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Building consensus for using protocols to validate collaborative robotics applications across a wide range of domains

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Being safe around collaborative and versatile robots in shared spaces

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DANISH TECHNOLOGICAL INSTITUTE · Fraunhofer IFF · cea · Roessingh Research and Development · Consiglio Nazionale delle Ricerche

Overview

- **The Challenge**
  - Collaborative robotics for various domains
  - Standards not always available
  - How to validate system safety?
- **Concepts of safety skills and protocols**
  - The standardization conundrum
- **COVR Approach**
  - Our path forward
- **Building a consensus**
  - Get involved! You can help!

The Challenge

- **Collaborative robots are coming to the market**
  - **But what about human health and safety??**
  - **What about the CE Mark?**
    - *“Have I identified the all the standards, directives and guidelines that are relevant for my application? “*
    - *“How do I prove that the safety mechanisms I have chosen are correct and offer the required level of safety?”*

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The Challenge

- What if my application doesn’t fit into a domain with available safety standards for collaborative robots?
  - Industrial manufacturing
  - Healthcare and rehabilitation
  - Logistics
  - Civil
  - Consumer
  - Agriculture

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The Challenge

- **How do I test to ensure that my system is “safe”?**
  - **Can I do the measurement myself?**
  - **Performance-based vs. Prescriptive regulation and standardization**
  - **Where/how can we specify a specific measurement procedure, sensor, etc.?**

“Give a person a fish,

feed them for a day.

Teach a person to fish,

feed them for a lifetime.”

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- **Can system integrators and end-users validate the safety of their applications featuring collaborative robotics themselves, whereby**
  - **…the validation procedure is well-understood by the integrator / end-user?**
  - **…notified bodies / health and safety inspectors across Europe accept the results without requiring further tests?**

The COVR Vision

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Safety Skills

- **Safety skill** is the ability of a collaborative robot
  - to mitigate the risk in a potentially hazardous situation
  - to implement safety requirements
- **Capability of effective risk mitigation** must be proved by **validating the skill**
- **Skills** are mostly cross-domain

Safety Skills

- Industrial manufacturing
  - ISO/TS 15066
    - 4 Safeguarding modes
      - Power and Force Limiting
      - Speed and Separation Monitoring
      - Safety-rated Monitored Stop
      - Hand-Guiding
- Healthcare and rehabilitation
- Logistics
- Civil
- Consumer
- Agriculture

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Safety skills

- Limit force and pressure during collision
- Ability to stop robot movement before a collision occurs
- Ability to reduce the impact effect during contact
- Ability to restrict a single degree of freedom
- Ability to restrict multiple degrees of freedom to define area or volume
- Limit / reduce speed during operation

Approach for Identification of Skills:

- bottom-up
  - identified from existing standards
- top-down
  - analysis of risks and mitigation approaches for various domains

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The Standardization Conundrum

- **Standards are non-binding**

BUT

- **Burden of proof of conformity increased when not using standards**

→ *Use safety skills - based in standards from other domains - to bridge the current gaps*

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- **Procedure** to assess the safety capabilities of a certain skill in a quantifiable fashion
  - **Protocols** ensure a consistent and correct validation procedure
- **Contribution** for the validation of collaborative robots
  - Comply with regulations
  - Implement best practices
  - Fill gaps
- **Community feedback** requested for creating new and refining available protocols
- **Developed and proved** through realistic in-house trials

Protocols

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Protocol Validation structure

- **Introduction** describes the area of applications including:
  - **Scope and limitations** clarify the specific purpose
  - **Normative references** summarize the applicable regulations
  - **Definition and terms**
- **Concept and Objectives** specify the target behavior and target metrics
- **Conditions** specify the system relevant parameters, sub-systems, and the environment
- **Set-up** describes the test arrangement, sensing devices and data acquisition
- **Procedure** describes the test plan, execution, data analysis and how to complete the report

- Can system integrators and end-users validate the safety of their applications featuring collaborative robotics themselves, whereby
  - …the validation procedure is well-understood by the integrator / end-user?
  - …notified bodies across Europe accept the results without requiring further tests?

The COVR Vision

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- Can system integrators and end-users validate the safety of their applications featuring collaborative robotics themselves, whereby
  - …the validation procedure is well-understood by the integrator / end-user?

    → Use Safety Skills concept and associated COVR Protocols for self-validation

  - …notified bodies across Europe accept the results without requiring further tests?

    → Under what conditions would notified bodies accept results from COVR Protocols?

The COVR Vision

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COVR Challenges

- Characterize measurement **variance**
  - COVR in-house trials
  - COVR Awards
- **Community feedback** requested for creating new and refining available protocols
  - Identify best practices
    - Identify alternative measurement techniques
  - Fill gaps
    - Add environmental conditions (domain/application specific)
    - Create a family of protocols

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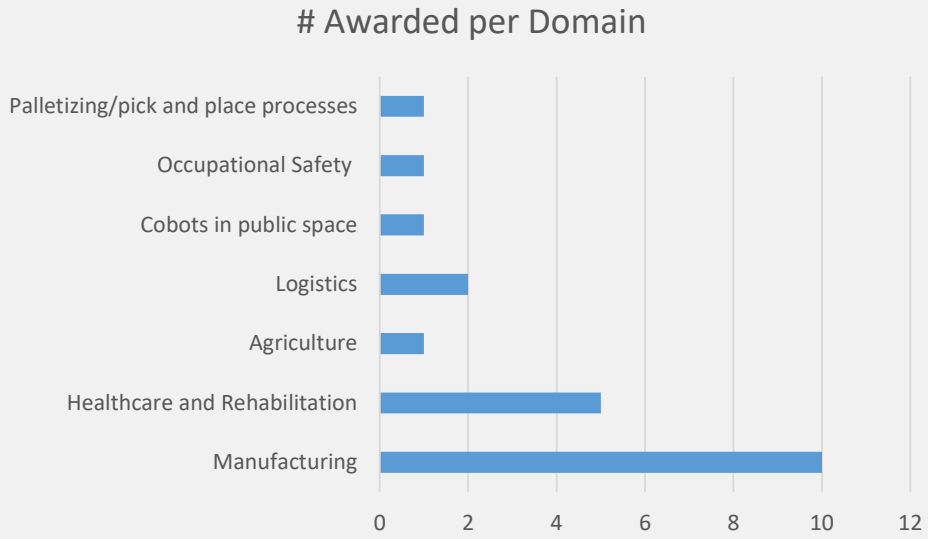
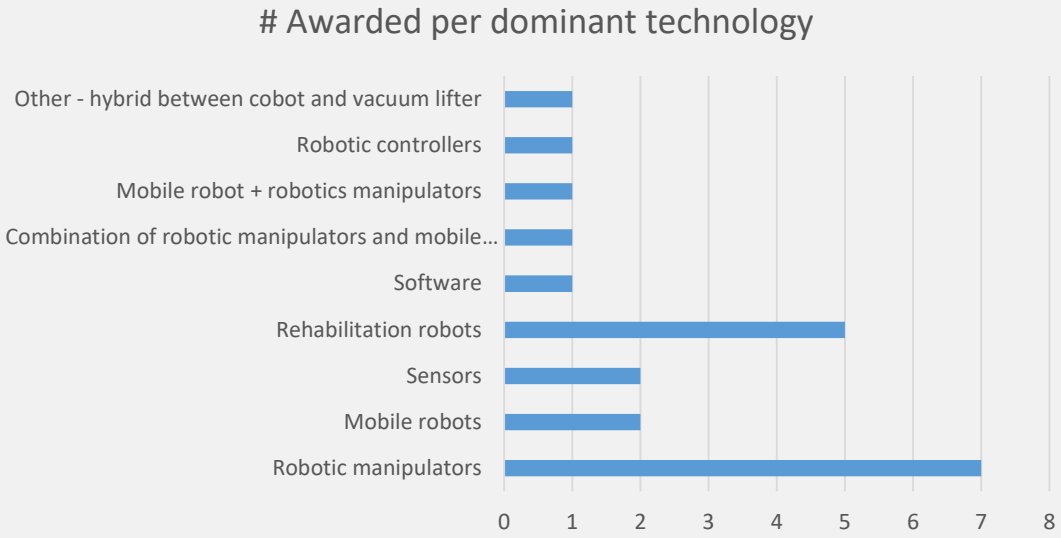
COVR Validation Awards

1st Call





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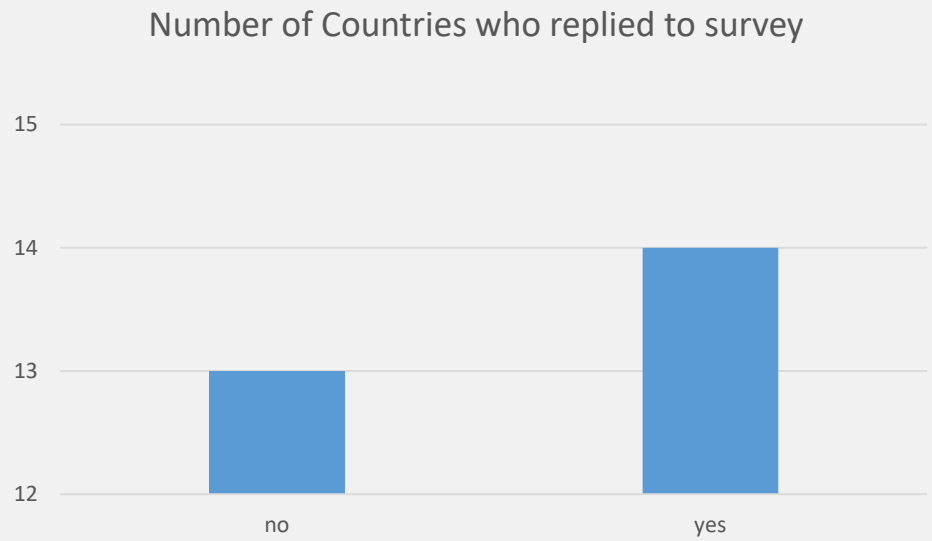
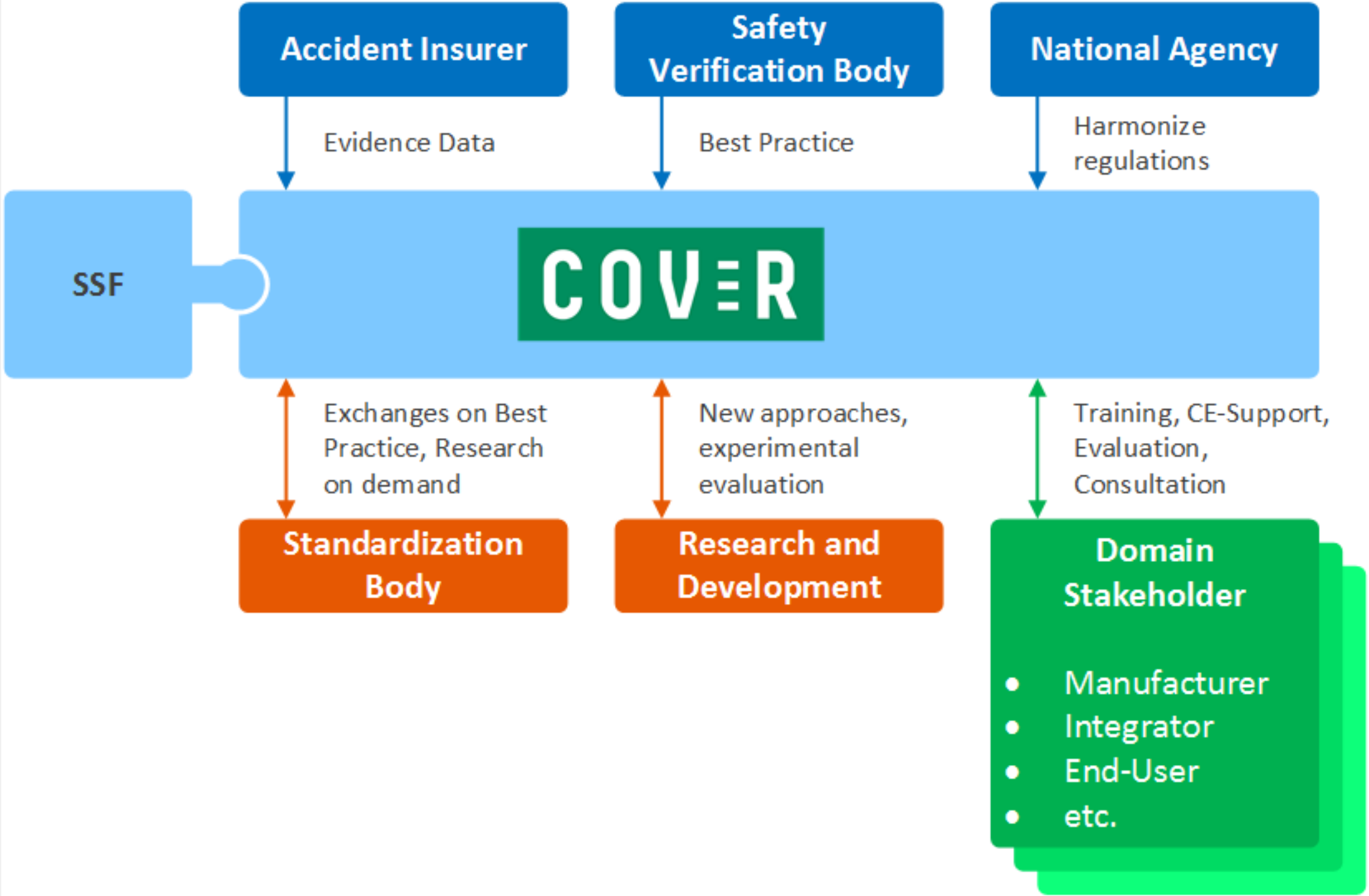
COVR Survey

Survey of all EU countries (contact info from EU-OSHA website)

- **Scenario:** I am a robotics system integrator who wants to install an application featuring human-robot collaboration (HRC) in a factory in your country.
- As I am familiar with EU legislation, I have done the following:
- Adhered to the Machinery Directive 2006/42/EC to be able to affix a CE Mark to the complete system. This included:
  - Carrying out a risk analysis according to EN ISO 12100
  - Determining risk mitigation measures and enacting them according to the C-level standards EN ISO 10218-1 and EN ISO 10218-2, as well as the ISO/TS 15066.
  - In a situation where Power and Force Limiting (according to EN ISO 10218-2, physical contact between human and robot is possible) is the safeguarding method, I have also carried out validation measurements to ensure that the contact forces and pressures in case of a collision are below the limit threshold values specified in ISO/TS 15066 and documented these.
- **COVR questions regarding national law:**
- Do I need to inform a national certified body or other agency in order to begin operation with my collaborative robot?
  - If yes, who?
- Do I need any further testing/validation/documentation besides the aforementioned standards?
  - If yes, what specifically?
- Do I need to consider other local/national legislation, restrictions or requirements beyond the aforementioned standards in order to bring the complete robotic application into the market?



Only 3 of the 14 responses cited national regulation that went beyond MD 2006/42/EC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National Agency
Evidence Data
Best Practice
Harmonize regulations
SSF
COVER
Exchanges on Best Practice, Research on demand
New approaches, experimental evaluation
Training, CE-Support, Evaluation, Consultation
Standardization Body
Research and Development
Domain Stakeholder
Manufacturer
Integrator
End-User
etc.

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Thanks for your attention!

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