Mid-term Conference

WP3 - Smarter LC: development and Integration of technical solutions

WP Leader: NTNU

Cerema, CERTH, Commsignia, Ifsttar, NeoGLS, NTNU, RWTH, SNCF, UIC, UTBM, ….

Elias Kassa, Professor
Norwegian University of Science and Technology (NTNU)
Objectives

To develop **technological solutions to improve safety** at level crossings as well as at working zones through **sharing information** and **giving warnings** to trains/vehicles approaching/arriving to level crossings and to workers at or near train passing zones.
Specific objectives

- Advanced video surveillance system for modeling and analyzing LC users’ behaviour
- Evaluate various safety enhancement techniques
- Develop Optimized Automatic/Smart Incident Detection (AID) system
- Develop smart sensor technologies for monitoring of LC infrastructure
- Develop systems to transmit and share the risks and hazard information detected at LCs
- V2X-based sensing, actuation and information sharing techniques to detect and forecast train arrivals and broadcast
- Automatic closure of level crossing triggered by the train geolocalisation
## Tasks and Involved Partners

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<th>Leader</th>
<th>Partners</th>
<th>Duration</th>
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<td>Task 3.1 – Risk evaluation</td>
<td>UTBM</td>
<td>CEREMA, DLR, NTNU, CERTH, COMM, UIC, INTADER</td>
<td>M5-M30</td>
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<td>Task 3.2 – Smart detection system</td>
<td>CEREMA</td>
<td>UTBM, COMM, VTT, NTNU, IFSTTAR, CERTH, UIC, SNCF, NeoGLS, INTADER</td>
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<td>Task 3.3 – Monitoring and remote maintenance</td>
<td>NTNU</td>
<td>CEREMA, IFSTTAR, UTBM, CERTH, NeoGLS, COMM</td>
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<td>Task 3.4 – Communication systems for cross-modal information sharing</td>
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<td>VTT, COMM, NeoGLS, NTNU, CEREMA, CERTH, SNCF, TRAINOSE</td>
<td>M5-M24</td>
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Interaction within & with other WPs

WP1
- Typical factors
- Types of LC to be evaluated
- Scenarios to be evaluated

WP2
- User behavior models

WP3
- Task 3.1 Risk evaluation
- Task 3.2 Smart detection system
- Task 3.3 Monitoring & remote maintenance
- Task 3.4 Cross-modal communication

WP4

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Task 3.1 – Risk evaluation

Task leader: UTBM, Cerema, ....
Objective

Provide a component of SAFER-LC Toolkit with semi-automatic and fully-automatic risk assessment

- Identifying and understanding the dynamics of hazardous situations in LC environments
- Extraction and description of dangerous behaviour models of user-to-user and user-to-infrastructure (LC) interactions
- Extracting quantitative information (number of occurrences of each dangerous behavior or interaction and classification)
Task 3.1 – Risk evaluation

Two main steps

1. **Knowledge extraction from video data**
   - Scene semantic segmentation (Machine learning/deep learning, background subtraction techniques)
     - Users detection and recognition
     - Infrastructure objects recognition
     - Barriers state recognition
   - Users trajectory extraction (objects tracking, matching, optical flow)

2. **Abnormal situations classification and user behavioural modeling**
   - Sequence segmentation (detection of state changing / important moment detection)
   - Analysis of the targets (vehicle, truck, pedestrian, etc.) involved in each detected subsequence
   - Classification of abnormal situations into different pre-defined models (zigzagging, obstacle, stopped vehicles line, etc.)
Generating data from simulation

Motivation:
- Real life video capture may not contain dangerous behaviors
- It takes a long time before data are available
- Privacy and confidentiality issues

Solution: Generate realistic looking videos with/without dangerous events using simulation
- Multi-agent based /behavioural simulation
- Vehicle dynamics simulation
- Weather and lighting simulation
Simulator

- New vehicle dynamics model
- Provides better stability at high speed (>60 kph)
- Better tire friction model
Risk Evaluation System architecture
User detection

- Vehicle detection
- Light Signal state detection
User detection and tracking
Barrier detection (Scene 1)
Barrier detection (Scene 2)

• Robust as long as lighting conditions are not too poor
Risk Evaluation System architecture
Task 3.2 Video sensing and communication

Mid term conference

Cerema, UTBM, NeoGLS, Ifsttar, RWTH, ....
Objective

- Identification of principle factors of accident at LC
- Real time detection, recognition and evaluation of potentially dangerous situations at level crossing
- Sharing alert messages by a communication system
- Research and experimentation of technical solutions
Initial idea
Global architecture

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Sensors
Video architecture

Surveillance camera

Supply

Camera

Camera link

Pc

Support

220V
Datasets

- Cerema dataset 1
- Cerema dataset 2
- Montaudran dataset
Smart detection system modules

Data sources → Data acquisition (1) → Object detection (2) → Object tracking (3) → Scenario detection (5) → Object classification (4)

Smart detection system
1) Data acquisition

Data sources:
- IP camera
- Recorded videos

Online: IP camera → Data acquisition → Image

Offline: Recorded videos → Data acquisition
2) Object detection

Image → Object detection module → Object location
3) Object tracking

Object location at time $t$

Object location at time $t+dt$

Object tracking

Object trajectory
4) Object classification

Object location → Object classification → Object type
Ex: car
5) Scenario detection

Object trajectory

Object type (Ex: car)

Scenario detection

Detected scenario (Ex: car zigzag)
Definition of possible scenarios to test

Open barriers

scenario 1: vehicle stopped at LC

scenario 2: vehicles crossing the LC (moving forward and backward)

scenario 3: pedestrians crossing the LC

scenario 4: pedestrians and vehicles crossing the LC
Definition of possible scenarios to test

Closed barriers

scenario 5: vehicle stopped at the LC (emergency exit from the vehicle)

scenario 6: vehicles crossing the LC (zigzagging)

scenario 7: pedestrian crossing the LC

scenario 8: pedestrians and vehicles crossing the LC
Smart detection system interface

User parameters

User commands

Live preview

Object detection result

Object tracking and events detection result

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Interaction with RSU

- Smart detection system
- IP camera
- Event database
- JSON-RPC Proxy process
- RSU
- OBU
Evaluation

Detection accuracy
Detection rate
Processing time
Sample size
Usability
Stability
Environment conditions for processing
Ability to work in hard conditions
Ability to transmit the information
Test site: Aachen

Aerial image of the test site
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Road/rail intersection area at Aachen test site
WP3 and 4- Cerema NC Test Site

Tasks 3.3 Monitoring and remote maintenance
Mid-term conference
Madrid – 10 october 2018

Delphine Jacqueline, Carl Calmo
CEREMA France

Elias Kassa
NTNU Norway

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What's the problem?
Conflict point with LC's longitudinal section → dramatic consequences (blocked truck, multi-vehicle collisions…)

How is this situation possible?
Topographic profil incompatibility due to design or LC deterioration

How is it possible to provide solution?
Detect all points of conflict with better precision of the profile surveys

What's the challenge for infrastructure managers:
→ to have a mobile, non-intrusive system that does not require intervention on the part of a road or rail agent, enabling acquisitions at 30-200 metres on either side of the level crossing
→ to have a solution developed for preventive maintenance (road/railway works or growth vegetation and snowfall)
Experimental level crossing - Cerema Rouen test site

Two approaches will be followed for the real time monitoring:

1. **Photogrammetric method** Measure displacements to monitor infrastructure surface condition → complemented with thermal-infrared measure to detect road fissures

2. **Vibration** Measure accelerations to assess the LC components status and set alert thresholds

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**Legend**:

- Stabilizer
- Carbon bar
- Camera
- Accelerometer
Test site configurations at Cerema Rouen

<table>
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<th>Configurations</th>
<th>Measures</th>
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<tr>
<td>Bump 1a, 1b, 1c</td>
<td>Vibration, photogrammetric</td>
</tr>
<tr>
<td>Hollow 2a', 2b'</td>
<td>Photogrammetric, thermoinfrared, Vibration</td>
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Current mock-up’s examples

Date 1

Date 2

Photogrammetric model

Conflict point profil for truck
Thanks for your attention
Deliverables

Deliverable

▲ D3.1. Proof-of-concept on data acquisition platform for the AID system (CEREMA) July 2018
▲ D3.2. Report on communication and warning system (IFSTTAR) - April 2019
▲ D3.3. Guidelines for installation of smart sensors for monitoring of LC infrastructure (NTNU) April 2019
▲ D3.4. Report on risk evaluation system and use cases for pilot test (UTBM) - October 2019
▲ D3.5. Report on smart detection system (CEREMA) - October 2019