World Academy of Science, Engineering and Technology
International Journal of Transport and Vehicle Engineering
Vol:11, No:09, 2017

TRAC: A Software Based New Track Circuit for Traffic Regulation

Authors : Jérôme de Reffye, Marc Antoni

Abstract : Following the development of the ERTMS system, we think it is interesting to develop another software-based track circuit system which would fit secondary railway lines with an easy-to-work implementation and a low sensitivity to rail-wheel impedance variations. We called this track circuit 'Track Railway by Automatic Circuits.' To be internationally implemented, this system must not have any mechanical component and must be compatible with existing track circuit systems. For example, the system is independent from the French 'Joints Isolants Collés' that isolate track sections from one another, and it is equally independent from component used in Germany called 'Counting Axles,' in French 'compteur d'essieux.' This track circuit is fully interoperable. Such universality is obtained by replacing the train detection mechanical system with a space-time filtering of train position. The various track sections are defined by the frequency of a continuous signal. The set of frequencies related to the track sections is a set of orthogonal functions in a Hilbert Space. Thus the failure probability of track sections separation is precisely calculated on the basis of signal-to-noise ratio. SNR is a function of the level of traction current conducted by rails. This is the reason why we developed a very powerful algorithm to reject noise and jamming to obtain an SNR compatible with the precision required for the track circuit and SIL 4 level. The SIL 4 level is thus reachable by an adjustment of the set of orthogonal functions. Our major contributions to railway engineering signalling science are i) Train space localization is precisely defined by a calibration system. The operation bypasses the GSM-R radio system of the ERTMS system. Moreover, the track circuit is naturally protected against radio-type jammers. After the calibration operation, the track circuit is autonomous. ii) A mathematical topology adapted to train space localization by following the train through a linear time filtering of the received signal. Track sections are numerically defined and can be modified with a software update. The system was numerically simulated, and results were beyond our expectations. We achieved a precision of one meter. Rail-ground and rail-wheel impedance sensitivity analysis gave excellent results. Results are now complete and ready to be published. This work was initialised as a research project of the French Railways developed by the Pi-Ramses Company under SNCF contract and required five years to obtain the results. This track circuit is already at Level 3 of the ERTMS system, and it will be much cheaper to implement and to work. The traffic regulation is based on variable length track sections. As the traffic growths, the maximum speed is reduced, and the track section lengths are decreasing. It is possible if the elementary track section is correctly defined for the minimum speed and if every track section is able to emit with variable frequencies.

Keywords : track section, track circuits, space-time crossing, adaptive track section, automatic railway signalling
Conference Title : ICRE 2017 : International Conference on Railway Engineering
Conference Location : London, United Kingdom
Conference Dates : September 21-22, 2017