Early version of RESIST integrated platform

Newsletter N°4 - October 2020

Editorial

Welcome to the fourth RESIST Newsletter!

The RESIST project is a Research and Innovation Action that has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under the Grant Agreement No 769066.

RESIST (RESilient transport InfraSTructure to extreme events), a 36-month project, started on 01 September 2018, and aims to increase the resilience of seamless transport operation to natural and man-made extreme events, protect the users of the European transport infrastructure and provide optimal information to the operators and users of the transport infrastructure.

This is the fourth issue of our bi-annual newsletter, which presents the early version of the RESIST integrated platform based on the progress of the project until M24.

Stay updated with RESIST on Social Media and through our website!

RESIST System Architecture

The development of the first integrated RESIST prototype was based on the RESIST system architecture defined during the first half period of the project taking into consideration the elicited technical and user requirements of the project. RESIST system architecture consists of several subcomponents, which operate either on the inspection field or in the RESIST's system backend and are accessible through a single point of access in the control center.

In general, the RESIST subcomponents can be grouped in three main categories as depicted in *Figure 1.*

(a) the data collection components located on the field, which are responsible for gathering information (during the inspection process) from the UAV systems or several used sensors, (b) the RESIST platform backend modules, which are responsible for the analysis of the collected inspection data to boost the situation awareness of the operator regarding the health condition of the infrastructure, and (c) the RESIST Integration Environment component, which is a secured single point of access for the operator located in the control center providing access through a common web browser to all applications of RESIST system.

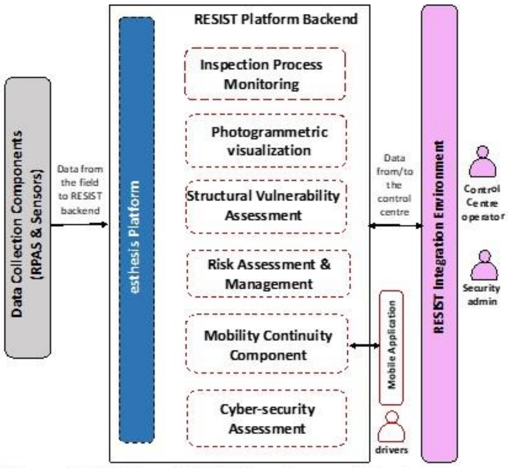

Figure 1: High level RESIST system architecture.

All the inspection data collected from the field (images, point cloud, sensor data, and processing metadata including the location and the type of defects) are transferred to the RESIST backend through the esthesis Platform, which is the actual interface between the components in the inspection site and the RESIST backend system. From the esthesis Platform, all gathered data are available for further processing by a large set of applications: (a) Inspection Process Monitoring application for live monitoring of the entire inspection process, (b) Photogrammetric Visualization application for 3D point cloud presentation including the location and the type of the defects, (c) Structural Vulnerability Assessment application for the actual assessment of the infrastructure condition, (d) Risk Assessment application for assessment, management and planning of further mitigation actions, (e) Cyber-security Assessment application for continuous cyber-security evaluation of all assets of the infrastructure including the entire RESIST system, (f) Mobility Continuity application for re-routing planning and drivers notification through personalized messages in case of extreme events. The user interfaces for all these applications are seamlessly provided though a single point of access (Integration Environment) to the operator in the control room.

A short description of all integrated applications in the early RESIST prototype is presented below.

Data Collection Components

For the collection of inspection data, UAV systems are used to cover the inspection needs in bridges and tunnels. The UAVs are responsible for capturing images and sensor data from several sensors, and for installing new sensors on the infrastructure. The operator of the UAV is able to guide the RPAS according to the provided flight plan from the control center using the GCS *(Figure 2)*. After the completion of the inspection flight, the available sensor data will be transferred to esthesis Platform, while the collected images will be used by the advanced computer vision systems of the project to finally: (a) detect the type and the location of the defects, (b) create 2D annotated images of the defects, and (c) create the 3D point cloud. The output of the computing vision systems will be finally stored in the esthesis Platform, which will also retain data from past inspections.

Figure 2: Ground Control Station (GCS) for UAV navigation and inspection.

RESIST Platform Backend

The Inspection Process Management (IPM) application is used by all actors of an inspection process located in the control center (infrastructure operator) and on the field (UAV operator and operator of the computing vision systems). In RESIST project, the IPM: (a) orchestrates the entire inspection process providing live monitoring of the process with step granularity to the operator in the control center, (b) orchestrates all actors of the inspection located in the control center and on the field, (c) facilitates the communication of all actors located in the control center and on the field, (d) facilitates control center operator to start a new inspection process, while simultaneously managing multiple inspection processes for the same or different assets, and (e) contributes on the standardization of the inspection process, as all actors through the IPM follow specific steps for the quick and the detailed inspection of bridges and tunnels. The sequence of all these predefined steps can be assumed as a protocol for the inspection operation. The IPM application *(Figure 3)* is available to all actors through the Integration Environment and through a common web browser.

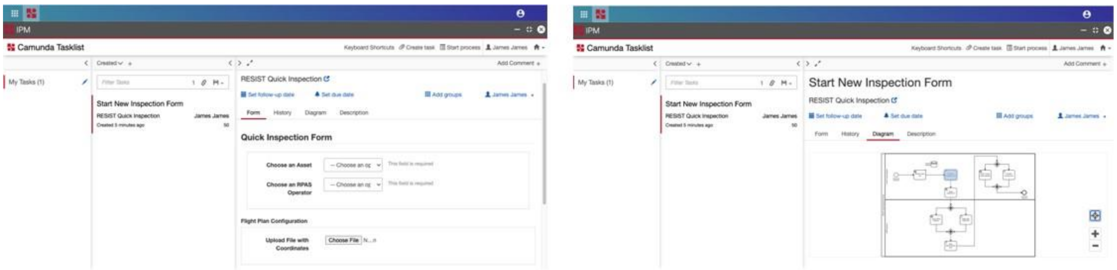

Figure 3: Indicative forms of IPM applications through the integration Environment. Form for creation of a quick inspection process for the infrastructure including the flight plan (on the left), and high level diagram for live monitoring of the entire inspection process (on the right)

The Photogrammetric Visualization application *(Figure 4)* provides a viewer for the generated 3D data from collected image data. Furthermore, detected damage annotations can be directly shown in the viewer. It includes several functionalities for the user to view an appealing 3D model of the observed structure, navigate the model and quickly take measurements such as distance measurements, area measurements, and angle measurements.

Figure 4: Photogrammetric visualization application through the Integration Environment

The RESIST mobility continuity application *(Figure5)* targets at informing commuters regarding events that could happen along their trip. Moreover, it provides recommendations and guidelines to mitigate possible issues. For example, in the case of road closure the system recommends alternative routes. In the case of lane closure the system reports adjacent predicted lane average speed by executing mobility simulations based on statistical data regarding the area of interest. By providing lane speed data, the RESIST mobility continuity module further enhances the level of information available to the commuters so that they can make appropriate adjustments when planning or during their trip.

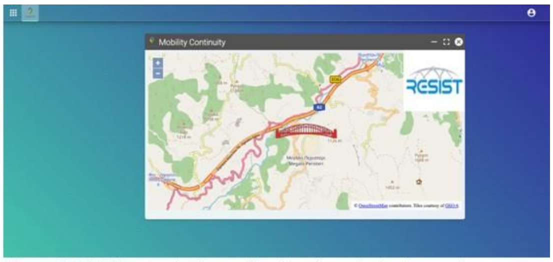

Figure 5: Mobility continuity application through the Integration Environment.

Furthermore, users of infrastructure can be informed regarding the status of the road and possibilities regarding rerouting in case of an extreme event through the mobility continuity mobile application (Figure 6). The mobile application provides also capability for destination selection and journey planning. The application is available for Android enabled devices installed with version 6.0 or later.

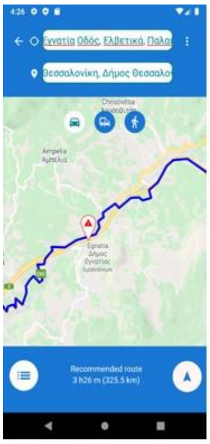

Figure 6: Rerouting instructions through the mobile application.

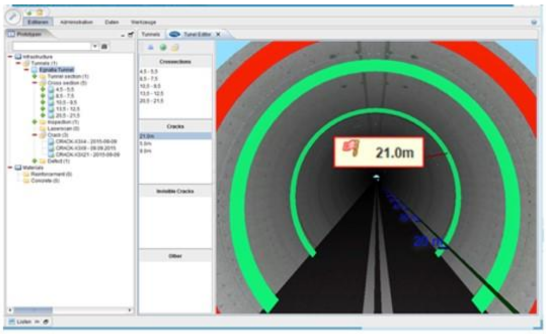

Figure 7: User Interface of Structural and Risk Assessment application

The Structural Vulnerability Assessment and Risk Assessment components contribute to the accurate assessment of the infrastructure condition of bridges and tunnels, while estimating the potential risks and proposing mitigation actions. Indicatively, *Figure 7* presents the visualization for tunnels each colored ring represents a cross-section where a crack has been detected, it has been structurally assessed and is colored according to its estimated risk level. Red stands for high-risk level, yellow for medium risk level and green for low-risk level. The user can interact with the visual tunnel, using the mouse buttons. The user can zoom in and out with the utilization of the mouse wheel and navigate inside the tunnel. If the user clicks on a specific cross-section from the list of cross-sections on the left or by clicking on the colored ring, he/she will be navigated to the corresponding length of the tunnel. Double-clicking a cross-section will open a new screen for further details.

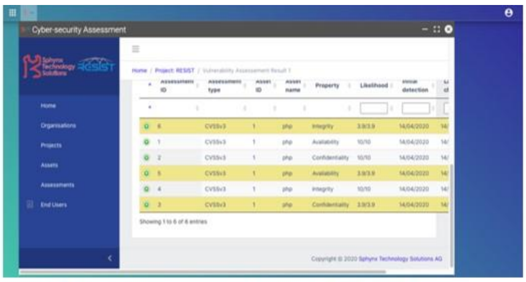

Figure 8: Cyber-security assessment results for assets of RESIST, presented through the Integration Environment.

The Cyber-security Assessment application *(Figure 8)* is a combination of models, processes and tools to enable the certification of security properties of services and components of RESIST project. Furthermore, within RESIST, the cyber-security assessment application enables the continuous assessment of the cyber-security of the system through the combination of runtime monitoring and dynamic testing. It also collects runtime system events and generate alerts that can be used for identification, prevention, and mitigation of cyber-attacks.

RESIST Integration Environment

The Integration Environment is a web-based application through which the user of RESIST will have access to the applications of the project through a simple web browser in a secured manner. Apart from the aforementioned applications that are already integrated in the application, the RESIST Integration environment is enhanced with applications for user and application management.

Figure 9: Two applications simultaneously opened through the RESIST Integration Environment.

Through these applications, user groups can be created and updated, while access to some applications can be restricted to only some users or groups. Also, the Integration Environment gives the opportunity to the same user to open and use two or more different applications simultaneously (*Figure 9).*

At this stage of RESIST project, the preliminary versions of the applications have already been integrated to create the first integrated prototype. During the next period, several refinements will take place in the applications to cover all requirements and needs of the end-users for a successful assessment of the entire RESIST solution in the two pilots of the project.

Dissemination Events

RESIST Virtual Workshop for Israel Community of researchers, end users and stakeholders

Date: 3rd November 2020 (13h - 15 h Brussels Time)

- The main objectives of the Workshop are:to involve community of Israel experts, researchers, developers and potential end users into the review process of technological elements of RESIST platform, pilot plans and future outcomes;
- to collect insights (using crowd-wisdom approach) for further bettering RESIST exploitation plan;
- to promote RESIST project and its future outcomes in Israel following the principals of dissemination plan and engage prospective end users. Registration & More info...

Joint Virtual Workshop - RESIST, FORESEE, SAFEWAY & PANOPTIS

Date: 10nd November 2020 (10h - 12h Brussels Time)

RESIST, FORESEE, SAFEWAY and PANOPTIS, are four EU collaborative research projects, funded under the same call of HORIZON 2020, with the aim to ease the continuity of mobility for both people and freight even in a case of serious disruptions due to natural or man-made circumstances. Major progress is done regarding individual mode components' resilience to damage due to extreme weather conditions, including reduction of maintenance and retrofitting needs. These projects contribute to achieve reliable modal interchanges allowing continuous fluid traffic flow even during or after a disruption. A high level of resilience of the transport infrastructure is an essential contribution to sustainable development and of impact on and adaptation to climate change conditions. Registration & More info...

"These projects received funding from the European Union's Horizon 2020 research & innovation programme under grant agreement No 769066 (RESIST), No 769373 (FORESEE), No 769255 (SAFEWAY), No 769129 (PANOPTIS)"

RESIST deliverables

D1.1 Quality and risk management plan

D1.2 Internal project server

D1.3 Data management plan

[D1.4 Innovation management plan](#)

[D1.5 Data Management Plan 1st update](#)

[D2.1 State of the art regarding physical/ cyber damage detection/ prevention/ response/ mitigation technologies and risk analyses in the land transport sector](#)

[D2.2 End-User requirements and Proceedings of the Workshop in Month N° 4](#)

[D2.3 Full specification set for RESIST system](#)

[D2.4 KPIs, Evaluation methodology, TechnoEconomic, Env., Social analyses](#)

[D3.1 Deterministic Structural Vulnerability](#)

[D5.1 Architecture of the networking platform supporting secure communications](#)

[D5.2 RESIST Cyber Security Mechanisms](#)

[D7.1 Risk Assessment System](#)

[D8.1 Integration Plan](#)

[D10.1 Website of the project](#)

[D10.2 Project flyer](#)

[D10.3 Dissemination and Communication plan](#)

[D10.4 Mid-Term Dissemination and Communication Activities](#)

[D11.1 Early Business Plan](#)

[D12.1 H - Requirement No. 1](#)

[D12.2 POPD - Requirement No. 2](#)

[D12.3 EPQ - Requirement No. 3](#)

All the RESIST deliverables can be found and downloaded here.

Links

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This project has received funding from the European Union's
Horizon 2020 Research and Innovation programme
under grant agreement No. 769066

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