An Intelligent Transportation System for Railway Crossing Safety and Integrated Management

D. Azzarelli, L. Fanucci, D. Moroni, G. Pieri, P. Ruggiero, O. Salvetti, A. Spada, M. Zedda

***Abstract*—** Railway level crossings have high impact on urban mobility, both for what regards safety of passengers and citizens and for the complex interactions with road traffic and congestions. Indeed, rail crossing can be a place of numerous and severe accidents, having causes ranging from faults in barrier closing to incorrect behavior of pedestrians and drivers. In addition, changes in closure times (due e.g. to train delay) might result in unpredictable effects on normal road traffic flows that can propagate from the crossing zone to nearby areas and, even, to other geographically distant parts of the city.

These issues cannot be addressed unless with the help of an intelligent transportation system integrating both information on train and vehicular flows, whose introduction is the main aim of this paper.

In particular, we propose an integrated system named SIMPLE (Railway Safety and Infrastructure for Mobility applied at level crossings) that, while providing superior 24/7 safety in railway level crossings, collects data on rail and road traffic and provides value-added services to citizens and commuters (including for example alerts, via variable message signs (VMS), to drivers and suggestions for alternative routes) towards a more sustainable, eco-friendly and efficient urban mobility.

SIMPLE includes an in situ monitoring platform made of networked devices of various typologies. In particular, besides conventional COTS sensors, it uses specially designed radar sensors to detect and early notify, through the railway signalling network, obstacles on the level crossing area as well as a network of pervasive smart cameras based on Internet of Things (IoT) paradigms for assessing traffic levels on roads around the city. A modular and standard-based service control unit integrates data collected in situ together with other information obtained through the connection to third party services e.g. to railway operator for real-time train traffic data. On the base of adaptive models, learned from the context, prediction on barriers closing times and road level of service are derived, together with suggestions for alternative routes, so as to mitigate the impact of rail crossing closure. Besides being divulgated through VMS, such provided information can be accessed by the users using smartphones and via the web.

The proposed system has been tested and validated during an extensive trial held in the mid-sized Italian town of Montecatini, a paradigmatic case where the rail network is inextricably linked with the fabric of the city. Results of the tests are reported and discussed.

***Keywords*—**Intelligent Transportation Systems (ITS), Railway, Railroad Crossing, Smart Camera Networks, Radar Obstacle Detection, Real-time Traffic Optimization, IoT, Transport Safety

D. Azzarelli is with Intecs S.p.A., Montacchiello, Pisa, Italy (phone: +39-050-965-7411; fax: +39-050-965-7400; e-mail: daniele.azzarelli@intecs.it)

L. Fanucci is with the Dip. Ingegneria della Informazione - University of Pisa, 56122 Pisa, Italy (phone: 050-2217-668; fax: 050-2217-522; e-mail: luca.fanucci@unipi.it).

D. Moroni is with the Signals and Images Lab, ISTI, National Research Council of Italy, Pisa, Italy, (phone: +39-050-315-3130; e-mail: davide.moroni@cnr.it).

G. Pieri is with the Signals and Images Lab, ISTI, National Research Council of Italy, Pisa, Italy, (phone: +39-050-315-3120; e-mail: gabriele.pieri@isti.cnr.it).

P. Ruggiero is with IDS (Ingegneria dei Sistemi) spa, 56121 Montacchiello, Pisa, Italy (phone: 050-312-41; fax: 050- 312-4201; e-mail: p.ruggiero@idscorporation.com).

O. Salvetti is with the Signals and Images Lab, ISTI, National Research Council of Italy, Pisa, Italy, (phone: +39-050-315-3120; e-mail: ovidio.salvetti@isti.cnr.it).

A. Spada is with Intecs S.p.A., Montacchiello, Pisa, Italy (phone: +39-050-965-7411; fax: +39-050-965-7400; e-mail: antonio.spada@intecs.it).

M. Zedda is with Aleph, Florence, Italy (phone: +39-055-359-734; fax: +39-055-359-734; e-mail: m.zedda@alephprogetti.com).