Preview of R15.08 Industrial Mobile Robot Safety

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Chair, R15.08 Drafting Subcommittee
Outline

• Background
• Scope
• Terminology
• Structure
• Discussions
• Participation
Background: R15.08

• Exploratory meeting 16Jul2015
• R15 SAC authorization: 6Nov2015
• …
• R15.08 meeting #8 13-14Nov2018
• R15.08 meeting #9 25-27Feb2019
• R15.08 meeting #10 16-17May2019
• R15.08 meeting #11 16,18-19Sep2019
Background: Related standards

- ANSI/RIA R15.06-2012
- RIA TR R15.606-2016
- ANSI/ITSDF B56.5-2019
- EN 1525
- ISO 3691-4 (currently at FDIS)
- ISO 13482:2014
Background: NIST report

• Towards Mobile Manipulator Safety Standards (Marvel & Bostelman, NIST, October 2013)
  • Gaps
    • Behavior of combined system
    • Safety signals between two controllers
  • Differences
    • Definitions
    • Requirements

• URL: https://www.nist.gov/publications/towards-mobile-manipulator-safety-standards
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Scope: Industrial Mobile Robots

• At least semi-structured environment
• Trained personnel; no public interaction
• Ground-based
• Silent on indoor vs. outdoor
• Silent on wheels vs. tracks vs. legs
Scope: Industrial Mobile Robot types

- IMR Type A
  - Autonomous Mobile Robot (mobile platform only)
- IMR Type B
  - IMR Type A + attachment (passive or active, non-manipulator)
- IMR Type C
  - IMR Type A + industrial manipulator
  - AGV + industrial manipulator
Examples: IMR Type C

Source: National Institute of Standards and Technology
Examples: IMR Type C

Source: Yaskawa America, Inc.
https://www.youtube.com/watch?v=wVI2cYaGVDY
Examples: IMR Type B

Source: Amazon
https://www.youtube.com/watch?v=JXkMevbjga4
Examples: IMR Type A & B

Source: Omron
https://www.youtube.com/watch?v=qWbPeOXlA0w
IMR Type C

Source: Fetch Robotics
https://fetchrobotics.com/robotics-platforms/fetch-mobile-manipulator/
IMR Type C

Source: KUKA Robotics
https://www.youtube.com/watch?v=p6NwH3G0V6Y
Examples: IMR Type A & C

Source: Boston Dynamics
https://www.youtube.com/watch?v=fUyU3Ikzoio
Scope: Decision tree
Scope: Mobility / Navigation

START

Industrial Application?

YES

Mobile Platform?

NO

MANUAL

Navigation?

AUTONOMOUS

GUILDED

NO

Manipulator (3+ axes)?

Industrial Robot (System) [See R15.06]

YES

END

 Autonomous Mobile Robot (AMR)  Automated Guided Vehicle (AGV)
Scope: Industrial Mobile Robots

Diagram:

- **Autonomous Mobile Robot (AMR)**
  - Attachment Type?
    - NONE
      - Type A AMR
    - OTHER
      - Type B AMR w/Attachment
  - MANIPULATOR (3+ axes)
    - Mobile Manipulator Type C

- **Automated Guided Vehicle (AGV)**
  - Attachment Type?
    - NONE
  - OTHER

**Industrial Mobile Robot** [See R15.08]

**Automated Guided Vehicle (AGV)** [See B56.5]
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Terminology

• Attachments
  • Passive
    • e.g. Shelves
    • Also manipulators as cargo
  • Active
    • Manipulator
    • Non-manipulator
Terminology: Restricted space / area

• Restricted space
  • From R15.06
  • Applies only to active attachments relative to their mount points

• Restricted area
  • From B56.5
  • Applies to personnel; different safety functions active
Terminology: other spaces

- **Free space**
  - Where the mobile platform can plan a path
- **Keepout zone**
  - Zone excluded from the free space
- **Monitored space**
  - Volume around the IMR where perception systems can monitor
- **Hazard zone**
  - e.g. spaces with inadequate clearance
Terminology: mobile platforms

- Working space
  - Mobile platform volume + attachment volume
- Base footprint
  - Two-dimensional projection of the IMR working space
  - Used for mobile robot path planning
Terminology: Modes

- Modes
  - Manual
  - Automatic
  - Semi-automatic / assisted manual
  - Maintenance
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Structure

• Part 1
  • Covers the IMR and attachments
  • In process, targeting ballot EOY 2019
  • Publish early/mid-2020

• Part 2
  • Covers site- and application-specific requirements
  • Started, but on hold due to focus on part 1

• Part 3
  • Guidance to users
  • Future
Structure: Part 1

• Clause 1: Scope
• Clause 2: Normative references
• Clause 3: Terms and definitions
• Clause 4: Hazard identification and risk assessment
Structure: Part 1

- Clause 5: Design requirements and protective measures
  - Clause 5.1: General / common requirements
  - Clause 5.2: Mobile platforms
    - AGV: See B56.5
    - AMR
  - Clause 5.3: Attachments
    - Passive
    - Active
      - Manipulator
      - Non-manipulator
  - Clause 5.4: Type B and Type C IMRs
  - Clause 5.5: IMR Fleet Management
Structure: Part 1

• Clause 6: Verification and Validation
• Clause 7: Information for Use
  • Also Marking/Labeling
• Annex A: List of Significant Hazards
• Annex X: Means for Verification
Structure

• Clauses 5.1, 5.2, 5.3, and 5.4 have (mostly) parallel structure
• Clause 5.1 has requirements common to all types of IMRs and attachments for IMRs
• Subclauses in 5.2-5.4 refer back to the corresponding subclause of 5.1, and in some cases have additional requirements specific to that section
5.1.1: What equipment is covered
5.1.2: Conformity with R15.06, B56.5
5.1.3: Modes
  • Manual
  • Automatic
  • Semi-automatic
  • Maintenance
5.1.4: Portable control units (pendants)
5.1.5: Start/restart/stops
5.1.6: Stopping distance
5.1.7: Navigation
• 5.1.8: Presence-sensing devices
• 5.1.9: Working space
  • Stow configuration
• 5.1.10: Movement without drive power
• 5.1.11: SRP/CS
• 5.1.12: Warning devices
• 5.1.13: Interfaces
• 5.1.14: Rated capacity
  • Also stability
• 5.1.15: Energy control
• 5.1.16: Mechanical power transmission
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Discussions

- Risk assessment reference: ANSI B11.0 vs. ANSI/ISO 12100
- Terminology
  - Portable control unit (vs. pendant)
  - Collision avoidance vs. obstacle avoidance
  - Operation / operating environment vs. “use”
  - Manipulator (vs. industrial robot)
- Simultaneous motion requirements: needed? location?
- Docking requirements: sufficient?
Discussions

• Structure
  • Lots of “empty” clauses in 5.2-5.4 with only reference to 5.1
  • Forcing only terminal nodes in the outline tree to have text vs.
    e.g. 5.1 with text followed by 5.1.1 with text
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Participation

• RIA standards development open to all interested parties
• Next meetings
  • 18-19Sep2019: Louisville, KY
  • Week of 24-28Feb2019: Marysville, OH
• Contact:
  • Carole Franklin, RIA Director of Standards Development
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