Industrial Mobile Robots Safety Standard Update

Michael Gerstenberger
Chair
R15.08 Subcommittee
Outline

• Background
• Definitions and examples
• Existing standards
• Key questions/topics
• Participation
Speaker Background

• 31 years experience in robotics industry
  – GMF Robotics (now FANUC)
  – KUKA Robotics

• Robot safety standards committees
  – RIA R15.06
  – RIA R15.08 (chair)
  – ISO TC 299/WG 3
  – UL STP 1740
  – CSA Z434
R15.08 Subcommittee Background

- Exploratory meeting 16Jul2015
- R15 Standards Approval Committee authorized formation of R15.08 6Nov2015
- R15.08 meeting #1 14-15Jul2016
- R15.08 meeting #2 21Oct2016
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Definitions: Robot

- http://www.merriam-webster.com: a mechanism guided by automatic controls
- ISO 8373:2012: actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks
Definitions: Industrial Robot

ANSI/RIA R15.06-2012 (ISO 10218-1:2011): automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications
Definitions: Robot

UL 1740: Automatically controlled, reprogrammable multipurpose machine, programmable in several degrees of freedom, which can be either fixed in place or mobile
Examples

Source: KUKA Laboratories, GmbH
https://commons.wikimedia.org/wiki/File:KUKA_omniRob.jpg
Examples

Source: KUKA Robotics
https://www.youtube.com/watch?v=p6NwH3G0V6Y
Examples

Source: Boston Dynamics
https://www.youtube.com/watch?v=rVlhMGQgDkY
Examples

Source: https://www.youtube.com/watch?v=iyZEOpsQsX0
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3.10 Industrial robot, NOTE 3 – The following devices are considered industrial robots for the purpose of this standard:

- ... 
- the manipulating portions of mobile robots 
- ...
Existing Standards

B56.5 Safety Standard for Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles

– Doesn’t address the hazards typically present with an industrial robot
– Language tailored to vehicles that follow a prescribed path
Existing Standards

• EN 1525 Safety of industrial trucks. Driverless trucks and their systems

• EN1526 Safety of industrial trucks. Additional requirements for automated functions on trucks

• ISO 3691-4 Driverless industrial trucks and their systems (Committee draft)
Existing Standards

ISO 13482:2014 Safety requirements for personal care robots

- Type 1.2: Mobile servant robot with manipulator
- Specifically excludes industrial robots
Existing Standards

ISO TS 15066:2016 Robots and Robotic Devices – Collaborative Robots

- Safety-rated monitored stop
- Hand-guiding
- Speed and separation monitoring
- Power and force limiting
- Silent on the topic of mobility
Existing Standards: NIST Report

Towards Mobile Manipulator Safety Standards (Marvel & Bostelman, NIST, October 2013)

- Gaps
- Differences
  - Definitions
  - Requirements
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Key Issues: Safety Strategies

• Traditional industrial robot safety
  – Separation of operator from hazards
  – Fencing, light curtains

• AGV safety
  – Well-defined paths
  – Awareness means
  – Bumpers, scanners
  – Training
Key Issues

• Mobility
• Integrated vs. isolated controllers
• Requirements
  – Components
  – Interfaces
  – System
Key Questions

• New standard vs. modifications to existing standards
• Framework for decision
Key Questions: Scope

• What is “industrial”?
  – Manufacturing only?
  – Distribution?
  – Commercial?

• Mobility environment
  – Airborne
  – Waterborne (on/under)
  – Indoor/outdoor

• Mobility modality
  – Wheels
  – Tracks
  – Legs
Key Questions: HRI

• How to deal with human-robot interaction
• Trained personnel vs. “the public”
  – Grocery stores
  – Stockroom vs. stocking shelves
  – Hospitals
Key Questions: Safety Performance

- **Industrial robots**
  - PL d with structure category 3
  - SIL 2 with hardware fault tolerance 1

- **Personal care robots**
  - PL d (no structure specified)
  - Lower PL for small and slow and light and no arm

- **AGVs**
  - Safety performance not specified in B56.5
Key Questions: Error Recovery

- Per R15.06, violation of the safeguarded space requires restart from outside cell
- Per B56.5, automatic restart after obstacle removed
Key Questions: Stability

- Static load due to arm position
- Dynamic load due to arm motion
- Legs, 2 wheels (Segway), 1 wheel (Ballbot)
Strategies

Framework for decision on new standard vs. revising related standards

– Committee members reviewing related standards
– May consider workload of committees responsible for related standards
– Related standards: base of people familiar with requirements vs.
– New standard: one stop shop for requirements
Strategies

• Use profiles, e.g.
  – Material handling with load/unload
  – Processing large parts

• Simultaneous vs. independent motion
  – Arm only moves when base doesn’t
  – Coordinated arm/base motion
Strategies

• Separate manufacturer requirements from integrator/user requirements
  – Similar to R15.06-2012, B56.5
  – Alternatively, base/arm requirements

• Equipment span of control
  – Common controller for arm and base
  – Separate controllers; communication & interface requirements
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• RIA standards development open to all interested parties

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