Analyzing challenges and strategies in integrating ETCS with existing signalling systems in rail transport.

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Introduction

The research aims to establish a standard framework or protocols that can be utilized by anyone involved in an Europium Train Control System (ETCS) – Mainline railway project. By adopting this standardized approach, scheme developers can save time and money, while improving efficiency and safety across various rail routes and regions. This necessitates the development of a common signalling plan.

Analysis

The development of an automation tool for common signalling plan generation, utilizing MicroStation V8i, Excel, and VBA. The process includes the validation of signalling standards to ensure compliance with industry regulations and safety protocols. A comparative analysis delves into safety parameters, drawing distinctions between traditional railways and ETCS.

Conclusions

The ultimate aim is the seamless integration of ETCS with existing mainline railway infrastructure, fostering a standardized framework for planning and implementation that facilitates coexistence and sets the stage for future advancements in the railway industry. Summarizing the advantages of transitioning to ETCS, Recognition is given to the potential benefits offered by moving block technologies, emphasizing the role of a common signalling plan in supporting this transition.Figure 1

Figure 1."Eurobalise" transceiver, installed between rails.

References

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SDN-Based Telecommunication Infrastructure and Security for Railway Emergency Messages

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Introduction

In the near future, we expect to see more sharing of network resources between road and rail systems. This is aimed at making transportation more efficient and reducing the cost of infrastructure. This kind of sharing could lead to the creation of global Cooperative Intelligent Transport Systems (C-ITS) [1].

In this study, an approach based on Software-Defined Networking (SDN) is considered to emulate the distribution of emergency messages on a network that is shared by both roads and railways. The aim of this work is to enhance the security of the shared telecommunication infrastructure and differentiate the data for railways and roads co-existence scenario.

The network slicing technique based on SDN is used to establish connectivity to the railway system and to send emergency messages to a designated server. These emergency messages are also delivered to other trains or rail that are in close proximity to the location of the emergency. To develop the infrastructure more secure the use of clusters of SDN-Controllers are deployed to prevent Distributed Denial of Service (DDoS) attacks. These attacks can overwhelm a network with traffic, causing the SDN controller to become unavailable. By using clusters of SDN-Controllers, the researchers can protect the network from these attacks.

Conclusion

In summary, SDN based telecommunication infrastructure is emulated and investigated to ensure that emergency messages are delivered securely to the designated server. The considered scenario is emulated and investigated using the Mininet-WiFi [2] and ONOS SDN [3] controller.

References

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Track circuit model validated against test-track data to explore impact of rail contamination on train detection

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Introduction

A new track circuit model has been validated against test-track data to improve understanding of how rail-wheel contamination leads to train detection faults. Track circuits remain the dominant method of train detection on conventional railway lines despite the introduction of alternatives including axle counters and ETCS position reports based on trackside balises (Railwaysignalling.eu, 2014). Such circuits rely on dividing the track into blocks separated by insulated joints, with the train completing a low voltage AC or DC circuit between the running rails to deenergise a train detection relay local to the train position. Track circuits can be tuned to account for current leakage and circuit length (dependent on ground moisture and track construction) but they remain susceptible to contamination at the rail-wheel contact presenting an increased resistance or more complex semi-conductor behaviour which disrupts train detection. In the most serious cases this can lead to train collisions, but more often it is a transitory failure where the train is briefly lost from the signalling system leading to traffic disruption while the line is checked.

Results

Data analysis indicated that widely deployed low voltage DC track circuits are particularly vulnerable to rail-wheel contamination (RSSB, 2023). A track circuit of this type was installed at a test track to enable careful control of rail-wheel contamination, and data was gathered for clean conditions, sand, and leaf contamination. A model of the track circuit was constructed in the Qucs circuit simulator and tuned to match power supply, train detection relay, and current leakage characteristics of the test site. After validation the model indicated the important role of train detection relay inductance when rail-wheel contamination leads to repeated highly transient interruption to current flow in the circuit. The model guided examination of track results revealing identical behaviour which may otherwise have been overlooked within the noise of the real-world data. Data sampling at much higher frequency than normally used in track circuit monitoring was crucial to observing the behaviour.

Conclusions

A model of a low voltage DC track circuit has been validated against test track data. The model revealed the importance of relay inductance when rail-wheel contamination leads to transient interruption of the track circuit train shunt. The model has application in further investigation of train detection failures and potential mitigations of the problem.

References

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Train Localization During GNSS outages: Exploiting Track Geometry Constraints and IMU Sensor Data

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Determination of train positions within a railway network must be fail-safe and of high accuracy. To meet these requirements, tracking solutions using sensor fusion of Inertial Measurement Units (IMU), GNSS (Global Navigation Satellite Systems), and track maps have been developed (see Otegui et al (2017)). Spinsante et al (2020) concluded that solutions relying on GNSS do not provide the required availability; therefore, we propose an approach of minimal sensor usage exploiting track geometry and IMU information. With this approach, we can preserve accurate positioning during a longer GNSS outage. An overview of the method is shown in Figure 1.

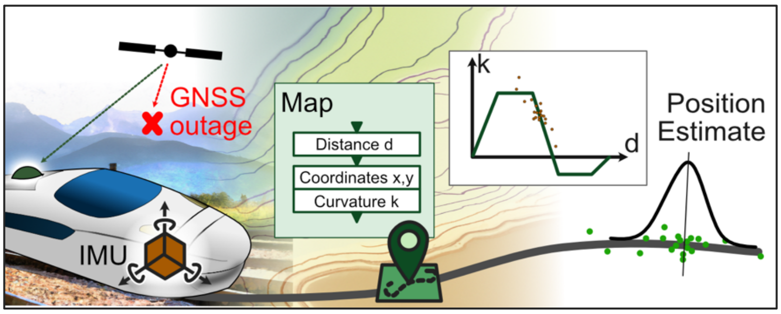

Figure 1. Method overview.

The core element of the proposed method is the innovative use of a discrete track map that serves as a look-up-table. The following variables are included: distance along track, position in a 2D coordinate system, and parameters that are functions of available sensor measurements. For localization we propose usage of a particle filter (PF) that is suited best for non-linear dynamic systems and ambiguous states. Due to the track constraint and map structure the state dimensions are reduced to a 1D problem. We provide an estimate of the 2D position by projecting the estimated distance on the corresponding coordinates from the track map.
We test the method on the experimental data set provided by Winter (2020) and conclude that our method can maintain accurate positioning even during longer GNSS outages, using few sensors and at low computational cost, while allowing easy extension to further sensor information.

References

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