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Deliverable D8.5

Video Showcase

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EXECUTIVE SUMMARY

The European Road Network (ERN) is undoubtedly one of the most important land infrastructures in the EU. Consisting of a wide variety of types of roads and motorways, it is and will remain for the foreseeable future a crucial artery for Europe. Transport infrastructure is fundamental for the smooth operation of the internal market, for the mobility of persons and goods and for the economic, social and territorial cohesion of the European Union. However, the most important factor for the quality of the ERN is maintenance and it is considered to be the most expensive function of a highway operating agency.

As a result, there is a real need for an early detection of deterioration mechanisms and of potential presence of defects through a more advanced road infrastructure inspection technology. Therefore, the ultimate goal of EU FP7 RPB HealTec project (Road Pavements & Bridge Deck Health Monitoring / Early Warning Using Advanced Inspection Technologies) is to develop an integrated solution that would be able to reduce the maintenance costs and improve the performance by means of accurate and fast road inspection

Deliverable D8.5 “Video showcase” provides an end-of-project deliverable, a public showcase will be performed to exhibit the performance capabilities of the RPB HealTec system and the features of the Graphical User Interface (GUI). The showcase is based on videos, photos and featuring data complied. The video is shared on YouTube, through the official RPBHealTec YouTube channel, permitting easy sharing via social networking and linked from the project website.

TABLE OF CONTENTS

ABBREVIATIONS

ACU	Air-Coupled Ultrasound
CCU	Central Control Unit
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GUI	Graphical User Interface
HDV	High Definition Video
IRT	Infrared Thermography
NDT	Non-Destructive Testing
VI	Visual Inspection
VS	Video Showcase
WP	Work Package

1 INTRODUCTION

With completion of the other work-packages, particularly work-packages 5, 6, and 7, the material was available to produce the Video Showcase (VS). The VS is a key vehicle to disseminate project outcomes, and is designed to accessible to anyone with an interest in inspection technologies. Crucially, the VS should provide the motivation for the project, the hardware system, its integration, as well as demonstrate capabilities of the software, both in terms of data acquisition and image processing for fusion and defect detection.

2 VIDEO SHOWCASE

The video showcase consists of a roughly 10 minute video that

1. Motivates the project
2. Introduces RPBHealTec
3. Describes the hardware and hardware integration
4. Describes the software, including acquisition and image processing
5. Provides a summary and link to the project website.

The video was produces in high definition (1080p) format to enable viewing on a variety of devices including computers and mobile devices.

3.1 Introduction

The video showcase begins with a short clip showing the prototype system performing a survey (this is described in D7.2). Overlaid on the clip is the RPBHealTec logo.

Figure 1.2 Introduction

This fades to white.

3.2 Motivation

A voice-over begins based on a script that was written (this script appears in the Appendix). The start of the video describes the motivation for the project. Facts about the European Road Network are provided, along with estimated costs of its construction and maintenance. This section provides a short overview on pavement condition monitoring, including functional and structural aspects, and motivates how defects should be detected early. This section also describes how surveys are typically performed, including visual inspection, the most common form of survey. Figure 1.3 shows a still of a junction in the Netherlands used in the video, and Figure 1.4 shows an image of defects that appears in the video.

Figure 1.3 Motivation – European Road Network

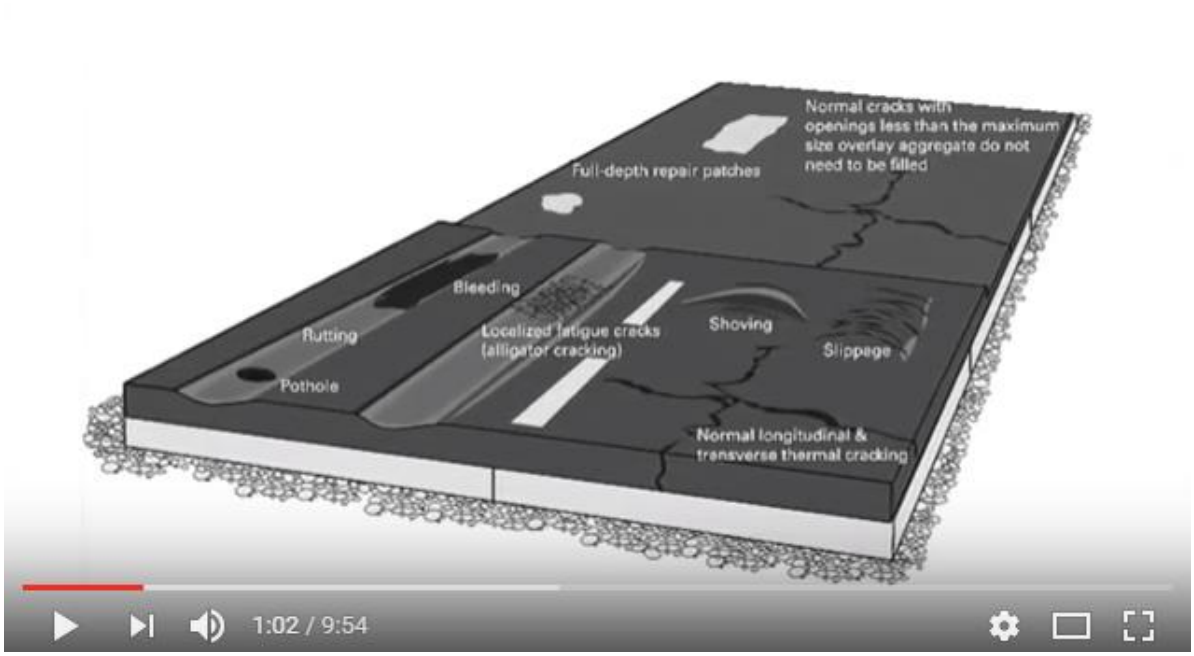

Figure 1.4 Motivation - Defects

3.3 RPBHealTec

Once the problem of early detection of defects is introduced, the video introduces the RPBHealTec system as solution. It lays out the primary objectives of the project, and mentions some facts about the consortium, along with funding from the European Union. An image from this section of the VS is shown in Figure 1.5.

Figure 1.5 Introduction of RPBHealTec

3.4 Hardware and hardware integration

The hardware used in the RPBHealTec project is reviewed. This includes

- Infrared Thermography
- High Definition Video
- Ground Penetrating Radar, and
- Air-Coupled Ultrasound.

These sensors are the key non-destructive testing devices used in the project. Other hardware including the Global Navigation Satellite System, Inertial Navigation System, and Distance Measuring Instrument are reviewed. This section concludes with a description of the hardware integration, including the trolley and its construction. Figure 1.6 shows a still when the GPR is being described.

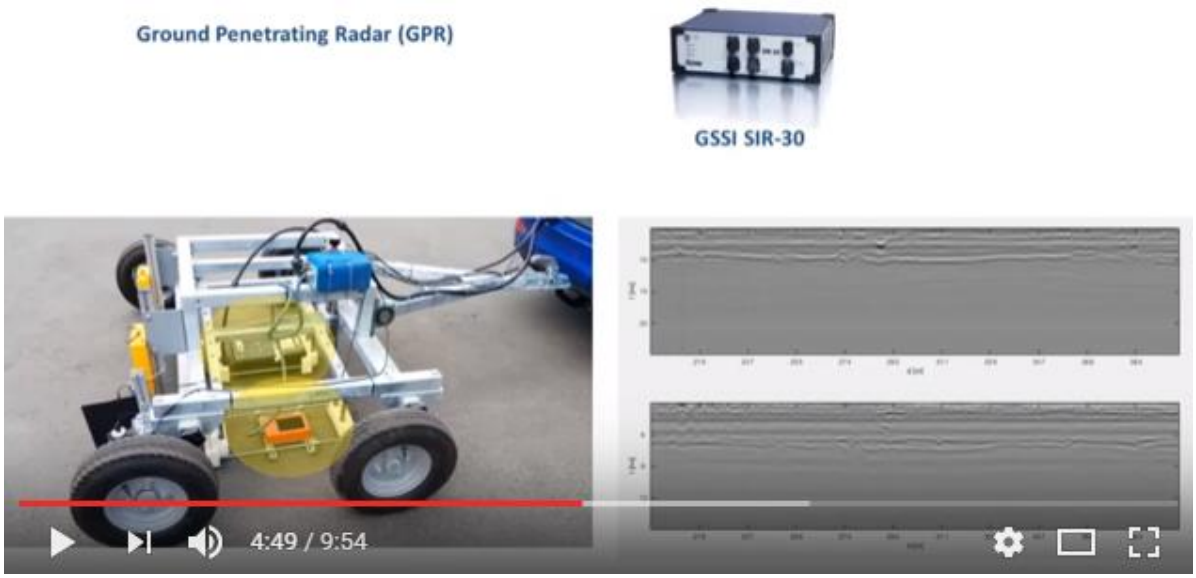

Figure 1.6 Description of RPBHealTec hardware and its integration

3.4 Software

The next section of the Video Showcase focusses on the RPBHealTec software. It begins by describing the Central Control Unit that provides a communications interface, data acquisition, database management, and storage of acquired data. Video showing an exemplar session is displayed, along with sample data acquired in the form of tables. Next, the Video Showcase demonstrates the capabilities of the image processing software, which operates on each modality and provides sensor fusion. Detected defects are automatically displayed for further analysis by the surveyor. Figures 1.7 and 1.8 show the CCU and image processing capabilities as stills from the Video Showcase.

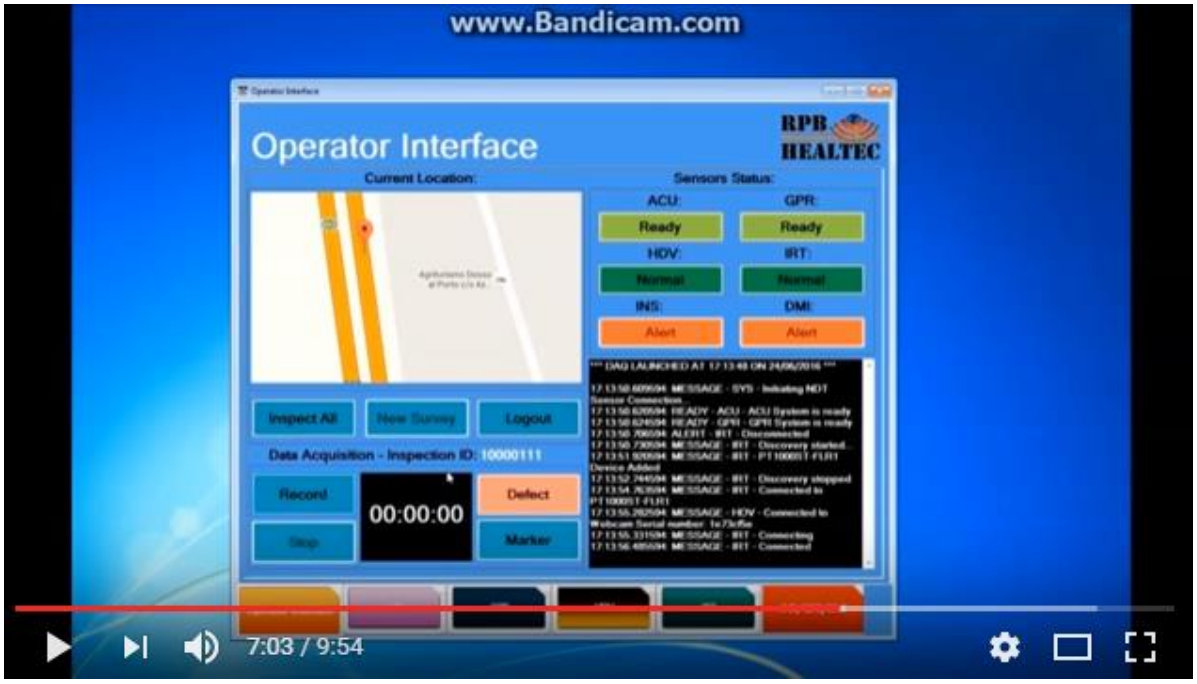

Figure 1.7 Demonstration of the CCU

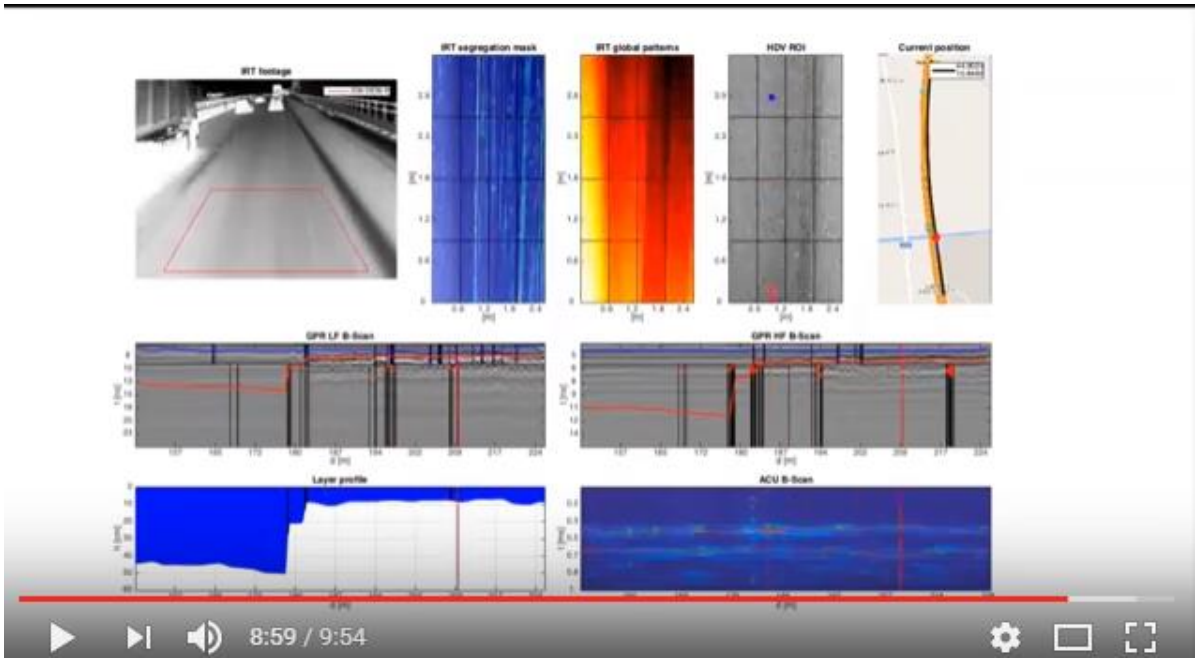

Figure 1.8 Demonstration of the fused results

3.4 Conclusion

The final section of the Video Showcase concludes the video, summarising the achievements and providing a link to the RPBHealTec webstie for further information, as shown in Figure 1.9.

Figure 1.9 Conclusion

3 YOUTUBE CHANNEL

A decision was made to create an official RPBHealTec YouTube channel for the project. This would provide a natural forum for uploading the Video Showcase. In addition, further videos could also be placed on the channel. Interested individuals can subscribe to the channel to receive updates and notifications.

The YouTube Channel can be accessed at

https://www.youtube.com/channel/UCAbs9nIXW4zu_PVo7fjlABA

or easily found through a Google or YouTube search by searching for "rpbhealtec". The RPBHealTec YouTube channel main page includes the project logo, as well as an image of the prototype system was tested in Italy and described in D7.2. A figure showing the YouTube channel appears below in Figure 1.1.

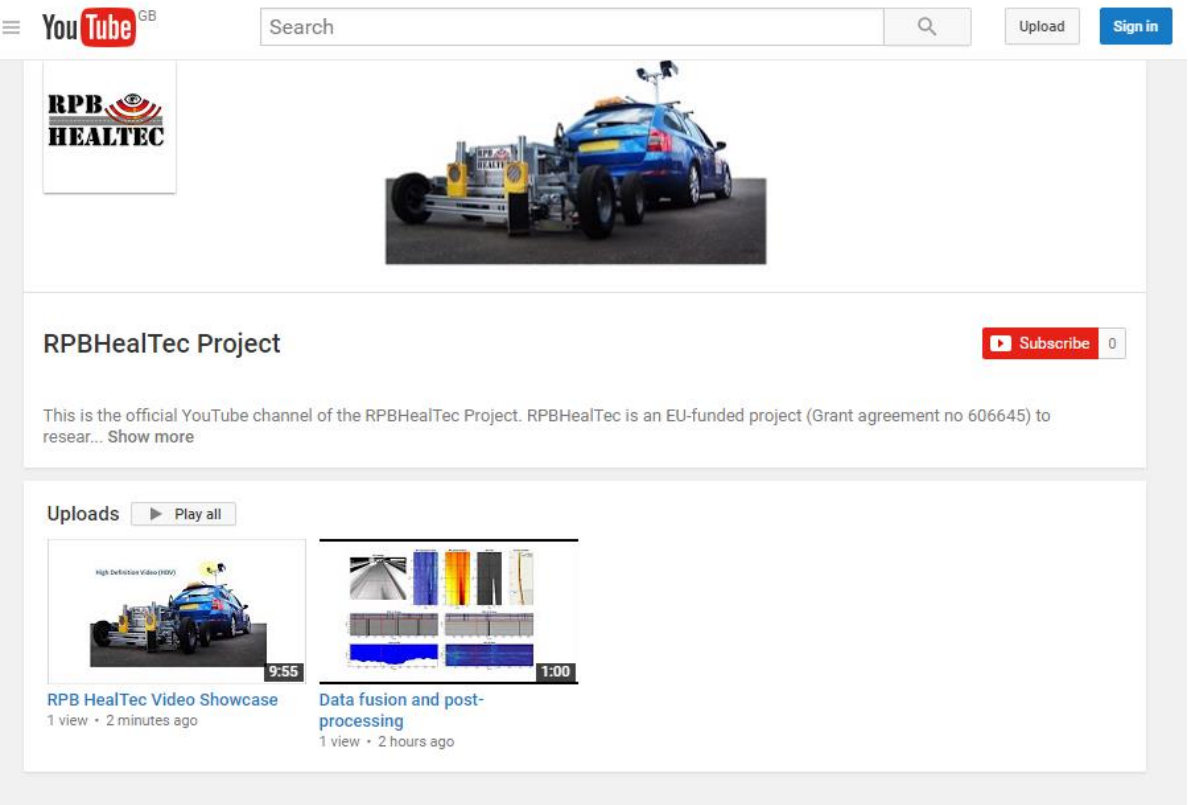

Figure 1.1 RPBHealTec YouTube Channel

4 CONCLUSIONS

The present deliverable covered the Video Showcase, in terms of its content. The Video Showcase exhibits the performance capabilities of the RPB HealTec system and the features of the Graphical User Interface (GUI). The showcase is based on videos, photos and featuring data complied. The video is shared on YouTube, through the official RPBHealTec YouTube channel, permitting easy sharing via social networking and linked from the project website. The YouTube channel permits additional Project videos to be shared externally.

APPENDIX

The script for the Video Showcase appears below.

Motivation

The European Road Network is estimated to be approximately 5,000,000 km in the EU 27. It is undoubtedly one of the most important land infrastructures in the EU, both in economic terms and social terms. A critically important factor for the quality of the road network is maintenance – in fact, this is considered to be the most expensive function of a highway operating agency. According to recent European Commission estimates, the annual total cost of road construction and maintenance is measured in tens of billions of euros.

The pavement condition is characterised with respect to its functional and structural aspects. The structural condition determines the structural capacity of the pavement from the measured layer thickness, while the functional condition assesses the ride quality based on the measurement of surface texture parameters and the presence of surface defects. Defects such as cracks, rutting, potholes, and slippage should be detected early and resolved through well-timed preventive maintenance actions such as crack sealing, surface coating, or patching. This extends the road pavement lifetime by deceleration of the deterioration processes.

Accordingly, regular road condition surveys reduce the costs of maintenance, traffic accidents, and the costs due to impedance of goods travel during maintenance periods. The most common type of survey is visual inspection, which is characterised by low inspection speeds and is highly dependent on the surveyor's level of expertise. Additional inspection measurement tools may be used, like high definition video and laser profilometry. However, despite these approaches, there remains a critical need for advances in road infrastructure inspection technologies for early detection of pavement deterioration mechanisms and potential presence of defects.

RPB HealTec

To address this need, we introduce RPBHealTec, a novel hardware and software system for high speed pavement inspection. RPBHealTec integrates multiple non-destructive sensing technologies into a common framework, allowing acquisition, storage, and automated analysis of road survey data. This system was developed in collaboration with nine partners, including universities, small to medium size enterprises, and end users. The project received funding through the European Union Seventh Framework Programmer for research, technological development, and demonstration. RPBHealTec seeks to advance the state of the art in the inspection of European roads, to reduce maintenance cost and increase traffic safety.

Hardware

Central to the RPB Healtec system are non-destructive sensing technologies. When combined, these sensors capture comprehensive multidimensional data for inspection of the road condition, extending previous pavement survey methodologies. Let's take a look at the sensors and hardware system realised in the prototype that was built.

- InfraRed Thermography, or IRT, directly senses the infrared radiation that an object emits due to its temperature. Subsurface defects in a material affect the heat flow through that material, triggering surface temperature differences. The RPB Healtec prototype uses the FLIR A655sc IR sensor for high-velocity pavement inspections. It offers image resolution of 640x480 and operates from –40°C to 150°C. The IRT sensor is safely screwed on a holder that is mounted on the vehicle. The holder has adjustable height and angle so that it offers adaptability for different cameras and lenses.

- Adjacent to the IRT is a high definition video camera captures images with high spatial and temporal resolution. This provides a detailed capture of the road surface including cracks and other defects. The RPB Healtec prototype uses a Logitec C920 camera capturing frames at 1920x1080 resolution.

- Ground Penetrating Radar, or GPR, provides information concerning the subsurface layer structure of the examined pavements, including layer thickness, as well as the depth and thickness of cracks, voids or other imperfections, including moisture problems. In the prototype, the GPR system is composed of a controller and two antennas, operating at 900MHz and 1600MHz. The 900MHz has a depth range of approximately 1 metre and the 1600MHz of approximately 0.5 metres. Their combination offers a good trade-off between depth penetration and minimum defect size detection, enabling inspection of both asphalt and granular subbase layer interfaces.

- The Air-coupled ultrasound, or ACU, is mainly applied for sensitive inspections for defects such as voids, cracks and disbands. It also provides the thickness of pavements, modulus of pavement elasticity, and the non-destructive testing of bridge decks and tunnels.

Additional sensors include a Global Navigation Satellite System, an Inertial Navigation System, and a Distance Measuring Instrument. These provide spatial context for data acquisition for subsequent alignment of measurements. The system captures data that is quantitative, reliable, precise, continuous and at-traffic-speed of 60 km / hr.

All sensors are mounted to an inspection vehicle either on an overhead bar or trolley. The trolley is designed for stability with four wheels and a sturdy suspension system. It is constructed with steel, aluminum and plastic parts that ensure rigidness and safety, both for the road safety as well as for the equipment. Additionally, the materials used were carefully selected so that they do not cause any disruption to the GPR signals. The design was carefully selected in order to allow the standard, easy mounting on any kind of vehicle via a car-hook.

Software

RPB HealTec system also features custom-built software. First, the Central Control Unit consists of novel software program for all-in-one command and control of the RPB HealTec NDT system. The manage all the subsystems. It provides

- A communication Interface;
- Data Acquisition Software for data capture, evaluation, and synchronisation;
- Database Management System that defines the structure of the data storage; and
- Storage of the survey data with implemented data compression and backup mechanisms.

The welcome screen appears when the RPB HealTec software is launched. The operator is required to login with a valid ID and password. The operator can initiate a new survey, including the location of the survey and environmental conditions. The operator interface is the main control interface. It allows the operator to initiate communications with the sensor modules. It also allows the operator to monitor the system performance during a survey, receiving alerts if sensors are operating normally or stop communicating data. The various tabs allow the operator to see data live as it is acquired.

All data is given unique identifiers and stored in a database. The database consists of a tables including tables for the user, survey, system console, sensors position, GPR, INS, HDV & IRT data, marked defects, marked position and DMI data. All these tables have one to many relationship links and they contain measurements raw data from the surveys. The data is stored in a MySQL database or exported for further analysis.

In addition, the RPBHealTec software includes automated image processing. The enables trend analysis and defect detection on each sensor modality. Furthermore, data is fused to provide a comprehensive analysis of the road condition. In the analysis software, the main GUI tab loads survey information and the road segment for processing. The software gives access to the survey information and settings for selection of a survey segment for investigation. It also provides GIS maps of the entire survey along with the local survey segment. Tabs providing image analysis for each modality are provided. This includes the LF and HF GPR, HDV footage, IRT data, and ACU and a LF GPR B-Scan are shown. The HDV and IRT data are reformatted using a projective transformation.

The Sensor fusion tab provides reformatted IRT and HDV frames, IRT footage, GIS map of the investigated survey segment and current location / GPR B-Scan, GIS map of the entire survey with the highlighted selected survey segment, LF and HF GPR B-Scans. All of these multimodal data including automatically identified defects are presented in a single view for analysis by the surveyor.

Conclusion

RPBHealTec has successfully demonstrated the capability to sense, store, and analyse road structures for the presence of defects through a novel hardware and software system. For further information, we encourage you to visit the project website, fp7-rpbhealtec.org, which provides more details about the project, including the sensors, hardware, software, work-packages, and partners in the consortium.