ECHORD++

The European Coordination Hub for Open Robotics Development

4rth Review Meeting – WP3

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Background

Motivation for the Work Conducted

- Main market requirements for automated industrial warehouses with LGVs (moving pallets for intra-logistics):
  - ✓ **Performance**: fast vehicles, little maintenance
  - ✓ **Safety**: manual actors can coexist with automated vehicles

Technical Problem Addressed / Challenge Overcome

- **Performance vs. Safety**: difficult trade-off in the hand of expert technicians
- **Technical challenge**: increase the plant efficiency while preserving safety

Expertise Relied on

- Elettric80, leader company in LGVs technology, with deep knowledge of big **LGV plant requirements** and industrial **environment conditions**
- University of Parma, with a solid research experience in the field of **automation and control**

Start-date 01/06/2016 - **End-date** 30/11/2017

Solution Developed

Starting Point

- Existing procedure: manual tuning of LGV trajectories and safety sensors in order to satisfy safety audits
- An existing LGV available for R&D has been exploited as a first prototype for testing new techniques

Approach Followed / Development Work Conducted

- Analytical calculation of the maximum speed according to path shapes, LGV kinematic constraints and safe environmental conditions
- New planning strategy, evaluating possible higher safe speeds, suitable for different parts of the path, sampled with a good granularity

Technical Result / End Point

- **Automatic velocity planner** generating most efficient speed profiles:
  - **Deterministic**: independent from technicians' skills
  - **Optimal**: best possible trade-off between performances and safety, and higher smoothness reducing maintenance costs
- **TRL7** working in real operational environment (PreGel plant) with **efficiency improvement of 8,48%** compared to the standard planner

Solution Developed

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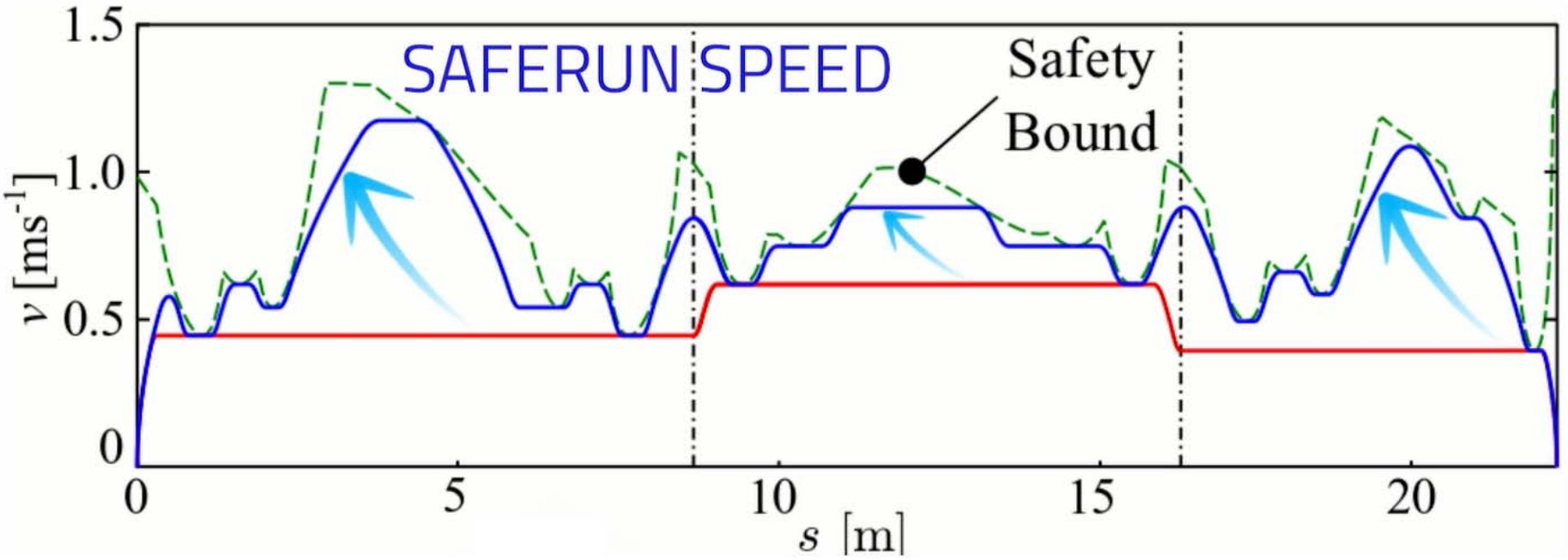

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Being an Experiment in ECHORD++

Benefit from participation in ECHORD++

Impact on Development Process

- ECHORD++ economic support allowed to finance a deep research in charge to the University, a new resource hired in E80, and a complete test campaign
- Funding resources provided by ECHORD++ sped up the project development, which otherwise would have required a much longer times.
- The required scheduling of reports pushed us to adopt a more rigorous method, with detailed documentation for each step (developing, testing, result analysis)
- ECHORD++ sponsorship gave more visibility to the project (local fairs and media) and new dissemination occasions have been offered to the University

Actionable Insights

- Some lack of information and delays about bureaucratic and administrative aspects may cause some difficulties for the involved partners
- Fortunately we did not suffer too much for that

Impact of Work Conducted

What do you have to show for it?

- The **new velocity planner** has been integrated in the Elettric80 systems, ready to be used by technicians in the design phase, and installed in new plants
- **First pilot project:** 3 LGVs are permanently working in the PreGel plant exploiting the new planner, showing a gain in efficiency of 8,48%
- One **conference paper** was published (IROS2017) and other **two journal papers** are currently being written concerning SAFERUN achievements and future developments

What has the support allowed you to achieve

- Validate a new approach and quantify the actual improvement on a real environment, confirming the convenience of its adoption
- Improved an important aspect of LGVs sold by Elettric80
- New jobs: 1 R&D Engineer for Elettric80, 1 PhD for University of Parma

How does the outcome fit with your development strategy

- The outcome fits with the continuous product improvement required to preserve the leadership on the LGVs market
- It will improve the quality of the LGV path design process and customer satisfaction

Outlook

Next steps

- The prototype is being industrialized in order to be fully integrated in the standard vehicle software (TRL8 will be reached in Q1 2018)
- A customer has been select for the first application in a new project starting from scratch: 30 LGVs, on site installation scheduled in May 2018 (TRL9 will be reached at installation completed)
- The integration of the new planner in the Elettric80's own design tools will be further improved thanks to the feedback of the technicians using it

Longer term perspectives and growth expectations

- Elettric80 means to adopt the new planner as the new standard for all future projects
- The new planner will help Elettric80 in selling projects fitting at best the more and more challenging requirements of customers (performance and safety)
- The higher smoothness of the new planned paths should fall back in a long term reduction of maintenance costs (motors, wheels)