Collaborative Robots in industry

Robots in Society: Event 2 – Current robotics

Nahema Sylla

08/11/2017
Introduction and context
Human-Robot Collaboration in industry

Principle: Human and robot sharing workspace without any fence

- Dexterity ✓
- Problem Solving ✓
- Fatigue ✗
- Strength ✓
- No fatigue ✓
- No intelligence ✗
Types of Collaboration (ISO 10218)

- Safety Monitored Stop
- Hand guiding
- Speed and Separation Monitoring
- Power and Force Limiting
Benefits and key applications in automotive industry

Maximum value for:

✓ Ergonomics improvements
✓ Use as a third hand
✓ Line balancing activities
✓ Quality improvement
✓ Better floor space utilization
✓ Versatile and flexible operations

Key applications:

- Screwing
- Loading
- Handling
- Assembly
- Gluing
- Inspection
The Cobots working group
#COBOTICS

The Future is Man with Machine

Cobots cheaper than fenced options

Cobots at forefront of the factory of the future
Context

Issue

• Perception from leading UK Automotive manufacturers that UK plants are falling behind their European and Global competitors in the application of Collaborative Robots
• UK plants perceived as less productive
• The issue is largely seen as the interpretation of standards and the development of implementation guidelines

Objectives of the working group

• Understand the root cause of this competitive disadvantage
• Facilitate safe, consistent and cost effective deployment of Collaborative Robots systems in UK automotive plants
• Develop and share best practice related to safe application
Partners and consultation process

Partners

• Supported by the Health and Safety Executive

Consultation process

• Commenced its activities in August 2016
• Meetings at regular intervals over a period of 10 months
• Workshops, consultations, interviews and gathering information through questionnaires
• Wide variety of inputs collected from universities, robot manufacturers, Catapult centres, software providers, automotive OEM’s, trade organisations, and other European industrial safety organisations
Main outcome

‘Implementation of Collaborative Robot Applications’


Aim:

• Provide a definition of a truly collaborative application and identify the differences to the standard collaboration modes
• Understand the legal requirements of safety compliance versus technical specifications
• Develop implementation guidelines for truly collaborative applications along with guidance for risk assessment
• Identify key applications for automotive manufacturing
• Establish key limitations for collaborative applications
Truly Collaborative application

Definition given by the working group:

“A truly collaborative application is a **programmable electromechanical system** that has been designed, constructed, assessed and locked through a **certified change control process**, within a **prescribed** environment to operate within a **tolerable level of risk** in all reasonably foreseeable modes whilst collaborating in a **shared workspace** with a **trained employee** performing a standard operation.”
Installation Guidelines for Collaborative applications

1. Identify the need
2. Design the application
3. Select the robot with right safety measures
4. Install the application
5. Test and validate the application

Risk Assessment
## Standards and regulations

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Sections/Tables</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 12100</td>
<td>“Safety of machinery, General principles for design, Risk assessment and risk reduction”</td>
<td>Table B1, 2 &amp; 3</td>
<td>Hazards, hazardous situations and hazardous events to consider to perform risk assessment</td>
</tr>
<tr>
<td>ISO 10218-2</td>
<td>“Robots and robotic devices, safety requirements for industrial robots, Part 2: Robot systems and integration”</td>
<td>Section 5.11.2 (a)</td>
<td>General requirements of collaborative robot operation; points to consider to perform risk assessment</td>
</tr>
<tr>
<td>ISO 10218-2</td>
<td>“Robots and robotic devices, safety requirements for industrial robots, Part 2: Robot systems and integration”</td>
<td>Section 5.11.5.5</td>
<td>Safety features to select for ensuring a safe work environment when using a truly collaborative robot</td>
</tr>
<tr>
<td>ISO/TS 15066</td>
<td>“Robots and robotic devices, Collaborative robots”</td>
<td>Section 4.2 (b)</td>
<td>Access and clearance factors to consider to reduce risks and hazards when designing a collaborative application.</td>
</tr>
<tr>
<td>ISO/TS 15066</td>
<td>“Robots and robotic devices, Collaborative robots”</td>
<td>Section 4.3.2 (b)</td>
<td>Identification of hazards related to robot applications, including Ex: end effector and workpiece hazards, operation motion and location, influence of the surroundings</td>
</tr>
<tr>
<td>ISO/TS 15066</td>
<td>“Robots and robotic devices, Collaborative robots”</td>
<td>Section 4.3.3</td>
<td>Identification and documentation of reasonably foreseeable tasks and hazards combination associated with the robot cell</td>
</tr>
</tbody>
</table>
TS 15066 : Bio Mechanical Limits

- General industry perception is that the standard is restrictive
- Regular working on line more force and pressure are experienced on the shop floor
- For payloads above 5kg within a shared workspace speed of 250mm/sec to 400mm/sec would satisfy the TS15066 (from a study of 6 applications)
Limitations

- **Low payload**
  - Low variety of parts to handle

- **Level of risk**
  - Unpredictability of human behaviour

- **Low speed**
  - Difficulty to meet the cycle time

- **Limited applications**
  - Shared workspace solve specific problems
Introduction

- Risk assessment for collaborative applications is extremely critical
- Gap in conducting risk assessment virtually before the physical installation

Goal: Create a virtual risk assessment tool for truly collaborative applications
Overview

**RACE** = Risk Assessment for Collaborative work Environment

- Developed as an add-on of an existing simulator
- Simulator should include both human and robot dynamic models
Simulator

- Highly customisable simulator
- Versatile and ideal for multi-robot application
- Large library of collaborative robot models
- Scripts written in C/C++, Python, Java, Lua, Matlab or Octave
Feature 1: Programming the Robot task

**Option a: Script Writing**

**Option b: Graphical programming**

Define manually the robot trajectory with waypoints

From inverse Kinematics
Feature 2: Operator envelope

- Envelope around the human model
- Collision tolerance
- Diameter = body segment length
Feature 3: Collision detection

- Detects any collision:
  - Human/Robot
  - Human Envelope/Robot
- Visual output: colour change during simulation
Feature 4: Speed calculation

- Maximum recommended speed calculation:
  - According to the body region
  - Compliance with ISO/TS15066
Next steps

Robot script transcription:
Import the robot script to program the robot task

Collision Report with details:
- Body region affected, time
- Type of contact (point, line, contact),
- Screenshot

User interface

Operator task
Graphical programming
Thank you.

www.hssmi.org