BRAKING CURVE PREDICTION FROM OBSERVED DECELERATION PERFORMANCE

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ABSTRACT

Research and /or Engineering Questions/Objective: Due to the long braking distance of railway systems and the high velocities achieved, railway operation needs to rely on train control systems. At the foundation of these systems are models to predict the motion of the trains, including their anticipated braking curve. Depending on the infrastructure manager, these braking curves need to be achieved with a given safety, which is typically in the rare event region of probabilities.

In current settings, it is typical to develop these so called braking curves either by physical modelling of the train followed by a Monte Carlo simulation or following a heuristic approach, mostly based on the high level of safety over the past centuries.

However, higher developed train protection and control systems, such as the European Rail Traffic Management System (ERTMS) or the Russian KLUB-U System together with current efforts towards quantitative risk analysis, e.g. the European Common Safety Methods, require a more formal approach to communicate the braking curve of a train between rolling stock and infrastructure.

An a priori determined set of braking curves is feasible for trains running in fixed or a limited number of formations, such as multiple unit trains, however in the freight railway system due to its vast amount of different vehicles and possible train setups, the determination of the braking curves is prohibitive.

Methodology: The braking behaviour of randomly mixed trains is simulated as required by current train protection system. The resulting data is fed to the algorithm and used as an input for the prediction algorithm.

Results: In this work, a procedure is proposed to obtain the variation in braking force from accelerometer data onboard the vehicles. The variation of the braking force from the expected value determined in this way can then be forwarded to a Monte Carlo Analysis using importance sampling methodologies to allow for an online calculation of braking curves based on the safety requirements communicated by the infrastructure manager. It is expected that such a procedure yields shorter braking curves than the safety factors currently proposed, leading to higher commercial speeds and thus higher infrastructure usage.

Limitations of this study: Owing to the inavailability of a sufficient amount of real time deceleration data, this study is applied to simulated data resembling the real world behaviour as closely as possible.

What does the paper offer that is new in the field in comparison to other works of the author: For this paper, the big data algorithm was reviewed and an implementation on a Hadoop Cluster, suitable for deployment of the approach to the railway system was achieved. Further, we also include infrastructure and environmental variables such as humidity and temperature in the algorithm, to improve the prediction in case position data is available.

Conclusion: A braking performance prediction algorithm is proposed and the feasibility for predicting the breaking performance of every train on the German network is shown. This algorithm is suitable for reducing headways and providing an incentive for good maintenance of the brake system in the railway space.