VILNIUS TECH
Vilnius Gediminas Technical University

# MOCO: MOTION CONTROL SYSTEMS OF MULTI-ACTUATED GROUND VEHICLES

presented by ***Viktor Skrickij***
Transport and Logistics Competence Centre, Faculty of Transport Engineering, VILNIUS TECH, Lithuania

2024-10-24

# Projects (for the last 5 years)

**Horizon Europe:**

**1. 2025–2028 MOCO (MSCA SE) - Motion Control Systems of Multi-Actuated Ground Vehicles.**

2. 2024–2027 PhDs EU-Rail - Extending the rail network of PhDs in Europe's Rail Joint Undertaking.

3. 2022–2024 Academics4Rail - Building a community of scientific research and enabling a network of PhD.

**Horizon2020:**

**4. 2020–2024 OWHEEL - MSCA RISE actions: Benchmarking of Wheel Corner Concepts Towards Optimal Comfort by Automated Driving.**

5. 2020–2024: ePIcenter (flagship, Smart, Green and Integrated Transport)- Enhanced Physical Internet-Compatible Earth-frieNdly freight Transportation answER.

6. 2020–2022 Gearbodies (Shift2Rail) - Innovative Technologies for Inspecting Carbodies and for Development of Running Gear.

7. 2018–2021 Assets4Rail (Shift2Rail) - Measuring, Monitoring and Data Handling for Railway Assets, Bridges, Tunnels, Tracks, and Safety Systems.

**BSR INTERREG:**

8. 2018–2021 MARA – Accessibility of Remote Areas and Areas Affected by Demographic Change

**National project :**

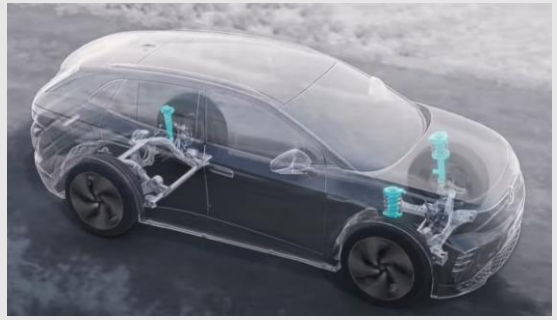
9. 2023–2026 conTROLL - Novel preview and control allocation algorithms for vehicle-integrated chassis control targeting ride comfort and handling improvement.

# *Marie Skłodowska-Curie Actions*

- MSCA Staff Exchanges – ***best HE programme projects***
  - Possibility to choose a topic.
  - The opportunity to work together with the best scientists.
  - Possibility of internship in industrial companies. As a result, much stronger connections between partners.
  - Possibility to get software/hardware.
  - There is no significant competition at the moment.

# *Experience in Marie Skłodowska-Curie Actions RISE/SE programmes*

- Project ***EVE*** - Innovative Engineering of Ground Vehicles with Integrated Active Chassis Systems
- Project ***OWHEEL*** - Benchmarking of Wheel Corner Concepts Towards Optimal Comfort by Automated Driving *(97/100)*
- Project ***MOCO*** - Motion Control Systems of Multi-actuated Ground Vehicles *(99.2/100)*



# *Recipe for Success*

- ***Idea*** (2): We need to achieve a state-of-the-art position, excelling in several areas.
- ***Consortium*** (1): A strong group consisting of industrial companies with R&D departments and reputable universities.
- ***Writing*** (3): Involves three people (first - writing, second - proofreading, third - communication with the consortium).

# *Idea*

- ***2021*** During the OWHEEL project, the industrial partner asked us to test the idea of the virtual sensor for unsprung mass velocity estimation.
- ***2021*** Literature review shows that there are few papers where similar investigations were performed (authors used a model-based approach)
- ***2022*** We prepare a proposal for a national project of research groups, receive funding, buy equipment and develop a test rig for HIL. OEM collects data at the proving ground, and the results show that the developed sensor outperforms previous ones.
- ***2023*** State-of-the-art belongs to our team. We publish papers; other industrial companies contact us regarding the developed approach.
- ***2023*** We prepare a proposal for the MOCO project: main idea –virtual sensors and their usage for novel control methods.

# Consortium

| Partici-pant number | Partnership Member | Legal Entity Short Name | Academic (Y/N) | Domain* | Country |
|---|---|---|---|---|---|
| | ***Beneficiaries*** | | | | |
| 1 | Vilnius Gediminas Technical University | VT | Y | G3 | Lithuania |
| 2 | AGH University of Krakow | AGH | Y | G1 | Poland |
| 3 | Aragón Institute of Technology | ITA | Y | G1 | Spain |
| 4 | APTIV Services Poland S.A. | APT | N | G3 | Poland |
| 5 | Technische Universiteit Delft | TUD | Y | G2 | Netherlands |
| 6 | French National Centre for Sci-entific Research | CNRS | Y | G2 | France |
| 7 | Graz University of Technology | TUG | Y | G3 | Austria |
| 8 | Technische Universität Ilmenau | TUIL | Y | G2 | Germany |
| 9 | Tenneco Automotive BV | TEN | N | G3 | Belgium |
| 10 | University of Technology of Compiegne | UTC | Y | G1 | France |
| | ***Partner Organisations*** | | | | |
| 11 | University of Tokyo | UT | Y | G2 | Japan |
| 12 | Korea Automotive Technology Research Institute | KAT | N | G3 | Republic of Korea |
| 13 | National Autonomous University of Mexico | UNAM | Y | G2 | Mexico |
| 14 | University of Pretoria | UP | Y | G3 | South Africa |

Leonid Fridman

Professor of Control, Nati

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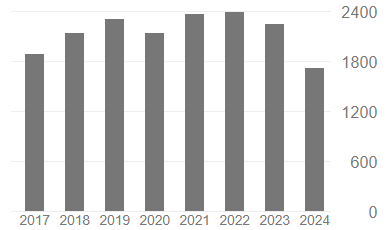
Automatic Control Nonli

Cited by VIEW ALL

| | All | Since 2019 |
|---|---|---|
| Citations | 27815 | 13167 |
| h-index | 74 | 50 |
| i10-index | 298 | 192 |

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The University of Tokyo

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Motion Control Electric V

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| | All | Since 2019 |
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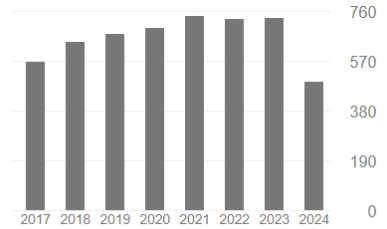
| Citations | 9019 | 4064 |
| h-index | 44 | 27 |
| i10-index | 200 | 94 |



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***Industrial leaders in their segment***

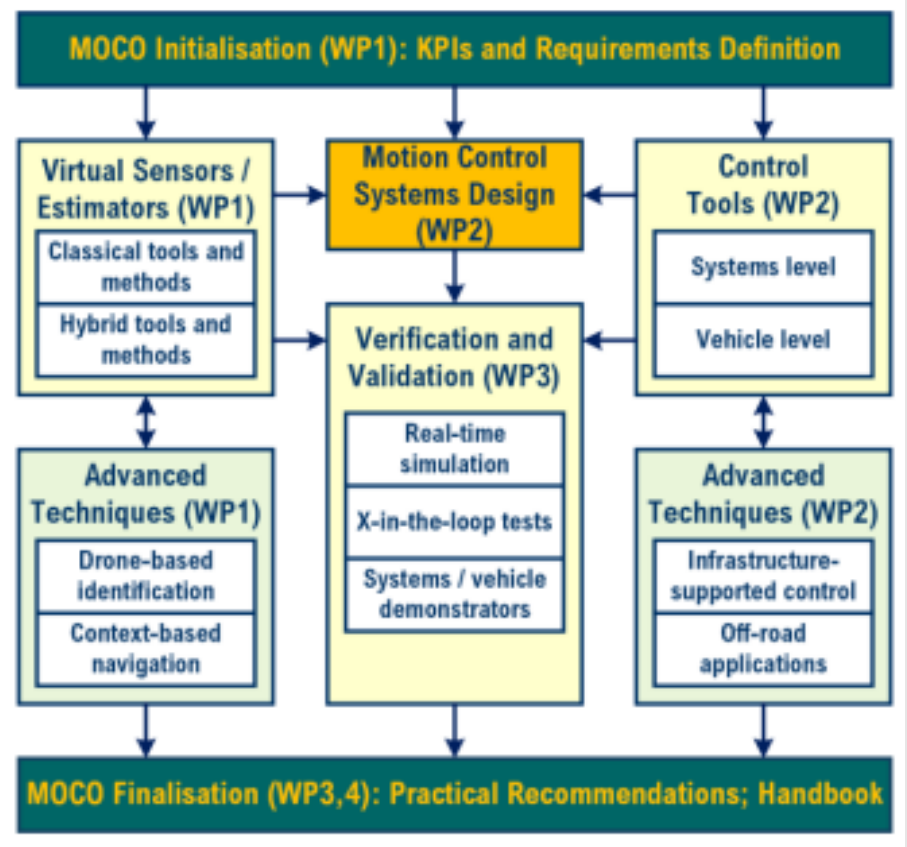
APTIV revenue €18.44 Billion

Tenneco revenue $18.9 Billion

# *Writing*

- Writing – three persons (first - writing, second - proof reading, 3 comunication with consortium)

| Work Pack-age No. | Work Package Title | Activity type |
|---|---|---|
| WP1 | System Identification and Estimation | Research and Training |
| WP2 | Motion Control Design | Research and Training |
| WP3 | Validation and Testing | Research and Training |
| WP4 | Dissemination and Exploitation | Communication and Dissemination |
| WP5 | Management | Management |



# Writing

**Evaluation Result**

**Total score: 99.20 % (Threshold: 70 /100.00)**

**Criterion 1 - Excellence**

Score: **5.00** (Threshold: 0 / 5.00 , Weight: 50.00% )

**The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme:**
**• Quality and pertinence of the project's research and innovation objectives (and the extent to which they are ambitious, and go beyond the state of the art).**
**• Soundness of the proposed methodology (including interdisciplinary approaches, consideration of the gender dimension and other diversity aspects if relevant for the research project, and the quality and appropriateness of open science practices).**
**• Quality of the proposed interaction between the participating organisations in light of the research and innovation objectives.**

*Strengths:*
*- The research and innovation objectives are very well-detailed and pertinent to Multi-Actuated Ground Vehicles (MAGV), including coupled heterogeneous systems (drone-to-vehicle interaction). The proposed objectives are associated with well-chosen KPIs related to vehicle dynamics, control performance, cyberphysical system-based robustness, and practical use case demonstrations. The way to measure and verify the objectives, per simulation and in a real-world environment in a proving ground, is very well explained. The objectives are realistically achievable.*
*- The state-of-the-art presentation is mainly oriented on theoretical research, well showing the open topics in some areas that have already been covered for over 30 years. Consequently, the proposal focused on pertinent challenges, such as hybridising classic estimation and control approaches with AI techniques to better face uncertainties and achieve a more robust result. The proposal's ambition to apply it to MAGV is novel from a research prospect, but going all the way to testing on vehicle demonstrators makes the proposal very attractive in terms of ambition.*
*- The overall methodology is sound and very well explained. The safety challenges are well considered. It is appreciated that the traceability between requirements and validation methods will be done by using a model-based systems engineering methodology.*
*-The proposal is highly interdisciplinary. Expertise and methods from different disciplines are well combined in a methodological manner and convincingly explained in the proposal.*
*- Open science practices are very well integrated in the methodology. The applicants provide concrete information on how they plan to comply with mandatory open science practices. They also clearly explain how they will adopt recommended practices.*
*- The applicants outline a very good data management plan, in line with the FAIR principles, which will define the data management cycle both during the project funding period and for a period after the completion of project activities.*
*- The AI robustness is very well addressed in the proposal, at the methods' level, and during the final evaluation process.*
*- The contribution of the partners is very well described by correlating tasks assigned to partners with their expertise. Their contribution to secondments is correctly highlighted in terms of the number of secondments per hosting and sending.*
*- The networking activities contributing to the research and innovation activities are very well identified and justified, i.e. yearly workshops, web-based knowledge exchange, and cooperative work process.*

# *Writing*

**Criterion 2 - Impact**

Score: **5.00** (Threshold: 0 / 5.00 , Weight: 30.00% )

**The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme:**
**• Developing new and lasting research collaborations, achieving transfer of knowledge between participating organisations and contribution to improving research and innovation potential at the European and global level.**
**• Credibility of the measures to enhance the career perspectives of staff members and contribution to their skills development.**
**• Suitability and quality of the measures to maximise expected outcomes and impacts, as set out in the dissemination and exploitation plan, including communication activities.**
**• The magnitude and importance of the project's contribution to the expected scientific, societal and economic impacts.**

*Strengths:*
*- The proposal very well demonstrates the consortium's capacity to achieve sustainable collaboration, given that it is the outcome of six former European projects led by the partnership and that it includes instruments to ensure sustainability, such as collaborative projects using various funding instruments, university degree programs to integrate the project's outcomes into new educational areas, as well as joint valorization of expected patents and start-ups.*
*- The proposal's strategy to generate knowledge transfer is clearly outlined. It will improve human capital in research and innovation for the participating organisations.*
*- The proposal contributes to the objectives of several EU strategic roadmaps and partnerships, in particular, Smart, Green, and Integrated Transport; Electronic Components and Systems for European Leadership; ERTRAC - the European Road Transport Research Advisory Council; EPoSS - the European Technology Platform on Smart Systems Integration; and Cyber-Physical European Roadmap & Strategy (CyPhERS). The steady effort shown by the consortium also confirms that the proposal will improve the research and innovation potential in these fields within Europe.*
*- The well chosen measures to realise the potential of individuals, allowing them to acquire new skills and enhance their knowledge, are credible and pertinent to improve their career perspectives.*
*- Dissemination, communication, and exploitation measures to maximize the proposal's impact are comprehensively described, including means (website, host-based events, public media, documentation, etc.), targeted audience, targeted journals, and quantified targeted sizes of these actions. Regarding exploitation, the beneficiaries have very well identified preliminary assets of the exploitation plans.*
*- The general strategy for the management of intellectual property is very well described and clear.*
*- The project will credibly generate scientific knowledge on motion control for electrified and automated multi-actuated ground vehicles. The impact of the proposal's scientific results beyond the immediate scope and duration of the proposal is convincing.*
*- The proposal credibly provides technological impacts beyond scope and duration, such as less expensive controllers.*
*- The project will make a difference in terms of societal impact, beyond the scope and duration of the project, through the development of reliable and safe technologies with positive environmental effects and through a contribution to safe transportation by preventing road accidents caused by human error.*

# *Writing*

**Criterion 3 - Quality and efficiency of the implementation**

Score: **4.80** (Threshold: 0 / 5.00 , Weight: 20.00% )

**The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme:**
**• Quality and effectiveness of the work plan, assessment of risks and appropriateness of the effort assigned to work packages.**
**• Quality, capacity and role of each participant, including hosting arrangements and extent to which the consortium as a whole brings together the necessary expertise.**

*Strengths:*
*- Overall, the work plan is appropriate and credible. The work packages follow a logical sequence and are coherent with the objectives of the proposal. The tasks are well substantiated to address the necessary development work.*
*- The proposed secondments are comprehensively described per work package and per task and their matching with the proposal's objectives and activities is very carefully designed. The duration is also well aligned with the objectives.*
*- Staff profiles align very well with the proposal activities and are appropriate for implementing the activities foreseen for the different secondments.*
*- Scientific and administrative risks are very well identified, and their associated mitigation measures are pertinent.*
*- The infrastructure and capacity of each participating organization are appropriate in light of the tasks allocated to them, especially the demanding ambition to go to the field for testing.*
*- The participants are compatible and complementary, and the tasks allocated to each participating organization are coherent with their expertise.*
*- The participants' expertise and track record in open science achievements are very well addressed through their publications' records.*

*Weaknesses:*
*- There are some minor discrepancies in the timing of correlated tasks.*

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# *Thank You !*


2024-10-24

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