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“Development of a Novel Integrated Inspection System for the Accurate Evaluation of the Structural Integrity of Rail Tracks”

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Abstract:
The present document presents the Publishable Project Summary for the 42 month reporting of the INTERAIL project.

Notes:
This summary makes part of the Periodic Project Report P3.

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1. Publishable Summary

INTERAIL (Development of a Novel Integrated Inspection System for the Accurate of the Evaluation of the Structural Integrity of Rail Tracks, is a collaborative FP7 project under SST.2008.5.1.1: “Advanced and cost effective infrastructure construction, maintenance and monitoring”, funded by the European Commission comprising 13 partners from seven European countries. INTERAIL aims to minimise the occurrence of rail failures through the implementation of a novel integrated high speed inspection system. Advanced manual defect verification techniques will also be researched for faster and more reliable inspection of structural integrity of rails.

1.1 Background

The technological advances in train design during the last years have enabled the construction of more high-speed rail lines and the broader use of high-speed trains as an alternative and environmental friendly means of travel, which offers fast and reliable transportation of passengers and goods between hundreds of cities across the European continent. The increasing trend for the industry’s business is forecast to continue in the forthcoming years, since rail transport is steadily becoming a more attractive option over other means of transportation for the public. This is due to the fact that train travel is generally cheaper than using a car or an airplane, and very often the fastest option to reach a destination. It is also inherently safer and far more environmentally friendly in comparison to car travel, without compromising passenger convenience.

Today, rail networks across Europe are getting busier with trains travelling at higher speeds and carrying more passengers and heavier axle loads than ever before. The combination of these factors has put considerable pressure on the existing infrastructure, leading to increased demands in inspection and maintenance of rail assets due to the higher risk of catastrophic failure. The successful implementation of the INTERAIL system will deliver a step change in rail inspection practices currently employed by the rail industry through the development of a novel inspection approach integrating in a single vehicle different advanced techniques, leading to higher levels of reliability and safety.

Figure 1 – The Hatfield Rail Track Site following the accident

1.2 Project Objectives

The INTERAIL consortium will develop and implement an integrated high speed inspection system based on a modular design, which will enable a faster and more reliable inspection of rail tracks at faster speeds compared to the available ones.

INTERAIL presents the following major objectives:

1) To overcome the limitations of current inspection procedures of rail tracks through the successful implementation of an integrated high-speed inspection system based on automated visual, Alternating Current Field Measurement (ACFM) and ultrasonics techniques, combined in a single architecture as shown in the figure presented.
2) To develop advanced verification and evaluation procedures of the defects detectable by the high-speed system based on ACFM, ultrasonic phased arrays, and high-frequency vibration analysis equipment.
3) To achieve higher levels of PoD of rail defects leading to the substantial improvement in the actual reliability of the European rail network.
4) To decrease inspection times and associated costs by up to 75% through the integration of three different rail track evaluation techniques that will complement each other as part of a functional single high-speed NDE.
5) To develop the required software and intelligent control unit to enable automatic and real-time analysis of the defects detected and minimise human subjectivity during the interpretation and analysis of results.
6) To contribute to the harmonisation of inspection procedures and network reliability across Europe.

1.3 Project Approach

The total work content of the project is divided in five technical workpackages (WP) as follows:

WPA: Sample procurement and system specification. Within this WP the consortium will collect and analyse data from the existing literature, rail infrastructure managers, rail track inspection providers, rail track maintenance companies and rail manufacturers in order to thoroughly evaluate the deficiencies that are currently associated with rail inspection and maintenance procedures and their effect on European rail transport.

WPB: Novel high-speed inspection system. This WP consists in the development of the integrated inspection system combining three main modules based on three different non-destructive evaluation technologies: ACFM, Ultrasonics and Automated Vision.

WPC: Positioning, sensor adjustment and defect marking subsystem. In this WP the positioning, sensor adjustment and defect marking system will be developed.
WPD: Manual defect verification inspection techniques. Development of a special equipment will be developed for the verification and evaluation of rail defects which are detected with the high-speed system.

WPE: Integration and validation. The integration of the output of WP B and WP C will carried out in a single high speed rail inspection system. The validation of the system and of the defect verification techniques will be the basis for the system assessment.

The successful integration and validation tests of the INTERAIL high-speed rail inspection system, defect verification and evaluation techniques will be followed by thoroughly planned field trials and demonstration of the system’s capability at the consortium railway operators.

1.4 Expected Final Results

The major results expected from the project are:

- High speed Automated Inspection equipment integrating several NDT techniques to be installed at REFER dedicated inspection vehicle.

- Intelligent software and control unit;

- Manual inspection equipment for faster and efficient inspections;

- Reduction of costs, time and accident probability;

- Increase of POD and reduction of POF;

- Training of operators and certification procedures.
1.5 Results up to date

The project has completed 42 months of activity in which the first 18 months were dedicated to the specification and development of the high-speed inspection system and applied manual defect verification equipment. 

The project activities during the first 18 months activity started by specifying the high speed system inspection system and the manual defect verification equipment. Gathering and characterisation of relevant rail samples was accomplished which will support the laboratory testing of both systems. Development of individual inspection modules as automated ACFM and ultrasonics for the high speed monitoring system have been accomplished and prototypes were tested in laboratory environment. The Vision system comprising 3 different dedicated modules as vision, rail profile and corrugation measurements were developed for integration in the overall system. 

The mechanical deployment system design and modelling studies started during the first 18 months as well as the development of the Central Control Unit for data collection and analysis. The manual defect verification techniques were developed particularly the manual ACFM, UT phased array and high frequency vibration analysis where modelling and test trials have been carried out. 

The second 18 months period of the INTERAIL project was focussed on the test and validation of the high-speed deployment system, inspection modules mechanical design interfaces and its manufacturing. The UT, ACFM and vision modules prototypes were available by month 24 and were intensively tested in laboratory before integration of the systems takes place. The Central Control Unit for data collection and analysis has been developed and adapted to each of the modules type of data format and train inspection location. A dedicated software for defect analysis has been developed and integrated into the Central Control Unit. The interfacing, including the mechanical and electronic integration, between the high speed inspection modules and the deployment system is now at the final stage of manufacturing and the final assembly in the inspection vehicle will be performed in the next period. Manual verification techniques, as HFV (High Frequency Vibration), UT phased array and ACFM were completed and tested and specific manual deployment mechanisms were developed for field application.

In the last six months period of the project all integration of the automatic system and validation of manual techniques were carried out. Consolidation and analysis of all the inspection modules results were carried out and presented in a dedicated deliverable (D8). Final demonstration of the system was carried out in the last 3 months of the project.

The project promotion have been systematically carried out and updated through the project website during all project duration. Dedicated promotional material (leaflets), technical papers and posters have been distributed and presented in conferences as NDT 2010 (ECNDT), RCM 2011, BINDT 2011/2012 and Railways 2012 by some of the partners.
INTERAIL was present in other relevant Railway research and industrial events as WCRR (World Congress for Railway Research), TRA (Transport Research Arena) and INNOTRANS 2012 where specific publications of the project results were available to a wider audience.

Other relevant technical papers were submitted to Journal of Transportation Research and in the Mechanical Systems and Signal Processing (MSSP) are under evaluation. An INTERAIL abstract has been submitted to the next TRA2014 to be held in April 2014 and has been accepted as a full paper for submission.

A Final Demonstration workshop was organised and held in Portugal in March 2013. A relevant audience has attended and on-train demonstration was carried out to the invited attendees. A dedicated video highlighting the main developments of the project was produced.

All project publications including the Demonstration workshop presentations and video are available at the project website.

1.6 Consortium and Coordinator details

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1.7 Intention for use and Impact of expected final results

The achievements and results produced within the INTERAIL project will have a significant number of positive impacts as it will contribute to the improvement of the: a) safety record within
the rail industry, b) reliability of rail transport and c) of industrial competitiveness in Europe. INTERAIL will be a major component on the road towards achieving the safety and business targets set for the European rail industry and will help push forward the European rail research agenda further. Widespread application of the INTERAIL platform will decrease inspection times and associated costs by up to 75% whilst it will improve the reliability of the rail network. Inspection costs currently represent 15% of the direct overall maintenance costs. Due to the decreased accuracy offered by current techniques, the use of preventative and reactive maintenance is not efficient enough. A significant improvement in inspection reliability achieved through the application of the INTERAIL systems could result in a further 10% reduction in maintenance times to be achieved. This could potentially lead to an overall reduction in current maintenance times and costs of up to 20%.

The partners will define the details necessary to share the results and use of the developed systems through an Exploitation Agreement. This will allow them to define their intention for use, and the impact they see individually for their company and collectively for society.

1.8 Dissemination & Project Website

The dissemination mechanisms of particular use to the project include: dedicated meetings; seminars; trade fairs; workshops; infodays; interface with other projects; interface with technological platforms (ERRAC) and the project website (www.interailproject.eu) through the production of technical papers, presentations and other promotion and dissemination material. The website is being used as the hub of all dissemination activities, with all the project information being placed onto the site. The site itself has areas that are for public access and allows questions to be asked or comments to be produced by the outside public to the experts within the project as well as areas that are restricted to the consortium. The use of the website has been shown to have a number of benefits include acting as a central resource for all partners and providing some feedback as a measure of the success of promoting the project to a wide audience. All technical publications presented in public conferences as well as in technical magazines made by the consortium are available for download at the project website. This will further increase as additional information related with the project final developments and results is posted via this route.
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