Belgian Road Research Centre
Together for sustainable roads

ERPUG

INFRACOMS Methodology for Appraisal of Emerging Technologies Explained by Examples

ERPUG

INFRACOMS is a CEDR Transnational Road Research Programme Call 2021 project (July 2022 – June 2024), see also at web pages:
https://www.infracoms.project.cedr.eu/

October 2023

CEDR
Conférence Européenne des Directeurs des Routes
Conference of European Directors of Roads

INFRACOMS: CEDR project (July '22 – June '24)

Innovative and **F**uture-proof
Road **A**sset **Co**ndition **M**onitoring **S**ystems

Today's topic:

Development of a methodology
for appraisal by NRA's themselves
of emerging technologies for
asset management (bridges and carriageways).

The result of the work of a whole consortium:

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INFRACOMS
Innovative and Future-proof Road Asset Condition Monitoring Systems

TRL THE FUTURE OF TRANSPORT
COWI
ZAG
vti
Belgian Road Research Centre
Together for sustainable roads
TU Delft
DANISH TECHNOLOGICAL INSTITUTE

INFRACOMS Methodology for Appraisal of Emerging Technologies Explained by Examples

What is INFRACOMS about???

INFRACOMS – the context

Key imperatives

Carriageways
- Availability
- Environment
- Socio-economic
- Safety

Bridges
- Availability
- Reliability
- Economy
- Safety

Current and emerging technologies

- Remote Sensing
- Internet of Things (IoT)
- Crowd sourcing
- Advanced data processing and Visualisation

Gap analysis

- Data Collection
- Data Analysis
- Data Management
- Advanced data processing and Visualisation

Gaps and solutions

- NRA's have "gaps" in their management processes.
- Innovative technology may "fill a gap"

  (or even propose a whole new management process).

If a technology provider offers some "new" technology, then NRA can appraise the technology:

- Does it "fill a gap"?
- How can it be integrated in existing processes?
- Cost/benefit (within the context of the NRA)?

Communication between provider and NRA

- Provider:

  "Look at all those beautiful data,
  surely useful for Asset Management!"

- NRA:

  "I don't need more data,
  I already have lots of data I don't use!"

Appraisal methodology could improve communication…

CEDR: sharing of appraisals between NRA's

- Initial list of emerging technologies "from the literature"
- Wiki-like environment under development
- NRA's of CEDR want to use this environment:
  - Add emerging technologies they identified themselves
  - Add and share their own appraisals with the other NRA's
  - Consult appraisals of the other NRA's

Appraisal method: a multiple step approach

1. Pre-evaluation: Superficial appraisal
   - Which gap seems to be covered by the solution?
   - From first information gathering: does it seem useful, workable?
2. Evaluation: Detailed appraisal
   - Need for NRA-internal details (from colleagues).
   - Probably Q/A from technology provider.
   - Roadmap to implementation.
3. Case study
   - Experiences from a test case.
   - Better understanding of cost/benefit factors.

Appraisal method: guidance

Always from the particular perspective of the appraising NRA

1. Pre-evaluation:

- List of standard questions, generating a priority score,
- Appraising "Technology Readiness Level (TRL)" of the technology:

TRL level	Description *Pre-Evaluation TRLs (as defined by European Commission)*
9	actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)
8	system complete and qualified
7	system prototype demonstration in operational environment
6	technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
5	technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
4	technology validated in lab
3	experimental proof of concept
2	technology concept formulated
1	basic principles observed
Unknown	TRL level can not be estimated due to the lack of information

Appraisal method: guidance

Always from the particular perspective of the appraising NRA

2. Evaluation:

- First make a description of the technology, then answer a list of standard questions,
- Give a score for:
  - data analysis associated to the technology,
  - data visualisation,
  - its potential for practical decision-making, and
  - ease of data integration.
- Roadmap: what steps needed for full implementation?
- "INFRACOMS Readiness Level"

INFRACOMS Readiness Level	Description of evaluation or implementation for an infrastructure authority for the use case under consideration
9	Proven Solution Deployment
8	System Level Production Verfication
7	Pre-Production Controlled demonstration
6	System Based Representative Testing
5	Isolated Representative Testing
4	Laboratory Testing
3	Research and Validation
2	Applied Research
1	Concept Exploration / Fundamental Research

Appraisal method: guidance

Always from the particular perspective of the appraising NRA

1. Pre-evaluation:
   - Appraising "Technology Readiness Level (TRL)" of the technology,
   - List of standard questions, generating a priority score.
2. Evaluation:
   - First make a description of the technology, then answer a list of standard questions,
   - Give a score for:
     - data analysis associated to the technology,
     - data visualisation,
     - its potential for practical decision-making, and
     - ease of data integration.
   - Roadmap: what steps needed for full implementation?
   - "INFRACOMS Readiness Level"
3. **Case study:**
   - List of deep questions,
   - Some form of cost/benefit description.

Developed by us: we tried it out ourselves

Objective: we deliver an appraisal toolkit.

We did as if we were an NRA…

- 64 current and emerging technologies from the literature.
  - We estimated their "Technology Readiness Level" (TRL).

- Evaluation:
  - We tried out the evaluation score on 24 technologies with TRL ≥ 7.

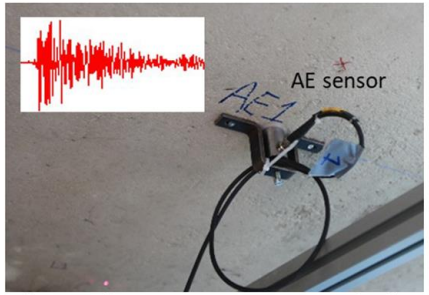
Case studies:

- We selected 6 technologies of those 24 that are used somewhere.
- Interviews with NRA's and providers.

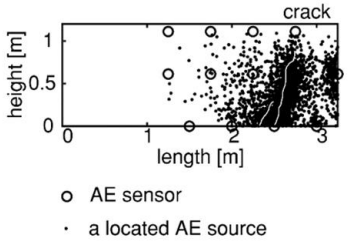
Hence: appraisal can be done partially or fully, "à la carte".

A glimpse of technologies

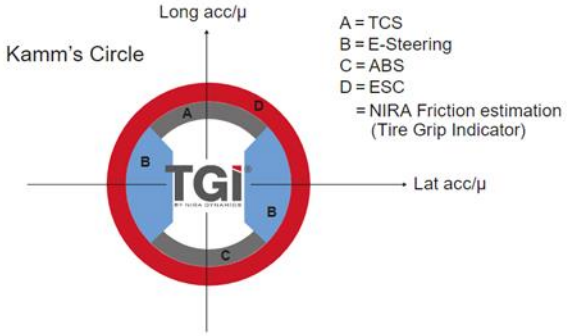
Title	Date of Appraisal	Asset type	Pre-Evaluation TRL	INFRACOMS Readiness Level	Organisation	Solution Group	Status	Strategic Imperative 1	Strategic Imperative 2	Strategic Imperative 3	Case Studies
Acoustic Emissions to detect wire break in steel cables in bridges	Jun 6, 2023	STRUCTURE	PRE-EVAL TRL 7	IRL 8	INFRACOMS	REMOTE SENSING	IN REVIEW	AVAILABILITY	N/A	N/A	NO
COWI Virtual Inspection Platform	Sep 1, 2023	STRUCTURE	PRE-EVAL TRL 9	IRL 9	INFRACOMS	REMOTE SENSING	IN REVIEW	AVAILABILITY	N/A	N/A	YES
Epsilon Rebar for measuring and reinforcing structural members	Sep 15, 2023	STRUCTURE	PRE-EVAL TRL 9	IRL 9	INFRACOMS	ADVANCED DATA ANALYTICS	IN REVIEW	AVAILABILITY	N/A	N/A	NO
EyeVi Technologies Platform for detection of road defects, signs, markings etc.	Sep 1, 2023	CARRIAGEWAY	PRE-EVAL TRL 8	IRL 8	INFRACOMS	REMOTE SENSING	IN REVIEW	SAFETY	N/A	N/A	NO
Tyre Grip Indicator (TGI) by NIRA as potential replacement for network-wide Sideways Force skid resistance measurement	Jun 6, 2023	CARRIAGEWAY	PRE-EVAL TRL 7	IRL 3	INFRACOMS	CROWDSOURCING	DRAFT	SAFETY	N/A	N/A	NO



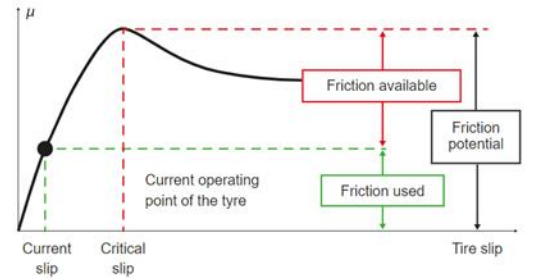
Installation of AE sensor on a concrete bridge and the received signal



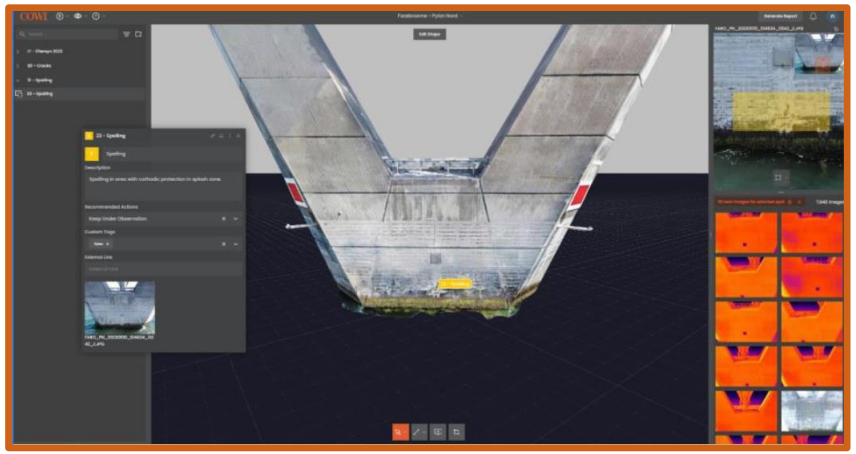
Using AE source localization technique to estimate the crack location

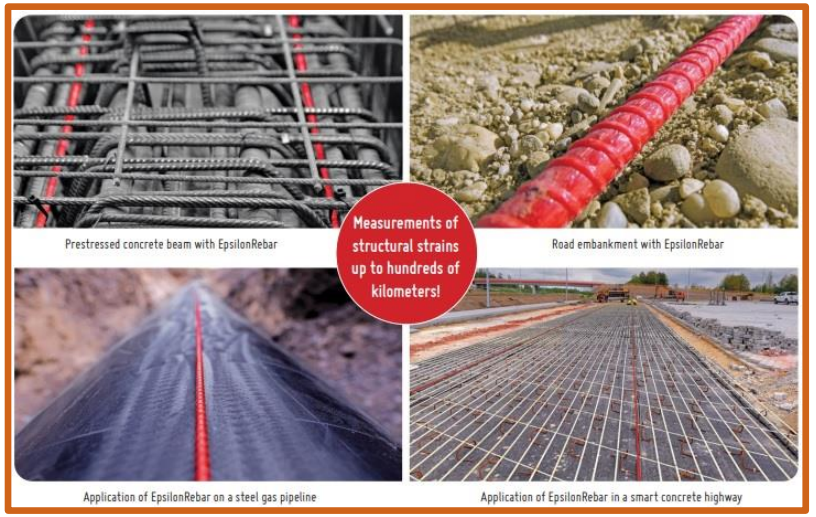


TGI estimates the friction between the tire and the road under normal driving conditions – long before ABS, ESC or traction control are activated. This means that the tire grip is monitored at all times.



TGI is able to accurately estimate the total available fric- tion by using only a part of the friction potential – thus being able to foresee the available friction before a critical situation occurs.





INFRACOMS Methodology for Appraisal of Emerging Technologies Explained by Examples

From here on, we'll show an example!

Note: the appraisal presented here was done by the INFRACOMS consortium as part of the development of the methodology.

Example: EyeVI

- Presentation at ERPUG 2022 in Scotland…

https://www.erpug.org/media/files/forelasningar_2022/08_221012_Erpug2022_EyeViTechnologies.pdf

- Case in city of Oslo was mentioned, hence

  at least TRL 8: "system complete and qualified"

- First impression: "Unclear level of commercial uptake, though system appears complete."
- Identified "imperative": safety
- This could be a technology covering a "gap"…

Steps in assessment

We tried out our own methodology…

- Overview: general description
- Pre-evaluation
- Evaluation

We did as if we were an NRA "discovering the new technology"…

- Case study (city of Oslo)

We did as if we were the city of Oslo… reporting on experience with the technology…

- Introduced in confluence environment

As an example…

Overview “made by the discovering NRA”

Sources, available info:

- ERPUG 2022
- Web page
- Leaflet
- …

Global presentation

EyeVi Technologies Platform for detection of road defects, signs, markings etc.

Assessment	
	INFRACOMS
	Simon Fjendbo
	Sep 1, 2023
Strategic Imperatives	
On this page	
Case Studies Attached	NO

Overview

EyeVi technologies platform include hardware for data co… extract detailed spatial information on e.g. the object types road markings, cr… noise retaining walls, fences, curbstones, speedbumps and traffic islands and def… verse cracking, longitudinal cracking, network cracking, joint reflection cra… patched road. This automated data capture and processing to detect objects and … detection. The 3D models can then be used to prioritize areas that require m… long-term maintenance costs and minimizing disruptions to traffic. EyeVi's techn… authorities plan and budget more effectively, improving the efficiency and cost-effe… maintenance programs.

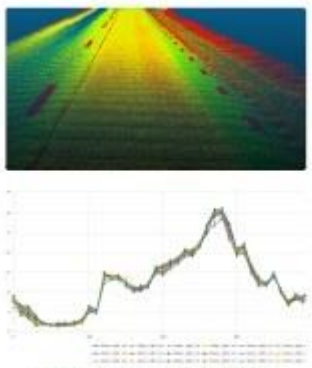
Hardware for data collection on a mounted vehicle

Some pictures

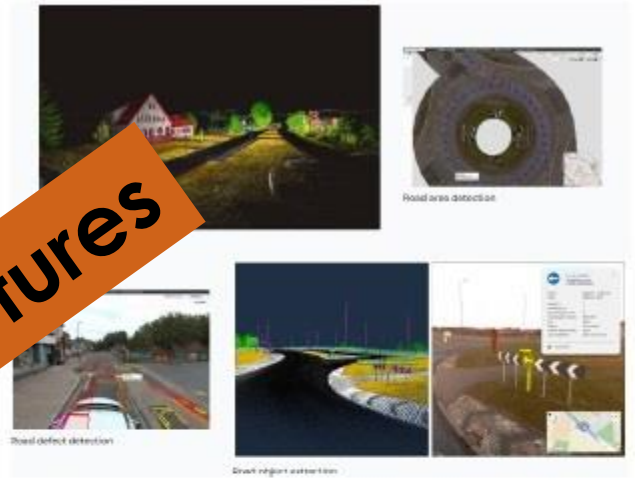
Overview of defects and class in Oslo, Norway

Generated point cloud

Overview of defects and class in Oslo, Norway



Validation of IRI and rutting measurements.



Road defect detection

Road object detection

Technology

EyeVi technology works through a plug and play data capture system that can be rented weekly or monthly for large-scale projects. The system … metadata, including detection of road defects and attributes, road objects, and more. The EyeVi Web Application is used for visual verification of results, corrections, data management, and reporting.

Use case

EyeVi technologies provides highly accurate and constantly updated spatial data about the road network, including the condition of the pavement, signs, markings, and road assets. This data is … to traffic. The 3D models generated from the captured data can also help authorities plan and budget more effectively, improving the efficiency and cost-effectiveness of their maintenance programs.

Brief description of the technology

There is a use case

Pre-evaluation “done by the discovering NRA”

Table to fill.
Won’t take long.
Based on “overview”.

Parameter	Assessment
Asset type	CARRIAGEWAY
Solution group	REMOTE SENSING
References	https://www.eyevi.tech/ https://www.eyevi.tech/blog/overcoming-oslos-infrastructure-problems-triona-and-eyevi-provide-solutions https://www.triona.eu/case/transport-infrastructure/triona-leads-the-way-for-oslo-municipality/
Performance indicators	Road environment, surface condition
Anticipated cost factors	• Hardware and software costs • Installation and maintenance expenses • Data processing and storage costs • Training and technical support fees • Costs will depend on size and complexity of road network, frequency of scans and the level of detail required
Anticipated benefits	• Early-age damage detection for safety and optimized intervention • Automated detection of road defects and attributes using AI-assisted tools, reducing human error and saving time. • Ease to gain updated and precise data, allowing road authorities to plan and budget more effectively. • Improved efficiency and cost-effectiveness of road maintenance programs, reducing long-term maintenance costs. • Improved road safety and sustainability by minimizing disruptions to traffic. • Easy to use, plug-and-play data capture system that can be mounted on any car type within an hour.
Anticipated limitations	• Potential data privacy and security concerns with the use of AI-powered software. • Challenges with integrating EyeVi technology with existing infrastructure management systems.
Pre-Evaluation TRL	PRE-EVAL TRL 9

Evaluation “done by the discovering NRA”

First answer standard questions for each topic.

- Technology and Data

From answers, give “score” for each topic.

1. Data visualisation
2. Data integration
3. Practical decision making
4. Data analysis

Even the “scoring” is guided through questions.

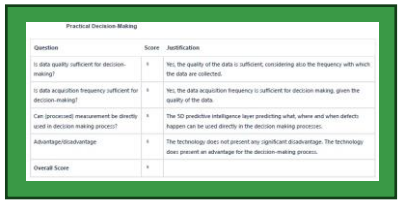
EyeVi evaluation results

1. Data visualisation

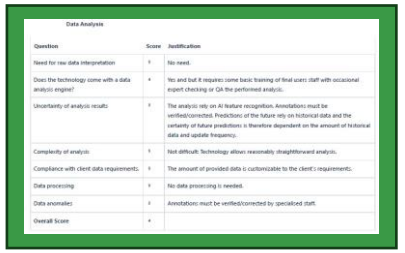
Question	Score	Justification
Does the technology come with a Visualisation platform?	5	Yes, Technology comes with clear and useful visualisation platform. The platform requires some basic training.
Can Visualisation data be extracted?	5	The output of the feature factory is a georeferenced data layer in .csv or .shp format. This can be imported and visualized in e.g. the EyeVi web application.
Current state and prognosis	5	The visualization provide information of the current state and based on historical data the AI module can predict what will happen and where it will happen.
Compliance with client Visualisation requirements for decision support/gap closure	4	The visualization provided gives sufficient and clear information for decision support.
Overall Score	5	

2. Data integration

3. Practical decision making



4. Data analysis



Case study "done by us as if we were city of Oslo": questions to address in a standard format

- Input from City of Oslo
  - **Data collection: some issues for EyeVi** but they dealt with it.

    Case study of a service (EyeVi+Triona), rather than of a technology

  - **Data integration in Norwegian National Road Database**:
    - Known by technology provider – no problem in this case, may be different for other road administrators.

    Assessment = **View from a particular (N)RA**

  - Update of part of the data is foreseen by Oslo in future:
    - Aspect of cost/benefit.

Case study ("done by us", so we needed additional info from provider to get the full picture)

- Data Collection
  - EyeVi Hardware and Sensors
  - Specifications
  - EyeVi DataCapture
- Data processing
  - EyeVi Data Processing Software
  - Output specifications
- Data analysis
  - Road Defects
  - Footway Defects
  - Traffic signs
  - Road Markings
  - Point Cloud Classification
- Data Representation: EyeVi Web Application
  - Orthophoto/Map View
  - Panoramic View
  - Point Cloud View
- Practical Decision Making
  - Monitor Pavement Conditions
  - Update Road Asset Registries
  - Identify and Manage Maintenance Problems
  - Share Visual Information
- Data Integration
  - Visualization Online with the EyeVi Web App
  - Export Capabilities
  - Web Services

Ongoing work: still to be integrated in the case study.

Next steps

- Some NRA's of CEDR try out the INFRACOMS methodology
- Roadmap: development of this aspect of the assessment
- Elaboration of the "confluence" "wiki-like environment"
- Training workshop for NRA's: when methodology is ready

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