

Editorial

Welcome to this ROBO-SPECT's fifth newsletter.

ROBO-SPECT is a European 7th Framework project funded under the ICT programme on Robotics Use Cases (contract No. 611145), implemented by 10 partners from 6 European countries.

The main objective of the project consortium is to provide an automated, speedy and reliable tunnel inspection and assessment solution that can combine in one pass both inspection and detailed structural assessment and that only minimally interfere with tunnel traffic. The proposed robotic system has been evaluated at the research infrastructure of VSH in Switzerland and at a tunnel of Egnatia Motorway in Greece, while its final version will also be field evaluated and benchmarked at an Egnatia Motorway tunnel in Greece.

The project officially launched its activities in October 2013. During the first years of the project the partners identified an extended group of end-users, derived user requirements and specifications and based on these, designed the first prototypes of all components and the integrated robotic system.

Inside this issue you will find the results of the field evaluation of the ROBO-SPECT robotic system at the Egnatia Motorway tunnel and information on the consortium's participation in conferences and other events related to the project's research field.

Angelos Amditis

Project Coordinator

PROJECT FACTS

Duration:

1 October 2013 –
30 September 2016

Total Cost:

4.592.196,00€

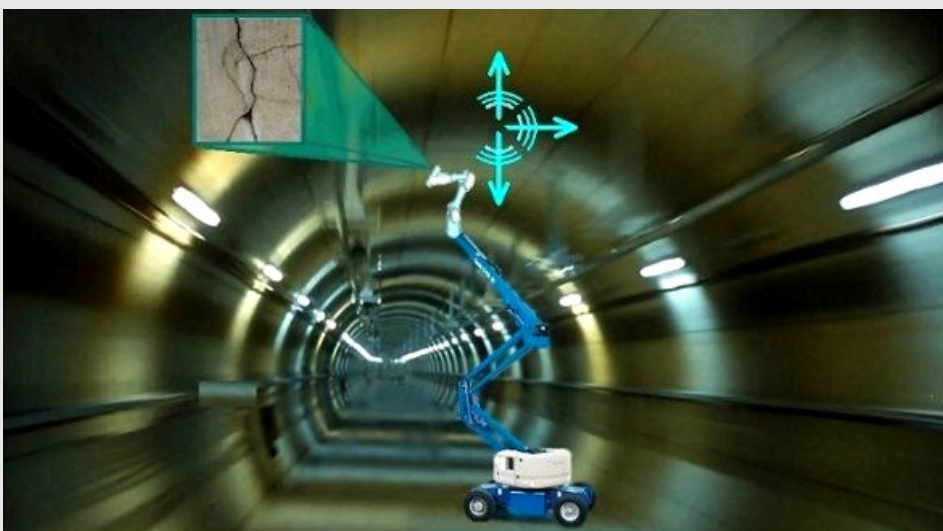
EU contribution:

3.306.599,00€

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Integration and Field Evaluation of the ROBO-SPECT System at a Tunnel of Egnatia Motorway in Greece

The ROBO-SPECT system has followed a series of integration and testing sessions organized at the premises of the ROBOTNIK partner, as well as the actual tunnels of Egnatia Motorway in Metsovo (Greece).

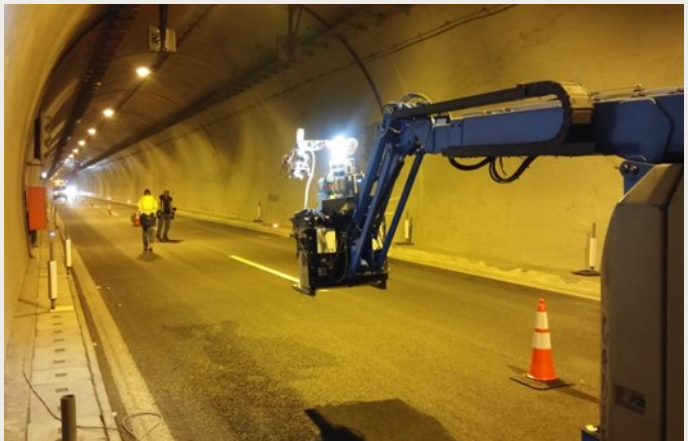
Initially the system has followed in-lab testing to verify the system operational characteristics and ensure proper configurations, as well as an overall operational behavior following the end-user requirements. Towards this, the operation of the different sub-modules was verified.

As a second step, the robotic system has been transported to the actual tunnels of Egnatia motorway in Greece for operational tests at the actual tunnels of the motorway.

The actual tunnels for testing have been selected following some representative scenarios able to demonstrate the system capabilities but at the same time providing spots with defects that the system can detect and actual positions of inspection interest for the Egnatia motorway as an end-user. For this two tunnels have been selected, the first being the Malakasi A tunnel and the second being the Metsovo tunnel.

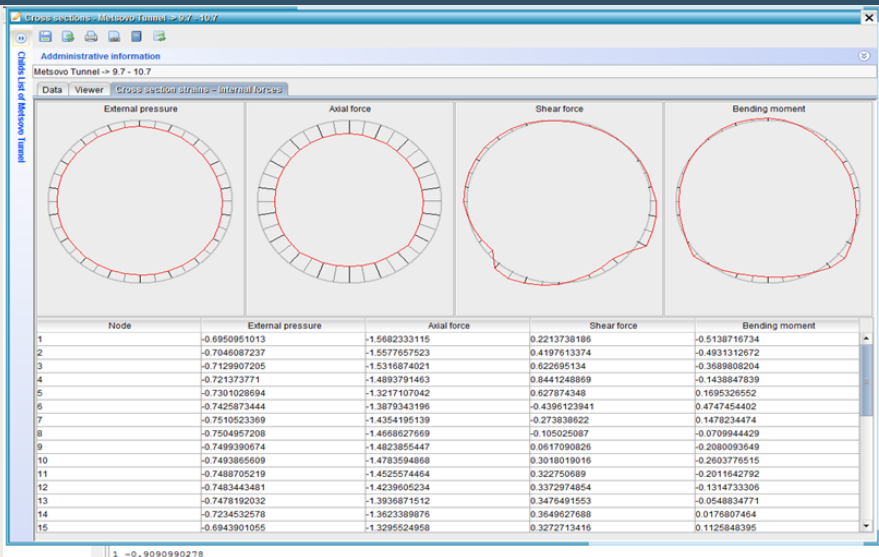
The Malakasi A tunnel has a total length of 400m, with similar characteristics to the Metsovo tunnel. It has been used to obtain pictures of defects to train the computer vision system.

The Metsovo motorway tunnel is a 3,5 km long twin tunnel. Construction of the north bore, whose maximum internal diameter is 9,6 meters and maximum internal height is 8.5m, was completed in 1994. The width of the pavement is 7,8 m and the width of the curbs is 0,85m. The clearance borderline has a height of 4,90 m and the maximum height measured from

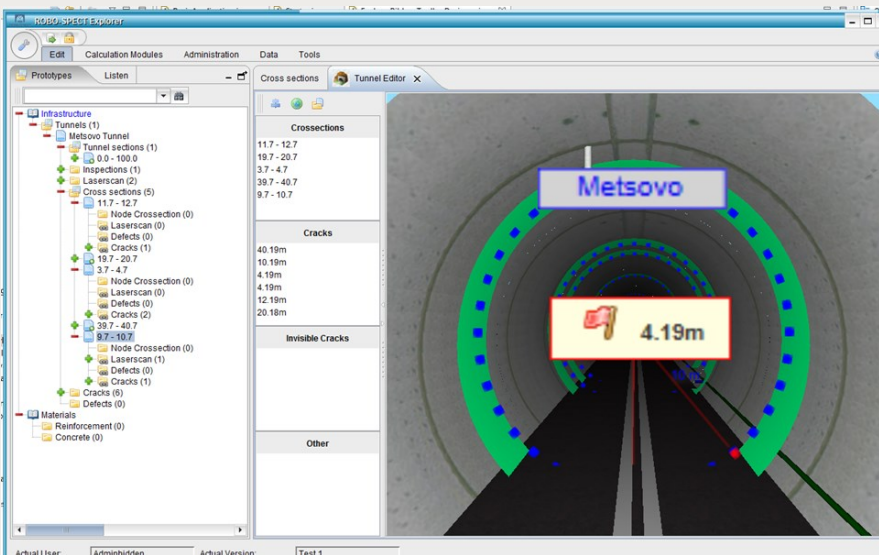


the pavement level up to the tunnel crown is 7,1 m. Egnatia Odos S.A. built the south bore and the cross passages and set the twin tunnel in operation in 2008.

The testing of the ROBO-SPECT system started from the left branch of the Metsovo tunnel, (first 200m from the east portal) whose lanes were closed to traffic, alternatively the right or left traffic lane. The traffic in the respective lanes was periodically controlled to ensure proper system operation, as well as safety for the operators and the consortium.



During the system first trials, the autonomous character of the system was tested and validated in its operational capability to perform structural inspection of transportation tunnels. This has proved beneficial for the tunnel operators and inspection companies (usually contractors) since such a system not only minimizes the inspection time but at the same time increases detection accuracy, keeps precise and analytical inspection log that enables future comparisons for the tunnel condition evolution, as well as dramatically increases inspectors' safety. At the same time, the inspection technologies were tested in actual operational conditions including the advanced computer vision detection that can identify visible cracks or other structural defects on the tunnel surface, a high precision laser scanner able to capture tunnel structural deformations with an accuracy of 1mm, as well as a high precision ultrasonic system able to measure crack width and depth with an accuracy of about 1mm as well. Based on the project field and lab trials and having actual feedback from the testing sessions (in lab and site) the system is currently being refined and benchmarked. It is planned that the system will be finally demonstrated to the EC project officer and reviewers in mid-July 2015.



Operational capabilities

During the tests the following operational capabilities have been tested, validated and benchmarked:

- Mission definition in waypoints inside the tunnel and inspection tasks per waypoint
- Capability of robotic system to autonomously follow defined path and execute defined inspection tasks
- Operation of crack detection, laser scanning and ultrasonic measurement of cracks in the tunnel intrados. Laser scanning will either be carried out along all the test path (200m of from the east portal of the left branch of Metsovo tunnel) or will be carried comparatively for selected cross sections, with and without cracks, for providing needed information for structural assessment purposes
- Mission debriefing following inspection results
- Decision Support System (DSS) on tunnel classification (based on recognized defects) and user interface.

Additionally, the above DSS can provide a detailed assessment of the structural condition of the tunnel exclusively based on robotic measurements (see the Figures on screenshots from the DSS based on a tunnel simulated environment).

News and Events

ROBO-SPECT Special Sessions

ROBO-SPECT Special Session at EU Robotics 2016

ROBO-SPECT was presented at a highly successful special session that was organized in the European Robotics Forum (ERF) 2016 in Ljubljana, Slovenia, 22 March 2016. The aim of this workshop was to present the recent developments and future challenges of the autonomous robotic inspection systems. The focus was on structural assessment of civil infrastructures such as highway and train tunnels, metro stations and underground storages. The main robotics and sensors analysis technologies were presented and discussed. The view of end-users of the tunneling sector was also presented.



The special session was attended by about 70 persons from the civil, robotics and inspection industries and academia. The programme of the special session was the following:

09:00 – 09:05 – Welcome and Introduction (A.Amditis, ICCS (GR), J. G. Victores, UC3M (E))

09:05 – 09:20 – State-of-the-art on robotics tunnels' inspection (C. Balaguer, UC3M (E))

09:20-09:35 – Future trends on robotics inspection of civil infrastructures (T. Bock, TUM (D))

09:35 – 9:50 – Computer vision methodologies and algorithms for tunnel structural assessment(K. Loupos, ICCS (GR))

9:50 – 10:05 – Ultrasonic technologies for measuring crack width and depth in high accuracy (Luca Belsito, CNR (I))

10:05 – 10:20 – End-users point of view: Tunnels' inspection and assessment (P. Wright, CH2M Hill (UK))

10:20-10:30 - Discussion and brainstorming

International Symposium on Visual Computing

A special session was arranged by ICCS and launched in conjunction with the International Symposium on Visual Computing with the title "ST5: Spectral Imaging Processing and Analysis for Environmental, Engineering and Industrial Applications" (see <http://www.isvc.net/>) to take place on Dec.12-14, 2016, in Las Vegas, Nevada. The session is supported by the ROBO-SPECT project as well.

11th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications

A special session was organized by ICCS and accepted in conjunction with the VISAPP 2016 11th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications , 27-29 February , 2016, in Rome Italy, under the title "RBG and Spectral Imaging for Civil/Survey Engineering, Cultural, Environmental, Industrial Applications".

News and Events

Presentations/Publications

- E. Protopapadakis, C. Stentoumis, N. Doulamis, A. Doulamis, K. Makantasis, K. Loupos, G. Kopsiaftis, A. Amditis, - AUTONOMOUS ROBOTIC INSPECTION IN TUNNELS, XXIII International Society for Photogrammetry and Remote Sensing (ISPRS) Congress, Prague, July 2016.
- K. Loupos, A. Amditis, P. Chrobocinski, R. Montero, L. Belsito, R. Lopez, N. Doulamis - AUTONOMOUS ROBOT FOR TUNNEL INSPECTION AND ASSESSMENT - 6th International Symposium on Tunnels and Underground Structures in SEE 2016 Urban, Underground Structures in Karst, March 16-18, 2016, Radisson Blu Resort, Split, Croatia
- K. Loupos, Angelos A. Amditis, A. Tsertou, R. Gerhard, V. Kalidromitis, S. Camarinopoulos, S. Lenas, A. Anastasopoulos, K. Lenz, M. Hill, A. Adesiyun, B. Frankenstein - SKIN-LIKE SENSOR ENABLED BRIDGE STRUCTURAL HEALTH MONITORING SYSTEM, 8th European Workshop on Structural Health Monitoring (EWSHM), 5-8 July 2016, Bilbao, Spain
- K. Loupos, A. Amditis, A. Doulamis, P. Chrobocinski, J. Victores, M. Wietek, P. Panetsos, A. Roncaglia, S. Camarinopoulos, V. Kallidromitis, D. Bairaktaris, N. Komodakis, R. Lopez - INTEGRATED ROBOTIC SOLUTION FOR TUNNEL STRUCTURAL EVALUATION AND CHARACTERIZATION – ROBO-SPECT EC PROJECT. International Conference on Smart Infrastructure and Construction (ICSIC), 27 - 29 June 2016, Robinson College, Cambridge

Additional Presentations of the Project Results

- ITA Croatia, 6th International Symposium on Tunnels and Underground Structures in South-East Europe with the title 'Urban Underground Structures in Karst' organized with the support of the International Tunnelling Association ITA-AITES (Split, Croatia, 16-18 March 2016). The title of the ROBO-SPECT publication was: "Autonomous Robot for Tunnel Inspection and Assessment"
- The Spanish Technological Platform in Construction (PTEC) forum 2016 in Barcelona (April 6) where a ROBO-SPECT poster was presented to an audience of large Spanish construction companies, such as ACS- Dragados, FCC, OHL, etc.

Consortium



Institute of Communications and Computer Systems (ICCS)



AIRBUS DS



University Carlos III, Madrid Dpto. De Ingeniera de Sistemas y Automatica Robotics Laboratory(UC3M)



VSH Hagerbach Test Gallery Ltd. (VSH)



Egnatia Motorway S.A. (EOAE)



Institute of Microelectronics and Microsystems, National Research Council of Italy (CNR)



RISA Sicherheitsanalysen GmbH (RISA)



Techniche e Consulenze Nell' Ingegneria Civile S.p.A - Consulting Engineers S.p.A



D. Bairaktaris & Associates Structural Design Office Ltd. (DBA)



Ecole des Ponts ParisTech (ENPC)



ROBOTNIK (ROB)

END USERS IN THE GROUP

End users that participate as partners, associate partners, subcontractors or members of an extended users' group that has been formed are: EUROTUNNEL, London Underground, RATP (Parisian metro), Attico Metro (Athinean metro), Harcrow Group Ltd., Egnatia Motorway S.A., Aegean Motorway S.A., SITAF, and CETU (in the French Public Roads Administration).

Contact Us

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