are available for end users' feedback.

System architecture

As a main achievement of this year, the INACHUS System Architecture has been defined and completed.

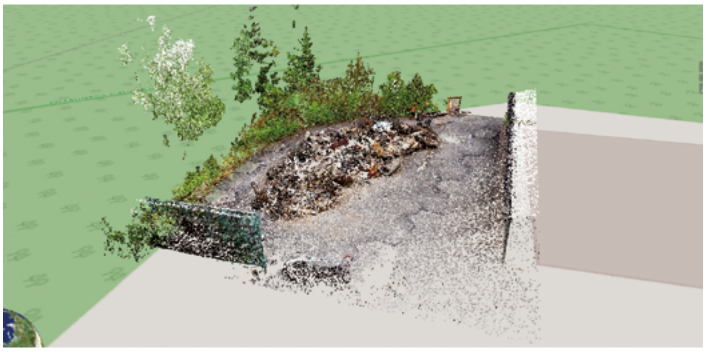
The end of September 2016 marked the completion of the "*Framework Design and Interoperability Issues*" of the INACHUS project. During 2016, the *INACHUS System Architecture* and the *Integration Plan* were completed, and the *First INACHUS Integrated Framework* was realised.

***The Integration Plan,* derived from the *INACHUS System Architecture* in order to present the integration roadmap, will ensure that the various, complex INACHUS components comprising the entire platform work properly once integrated.**

Framework & system

Common Operational Picture

Designed as a "map-centric" application, INACHUS COP will have to be able to aggregate and merge a heterogeneous set of massive geo-located data from worldwide to local scales in a cartographic representation, displayed in a real-time and interactive 3D environment for intuitive situation awareness, and manipulated at both operational and strategic levels.



All data provided by project partners and coming from field sensors, reconstruction tools and simulation tools tend to be displayed on the INACHUS COP. These heterogeneous, multi-source, multi-format data are then to be retrieved and centralised in order to be accessed through environment services in the same efficient and secure way than regular GIS data used for map background.

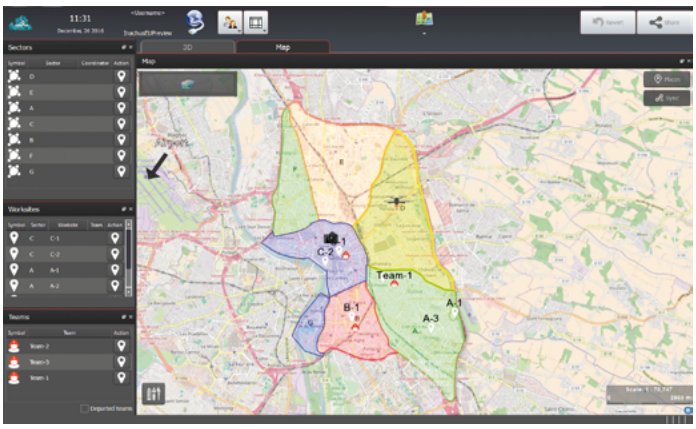
The Environment Service architecture relies on Free and Open Source solutions on the server side as well as dedicated tools on the client side to publish and manage served data. In order to deal with security issues, a front-end service has been introduced and a RESTful API has been developed to publish and manage imagery, elevation and vector data for now. The work-in-progress publication tools allow to provide the system with all these data that can then be accessed through OGC-compliant web services.

Proofs of concept of data integration have been achieved, displaying successively in the COP: point cloud datasets from laser scanners, image mosaics from UAV imagery, localisations of victims and on-the-fly density maps of detections from the Mobile Phone Detector (MPD).

Beta Version

First versions of the COP application have been developed and demonstrated during table-top exercise, pilot 1 demonstration and end-user workshops.

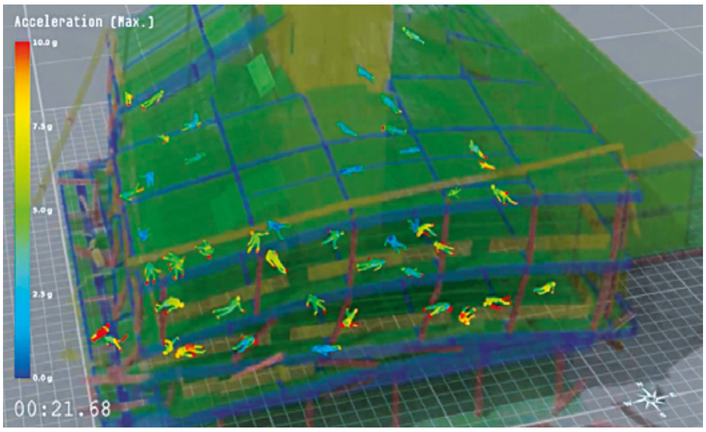
Constantly improved depending on end-user driven iterations, a first release has been distributed during the last workshop in Freiburg. This will give the end users the opportunity to autonomously deploy the software and become familiar with the GUI, 2D/3D interactions, drawing tools and operational concepts of the COP.



Among the numerous features provided by the COP, drawing automatically clipped sectors and creating automatically named worksites are ones of the most important to be discussed with end users during next iterations.

Collapse Simulation

During the summer 2016, the collapse simulation software (BCB) that is developed at LUAS was tested thoroughly when it was applied to simulate the collapse of the Pyne Gould Corporation building that was destroyed in Christchurch by a major earthquake. The simulation results featured an excellent match with the building´s real debris formation.



For example, the whole basement withstood collapse entirely and the midway shear core that contained lifts and stairways tilted eastwards. Thereby, the upper-floor slabs formed voids at the transition to the lift shaft. Reports by rescue personnel that arrived at the site short after the earthquake show that some survivors were indeed found in the collapsed building in similar cavities.

This simulation accuracy was made possible with newly added connection properties supplied by the BCB software. The new connectivity between building elements now allows tensile deformations that are needed to simulate approximately the behaviour of steel reinforcement.

In a nutshell, the BCB is an add-on that complements the Bullet Physics engine in the 3D software Blender. It allows to attribute realistic structural dependencies between elements of a virtual building model such as pillars, walls, beams, slabs etc. The BCB automatically sets multiple constraints to enable several force evaluations on precise junction points between rigid objects. The script also automatically calculates the breaking threshold values for each of the constraints based on material properties. The toolset in conjunction with the Bullet Physics engine should deliver satisfactory simulation results. It is expected to simulate failing building structures under hazardous impact to a degree that allows predictions, what building parts will resist the impact and where falling debris will accumulate.

The BCB development aims at easy operation even by relatively unexperienced users. Several supporting tools are therefore included that support the user to prepare building models for simulation.

Blender´s built-in rich 3D functionality was utilised to allow users to intuitively walk through the collapsed model. Victim dummies were placed in the building and their position was tracked during the collapse process.

This simulation software environment with its highly realistic render capability has an inherent potential for the creation of an educational tool for USaR personnel that allows users to virtually experience a realistic collapse scenario without being at risk. With the help of modern VR technology and motion-tracked, handheld controllers (HTC Vive), students could directly manipulate objects, remove debris or interact with victims.

Presentation in related events & conferences

Events & Conferences

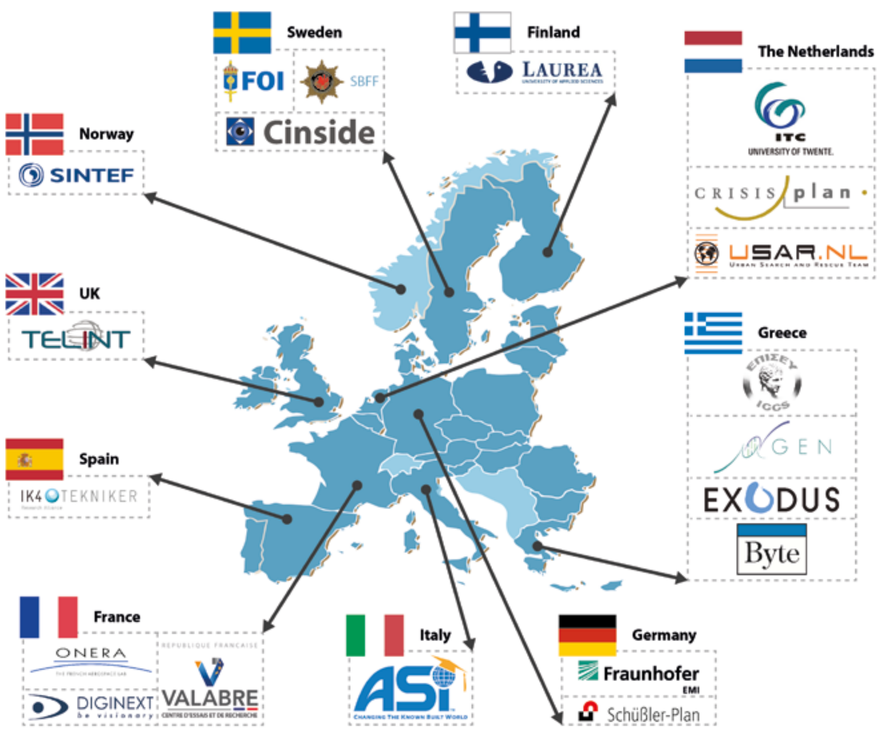
- A technical poster entitled "Compact Aperture Coupled patch Antenna Design" was presented at the Swedish Microwave Days 2016, Linköping, Sweden; 15-16 March 2016.
- A poster presentation entitled "INACHUS Snake Robot for Research and Rescue Missions" was given at the 7th edition of the European Robotics Forum (www.erf2016.eu), Ljubljana, Slovenia; 21-23 March, 2016.
- One INACHUS presentation in the congress by TEKNIKER: "Jornadas de gerencia de riesgos y emergencias" (Risk and Emergency Management Congress, http://gerenciariesgosyemergencias.eu/) which took place in San Sebastian, Spain; 23-27 May, 2016.
- A paper entitled «Trapped Victim Detection using a Miniaturised LWIR Camera» has been presented in the 11th International IR Target and Background Modeling & Simulation Workshop, Carcassonne, France; 27-30 June, 2016.
- A paper entitled «Real Time Earthquake's Survivor Detection using a Miniaturised LWIR Camera» has been presented in the 9th ACM Pervasive Technologies Related to Assistive Environments, Corfu, Greece; 29 June – 1 July, 2016.
- The INACHUS Snake Robot has been presented through a short video at Industri 2016 (http://industri.norskindustri.no/), Bodø, Norway; 28-29 September, 2016.
- A paper entitled «UAV-Based 3D Modelling of Disaster Scenes for Urban Search and Rescue» has been presented in the 2016 IEEE International Conference Imaging Systems and Techniques, Chania, Greece; 4-6 October, 2016.
- Presentation entitled «Verwundbarkeitsanalyse urbaner Gebiete – 3D Bewertung für Nachhaltigkeit und Resilienz (Vulnerability analysis of urban areas – 3D assessment for sustainability and resilience)» in the 5th Forum of Digital Cities at the 34th CADFEM ANSYS Simulation Conference (http://simulation-conference.com/en/), Nuremberg, Germany; 7 October, 2016.
- INACHUS project presentation to USAR.NL organisation during their Annual Meeting Rotterdam, The Netherlands; 24 November, 2016.
- INACHUS dissemination material was distributed during the PSC Europe Forum Conference, Athens, Greece; 23–24 November, 2016.

Future events

Event Planning for 2017

- INACHUS will organise a session on “Monitoring and resilience of Critical Infrastructure in the hyper-connected society” in ISCRAM 2017 (https://iscram2017.mines-albi.fr/); 21-24 May, 2017.
- A paper on INACHUS will be published in the International Geoinformatics Research and Development Journal (IGRDJ) in 2017.
- A conference paper «Deep Learning for Urban Remote Sensing» (ONERA) has been accepted at JURSE’2017, Dubai, UAE; 6-8 March, 2017.
- The second pilot of INACHUS project will take place in Spring, 2017.
- INACHUS will organise a workshop during the ISCRAM 2017.
- INACHUS will participate in a workshop titled “Pervasive Intelligence in Engineering” during PETRA 2017.

Please stay tuned for more information !



This project has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement n°607522