Generic Operational Requirements for Video based Applications at Level Crossings

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Motivation

- There are many level crossings (LC) all over the world
- There are numerous incidents at LC with high damages to material and fatalities
- There is no danger zone supervision at LC that have only flash lights or half-barriers
- Many accidents occurred due to
  - mistakes in noticing or obeying the warning signs
  - non detection of breakdown vehicles at danger zone

Target

- Identifying a LC safety system which is included in the European way of harmonized development
  - For a higher level of safety where needed
  - For a simpler way of approval where needed
  - For better operative conditions
  - For more cost-efficient solutions
**Motivation**

Our project expertise in safety

- Analyzing safety systems by using Failure Mode and Effects Analysis
- Identification of accidents by using Why-Because-Analysis
- Safety cases for railroad vehicles
- Cross Acceptance of safety relevant applications
- Certification roadmap for signal in space for future GNSS
- Study about measures for improving safety
- Interlocking simulation at RailSiTe (DLR Railway test and validation laboratory)
Motivation
Our project expertise in operational requirements

- Operational rules definitions for ERTMS
- Operational requirements and operational impacts of new technology
- Development of adequate safety case procedures
- Integration of LC in testing and simulation facilities
- Economic evaluation of operation procedures
Current state
Video based applications

State of the art
- Train departure is dispatched by the driver
- Monitoring of LC danger zone

All applications are only supporting tools without safety relevance
Current state
Activation of LC safety systems

Interlock through main signal (Hp)
- Activating LC through interlocking system
- To set signals → LC must be safe
- *Principle: locking - verifying – driving*

Control through signaler (Fü)
- Activating LC through train
- Control LC at interlocking system → signaler
- *Principle: activating - driving - verifying*

Control through train driver (ÜS)
- Activating LC through train
- Control LC at LC signal → train driver
- *Principle: driving – activating – verifying*
Current state
Activating distances for LC at 120 km/h

**Hp**
- Braking distance = 1000 m
- Point of activating LC > 1500 m
- Different distance

**Fü**
- Point of activating LC = 1000 m

**ÜS**
- Braking distance = 1000 m
- Point of activating LC ~ 1333 m
Operational requirements
For safety systems at LC

New LC safety system has to

- be available and reliable during operation
- support staff and support safety technology
- reduce accidents at LC
- decrease waiting time for road traffic users
- decrease the extend of damage (reduce speed of collision)

LC safety system can be characterized by detection of obstacles at LC ➔ This case is the first regarded objective

Detection at LC has to

- activate and de-activate the LC safety system through train localization
- detect road traffic users at danger zone while train approaches
- warn signaler or train driver if obstacle is in danger zone
Operational requirements
Using video to support state of the art technology

Potential solutions to support existing LC systems by using video

- At full barrier
  - Automatic danger zone supervision (high safety relevant)
  - Closed full barrier system within a “call” function to open barrier automatically

- At half barrier system and systems with flash lights
  - Automatic obstacle detection between barriers
  - Obstacle detection to inform, to warn, to brake the train
  - Detection of the closing barriers (availability)

- At passive (non-technical locked) LC
  - Live-view-transmission for train driver to enlarge his sight
Operational requirements
Using video to support state of the art technology

Example

- Supervision system at LC based on video
  - Activation of video supervision when LC is locked
  - The video based supervision system has to identify its own availability permanently
  - If not available → fall-back system has to start

- Fall-back system for using automatic video supervision
  - Closing the barriers
  - Train driver operational procedures
  - The signaler as fall-back together supported by live-view-transmission
Idea of video based application (example)
Danger zone supervision at half barrier LC

**Situation**
- Level crossing secured with
  - half-barriers,
  - flash lights and
  - no danger zone supervision.

**Solution**
- Two camera system
  - Support existing safety system
  - One camera at each barrier
  - Mounted on warning sign
  - Each camera consists of
    - visible ranges (video) and
    - non-visible (infrared)
Idea of video based application (example)
Danger zone supervision at half barrier LC

Operational integration

1. Activation by transmission via broadcast
   - 1 video detection algorithm
   - 2 antenna
   - 3 communication device
   - 4 LC safety system
   - 5 video sensor
   - 6 on board positioning system (e.g. GNSS etc.)

2. Reduced waiting time for road traffic users (optimized activation time)
   - Detection of road traffic users which are between the barriers

3. Warning and automatic braking in case of danger
Conclusion

> Supervision; obstacle detection; end of train detection (for de-activating LC)
> Video-system (alert) output application possibilities
  > Warning to the operator / signaler (→ *to long reaction time*)
  > Warning to the train driver (→ *human factor, concentration*)
  > Automatic braking system with radio system (RCAS¹) (→ *safe transmission*)

Idea of video based application (example)
Danger zone supervision at half barrier LC
Summary

- The implementation of video based technology can help to increase the safety at level crossings.
- Innovative systems using video based technology can be an economical alternative to existing units.
- Important facts for the impact of a video based system
  - Describing the rules for a fall-back system
  - Don’t forget the transmission!
  - Don’t forget the human factors → road and rail (situation awareness)!
- To implement and admit an innovative system,
  - intensive test campaigns are necessary,
  - the specific operational requirements have to be defined,
  - discussions with assessors can help to find a suitable solution.
- The Institute of Transportation Systems of the DLR is developing a video based system for LC and will evaluates it several field tests.
Thank you for your attention

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