tourings

training for collaborative robotics integration

TOURINGS

Joint Curriculum

Overview

Final Version

Erasmus+

The Project

1 About TOURINGS

TOURINGS is based on a transdisciplinary strategic partnership composed by a national standardisation body, higher education institutions, vocational education and training institutions and research centres on smart manufacturing, high-performance production and innovation in engineering. Each of the partners will provide their knowledge and expertise related to collaborative robotics, manufacturing, project management, ergonomics assessment, assembly line balance and digital simulations, aligned to the ISO-TS 15066 and considering problems such as work-related musculoskeletal disorders.

2 Context

The use of robotics in european industry continues to grow. According to the latest report from the International Federation of Robotics, the supply of industrial robots has increased 7% in Europe from 67.000 to 71.000 units in the last years. By 2020, more than 1.7 million new robots will be installed worldwide [1]. A collaborative robot is designed for direct human interaction in a defined collaborative space. Their integration in the industry allows to automate non-ergonomic or repetitive tasks. It improves assembly times, to make automation flexible for changing environments and automates work in restricted areas, a set of advantages which makes it very useful for manufacturing sectors. Only ISO-TS 15066 regulates cobots [2], complementing two existing type C standards on industrial robots (UNE 10218-A and 10218-2). This standard is key in terms of risk assessment and design of safety features considering contact situations and different collaborative methods like safety-rated monitored stop, hand guiding, speed and separation monitoring or power and force limiting.

European workforce is ageing, and repetitive and non-ergonomic tasks are one of the main concerns of european healthcare due to WMSDs. Cobots enhance workers well-being and improves employment conditions and the efficiency of some tasks. This is a key point considering the competition that european manufacturing sector has to face with more automatized countries like China or Japan and other emerging countries with a younger and cheaper workforce Under this context, different training topics are targeted: Cobots installation and workstation design, hardware, software and cells design, functionalities design, assembly line balance and ergonomics assessment of human-robot interaction.

3 Main Goal

The desire of TOURINGS is to develop innovative training tools addressed to manufacturing sectors in the fields of collaborative robotics and thus facilitate its installation and improve the skills and knowledge on this key technology for the upcoming years.

TOURINGS will deliver a training course addressing key aspects for European manufacturing sectors:

a) safety requirements for human-robot interaction,

b) ergonomic measurementin human-robot interaction,
c) cobots integration in the assembly line balance and
d) design of different robot modules and behaviours to address production needs.

TOURINGS aims to foster the installation of cobots aligned with ISO-TS 15066 across EU to improve workers' wellness by avoiding work-related musculoskeletal disorders (WMSDs), improve the design of cobots behaviours by its modularity and improve the knowledge on the assembly line principles.

The training course should consist of the following modules:

1 **Collaborative Robotics Basics**: it will include all the pertinent aspects related to mechanics, electronics, computer science, artificial intelligence, control engineering and physics among others.
2 **Collaborative Robotics Modular Design and Behaviour**: it will show the possibilities of modularity and re-programmability of collaborative robotics' functionalities and different robotic cells

3 Collaborative Robotics Safety Requirements: it will cover all the relative aspects related to a safe physical human-robot interaction aligned to the requirements of ISO 15066

4 Collaborative Robotics Installation on the Assembly Line: it will introduce the learners in some assembly line and manufacturing principles to take into account before installing collaborative robotics to the make the most of it

5 Collaborative Robotics Interactions. Digital Human Model, Digital Human Simulation and the RULA Method: this module will show how a digital human model can be created to measure physical human-robot interaction using different methods.

The course will be addressed to manufacturing companies along EU with special attention to those sectors where workers have more repetitive tasks, with heavy loads in nonergonomic positions. It is also addressed to human resources managers, policy makers, VET providers, training organisations and trainers and Higher Education Institution specialized in robotics, consultancies offering specialized support for robotics installations and assembly lines balance and students and unemployed interested in collaborative robotics.

JOINT CURRICULUM

Module 1

Basics of Collaborative Robotics	**1 History** 1.1 Industrial Revolutions 1.2 Robotics from the beginning to present 1.3 Impact of Robotics in the production process	
	2 Structure of Collaborative Robots 2.1 Axes 2.2 Coordinate Systems 2.3 Digital inputs and outputs 2.4 Analog inputs and outputs	**3 Characteristics of Collaborative Robots** 3.1 Weight and Payload 3.2 Reach 3.3 Precision and Repeteability 3.4 Speed and acceleration
	4 Initial Cobot Configuration 4.1 Installation files 4.2 TCP (Total Center Point) 4.3 Center of mass 4.4 Limits	**5 Basic Programming Techniques** 5.1 Program structure 5.2 I/O Instructions 5.3 Movement instructions 5.4 Control instructions

Module 2

Collaborative Robotics Modular Design and Behaviour	**1 Hardware Cobot** 1.1 Robot frames, links and joints 1.2 Cobot / Robot technical Capabilities.Drive system 1.3 Cobot / Robot selection principles	
	2 Cobot Gripping Systems 2.1 End of Arm Tooling construction and classification 2.2 Using end effectors in different applications 2.3 EOAT selection and use in the company	
	3 Sensor Application and AI in Robotics 3.1 Sensor classification and applications 3.2 Needs for using sensors 3.3 Integration of sensor information in the cobot working cycle 3.4 AI technologies for process improvement	
	4 Typical cobot applications 4.1 Assembly 4.2 Quality inspection 4.3 CNC machine tending 4.4 machining 4.5 Palletizing	**5 Risk assessment and Cost-Benefit Analysis** 5.1 Risk Assessment 5.2 Cost-benefit analysis

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Module 3

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<tr><td rowspan="3">Collaborative Robotics Safety Requirements</td><td colspan="2">1 Standards
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1.2 ISO/TS 15066 standards
1.3 Their limits in their application
1.4 Points of attention while implementing cobots in production lines</td></tr>
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2.1 Definition of biomechanical limits
2.2 Types of measures of the biomechanical limits</td><td>3 CE-Conformity & Risk Assessment
3.1 Definition of the risk assessment
3.2 Ways of the risk assessment</td></tr>
<tr><td>4 Planning a safe cell
4.1 Principles of a safe cell
4.2 Bases of design
4.3 Bases of project management
4.4 CAD models
4.5 Needs to implement a safe cell
4.6 Design of safe gripping fingers</td><td>5 Safety Technologies
5.1 Types of safety sensors and their way of working
5.1.1 Light barriers
5.1.2 Light grids
5.1.3 Optical systems
5.1.4 Others</td></tr>
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Module 4

Collaborative Robotics Installation in the Assembly Line	**1 Basics of integration project** 1.1 Integration general understanding 1.2 Cobot integration principles 1.3 Benefits of cobot integration 1.4 Main mistakes in the integration process
	2 Implementation principles and Workplace layout 2.1 General principles of robot implementation 2.2 Main stages of the implementation project 2.3 Robot workplace design principles 2.4 Workplace layout 2.5 The impact of work task on workplace design 2.6 Project management principles
	3 Integration of cobot in assembly line and assembly line balancing 3.1 Assembly system 3.2 Main steps for cobot successful integration 3.3 Integration tools and methods 3.4 Assembly line balancing meaning 3.4.1. Tact time calculation 3.4.2. Definitions considered with line balancing 3.5. Principles and models for assembly line balancing
	4 Configuration and recon-figuration of assembly line 4.1. Human – robot collaboration 4.1.1. Human-robot collaboration basic 4.1.2. Humans and cobots possibilities to work together in a workplace 4.2. Collaborative robots on a production line 4.3. Configuration and reconfiguration principles 4.3.1 System configuration 4.3.2 Hardware and software configuration
	5 Production in an assembly line and its performance 5.1. Production processes in an assembly line 5.2 Workplace and assembly line performance

Module 5

Collaborative Robotics Interactions. Digital Human Model, Digital Human Simulation and RULA Method	**1 Collaborative robotics interactions** 1.1 Definition of collaborative robotics interactions 1.2 Risks of WMDs 1.3 Risks of psychological disorders by using collaborative robotics
	2 Digital Human simulation and RULA method 2.1 Definitions of digital human model, digital human simulation and RULA method 2.2 Reasons to use those methods 2.2.1 more productivity 2.2.2 Better well being of the employees 2.2.3 Better employer brand 2.3 Ways to mesure those methods
	3 Analysis of the results of digital human simulation and RULA method 3.1 Evaluation of the risk 3.2 Calculate the most effective way to apply solutions 3.3 Measurement of the advantages led by use of collaborative robotics 3.4 Ways to improve current situations