IT+Robotics

• Spin-off of University of Padua founded in 2005
  • Strong relationship with IAS-LAB (Intelligent and Autonomous Systems Laboratory)

• Mission:
  Increase the flexibility of industrial processes by transforming the latest results of the academic research into industrial solutions.
What we do

• Technological transfer in the following fields:
  • Automation
    • Robotics simulation for off-line programming
    • Real-time systems for machine control
  • Machine vision
    • Visual inspection for quality control
    • Robot guide

• International research projects
  • 4 FP7 projects (robotics vision and simulation)
  • 2 national projects (video surveillance)
Where we are

- Registered Office
  - Vicenza

- Operating Office
  - Padua

- Deep collaboration with:
  - IAS-LAB
    (University of Padua)
Workcell Simulator

- **Software suite for off-line programming of work cells**
  - Create the workcell
    - Modular plug-in architecture to adapt easily to any process
  - **Simulation**
    - Cutting-edge algorithm for automatic motion planning
    - **Scripting engine** to customize process
  - **Controller code generation**
    - **Vendor independent** code generation
Smart Pick 3D

- Turn-key solution to random bin picking
- Key features
  - Model loaded using CAD or based on template
  - Robust to illumination changes
  - Single camera, multiple cameras, laser triangulation
Smart Check 3D

• Vision system for **visual inspection**

• **Key features**
  
  • **Robot manipulator** to move the vision system OR the product
  
  • **Off-line** definition of inspection cycle
Flexible visual inspection

SMART CHECK 3D
Cost-effective visual inspection

• Introduction of visual inspection systems is not a matter of technical flexibility but of economic efficiency

• SMEs willing to archive lean production paradigm
  – Small batch size (down to the size of one)
  – Frequent introduction of new product models and change of product’s quality assessment requirements
Cost-effective visual inspection

• Shift of programming effort to end-user
  – End-user must be able to introduce new products and rapidly change quality assessment requirements without requiring system integrator effort
  – Programming must be performed offline
Objectives

Flexibility

• One work cell for many (different) products
• Archived using robot manipulator (to move the vision system OR the product)

Ease of programming

• Programming performed by end-users
• Archived using software developed to fully define inspection cycle offline
3D Complete

- Efficient 3D completeness inspection
- FP7 European Project
  - 2 years, start date September 2010
  - Research for SME (FP/-SME-2010-1)
- Objective:
  - Build a efficient system for 3D completeness inspection on assemblies combining both 3D shape and texture
  - Typical checks: presence of a part, part id, part position and orientation, ...
Thermobot

• Autonomous robotic system for thermo-graphic detection of cracks
  – FP7 European Project
  – 3 years, start date January 2012
  – Factory of the Future (FoF.NMP.2011-3)

• Objective:
  – Detection of cracks using thermography
  – Automatic definition of process using off-line programming starting from CAD data
  – Online adaptation of process using feedback from camera
Smart Check 3D

- **IT+Robotics solution for visual inspection:**
  - Combines 3D vision and 2D vision using a single sensor
  - Focused on completeness inspection, but can be extended to any visual inspection check
  - Two configurations:
    - Product on **conveyor belt**: maximizes **cycle time**
    - Vision system mounted on **robot**: maximizes **flexibility**

- **Advantages of our solution:**
  - Combination of 2D and 3D
  - **Offline** programming software to define inspection cycle
    - Easy to configure & re-configure
    - Automatic computation of viewpoints
  - **Auto-calibration** procedure
  - **Fast** production change
Work cell Definition

• **Import** components to simulated environment  
  – Define robot and other objects in the workcell  
  – Define sensor(s)  
    • currently standard camera or laser triangulation system

• **Perform** **calibration**  
  – Sensor calibration  
  – Robot-sensor calibration  
  – Product position calibration
Configuration of inspection task

Configure acquisition
- Choose sensor
- Define ROI on the product
- Define required resolution

Test inspection
- Virtual defect generation
- Assess quality inspection performance

Configure inspection
- Define inspection task
- Configure parameters
Virtual acquisition

- Region of interest
- Required resolution
- Sensor model and calibration
Definition of inspection algorithm

• Add inspection task
  – 3D: alignment, cut-box, cross-correlation, ...
  – 2D: alignment, image mask, edge-detection, ...
3D inspection

- Sample: completeness inspection
  - Check part presence/absence
  - Measure deviation from reference object
2D inspection

- Sample: check for inclusions
  - Acquisition of reference 2D image
  - Acquisition of 2D image during cycle to compare it with reference
Merging of acquisitions

• Configuration may include several tasks
  – Objective: reduce cycle time

• Definition of groups of neighbor defects may cause performance degradation due to start-stop motion

• Acquisition merging allows to overcome this issue
  – Merge near acquisitions with compatible parameters
Path planning

• Objective: generate collision-free path
  – Uses motion planning algorithms of WorkcellSimulator to compute a collision-free path between inspection points

• Objective: reduce cycle time
  – Reorder acquisitions to reduce overall inspection time (TSP problem)
Online execution: learning

- Robot Code
- Cycle start
- Robot motion
- Sensor acquisition
- Reference data
Online execution: inspecting

Robot Code

Cycle start

Robot motion

Sensor acquisition

Inspection result

Reference data

Asynchronous multi-threaded algorithms execution
Case study

- Inspection of **cast aluminium** products for leading supplier in the **automotive** sector
- **Robot manipulator** equipped with smart camera featuring peak detection in hardware
  - Dual-laser pattern projector for **3D** acquisition
  - Ring LED illuminator for **2D** acquisition
Future works

• **Metrology**
  – Improve *precision* in the acquisition of point cloud using laser triangulation system
  – Continuous feedback from robot controller to associate precise *robot position* to each frame

• **Online trajectory planning**
  – Determine acquisition sequence based on *current cycle* results
    • E.g.: if doing a rough scan result is uncertain, perform a more detailed scan on the required spot
  – Requires fast *online planning* algorithms
THANK YOU