ROBO-PARTNER: Safe human-robot collaboration for assembly: case studies and challenges

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Introduction

Human sensitivity required by operation

+

Flexible materials with unpredictable behavior

+

Multiple operators – Cooperative assembly

Human Operators are preferred

Precision

+

Repeatability

+

Cycle Time

Robots are preferred

Challenge:

*"Integrating new forms of interaction between robots and workers - make the most out of the **synergy effect**"*

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Motivation

TODAY

From traditional production lines …
... separating human and robot working areas to ensure the operators' safety
… not designed to efficiently accommodate both types of production entities.

VISION

… to enable different human-robot collaboration schemes
… to design and deploy safety systems allowing collaboration between operators and industrial robots in common task and workspace

MOTIVATION

… safety of the operators will always be the primary factor
... Collaboration types between operator and robot require different concepts

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Human robot interaction

Examples of Available robot platforms for HRI

DLR® lightweight robot

KUKA LBR iiwa ®

Baxter ® Rethink Robotics

Universal UR5/UR10®

ABB Yumi ®

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Human robot interaction

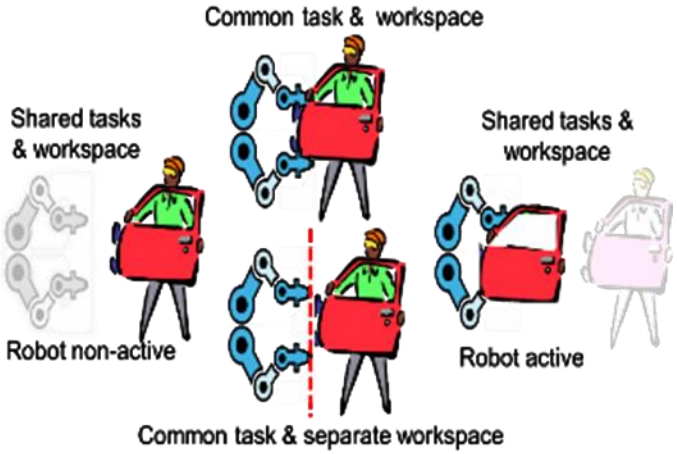
Safety achieved through:
- Dynamic monitoring of the environment
- Robot collision avoidance
- Two levels of active safety (proximity and contact)

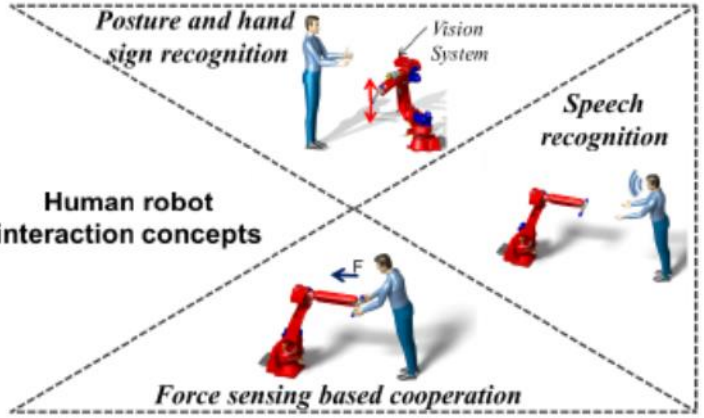
Enables

Interaction with robot through:
- Force interaction
- Voice commands
- Gestures

Allows

- Fenceless industrial environment
- Physical load reduction - heavy parts manipulated by the robot
- Cognitive load reduction - robot always provides the correct parts





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Human Robot Interaction and safety

- Industrial robots are large, move fast and carry heavy or blunt parts
- Current practices require complete physical separation between people and high powered active industrial robots .
- Limited industrial solutions - sort of fenceless operation (e.g. the SafetyEye) - more are not close to industrial application
- Use of redundant sensors : cameras, ultrasonic/laser range sensors, thermal imaging devices, capacitive/conductive robot skins etc..
- The main challenge remains the conformance and certification against EU legislation and standards

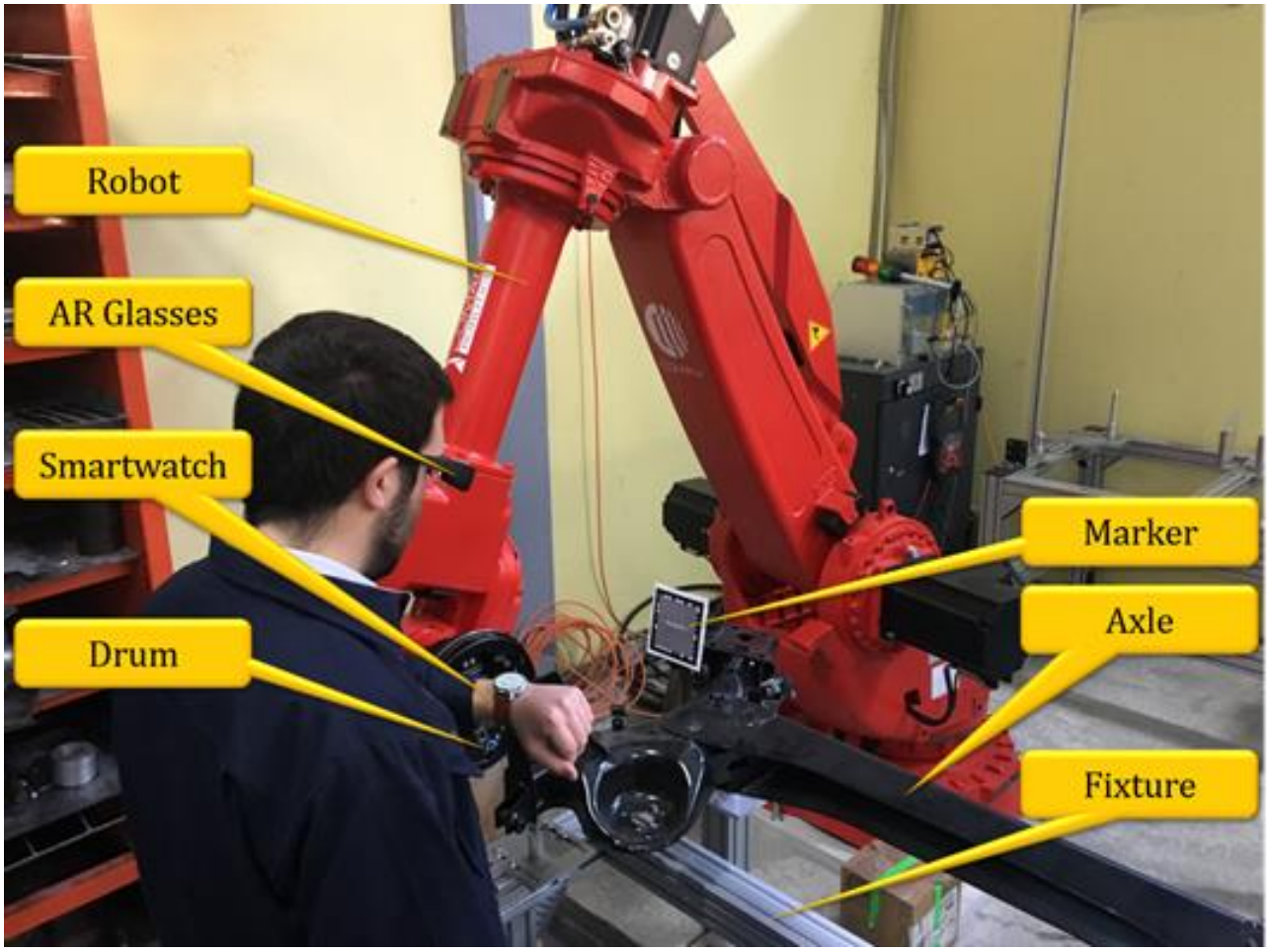
Case 1: Automotive rear suspension assembly

Video

Case 2: Refrigerators assembly

Video

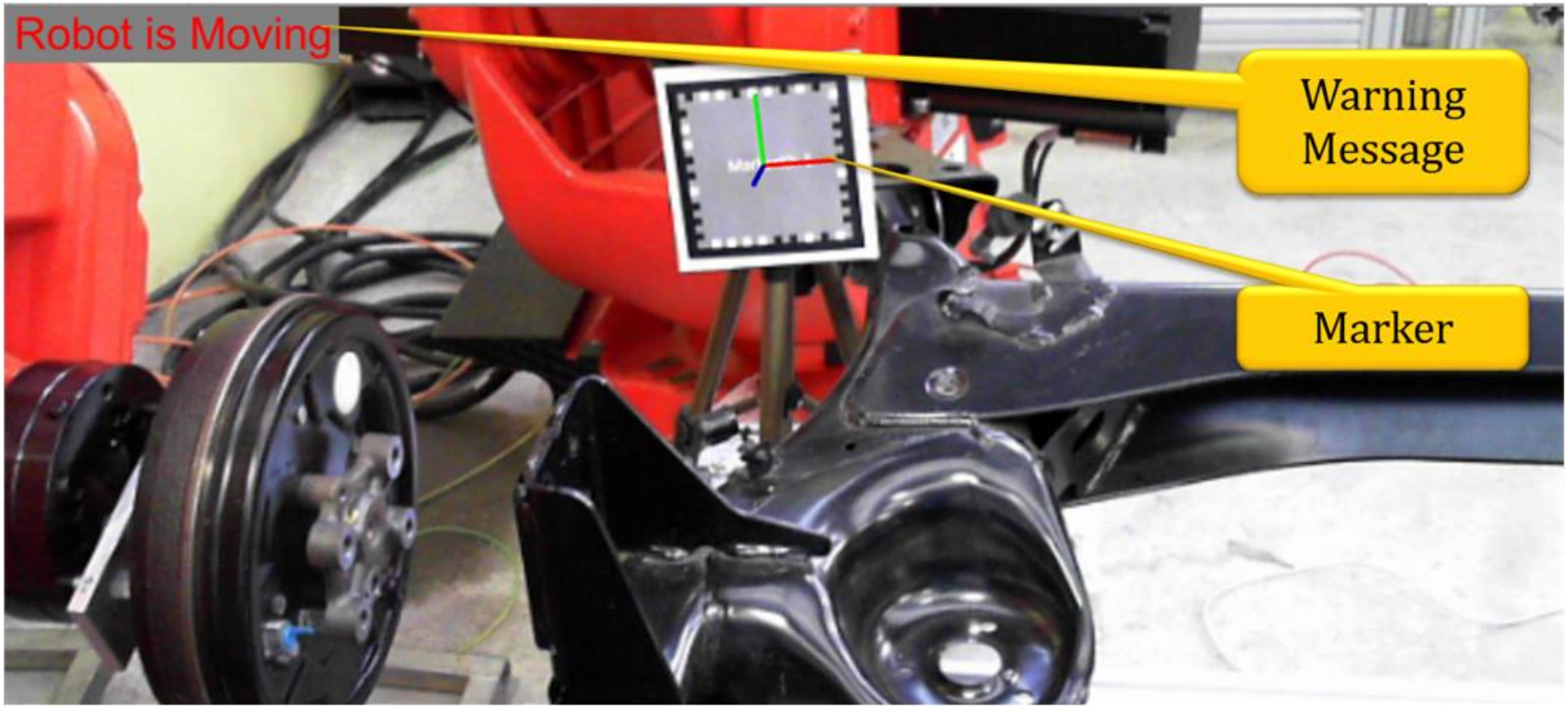
AR based interaction



AR System implementation

Implemented System Functionalities

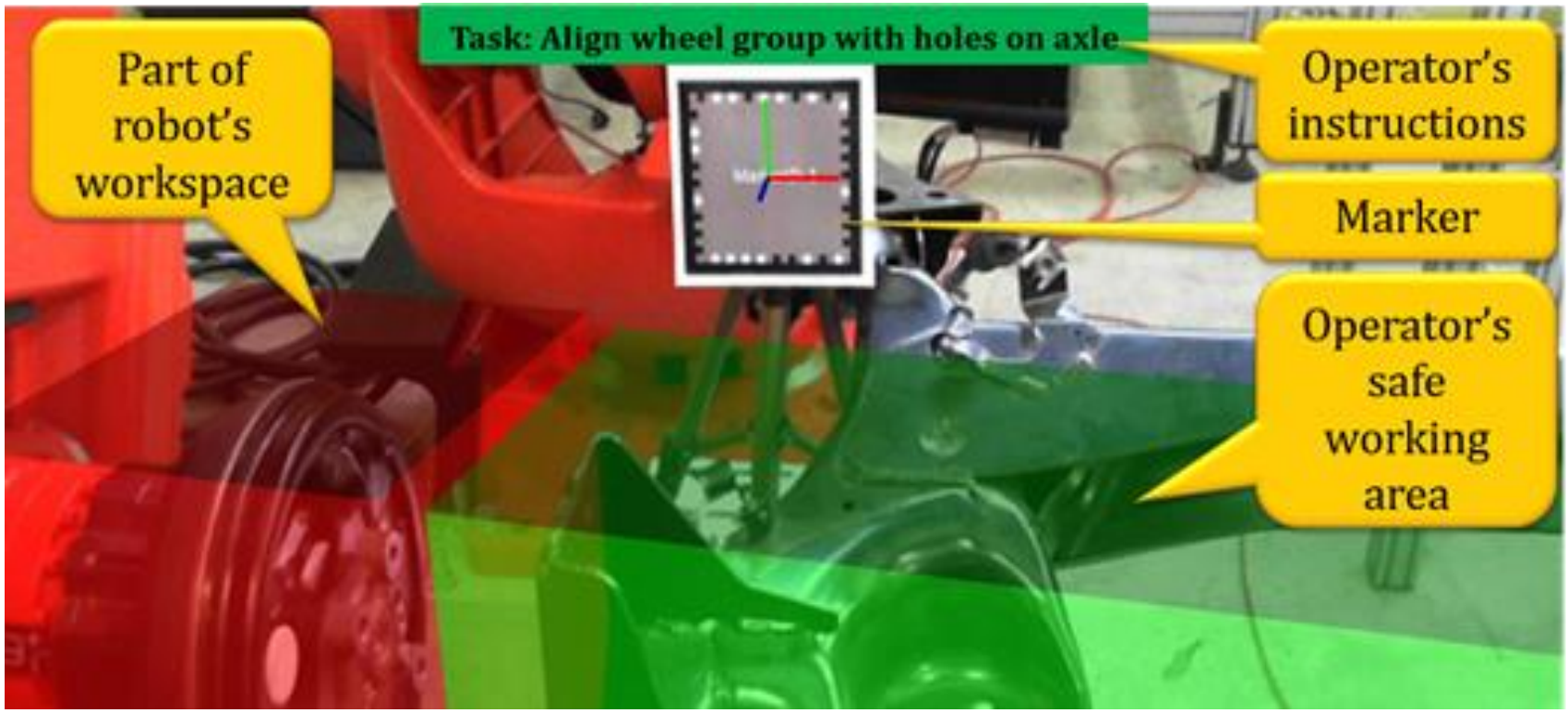
- Automated warnings and alerts



AR System implementation

Implemented System Functionalities

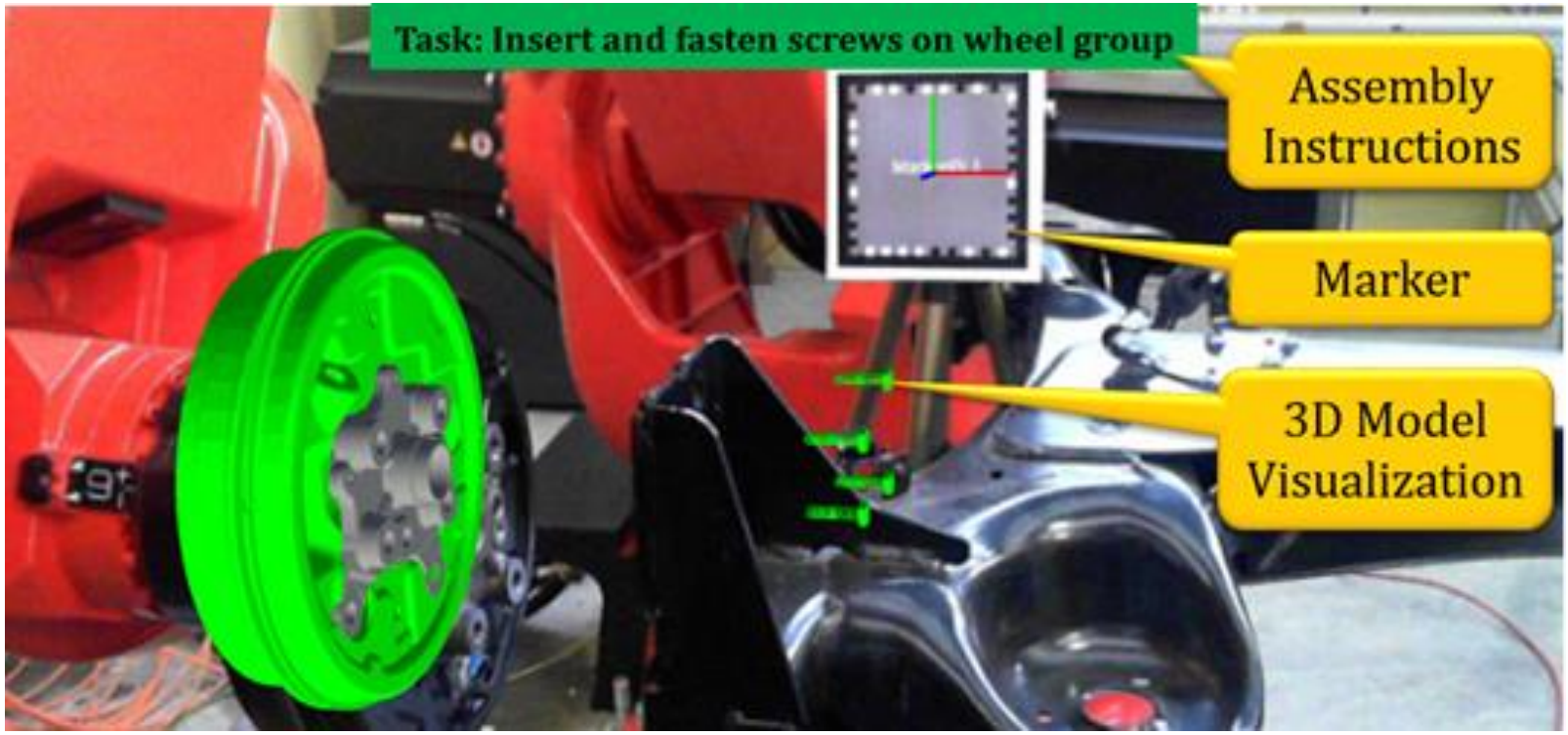
- Operator and robot working areas



AR System implementation

Implemented System Functionalities

- Assembly process 3D info



Conclusions

Multiple aspects of safety for designing and deploying HRC work cells.

Safety requirements may originate from:

- the type of the robot (dual/single arm),
- the robot's payload and power/force that it can apply
- the part's characteristics (geometry/weight)
- the assembly/manufacturing process, considering end effector and robot motion.
- the collaboration requirements

Humans feel more comfortable when they are aware of the underlying safety. Workplaces need to include interfaces such as visual, audio and tactile.

- Developing methods for better immersing the human in the new safe measures that are becoming available.

- Reducing the complexity of deployment. Each safety function requires different systems to implement – error free operation may be at risk

Acknowledgement

Seamless Human-Robot Cooperation for Intelligent, Flexible and Safe Operations in the Assembly Factories of the Future

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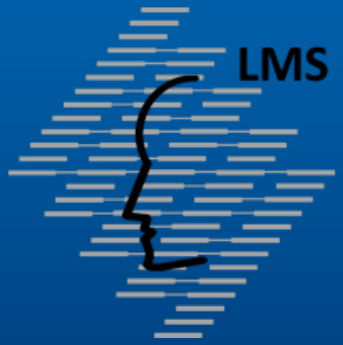
THANK YOU!



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