SEVENTH FRAMEWORK PROGRAMME

AR-Enhanced Human-Robot-Interaction Methodologies Algorithms

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eon reality

Agenda

- Introduction
- Related Work
- Approach
- Sample Prototype
- Results & Discussion
- Conclusions and Future work

Introduction

"Robots will become common tools for human workers on assembly shop floors"

Today, for [drilling] Future in repetative assembly tasks

More specific:

- increase the productivity of currently manual shop floors,
- improve the ability of assembly workshops to adapt to changing work load,
- improve the working conditions of humans by relieving them of jobs that are repetitive and non-ergonomic,
- increase the degree of automation in assembly workshops without the need for high investments

Symbiotic Human Robot Cooperation

Introduction

- Mainly driven by the five pilot cases defined by the industrial users' needs.
- The method and tool developers will consider generality and openness as critical characteristics of the development, so that the framework may be later on efficiently transferred to other industrial applications.
- The pilot cases will provide the opportunity for the LIAA framework to be used in a set of real industrial scenarios.





Introduction

Pilot Cases:

- **Opel**: Turbocharger assembly
- **Dresden Elektronik**: Final assembly of HAL sensor PCB
- **SPINEA**: Assembly of TwinSpin Reduction Gear
- **Fischer**: Assembly of roof luggage rack
- **TELNET**: Radiant Element Assembly

Introduction

- Motivation
  - Reduce training time
  - Make learning procedure more enjoyable
  - Error handling

- Why it is necessary to conduct research in the WP 06 topics:
  - Augmented Reality (AR) and interactive glasses are such artefacts that can be used.
  - Worker will be able to have a direct augmented view of the assembly process and react with it so as to learn how to execute each assembly step.
  - We need to research and find the best way to use AR

Related Work

- Augmented and Virtual Reality (AR/VR) in Robotics as of today include how different hardware and software can collaborate with human and robot system to program, handle maintenance and errors.

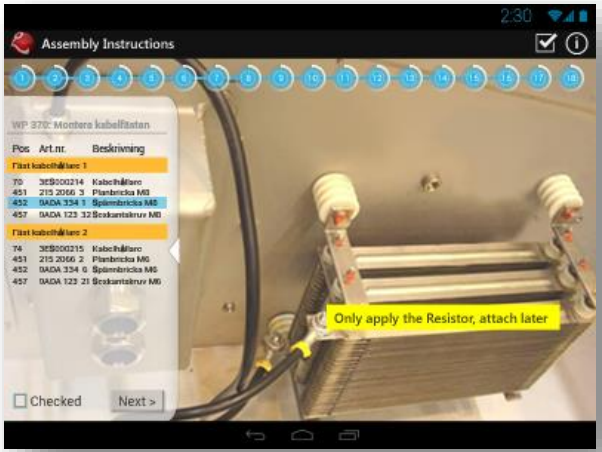
- Most of the usage of AR and VR in Robotics today is limited to **laboratory research** projects and has not yet reached production.

- There are many very interesting projects at various locations throughout the world and the research results from the last years are very valuable.

- NOTE: Very few research results has led to general daily use, LIAA aims for the five use cases to use the LIAA Framework.

Approach

- Scientific Objective
  - Discover the possibilities and potential of applying Augmented Reality solutions to assist and protect humans during manufacturing tasks and to improve human-robot interaction.
  - Applying modern devices like:
    - Head Mounted Display (PENNY)
    - Tablet / computer display (Android, iOS, Windows)
- Technical Objectives
  - Use Augmented Reality for
    - Training
    - Error handling
    - Robot Programming
    - Process/Workflow monitoring/feedback

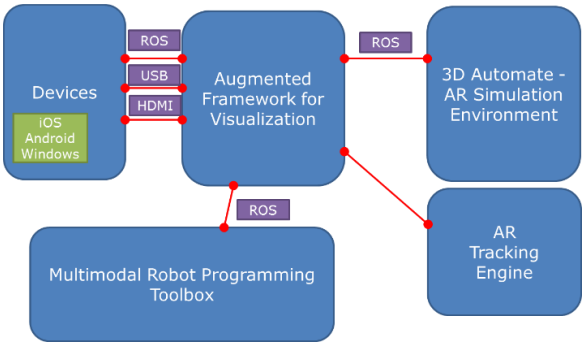


Approach

- Divide the solution into four main different parts.
- Each part can be developed individually and communication between the parts is conducted by network using ROS.

1. Multimodal Robot-Programming Toolbox
2. AR Framework for Visualization
3. Symbiotic Workplace Design Tool
4. Devices

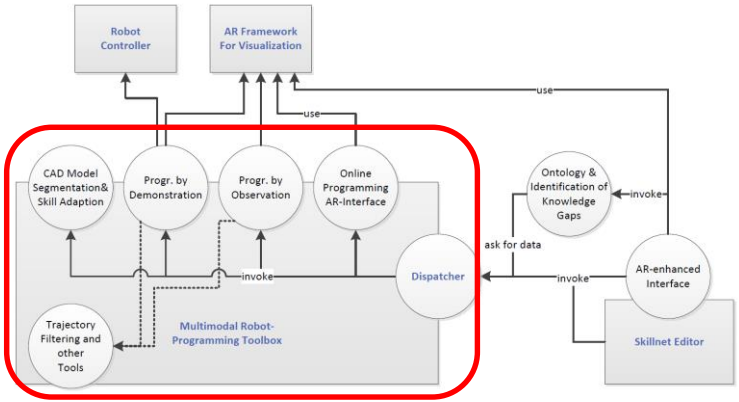
Approach



- The main software parts can work independent of each other
- The fourth part consist of hardware devices like displays and cameras

Approach: Multimodal Robot-Programming Toolbox

- The interactive, multimodal robot programming toolbox is used to parametrize skill instances.
- The hierarchy of parameters allows us to split up complex parameter sets into their (simpler) sub-components if no tool exists to define the parameter set in one single step.



Approach: AR Framework for Visualization

- The AR Framework for Visualization will combine a number of algorithms, input from rosbridge for jobs and tasks and generate correct 3D Visualization images based on AR tracking and user position using the **EON 3D Engine**.

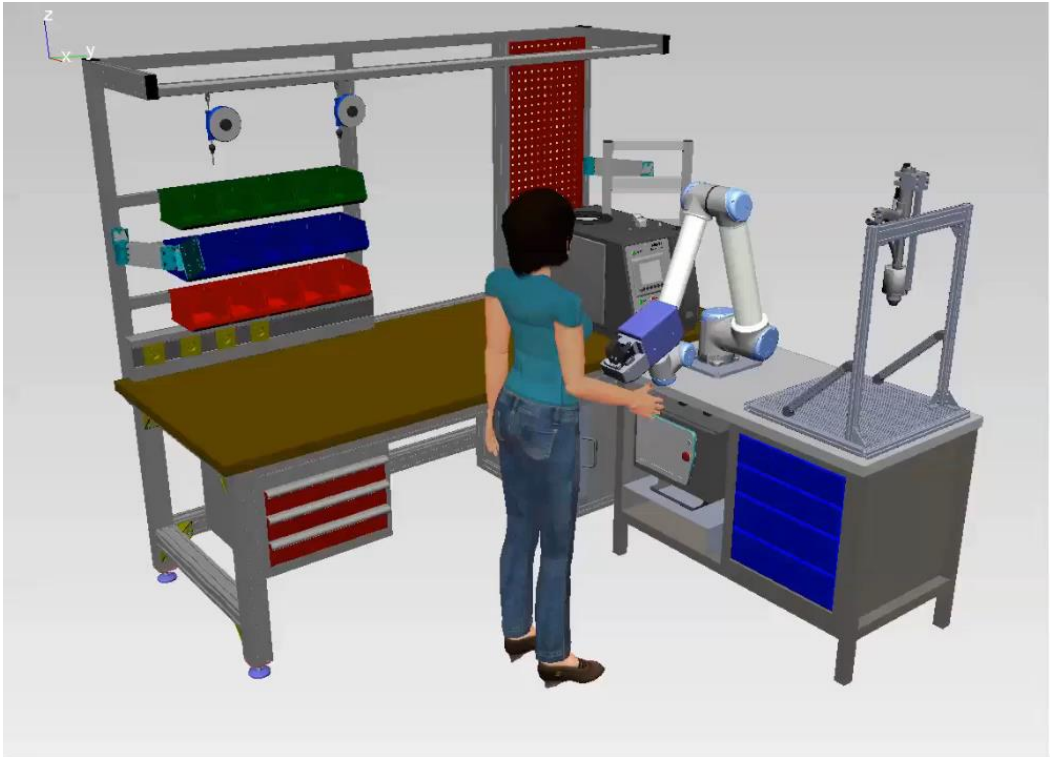
- The main part of this framework is **AR Visualization and instruction tool** – visualizing state of robot cell and task to do. It is proposed to access to robot joint properties via the **AR-Enhanced Simulation Tool**. For programming this framework will use **Robot Programming Tool Box** and **AR-Enhanced Contextual Programming**. Communication with other parts in the system be realized through rosbridge **Symbiotic Workplace Design Tool**.

Approach: Symbiotic Workplace Design Tool

- **3D Automate** is used for the **Symbiotic Workplace Design Tool** where the user can import CAD models, create 3D animations for workers and visualize the complete robotic cell.

- The simulation tool will also provide with screenshots, graphics and videos to the AR-visualization framework for AR visualization.

Video



Approach: Devices

- The devices subsystem will handle the supported display devices and also cameras. The proposed display devices to support consist of.
  - Head Mounted Display(HMD) (PENNY)
  - Tablet display (Android, iOS and Windows)
  - Monitor (Windows)

- HMDs and Monitors will be connected as standard display devices to a computer while tablets have the display built in to the device itself.

Sample Prototype (Video)

Conclusions and future work

- The current work constitute a roadmap for application of AR technologies in the industrial sector. The early implementation of the idea of such applications, constitutes a proof of concept for the proposed methodologies. Though the implementation of the first prototype the following points of interest have been identified:
  - AR technology for enabling Human-Robot interaction in unstructured environment have been identified and categorized.
  - It is easy to develop add-ons for communication into existing tools for our purpose by using a standard protocol, ROS.
  - Algorithms for using various types of markers for AR is in global progress by various actors worldwide and we expect to see improved AR tracking in near future.

- The proposed algorithms and methodologies will be enhanced and integrated together, in order to implement a generic and broad AR based Robot programming tool.

Acknowledgements

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Thank you for your Attention!

Questions?

For more information visit us at www.project-leanautomation.eu