



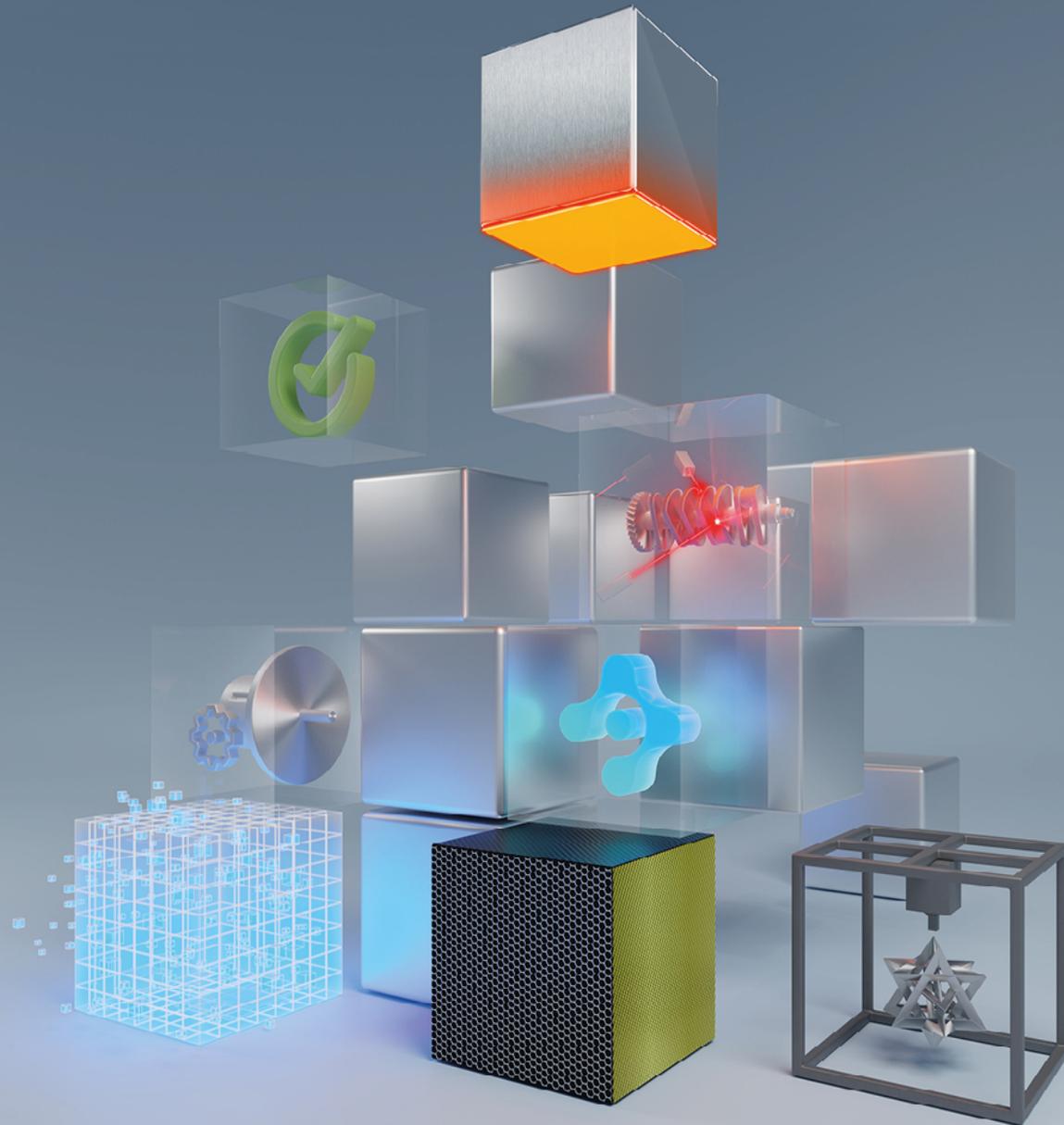
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9-12/10/2024

TUTTE LE FACCE DELL' INNOVAZIONE

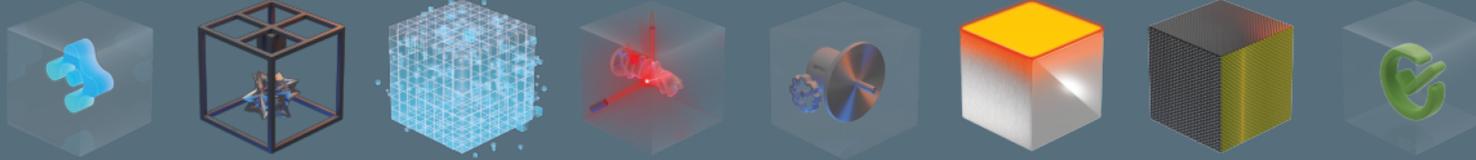
SIRI e AIRO/AIxIA

Intelligenza Artificiale e Robotica: verso
un'integrazione sinergica: *Relazioni
accademiche e confronto con l'Industria*
Coordinatori: Enrico Pagello e Alberto Finzi



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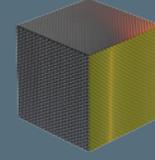
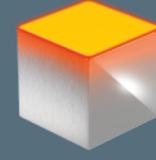
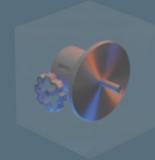
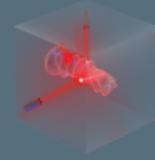
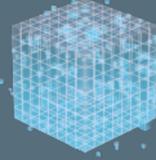
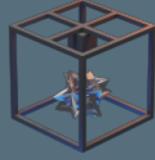


Associazione
Italiana per
l'Intelligenza
Artificiale

L'**Intelligenza Artificiale** (AI), nata nel 1956 negli Stati Uniti, a partire dalla terza decade degli anni 2000 sta occupando sempre più il centro dell'attenzione scientifica e mediatica internazionale grazie alla affermazione della Generative AI ed allo sviluppo dei modelli linguistici di grandi dimensioni.

In questo contesto diventa quindi sempre più rilevante discutere quanto e come l'AI, che aveva pervaso il mondo della robotica già dai primi anni '70, possa avere oggi un impatto dirompente aprendo nuovi scenari di ricerca e sviluppo grazie alla introduzione di paradigmi scientifici assai più evoluti di quelli utilizzati fino ad ora.

Questo **Secondo Evento** promosso dalla Associazione Italiana di Robotica e Automazione (**SIRI**) in cooperazione con il Gruppo di Lavoro in AI e Robotica (AIRO) della Associazione Italiana per l'Intelligenza Artificiale (**AIxIA**), e con il Patrocinio di **FAIR – Future Artificial Intelligence Research**, segue l'evento avvenuto alla **33.BI-MU nel 2022**

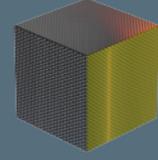
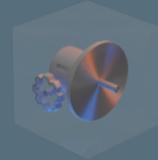
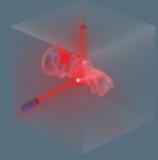
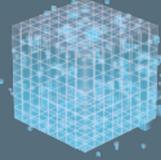
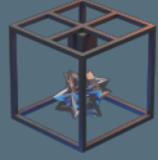


Nell'incontro verranno brevemente discusse tecniche e metodologie avanzate di AI dalle seguenti tre Relazioni:

Matteo Matteucci – Politecnico di Milano

La percezione dei robot al tempo dell'AI: precisione o flessibilità?

Nel contesto dell'autonomia robotica, la percezione è un prerequisito fondamentale per comprendere l'ambiente circostante e prendere decisioni. In particolare, la visione artificiale è oggi uno strumento chiave in task quali il riconoscimento di oggetti e il controllo qualità. L'Intelligenza Artificiale ha rivoluzionato l'interpretazione delle immagini: si vogliono mettere in evidenza potenzialità e limiti di questa tecnologia in un contesto industriale rispetto a metodiche ben assestate e collaudate negli anni.



Luca Iocchi – Sapienza Università di Roma

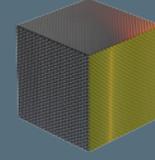
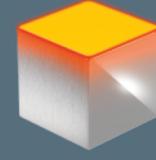
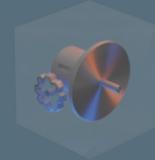
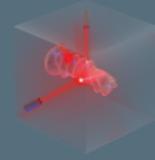
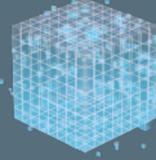
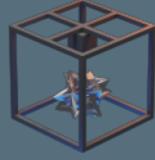
Autonomia condivisa e regolabile nelle interazioni persona-robot

In questo intervento verrà illustrato **FAIR** – Future Artificial Intelligence Research, il progetto nazionale di ricerca del MUR per realizzare gli interventi finanziati nell'ambito del PNRR, relativamente all'area tematica su *Intelligenza Artificiale: Aspetti Fondazionali*. Verrà illustrato il concetto di autonomia regolabile e discusso il seguente caso d'uso: i Large Language Models (LLMs) per il controllo di robot.

Alberto Finzi – Università di Napoli Federico II

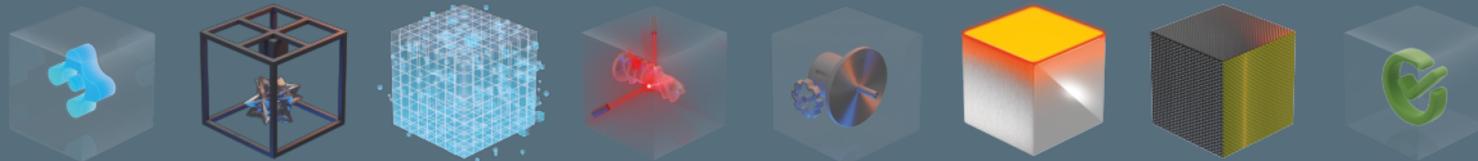
Esecuzione flessibile e adattiva di task strutturati con robot collaborativi

In questo intervento verranno presentati metodi per l'esecuzione collaborativa e flessibile di task strutturati discutendo tecniche di composizione, orchestrazione e apprendimento incrementale di compiti robotici in scenari applicativi di assemblaggio e disassemblaggio



**Alle 14:05 SEGUIRA' un PANEL fra accademici ed industriali
per discutere le potenzialità, limiti e sinergie della IA & Robotica**

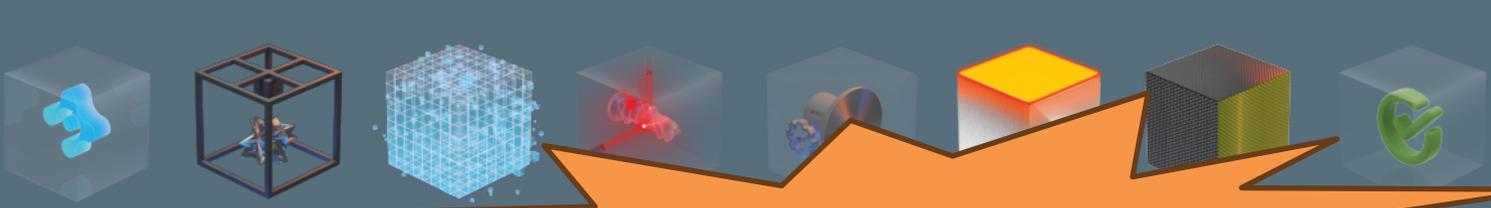
Nota Bene: i brevi filmati e le animazioni contenute nelle slide originali proiettate in Arena possono essere visti guardando il video con la registrazione di tutto l'incontro



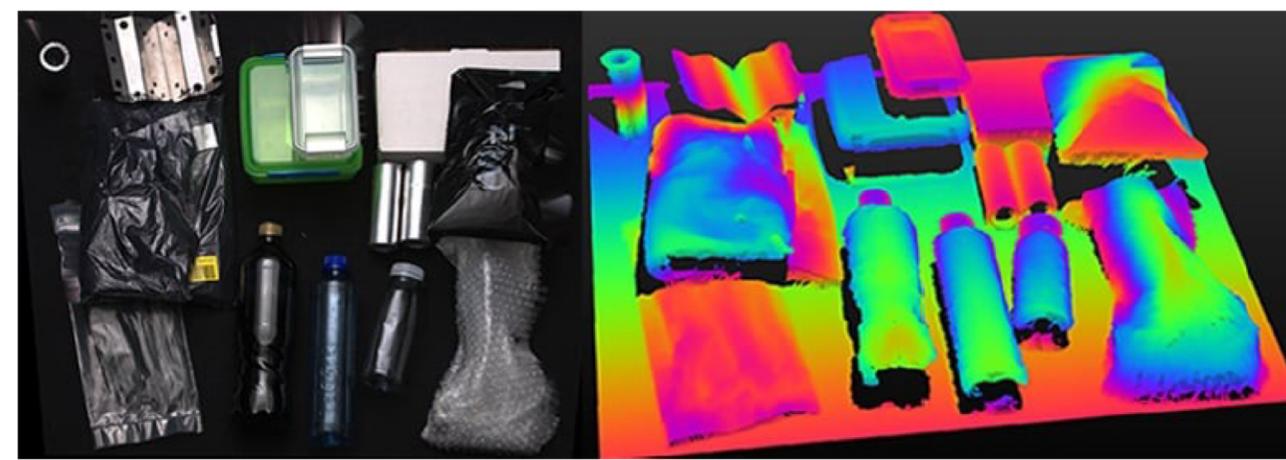
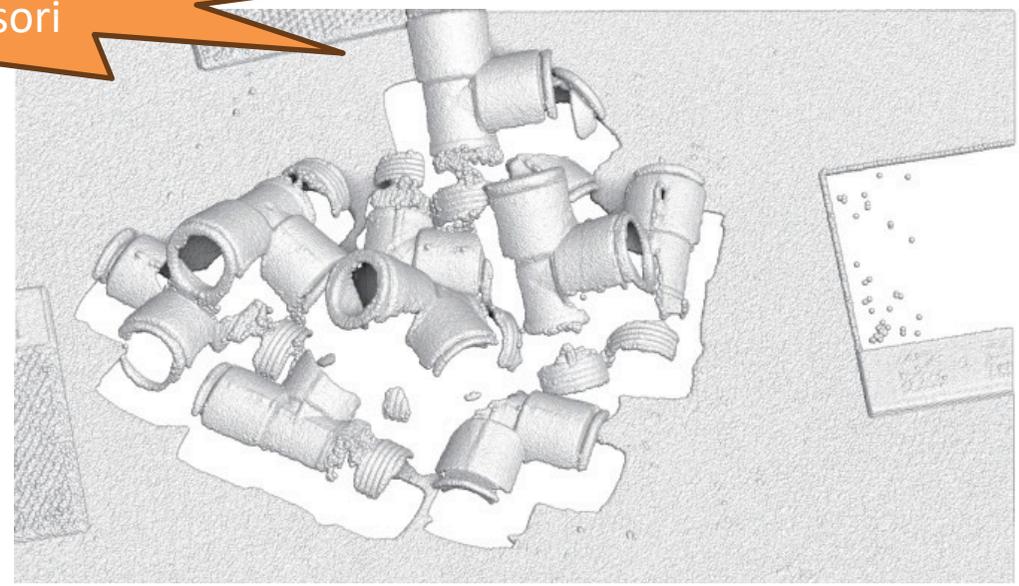
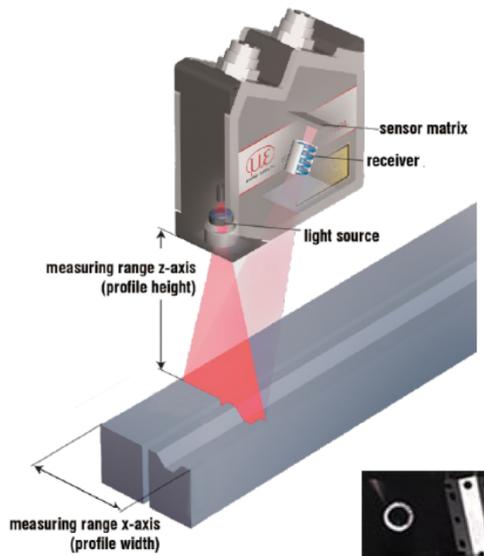
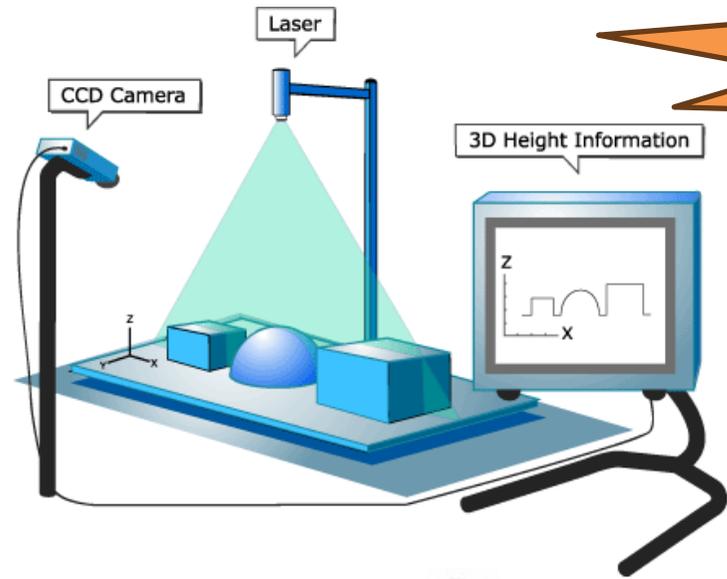
ISO 8373:2012 - Robots and Robotic Devices

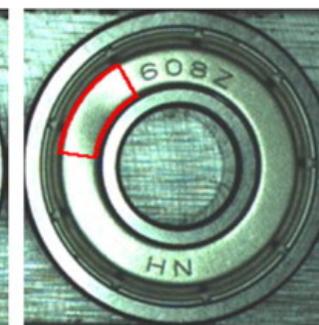
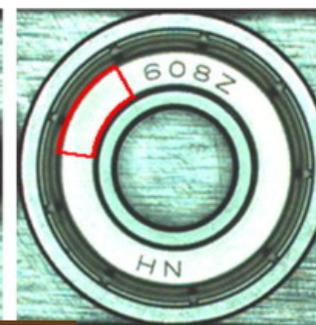
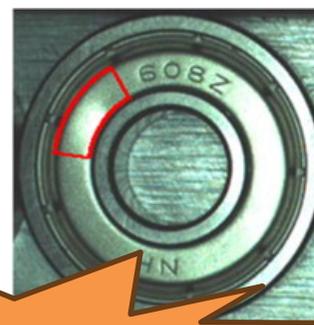
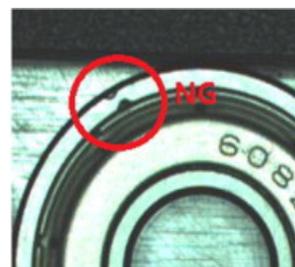
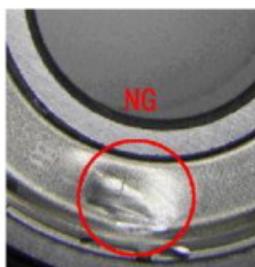
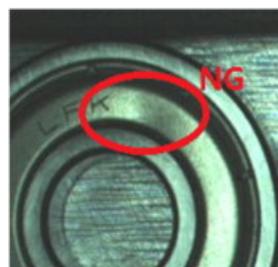
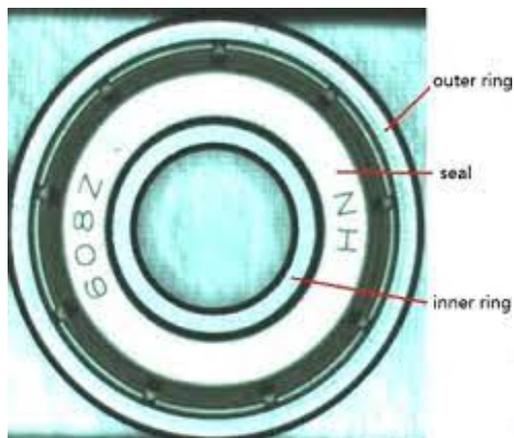
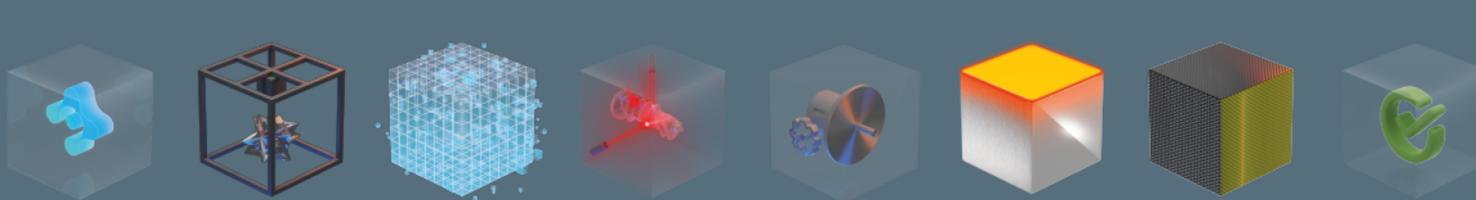
A robot is an actuated mechanism programmable in two or more axes with a *degree of autonomy*, moving within its environment, to perform intended tasks. Autonomy in this context means the ability to *perform intended tasks based on current state and sensing*, without human intervention.





Percezione e' estrarre
informazione dai sensori





deformation1

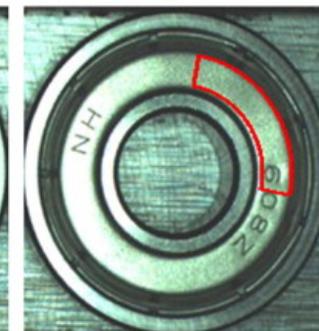
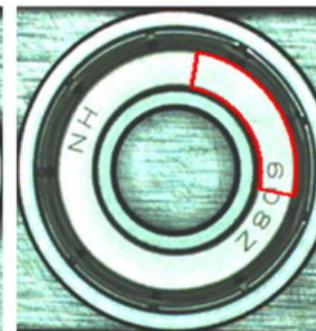
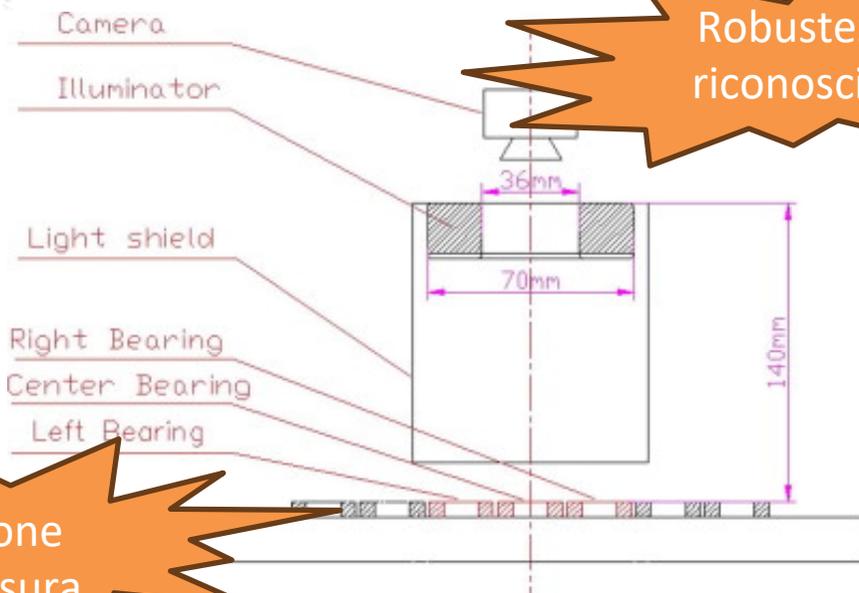
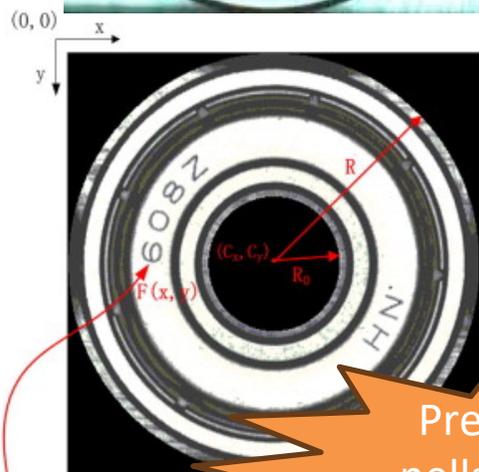
deformation2

crack

M1

R1

Robustezza nel riconoscimento

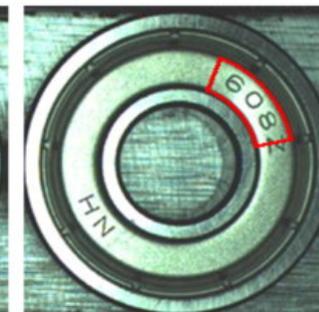
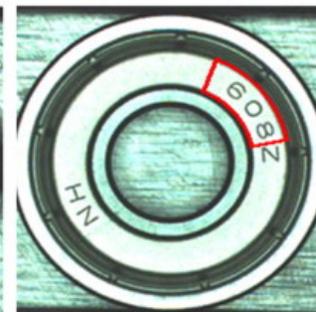
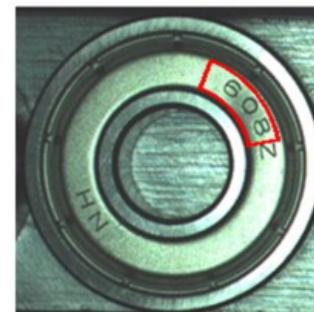


L2

M2

R2

Precisione nella misura



L3

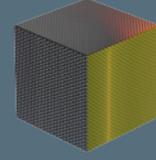
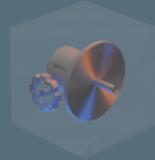
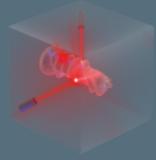
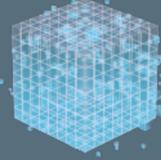
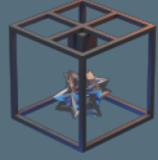
M3

R3

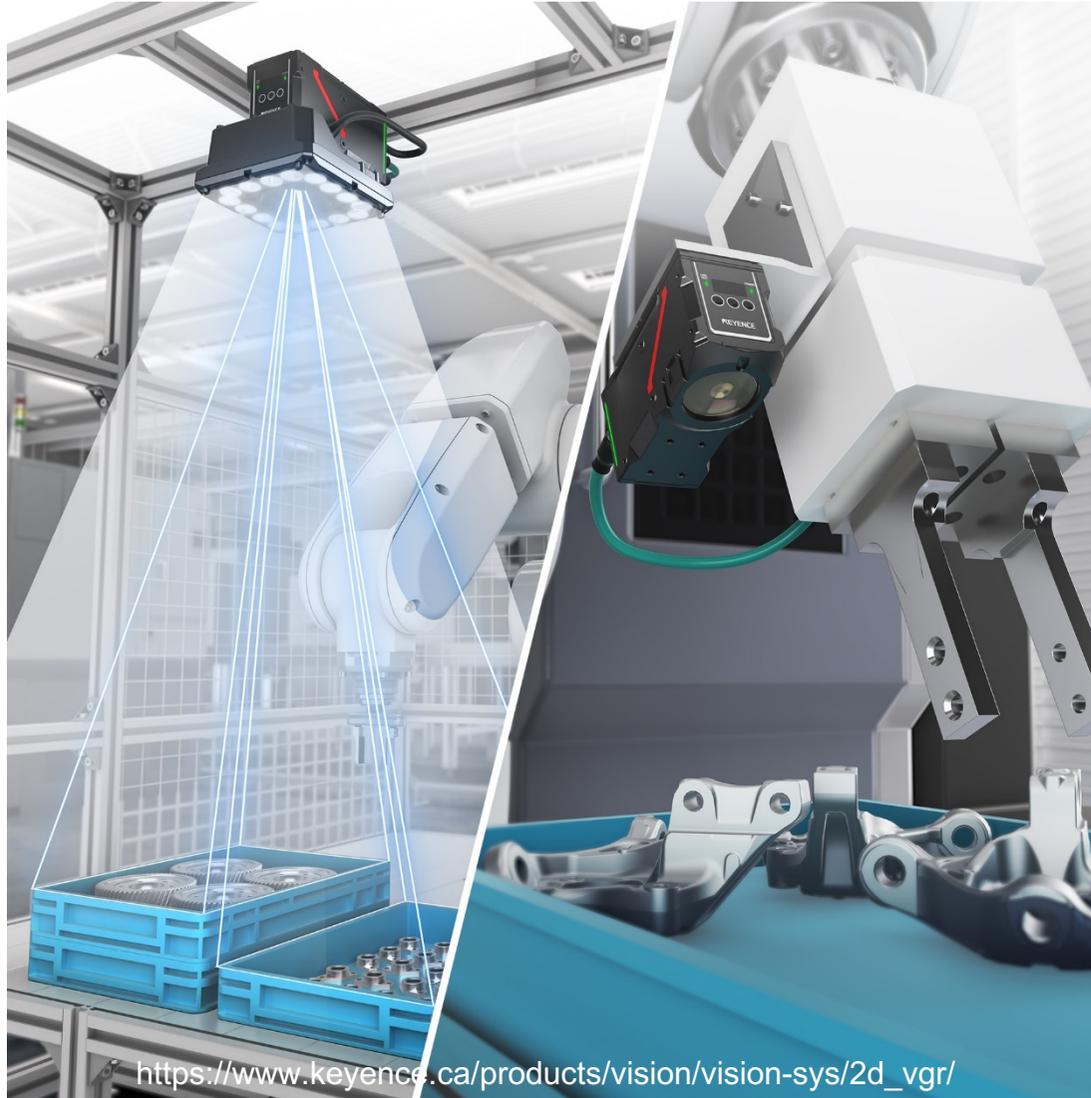
Hao Shen, Shuxiao Li, Duoyu Gu, Hongxing Chang,
Bearing defect inspection based on machine vision,
Measurement, Volume 45, Issue 4, 2012



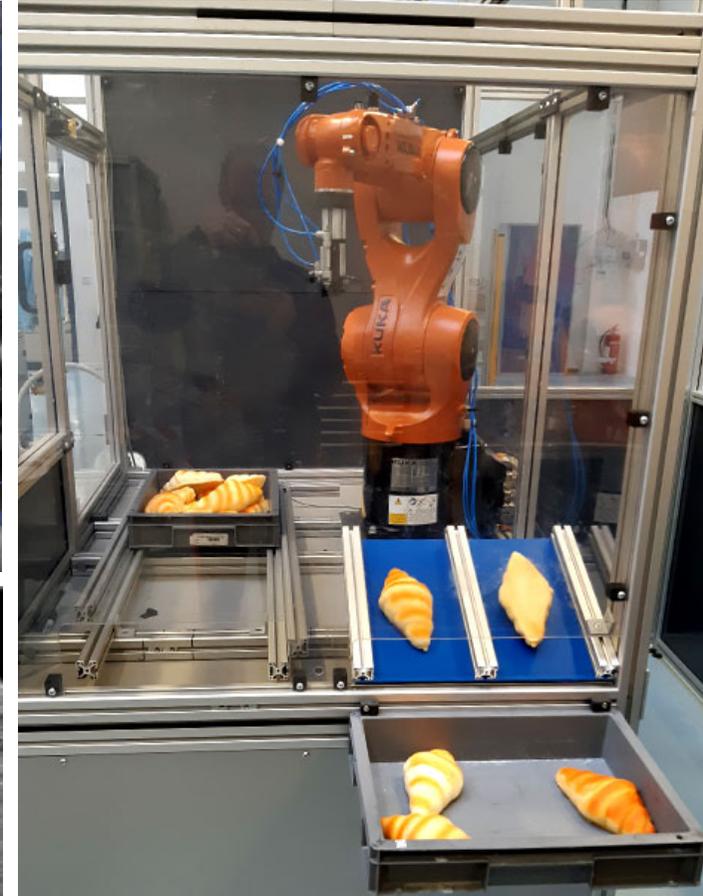
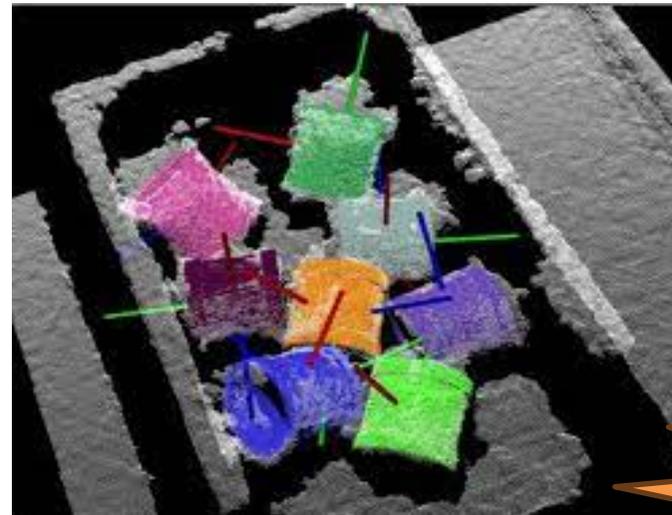
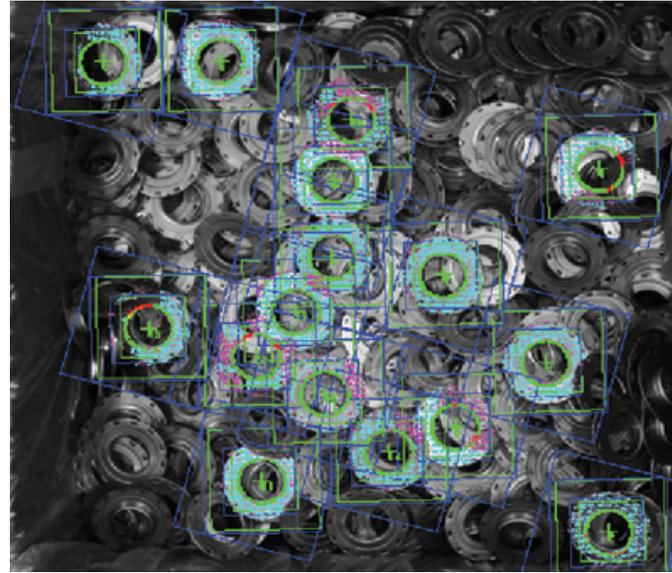
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BI-MUpiù



https://www.keyence.ca/products/vision/vision-sys/2d_vgr/



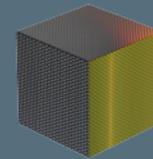
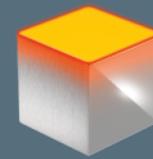
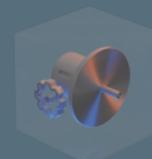
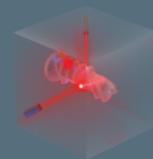
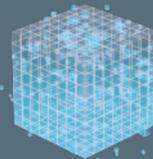
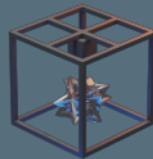
Robustezza
nel riconoscimento

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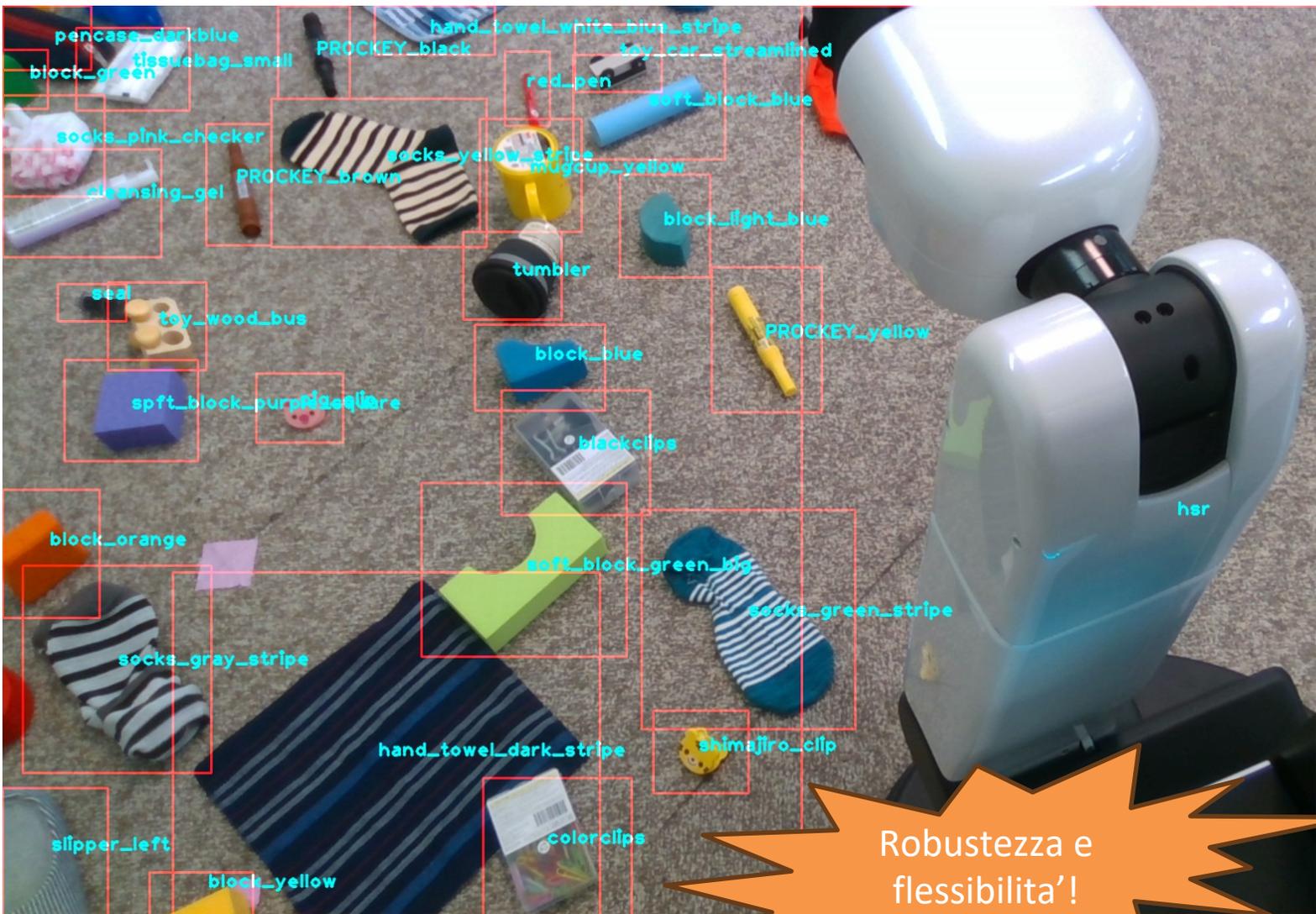




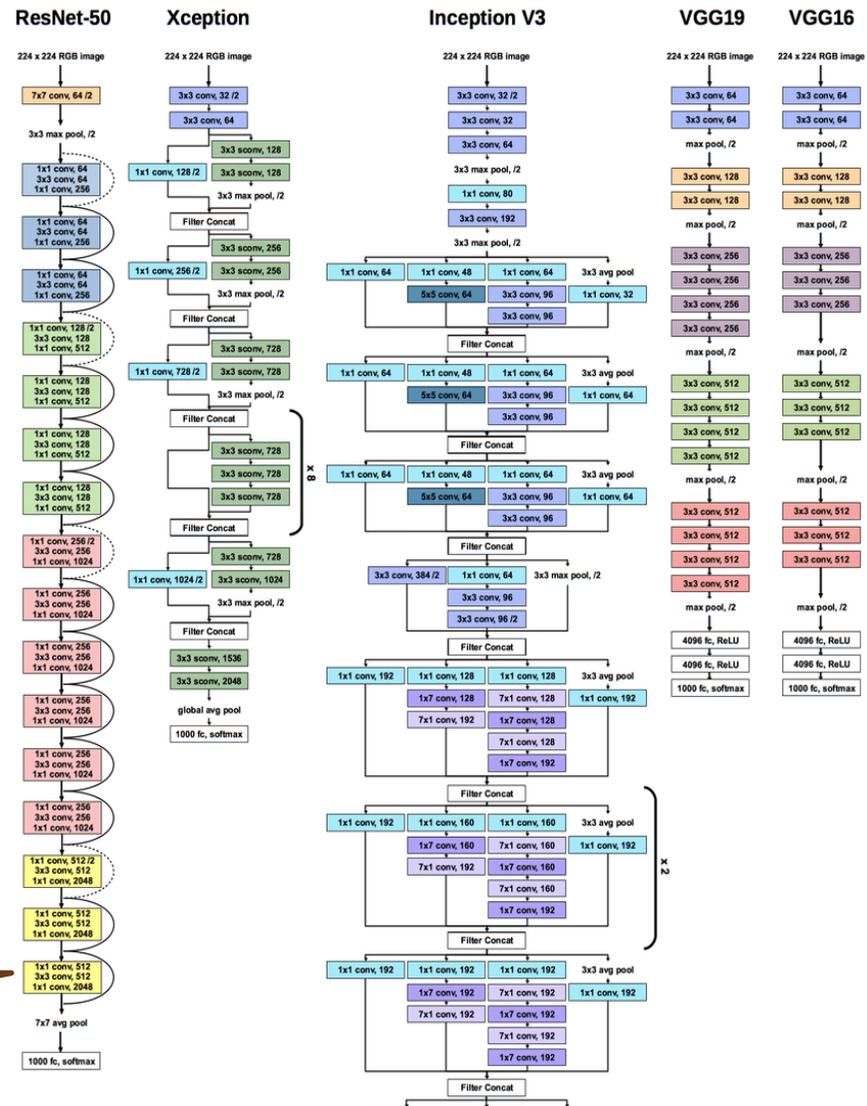
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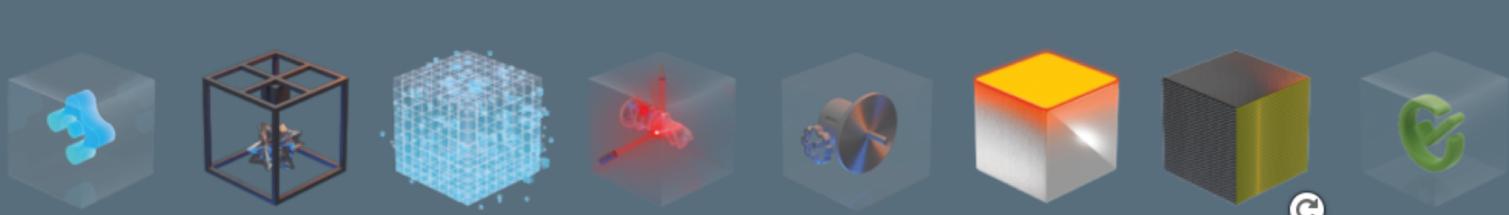


BI-MUpiù



Robustezza e flessibilita'!





FoundationPose: Unified 6D Pose Estimation and Tracking of Novel Objects

Bowen Wen Wei Yang Jan Kautz Stan Birchfield

NVIDIA

Abstract

We present FoundationPose, a unified foundation model for 6D object pose estimation and tracking, supporting both model-based and model-free setups. Our approach can be instantly applied at test-time to a novel object without fine-tuning, as long as its CAD model is given, or a small number of reference images are captured. Thanks to the unified framework, the downstream pose estimation modules are the same in both setups, with a neural implicit representation used for efficient novel view synthesis when no CAD model is available. Strong generalizability is achieved via large-scale synthetic training, aided by a large language model (LLM), a novel transformer-based architecture, and contrastive learning formulation. Extensive evaluation on multiple public datasets involving challenging scenarios and objects indicate our unified approach outperforms existing methods specialized for each task by a large margin. In addition, it even achieves comparable results to instance-level methods despite the reduced assumptions. Project page: <https://nvlabs.github.io/FoundationPose/>

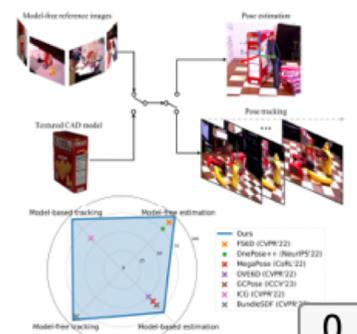
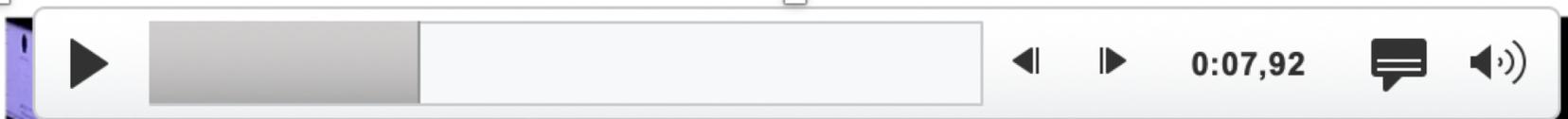
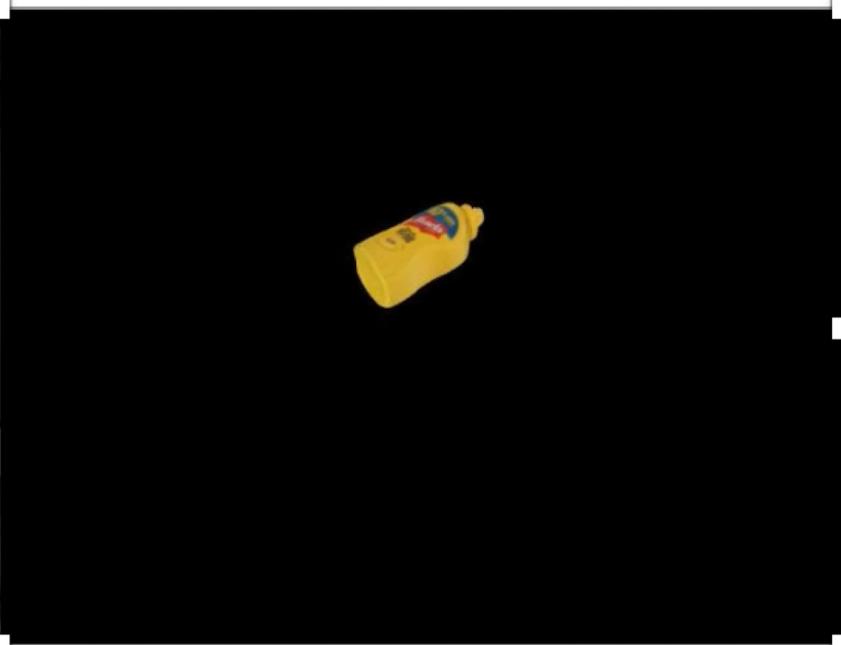
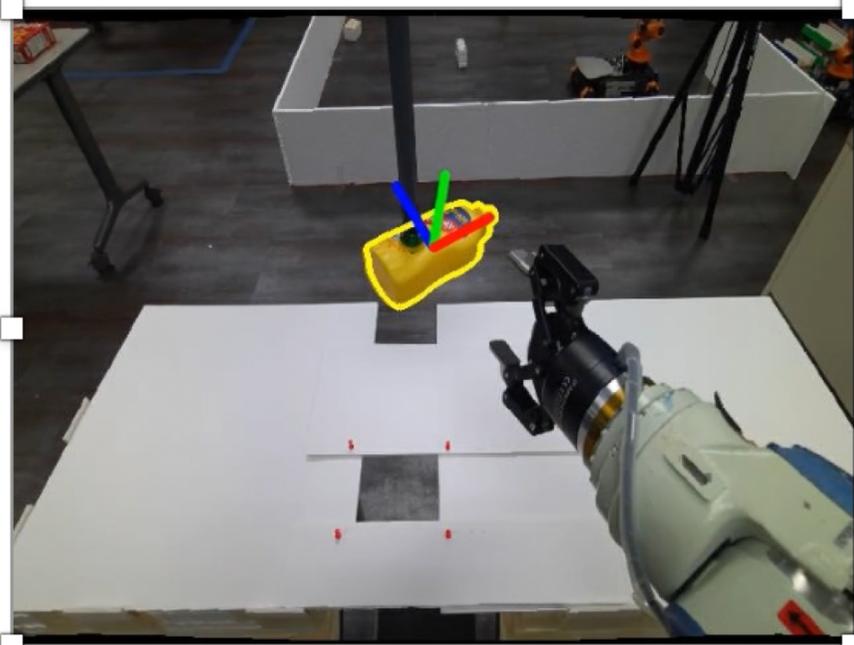


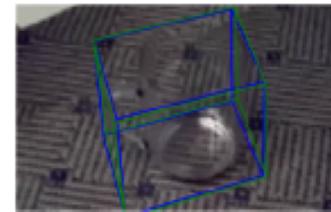
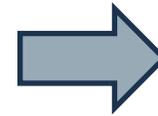
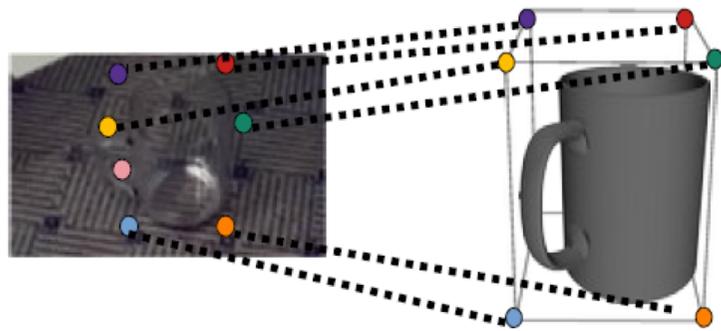
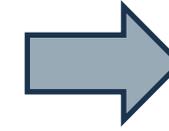
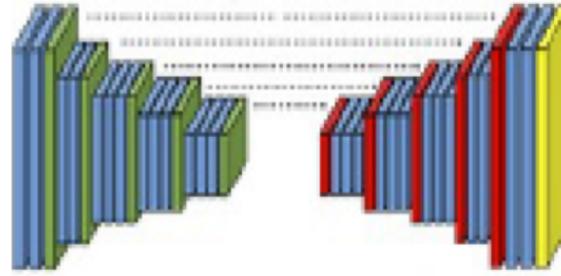
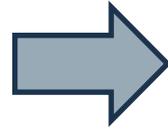
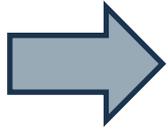
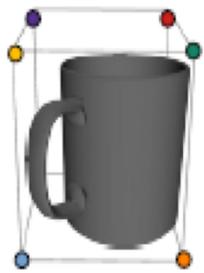
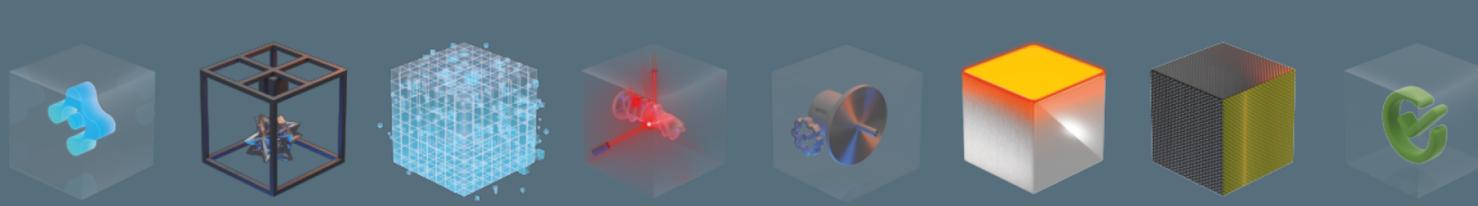
Figure 1. Our unified framework enables both 6D pose estimation and tracking for novel objects, supporting the model-based and model-free setups. On each of these four tasks, it outperforms prior work specially designed for the task (• indicates RGB-only; × indicates RGBD, like ours). The metric for each task is explained in detail in the experimental results. considered, depending upon what information is available at test time: *model-based*, where a textured 3D CAD model of the object is provided, and *model-free*, where a set of reference images of the object is provided. While much progress has been made on both setups individually, there remains a need for a single method to address both setups in a unified way, since different real-world applications provide different types of information. Orthogonal to single-frame object pose estimation, pose tracking methods [8, 29, 36, 39, 56, 63, 67, 72] leverage temporal cues to enable more efficient, smooth and accumulated pose estimation over a long sequence. These methods address the aforementioned issues to their counterparts by leveraging temporal information, depending on their assumptions on the scene.



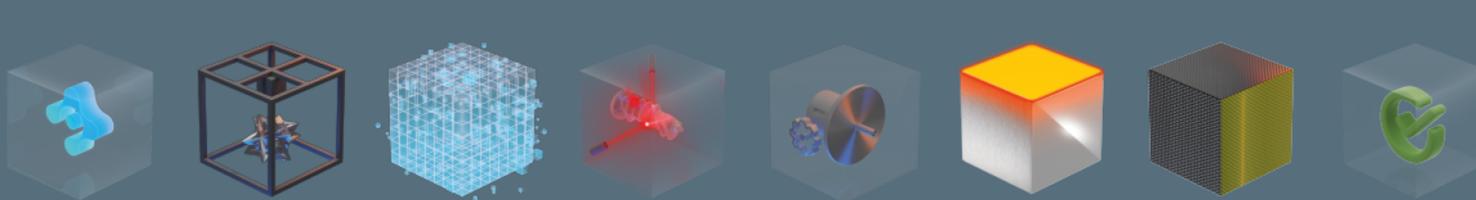
1. Introduction
Computing the rigid 6D transformation from the object to the camera, also known as object pose estimation, is crucial for a variety of applications, such as robotic manipulation [30, 69, 70] and mixed reality [43]. Classic methods [20, 21, 31, 50, 68] are known as *instance-level* because they only work on the specific object instance determined during training time. Such methods usually require a large model for generalizing to new objects, and a training dataset applied to an un-

Flessibilità estrema!





Il meglio dei
due mondi ...



ULTRASONIC
MAGNA, TEXAS INSTRUMENTS, Continental, Valeo, BOSCH, TDK

LIDAR - SCANNING
Velodyne LiDAR, HOKUYO, OUSTER, WAYMO, HESAI

RADAR
vayyar, arbe, UHNDER, BOSCH, ZENMO, GhostWave

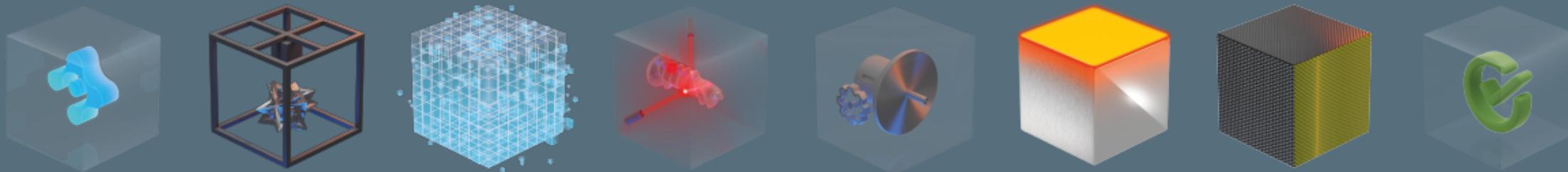
SOFTWARE
TANGRAM, occipital, kudan, AUGMENTED PIXELS, SLAMCORE, outlook, wikitude, aivero

DEPTH SENSING
intel REALSENSE, MYN, STRUCTURE, SOI, STEREO LABS, Azure, OR, Xonjs, PMO, 50

THERMAL
FLIR, Seek thermal, COGNEX, BASLER, FLIR, KEYENCE, DATALOGIC

INDUSTRIAL
FLIR, KEYENCE, DATALOGIC, COGNEX, BASLER

THOUGHT BUBBLES:
Come vedremo domani?
Sicuramente useremo l'AI !!!
... ma non dimentichiamo i fondamentali!



GRAZIE

34 **bi**
mu
fieramilano
9-12/10/2024

BI-MU più 

34 **bi** UCIMU
mu

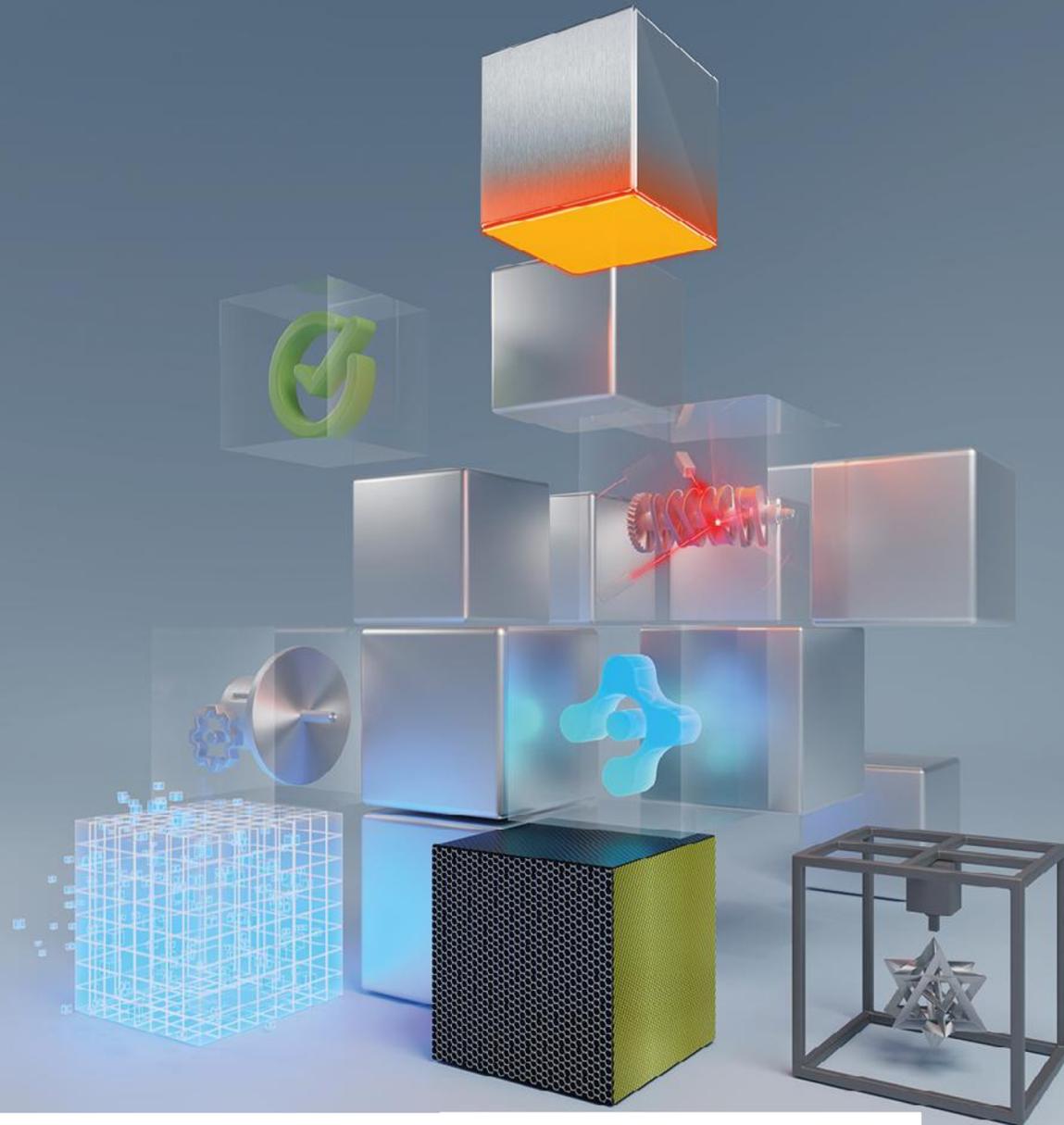
fieramilano

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TUTTE LE FACCE DELL' INNOVAZIONE

Sapienza Università di Roma
**AUTONOMIA CONDIVISA E REGOLABILE NELLE
INTERAZIONI PERSONA-ROBOT**
Luca Iocchi

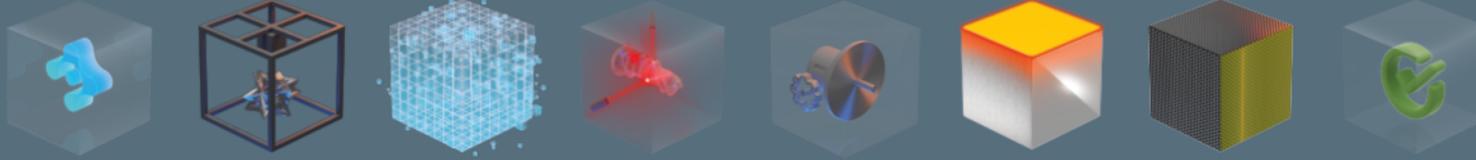
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DIPARTIMENTO DI INGEGNERIA INFORMATICA
AUTOMATICA E GESTIONALE ANTONIO RUBERTI

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FAIR Future
Artificial
Intelligence
Research



BI-MUpiù

TP2: Vision, Language and Multimodal Challenges

Computer Vision, Natural Language Processing and Multimodal data processing

TP4: Adjustable Autonomy and Physical Embodied Intelligence

Artificial Intelligence embedded in physical systems (robots)

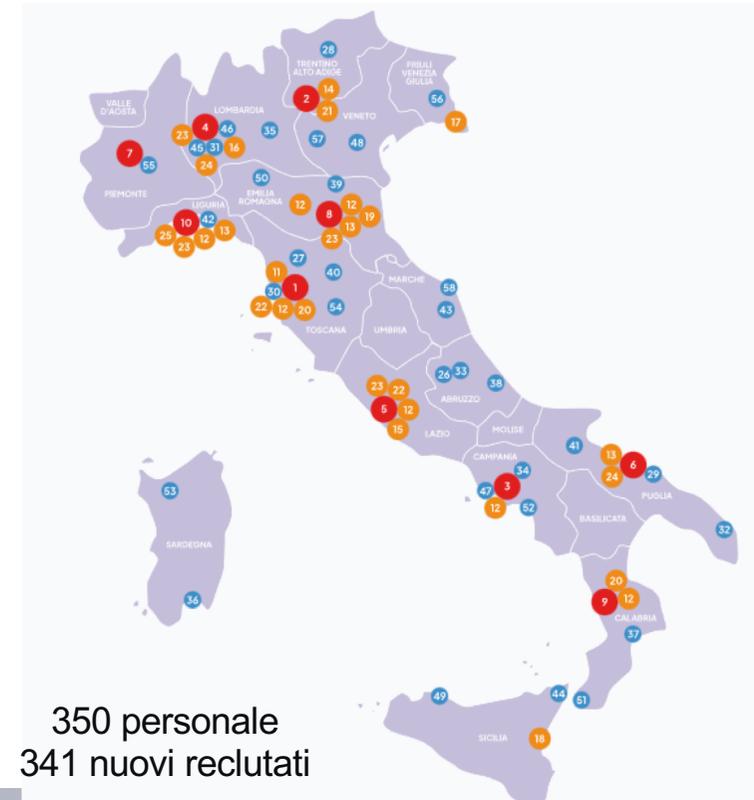


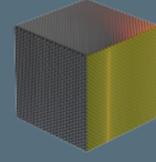
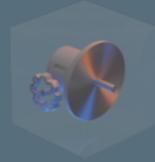
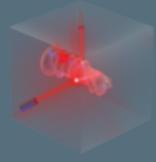
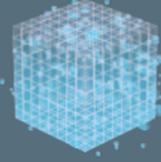
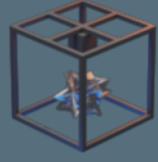
<https://fondazione-fair.it/>

Minerva LLM
addestrato su dati
italiani selezionati,
noti e di alta qualità

<https://nlp.uniroma1.it/minerva/>

Modelli e algoritmi
per sistemi
persona-robot-AI



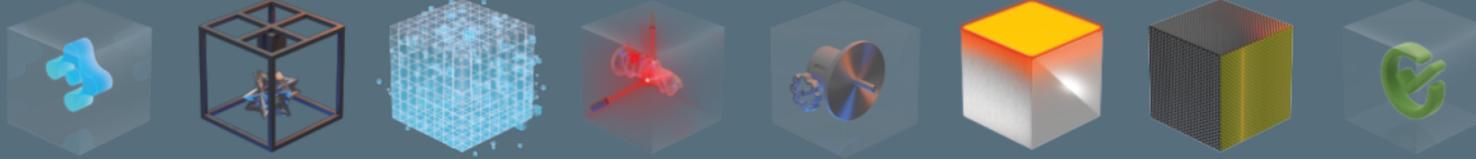


Sistemi robotici

- Autonomia: risolvere problemi e agire senza supervisione diretta umana
- Flessibilità: svolgere diversi compiti
- Adattività: adattarsi a situazioni impreviste

Sistemi Persona-Robot-AI

- interazioni naturali
- cooperazione nelle decisioni e nello svolgimento dei compiti
- autonomia condivisa e regolabile



Nuove tecnologie AI

- AI Generativa
- Large Language Models
- ChatGPT
- DALL-E
- ...

Immagini generate da DALL-E

domanda



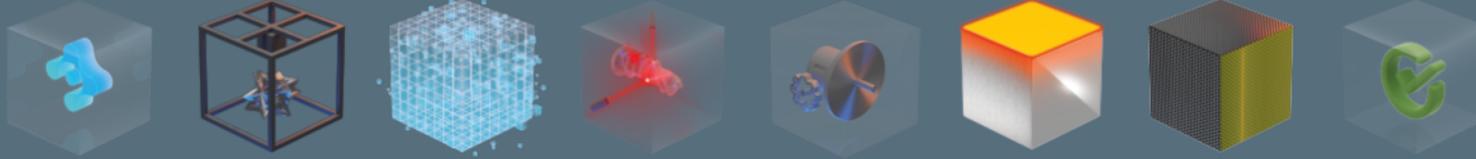
risposta

Allucinazioni amplificate dal sistema fisico

comando



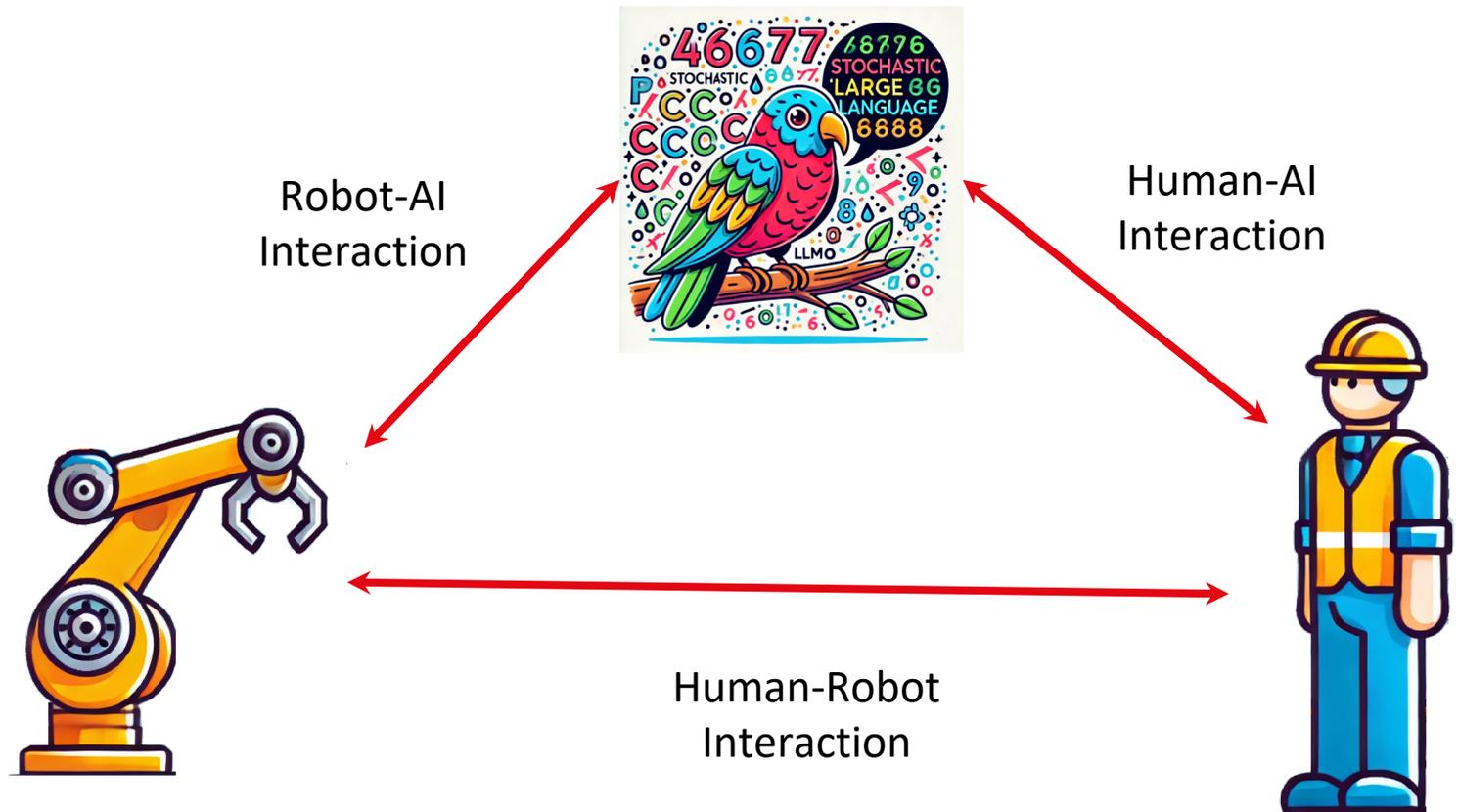
esecuzione

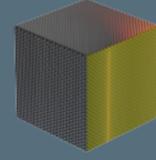
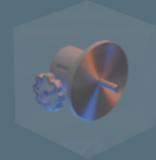
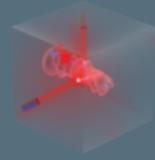
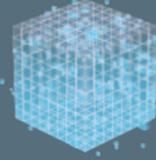
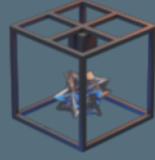


Sistema Persona-Robot-AI



Immagini generate
da DALL-E





Opportunità dell'interazione naturale persona-robot-AI

- migliore cooperazione nello svolgimento dei task
- flessibilità di programmazione
- negoziazione per autonomia condivisa e regolabile

Problemi aperti

- sicurezza
- robustezza
- accettabilità

Ricerca in corso

- LLM sicuri e affidabili (dati italiani nativi)
- interazione robot - LLM
- programmazione in linguaggio naturale
- sicurezza nelle interazioni sociali
- comportamenti adattivi in MARL (policy repair)
- rappresentazione dei fattori di affidabilità (trust)

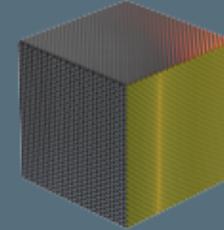
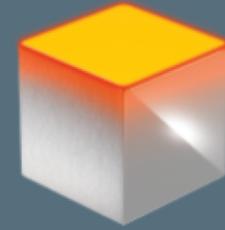
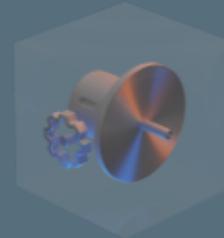
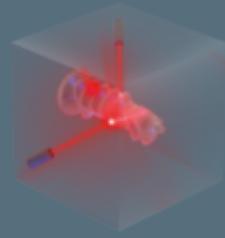
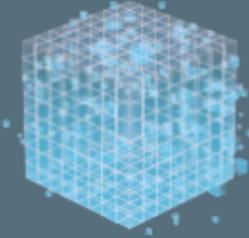
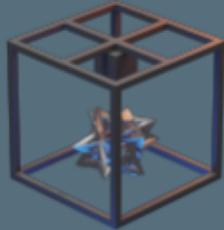


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Future
Artificial
Intelligence
Research



GRAZIE





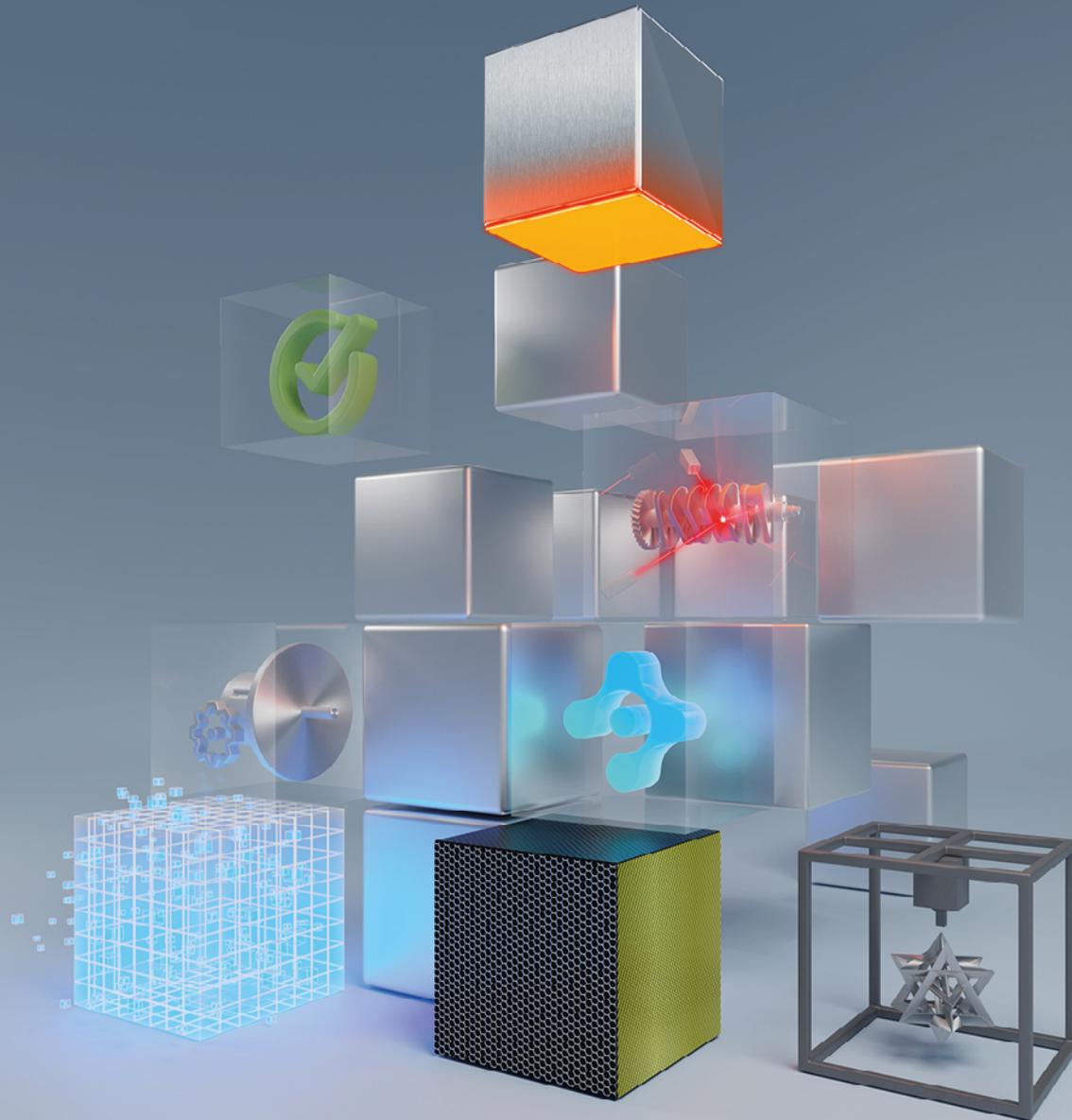
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TUTTE LE FACCE DELL' INNOVAZIONE

Università di Napoli "Federico II"
Esecuzione Flessibile e Adattiva di Task Strutturati
con Robot Collaborativi
Alberto Finzi

bimu.it



Robotica Collaborativa



- Sistema di produzione **flessibile, ergonomico, efficiente, efficace**
- Stretta interazione **fisica** e **cognitiva** tra operatori e robot
- Cooperazione tra team di **multirobot** e **team** di operatori
- Collaborazione **naturale, sicura, affidabile** nel contesto di task condivisi

- Vantaggi della robotica collaborativa:
 - **Spazio:** Condivisione dello spazio fisico con robot intrinsecamente sicuri (non segregazione)
 - **Ergonomia:** compiti pesanti e ripetitivi affidati ai robot
 - **Precisione:** precisione e controllo di qualità integrato
 - **Programmazione:** semplicità di programmazione e configurazione
 - **Flessibilità:** riconfigurazione per utilizzo su task diversi

Esecuzione collaborativa di task complessi:

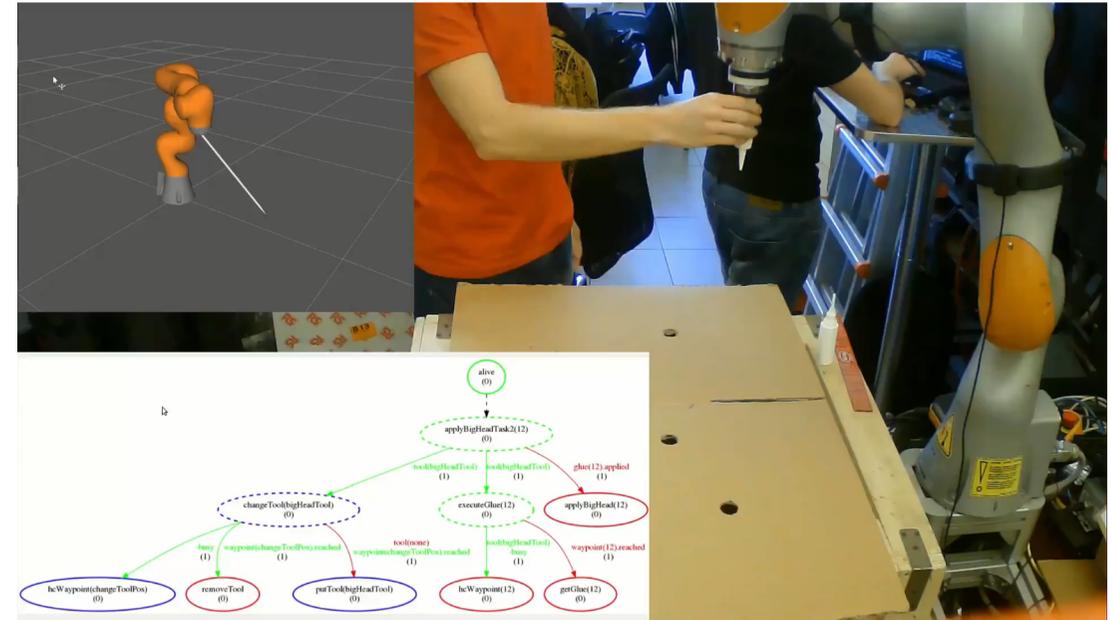
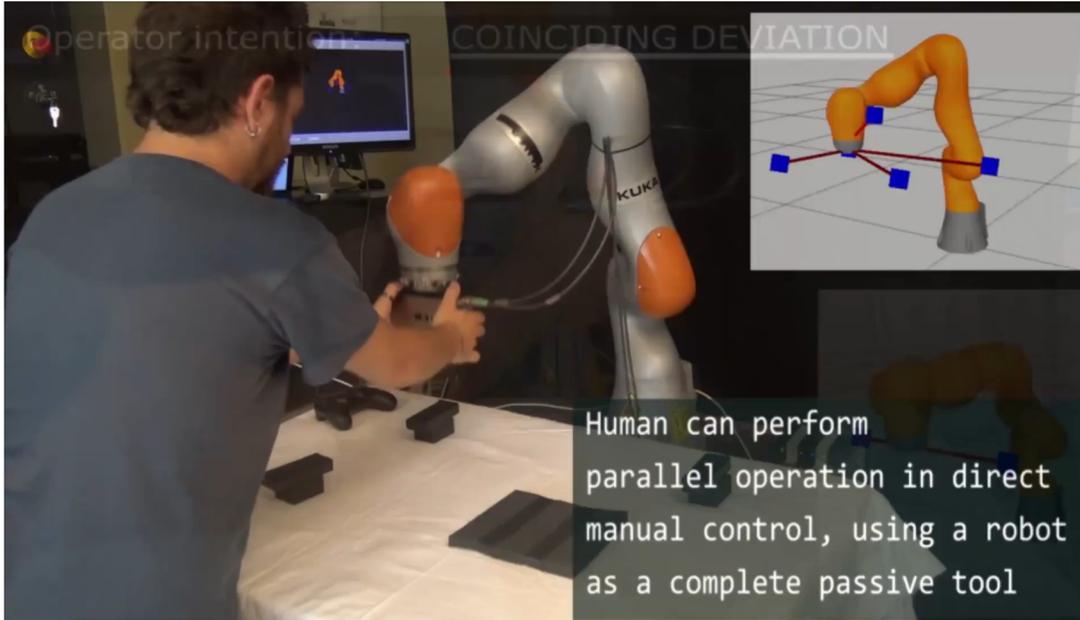
- Pianificazione/riplanificazione dinamica dei task
- Orchestrazione di task multipli
- Esecuzione collaborativa di task condivisi
- Riconoscimento dell'attività/intenzione/oggetti
- Comunicazione naturale persona-robot
- Apprendimento per dimostrazione di compiti
- Apprendimento continuo e incrementale



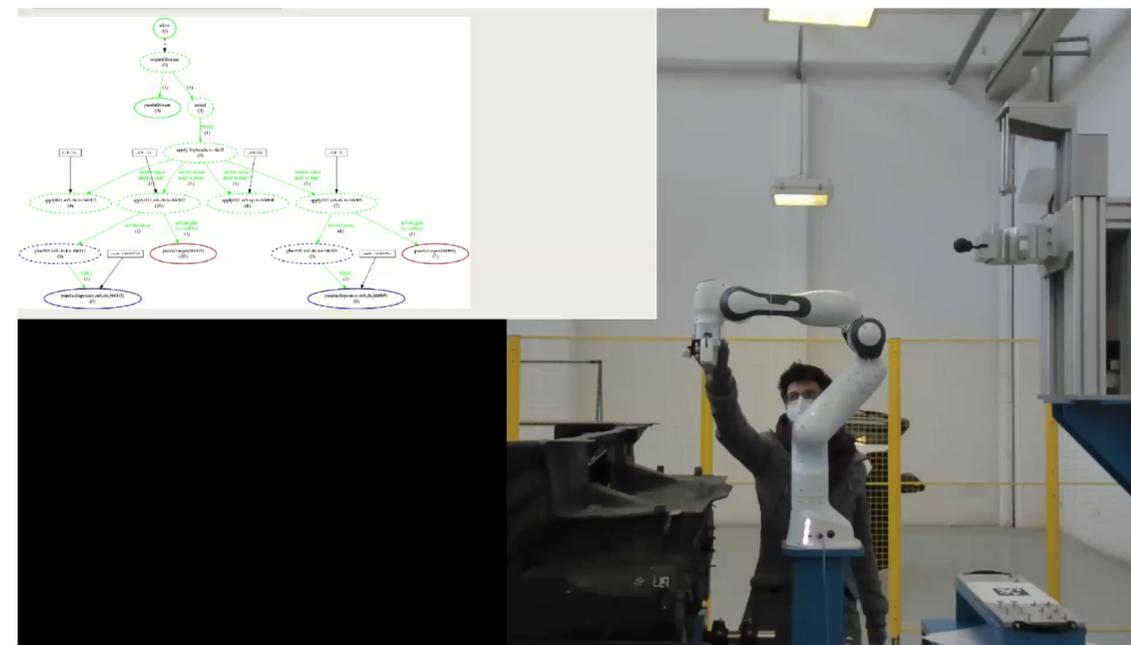
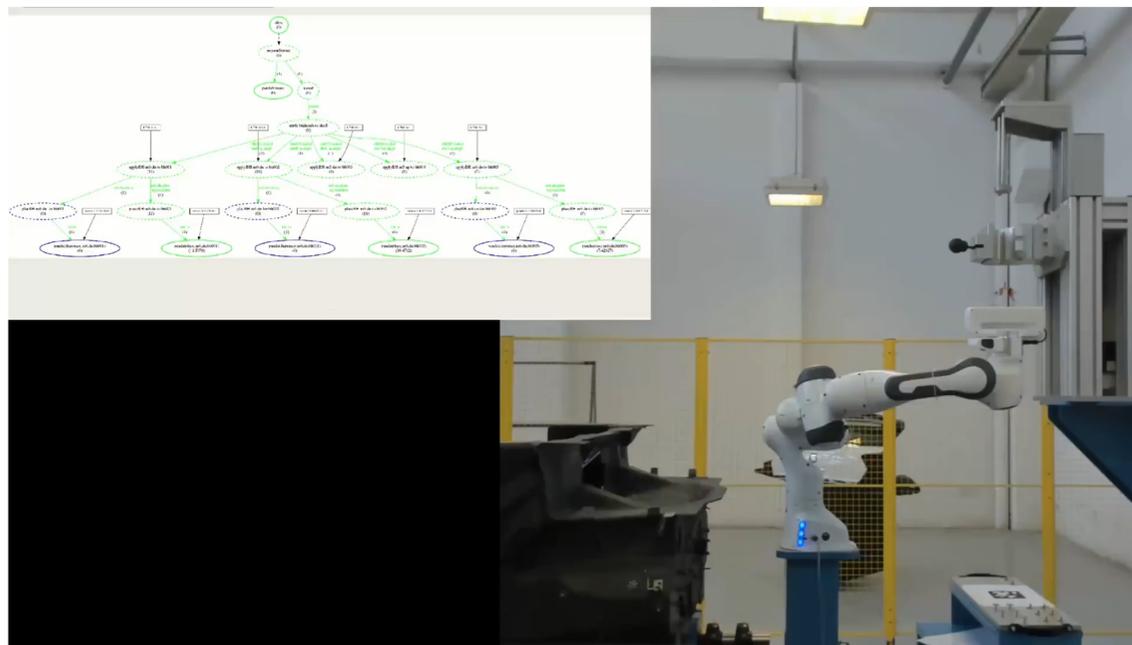
- Esecuzione collaborativa di task strutturati:
 - Rappresentazione e composizione di task strutturati
 - Continua interazione, interpretazione e adattamento dei piani
 - Monitoraggio di task a diversi livelli di astrazione
 - Esecuzione di task multipli e commutazione flessibile tra task in lavorazione



- (AI Planning)
- (Activity Recognition)
- (Task Monitoring)
- (Task Orchestration)

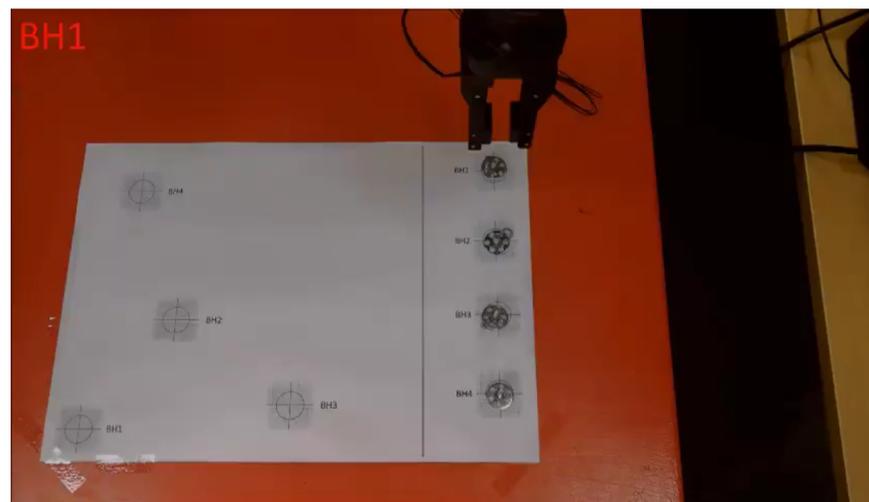
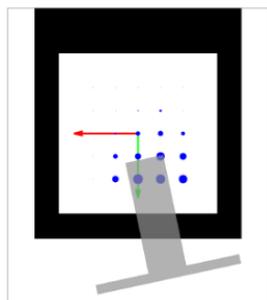
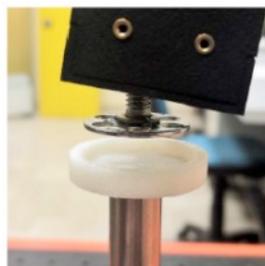
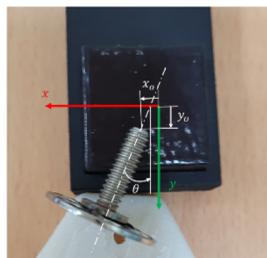
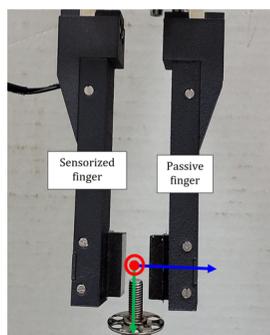


- Esecuzione flessibile di task di assemblaggio:
 - IA per supervisione e orchestrazione dei task, HMI, interazione persona-robot (sicurezza)



Caso di studio di Assemblaggio presso ALMAS: operatore interagisce in hand-guidance con un CoBot per eseguire inserimenti di elementi metallici in una scocca in fibra di carbonio

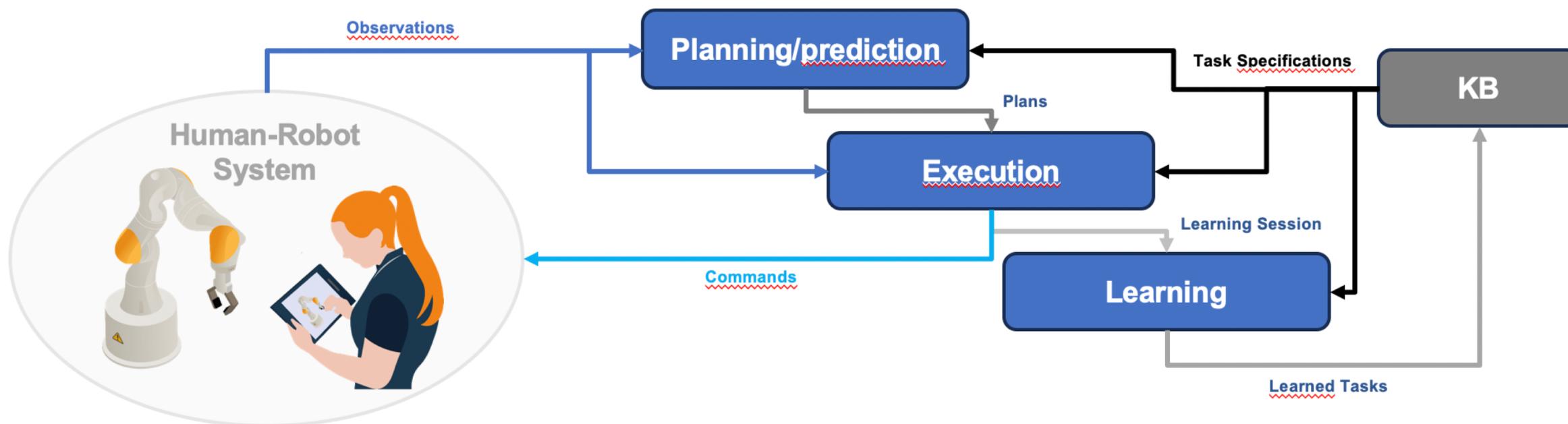
- Esecuzione flessibile di task di assemblaggio:
 - Percezione tattile su gripper per interagire con oggetti e persone
 - Monitoraggio della presa, manipolazione in-hand, adattamento e precisione
 - Interazione aptica persona-robot



V: Università degli Studi della Campania Luigi Vanvitelli

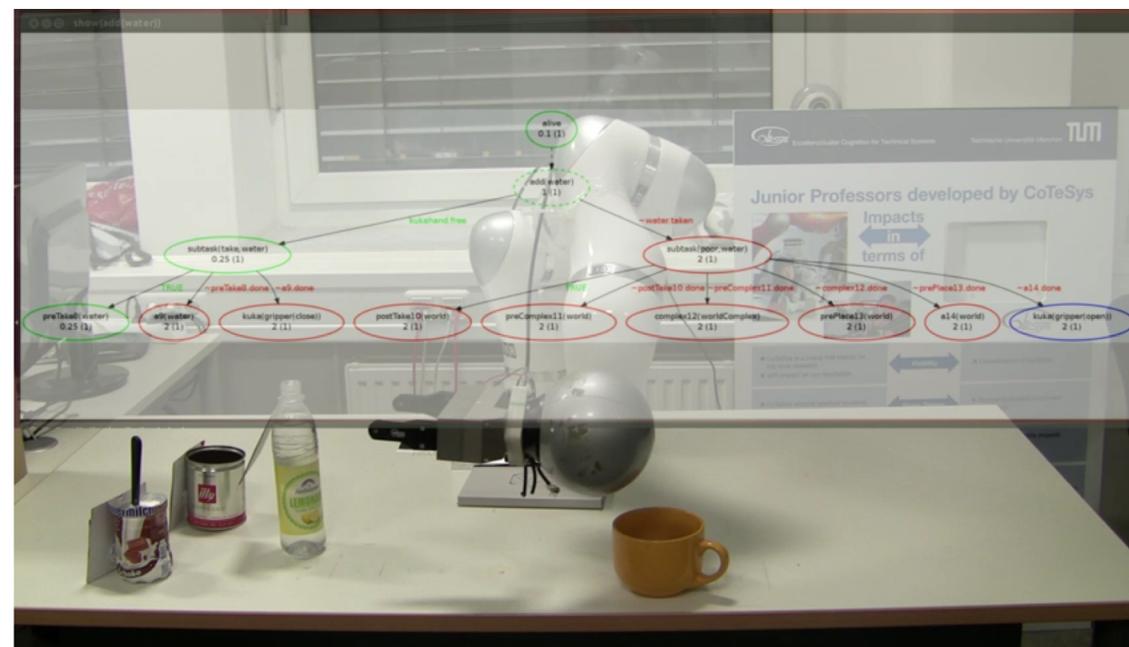
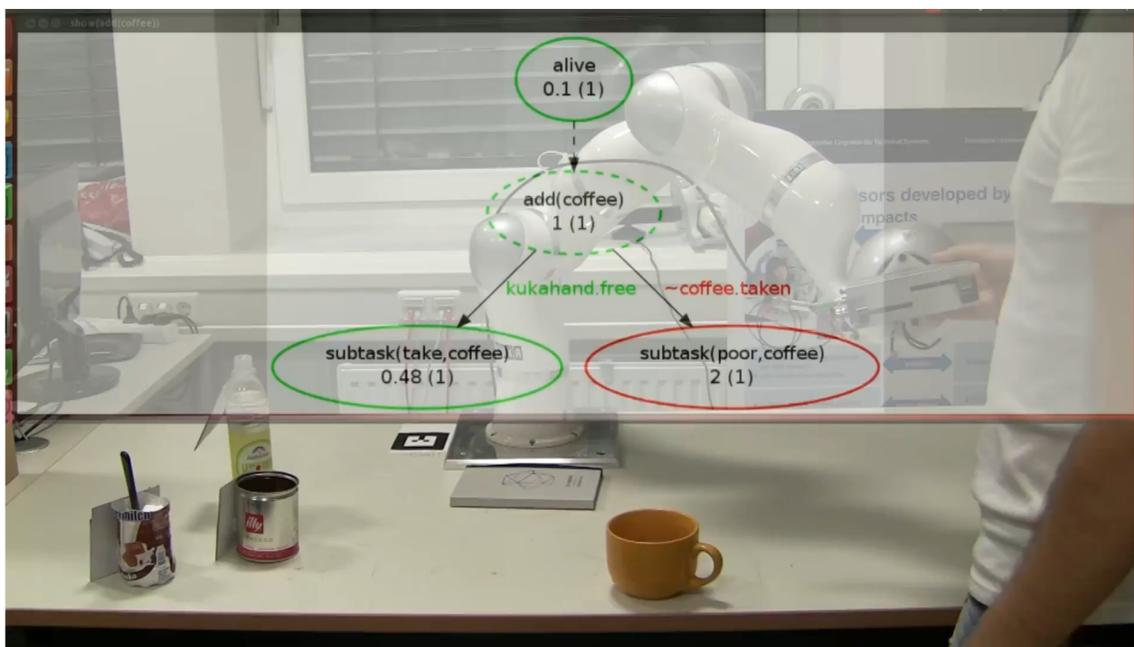


- Riutilizzo e trasferibilità
- Da assemblaggio a disassemblaggio (riciclo)
- Task inversi sono pianificati, ripianificati, appresi
- Inversione gestita a diversi livelli:
 - Esecuzione: inversioni semplici/dirette
 - Pianificazione: inversioni pianificate
 - Apprendimento: inversioni che richiedono nuovi skill per il robot



Apprendimento Incrementale di Task

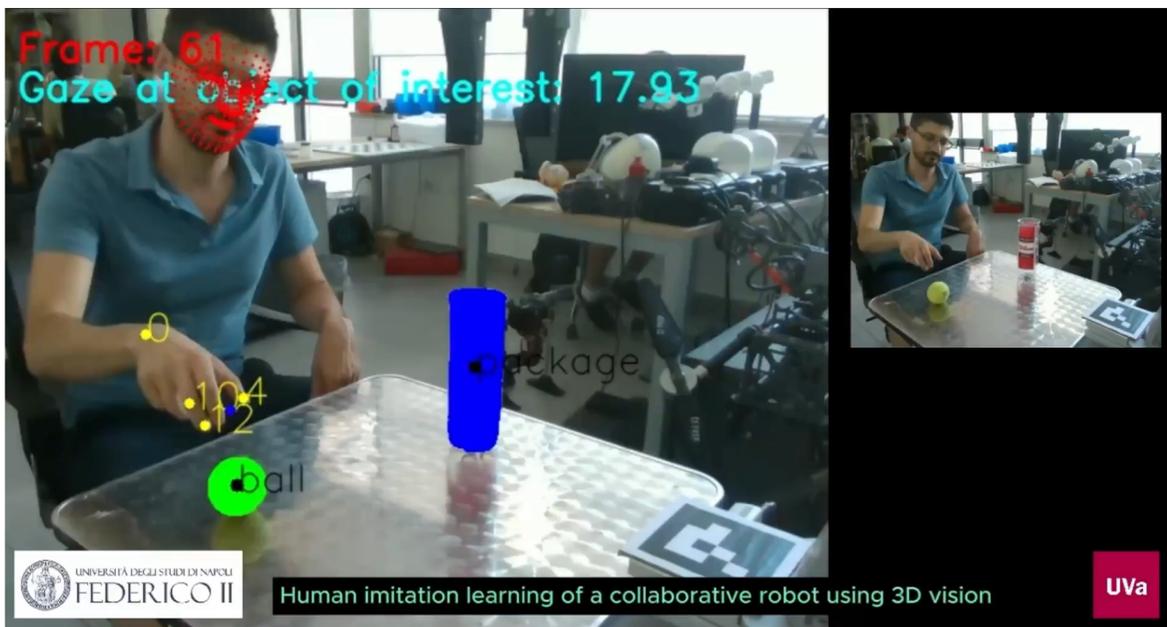
- Apprendimento per dimostrazione cinestetica:
 - Apprendimento per dimostrazione (invece di programmare)
 - Apprendimento continuo and incrementale
 - HRC può supportare l'insegnamento dei task



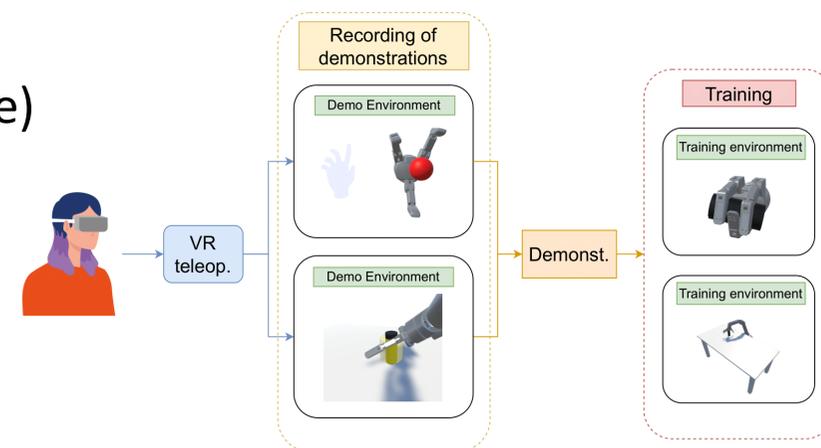
Apprendimento Incrementale di Task



- Apprendimento per dimostrazione:
 - Apprendimento per dimostrazione (invece di programmare)
 - Apprendimento continuo and incrementale
 - HRC può supportare l'insegnamento dei task



One-Shot Learning



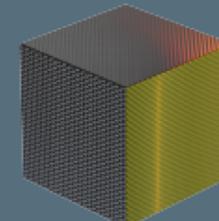
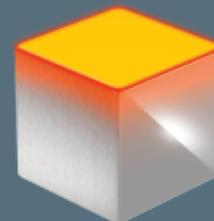
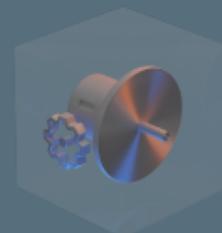
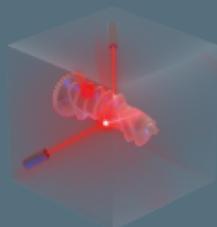
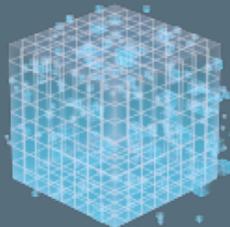
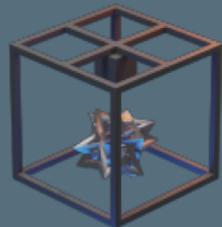
Incremental Learning from Demonstrations in VR

Robotica Collaborativa ed IA



- Metodi e tecnologie IA per sviluppare piattaforme collaborative avanzate per interazione flessibile ed ergonomica:
 - Collaborazione naturale e fluente
 - Apprendimento per dimostrazione dei compiti (al posto della programmazione)
 - Apprendimento continuo ed incrementale
 - Trasferibilità e adattamento dei task appresi
 - Flessibilità (e.g., inversione del task per disassembly, riconfigurazione rapida)

- Barriere:
 - Normativa (sicurezza robot collaborativi)
 - Sensoristica affidabile, non costosa, non ingombrante per il monitoraggio dell'operatore
 - Flessibilità vs Precisione e Velocità
 - Costi, robustezza, manutenzione della postazione collaborativa
 - Definizione delle piattaforme collaborative e dei task dove sia chiaro il valore aggiunto in termini di qualità, efficienza, sicurezza, ergonomia, etc.



GRAZIE



MELODY

Next Gen. EU, Miss. 4 Comp. 1
CUP E53D23017550001





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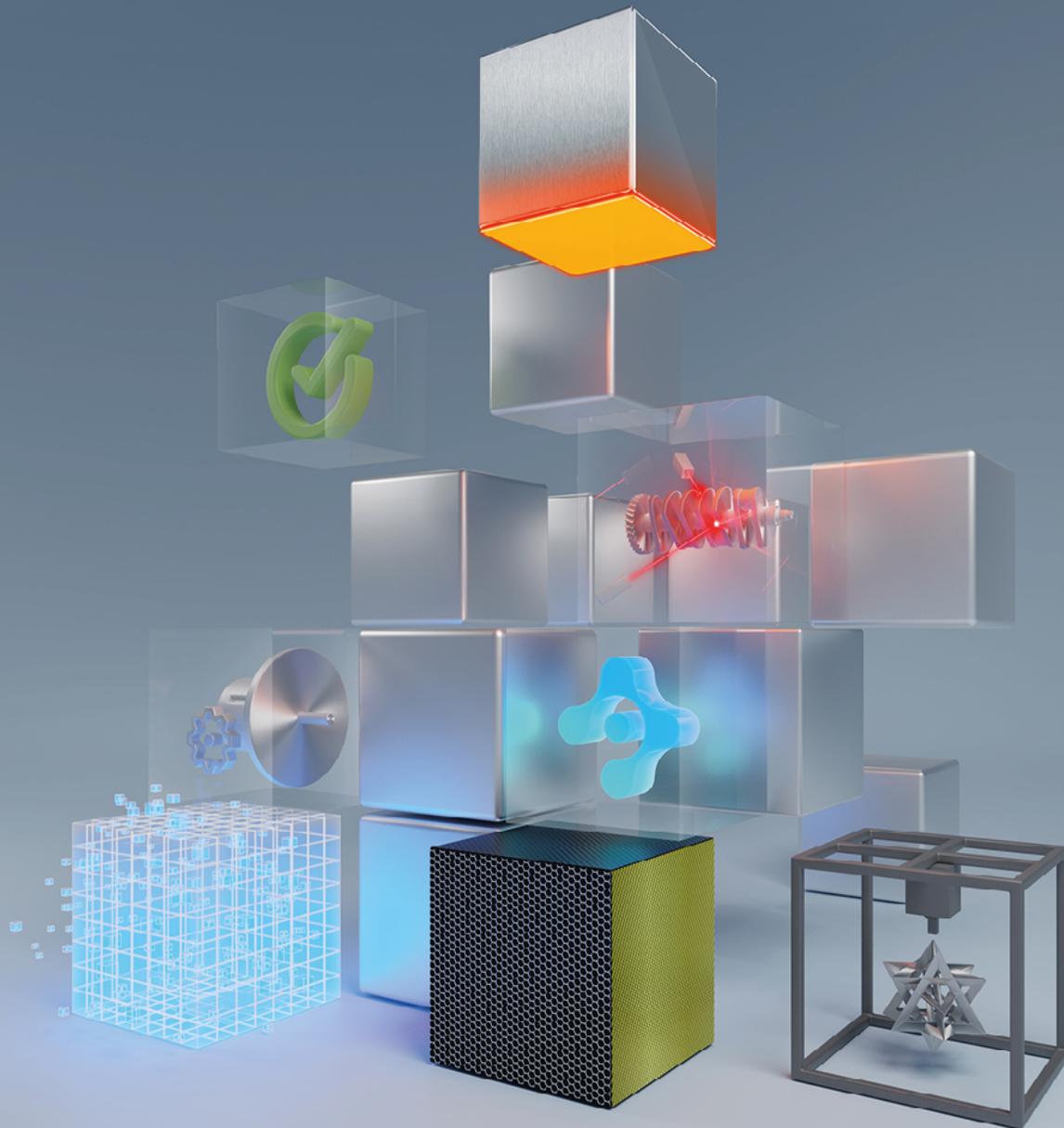
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TUTTE LE FACCE DELL' INNOVAZIONE

SIRI e AIRO/AIxIA

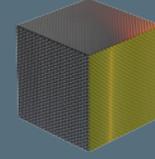
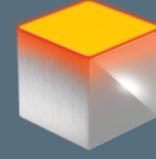
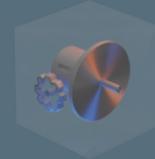
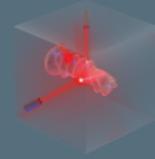
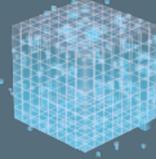
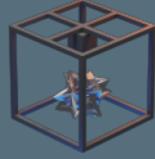
Intelligenza Artificiale e Robotica: verso
un'integrazione sinergica: il Panel.

Coordinatori: Alberto Finzi e Enrico Pagello



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Panel

Intelligenza Artificiale e Robotica: verso un'integrazione sinergica

- *Discussione sulle potenzialità, limiti e sinergie IA & Robotics: benefit della tecnologia, barriere, reali opportunità, casi di successo*

- **Panelist**

Domenico Appendino, Presidente SIRI

Alessandro Santamaria, Vice-Presidente SIRI, Roboteco

Ennio Chiatante, Consigliere SIRI, COMAU

Francesco Amigoni, Politecnico di Milano,

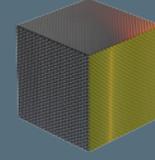
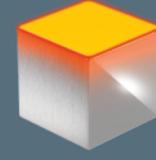
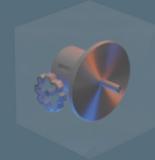
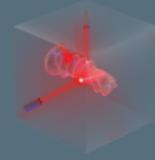
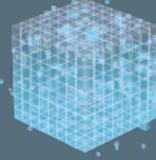
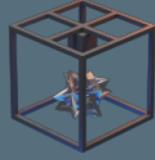
Gloria Beraldo, ISTC-CNR

Alberto Castellini, Università di Verona,

- **Moderatori**

Alberto Finzi, Coordinatore AIRO/AIxIA,
Università di Napoli

Enrico Pagello, Consigliere SIRI,
Università di Padova e IT+Robotics Srl



Panel

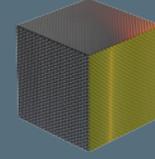
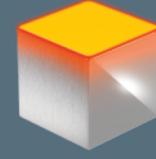
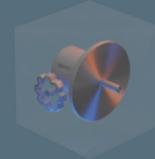
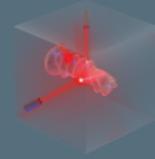
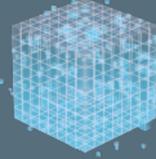
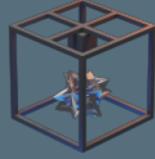
Discussione sulle potenzialità, limiti e sinergie IA & Robotica: benefit della tecnologia, barriere, reali opportunità, casi di successo

- **Obiettivi:**

Nel panel i promotori si propongono di far interagire i ricercatori accademici con il mondo industriale portando alla pubblica discussione una riflessione sulle nuove aree di indagine scientifica nel settore della IA capaci di creare nuove sinergie con la ricerca e sviluppo in robotica

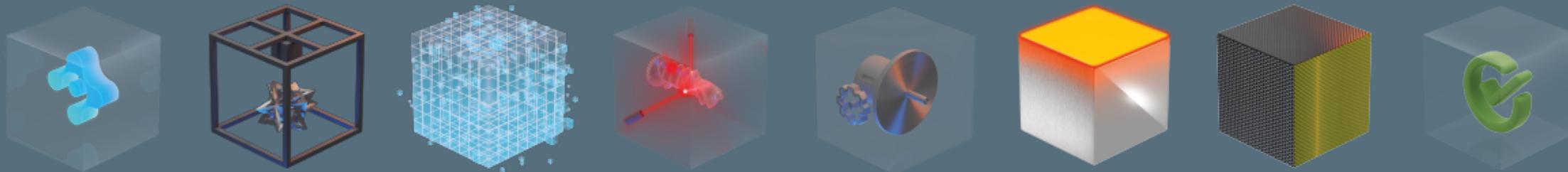
- **Tematiche**

Nuove e vecchie sfide / Ruolo della IA Generativa / Sostenibilità e nuovi paradigmi
Maturità tecnologica vs. timing / Barriere e casi di successo



Domande

- **Sfide:** Robotica IA (flessibilità/versatilità/interazione) vs. Robotica Industriale (precisione/prestazione). L'IA sta cambiando orizzonti e paradigmi oppure le sfide aperte di oggi rimangono le stesse di ieri?
- **AI Generativa:** Qual è la potenzialità reale della AI Generativa in robotica industriale? Es. i Large Language Models possono realmente favorire una migliore interazione robot/operatore?
- **Sostenibilità:** può l'AI contribuire alla sostenibilità, problema centrale dei processi industriali moderni? Es. smantellamento e riciclo richiedono ambienti meno strutturati e tecnologie nuove?
- **Timing:** È il momento giusto per un cambio di paradigma? Siamo pronti per introdurre metodi IA & Robotics nei processi industriali o è ancora presto?
- **Barriere:** Normative, sicurezza, investimenti, piattaforme hw-sw affidabili, standard. Esistono casi di successo convincenti?



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