Robotics & AI for Health
The Future is Now!

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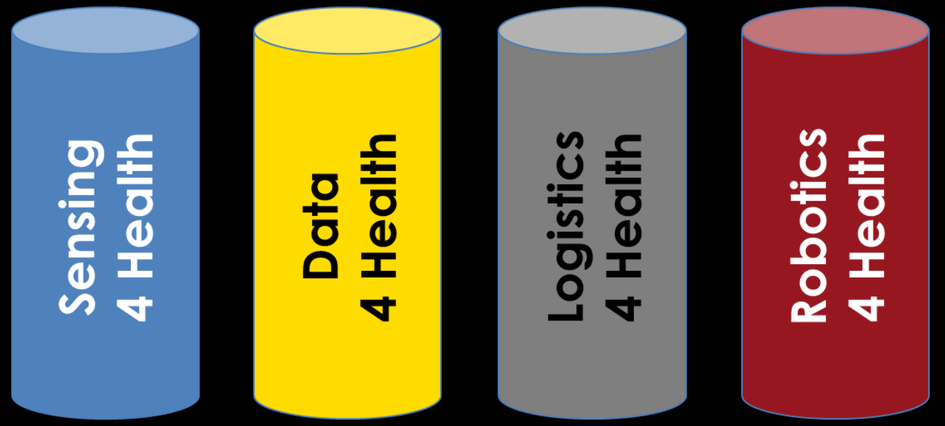
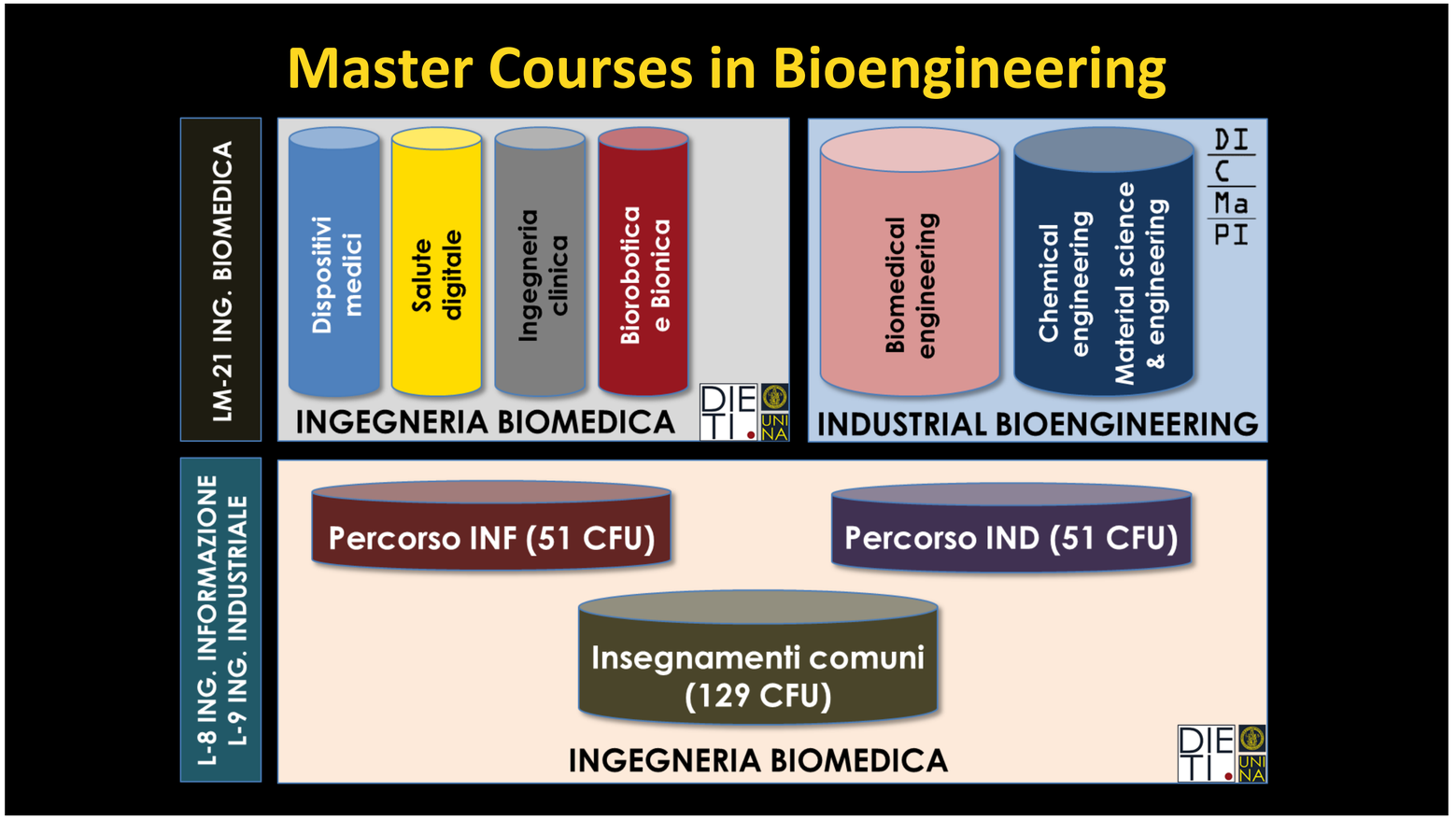
DIETI UNINA

ICT 4 Health

MUR

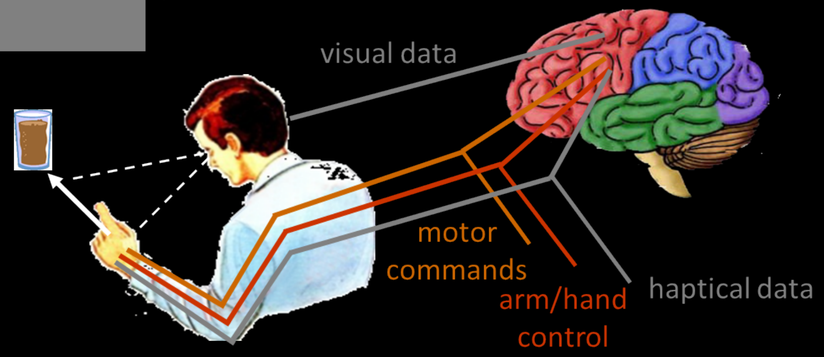
- ✓ *Dipartimento di Eccellenza*
- ✓ *9.35 M€ in 60 months*
- ✓ *1 Full Professor*
- ✓ *1 Associate Professor*
- ✓ *4 Tenure-track Assistant Professors*
- ✓ *Augmented Reality for Health Monitoring (ARHeM) Lab*
- ✓ *eHealth Big Data Analytics (eHBDA) Lab*

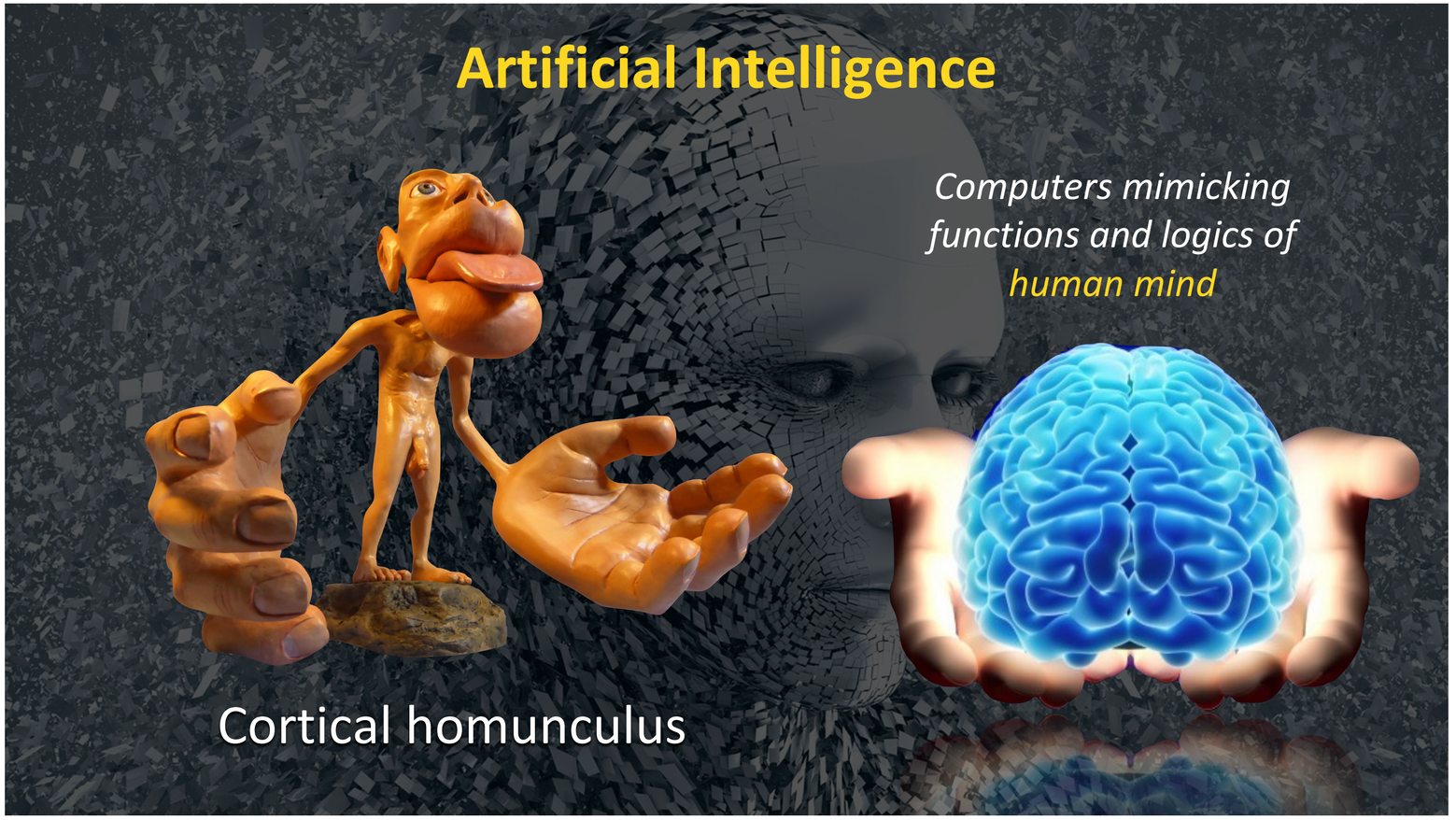


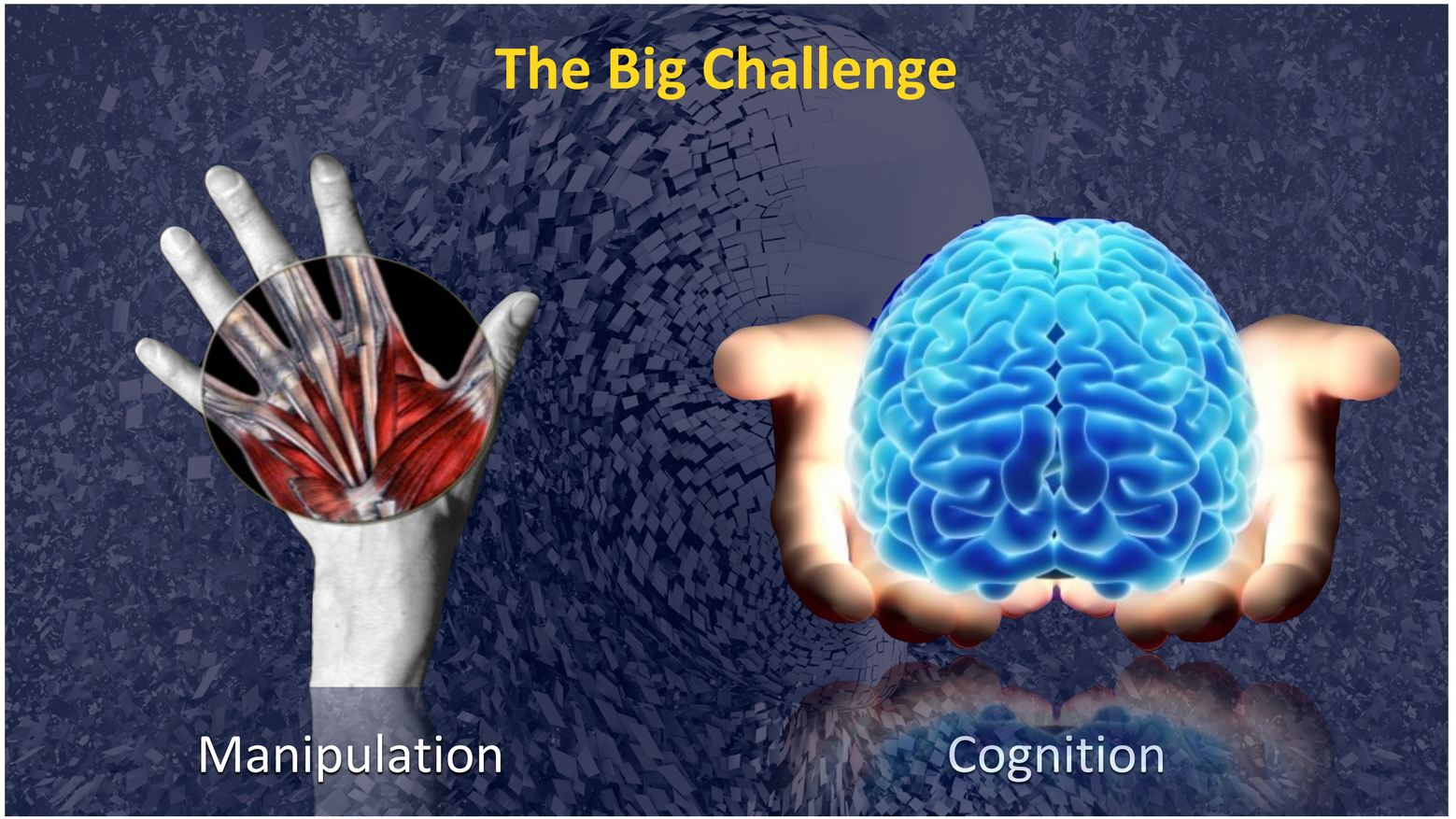


Robotics

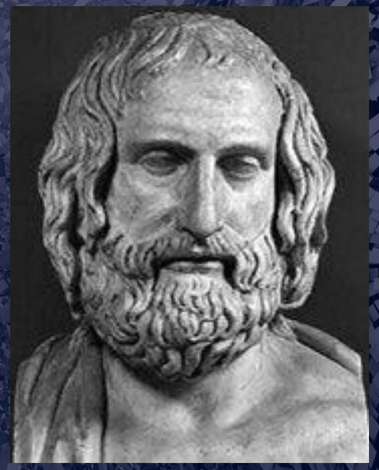
intelligent connection of perception to action

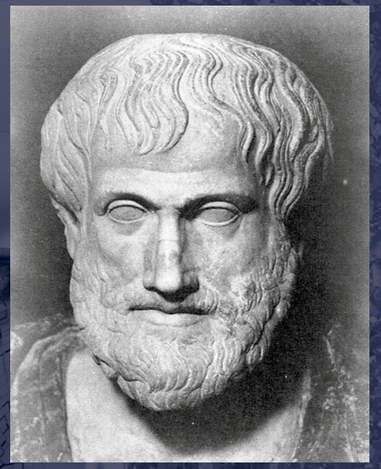






Body vs Mind





Anaxagoras

Aristotle

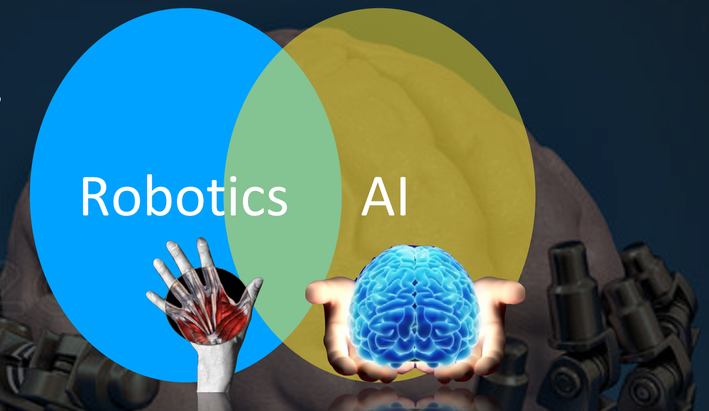
Embodiment

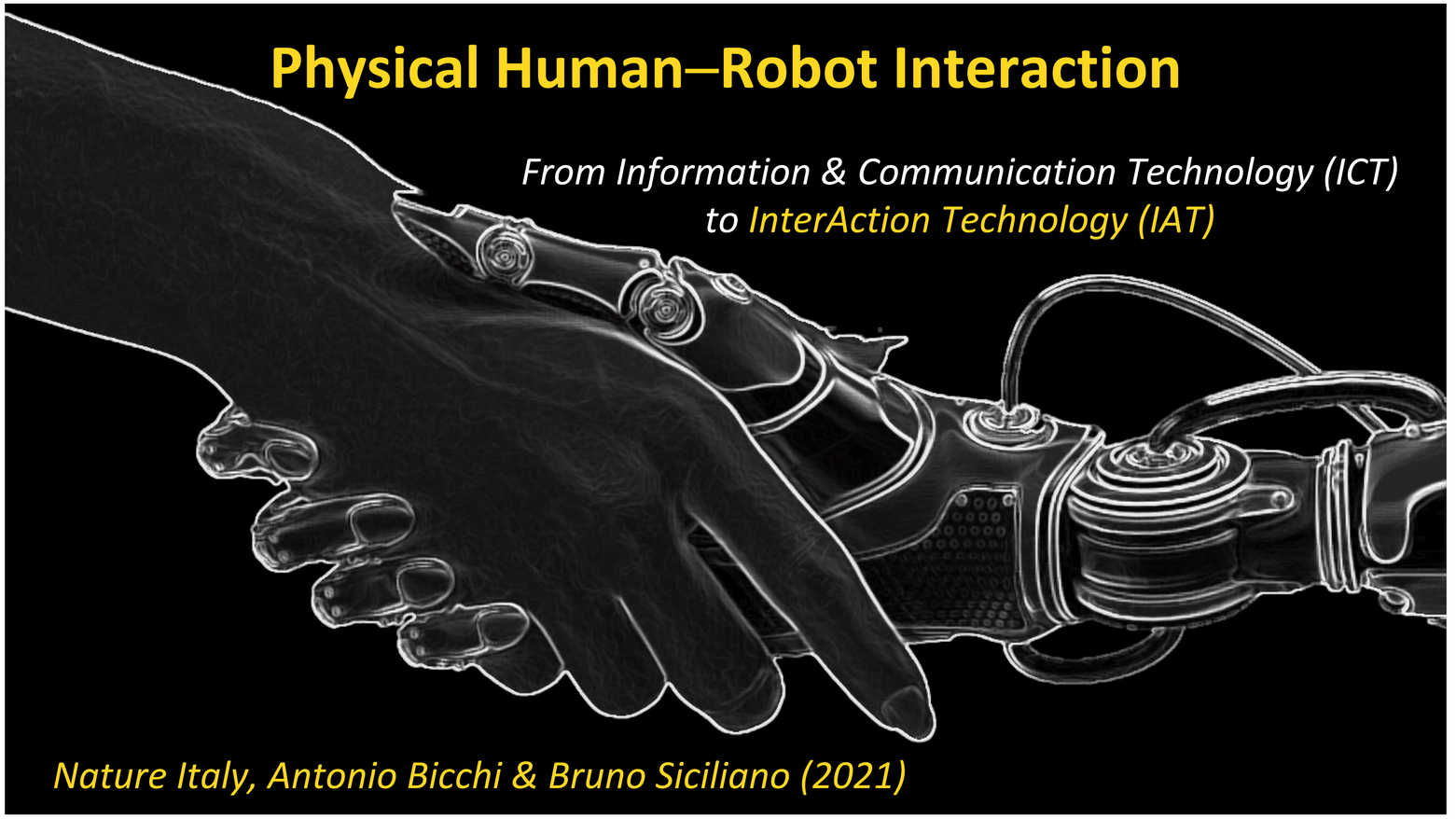
Physical Artificial Intelligence

The big challenge is found at the intersection of Robotics and AI

Physical Artificial Intelligence is MUCH harder

AI is not deterministic and "blind" use in robotics can be potentially dangerous



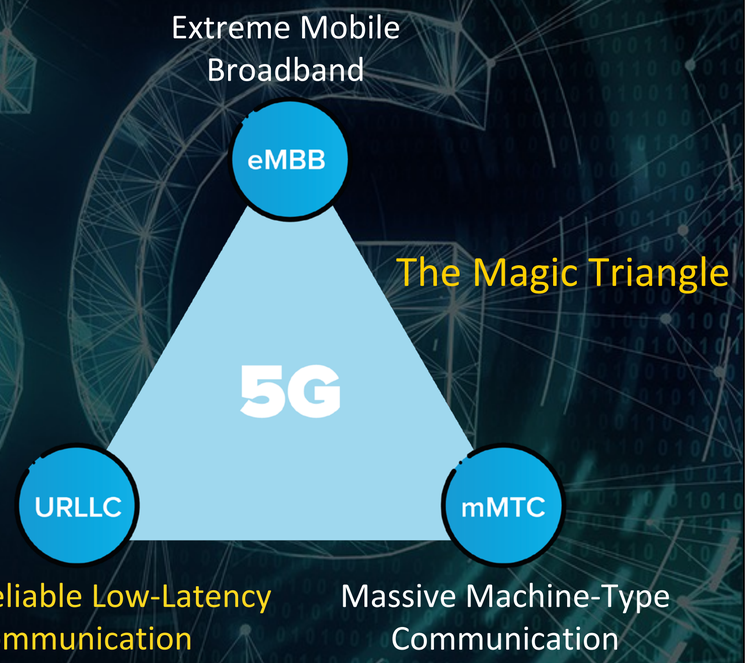


Fifth Generation of Wireless Technology

5G will pave the way for a new generation of robots

The vast computing and data storage resources of the cloud is exploited

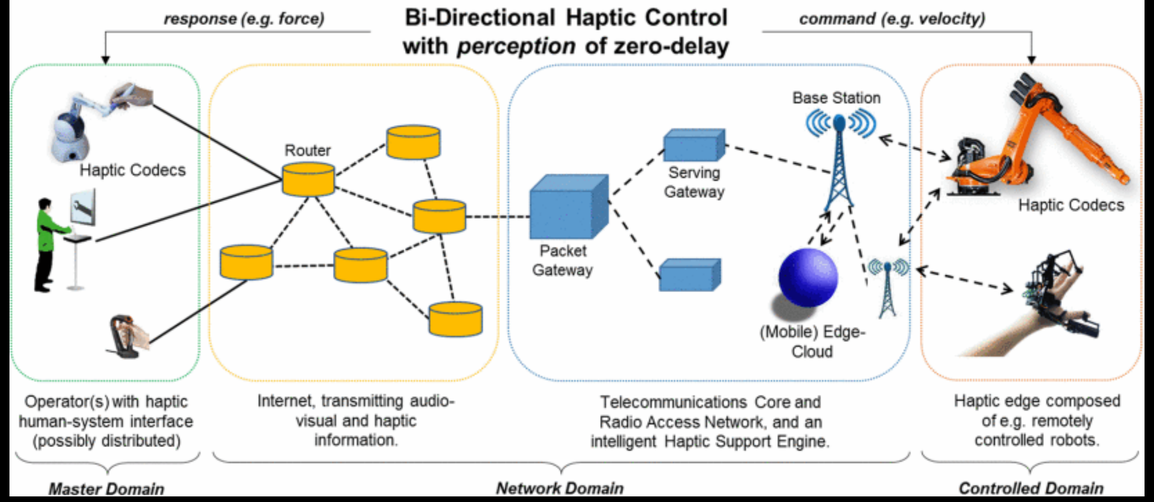
Robots can be controlled dynamically in real time and be connected to people and machines locally and globally



From IoT to IoS — The Phygital

1) **Ultra-Fast Networks** (Tactile Internet)
2) **Haptic Encoders** (both kinestaethic & tactile)
3) **Edge Artificial Intelligence** (to beat light-limit)

Core Technology Enablers of the "Internet of Skills"



Pillars of Next Generation Robotics

The Factory, Reimagined

NDT, Autonomous

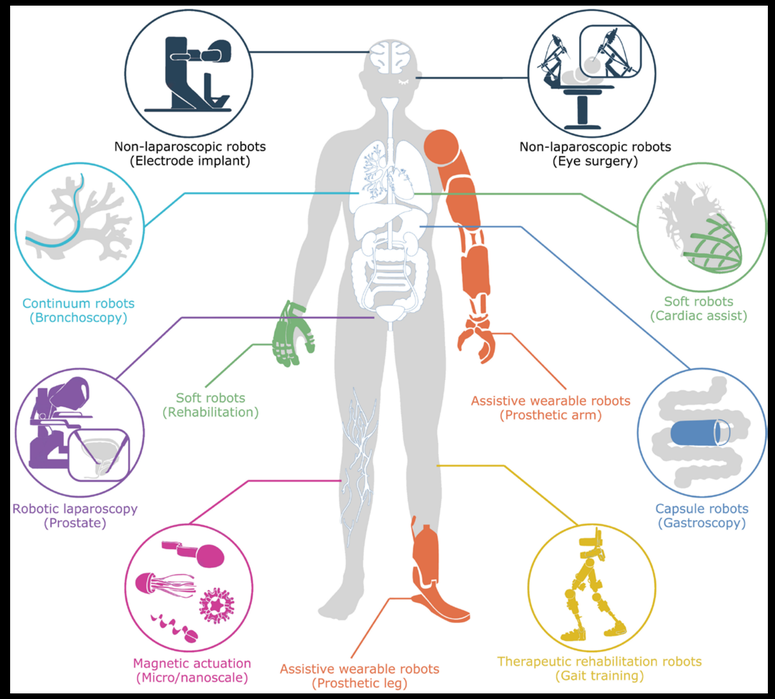
PNR
Programma Nazionale per la Ricerca

European Commission

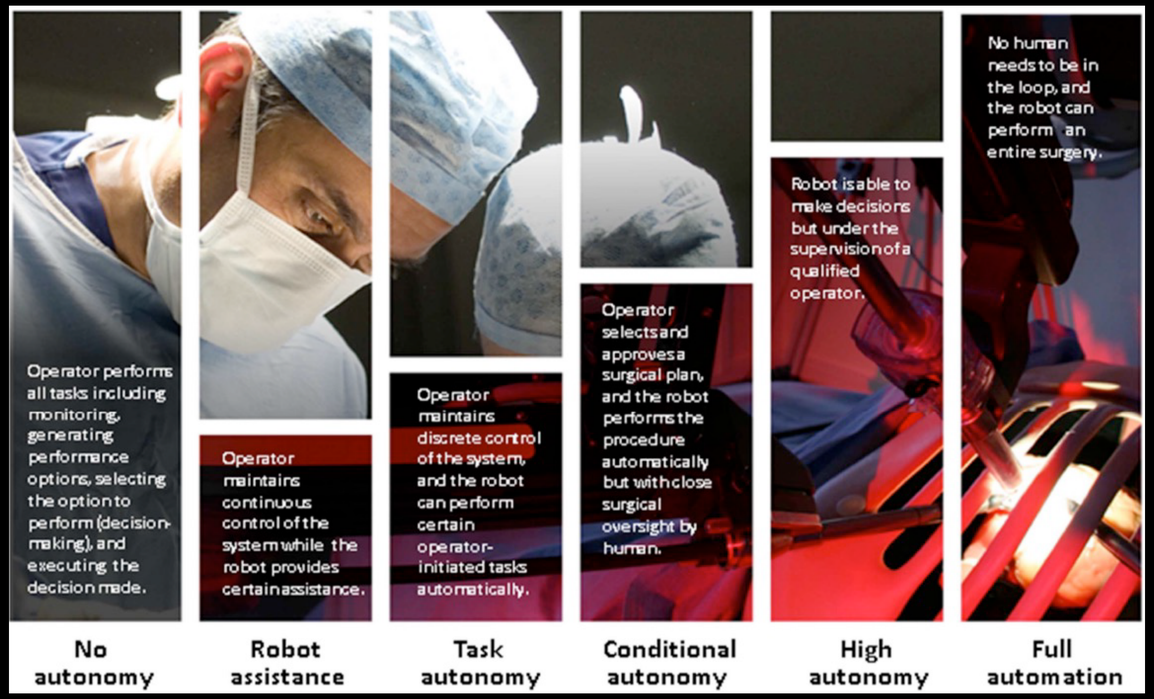
Healthcare, Revolutionized

Field Robots, Unthetered

Key Areas of Medical Robotics



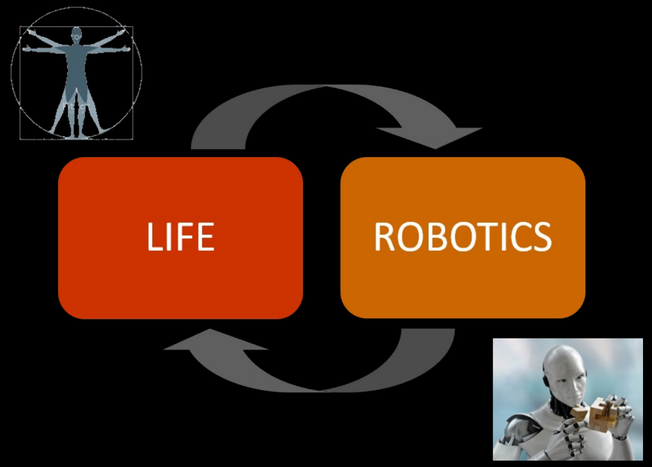
Levels of Autonomy



Robots & Humans

«La scienza m'interessa proprio nel mio sforzo per uscire da una conoscenza antropomorfa; ma allo stesso tempo sono convinto che la nostra immaginazione non possa essere che antropomorfa»

Italo Calvino

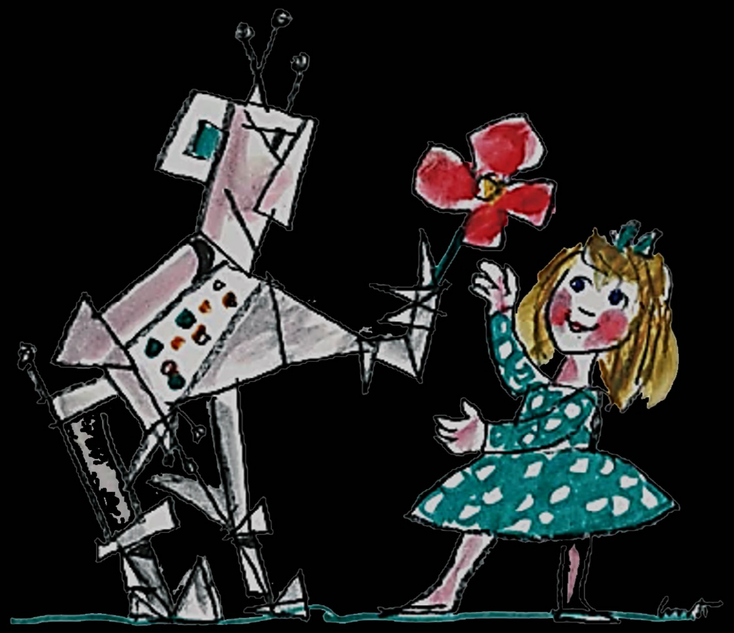


Biological inspiration in design and learning from nature (biomimicry and bionics)

A future where robots are more social than solitary (robot companion)

Robots will enhance human work and life rather than replace us in our homes, hospitals, factories, farms and freeways

Roboethics



Ethical, legal, societal and economic (ELSE) issues for design, construction and use of robots

Cohabitation of humans with robots

Fundamental human rights and the moral duties corresponding to them

Challenges and Outreach

New emerging areas
Biomechanics
Haptics
Neurosciences
Machine learning
Virtual prototyping
Animation
Surgery
Rehabilitation
Sensor networks
...

New communities of users and developers

Most striking advances happening at intersection of disciplines

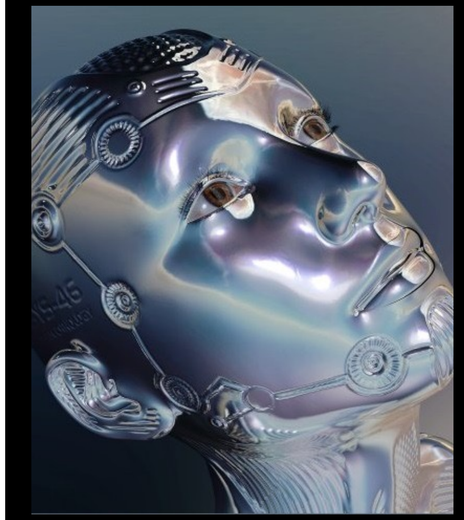
Future developments and expected growth of field largely depending on scientific cooperation

Robotics technology becoming ubiquitous, distributed and embedded into smart environments

Towards a Technological Humanism

«In effetti l'uomo si dimostra essere cosa divina perché dove la natura finisce di produrre le sue spetie l'uomo quivi comincia colle cose naturali a fare coll'aiutorio d'essa natura infinite spetie»

Leonardo da Vinci



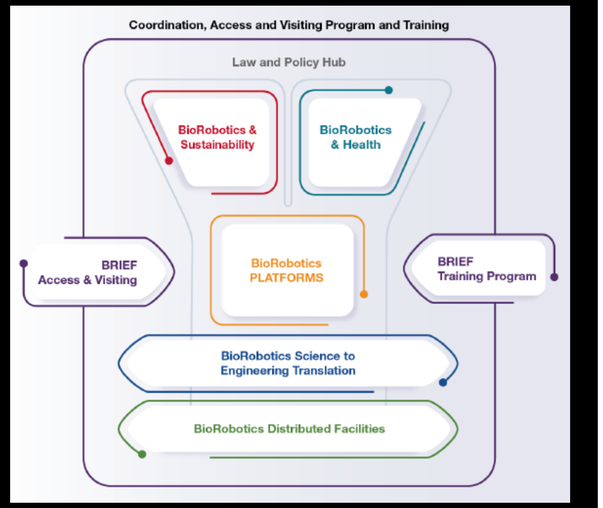
«A distanza di 100 anni dall'ingresso della parola robot nel nostro lessico, la sfida e allo stesso tempo l'opportunità che il mondo della ricerca dovrà rappresentare è relativa a futuri scenari in cui la robotica diventerà un mezzo interattivo per contribuire a migliorare le condizioni di vita. In questa visione, la rivoluzione dei robot potrà aiutarci a riaffermare la caratteristica meno artificiale del nostro mondo: la nostra umanità»

Atlante Treccani, Bruno Siciliano (2020)

BRIEF Biorobotics Research & Innovation Engineering Facilities

Piano Nazionale di Ripresa e Resilienza
#NEXTGENERATIONITALIA

- ✓ *Strengthening infrastructures having long-term sustainability*
- ✓ *24 M€ in 28 months*
  - ❖ *Grants from competitive calls*
  - ❖ *Institutional endowments from public bodies*
  - ❖ *Revenues from commercial contracts*
- ✓ *3 Institutions*
  - ❖ *SSSA*
  - ❖ *UniNa*
  - ❖ *PoliBa*
- ✓ *UniNa*
  - ❖ *4.8 M€*
  - ❖ *Biomimetic and Biohybrid Robotic (B2R) Lab @ DIETI*
  - ❖ *Robotic-assisted in Situ Tissue Regeneration and Repair (REISSUE) Lab @ CRIB*

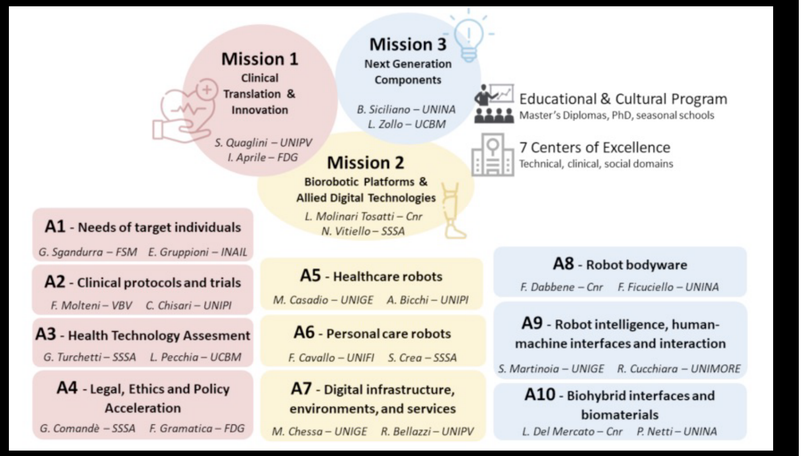


FIT4MEDROB:

rivoluzionare i modelli assistivi e riabilitativi

Piano Nazionale di Ripresa e Resilienza
#NEXTGENERATIONITALIA

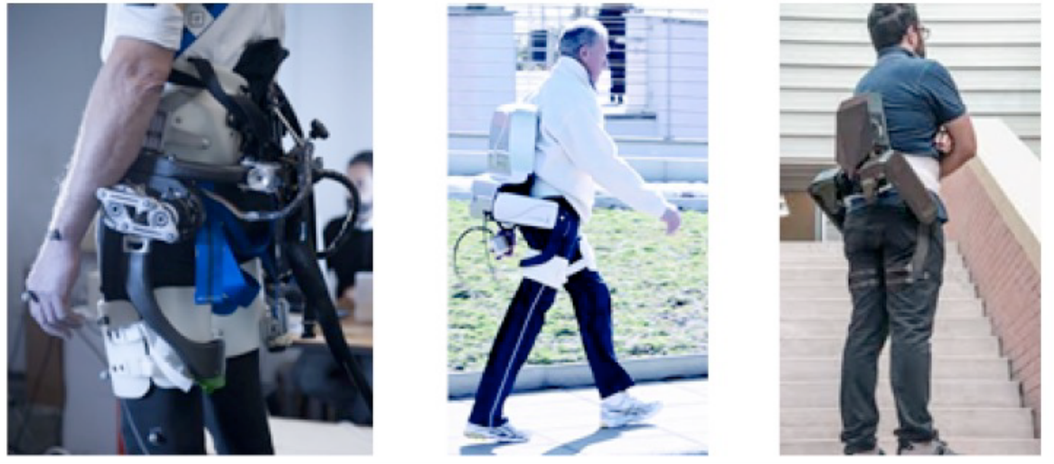
- ✓ *A new generation of biorobotic and digital technologies for a sustainable welfare*
- ✓ *126 M€ in 44 months*
- ✓ *Hub & Spokes model*
- ✓ *26 Institutions*
  - ❖ *1 Research Centre (CNR)*
  - ❖ *10 Universities*
  - ❖ *12 Clinical Centres*
  - ❖ *3 Companies*
- ✓ *UniNa*
  - ❖ *31 M€ (13 M€ + 18 M€ cascaded funding)*
  - ❖ *4 Engineering Departments + 4 Medical Departments + 1 Physics Department*
  - ❖ *Center of Excellence for Biorobotic and Bionic Materials and Systems*



Exoskeleton-assisted walking for prehabilitation and active aging

MUR

- ✓ *Promoting active lifestyles based on regular moderate-intensity physical training*
- ✓ *170 K€ in 24 months*
- ✓ *3 Institutions*
  - ❖ *SSSA*
  - ❖ *UniNa*
  - ❖ *UCBM*



Harmony

Assistive robots for healthcare

European Commission

- ✓ *7.2 M€ in 36 months*
- ✓ *Navigation and SLAM*
- ✓ *19 total DOFs*
- ✓ *Manipulation*
- ✓ *Human–robot interaction*
- ✓ *Perception*
- ✓ *Speech recognition*
- ✓ *Sensors: laser, sonar, IMU, RGBD-camera, wrist force/torque sensor*

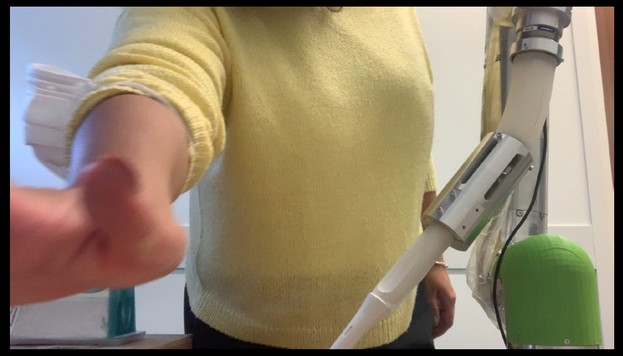
Human–robot cooperation

Human–robot teleoperation

PROSCAN

PON RICERCA E INNOVAZIONE 2014 - 2020

- ✓ *8.75 M€ in 42 months*
- ✓ *Design of a soft/rigid robot*
  - ❖ *Intrinsically safe*
  - ❖ *Force/torque wrist sensor*
  - ❖ *Under-actuated*
  - ❖ *Lightweight*
- ✓ *Control*
  - ❖ *Manual guidance*
  - ❖ *Motion planning with SOFA*
  - ❖ *AI for image-guided pose refining*
  - ❖ *Finite-element method for soft part*



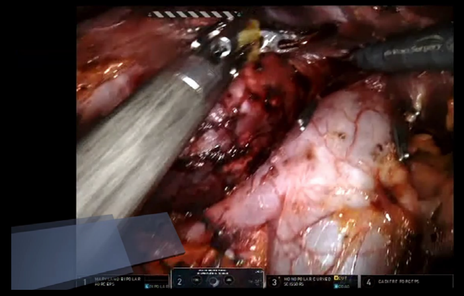
Modeling a soft-rigid Hybrid arm

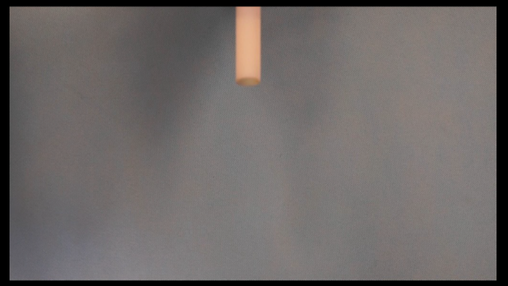
Micromechanic and robotic approaches for diagnosis and therapy of prostate cancer

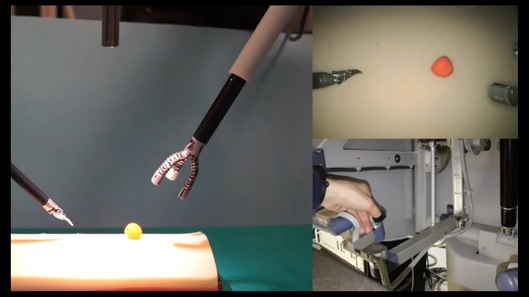
MUSHA

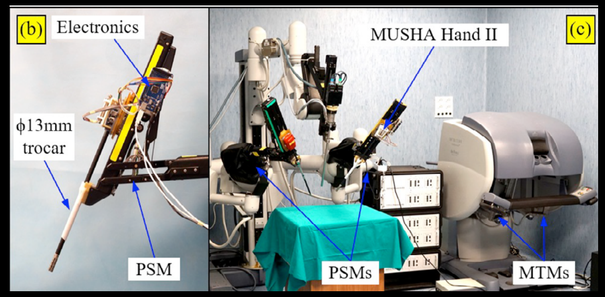
FONDAZIONE BANCO di NAPOLI

✓ *95 K€ in 24 months*









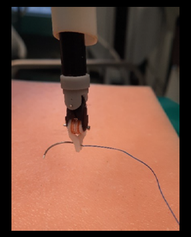
Mini-invasive surgical tools and artificial anthropomorphic hands

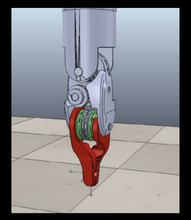
Needle Holder with Handling Capability (PACMAN)

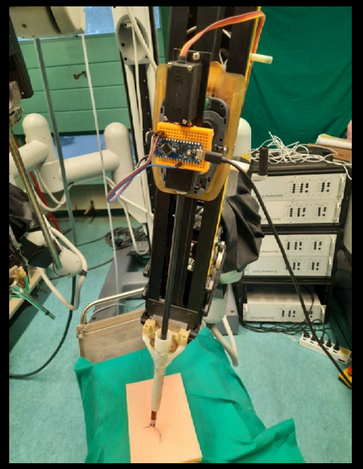
Ministero dello sviluppo economico

- ✓ *75 K€ in 18 months*
- ✓ *Rolling capabilities for needle reorientation (1 extra DOF)*
- ✓ *da Vinci Research Kit integration with control interface*

The five degrees of freedom of the gripper are demonstrated







New surgical tool for in-hand rolling

Remote Surgical Training (ReST)

INTUITIVE SURGICAL®

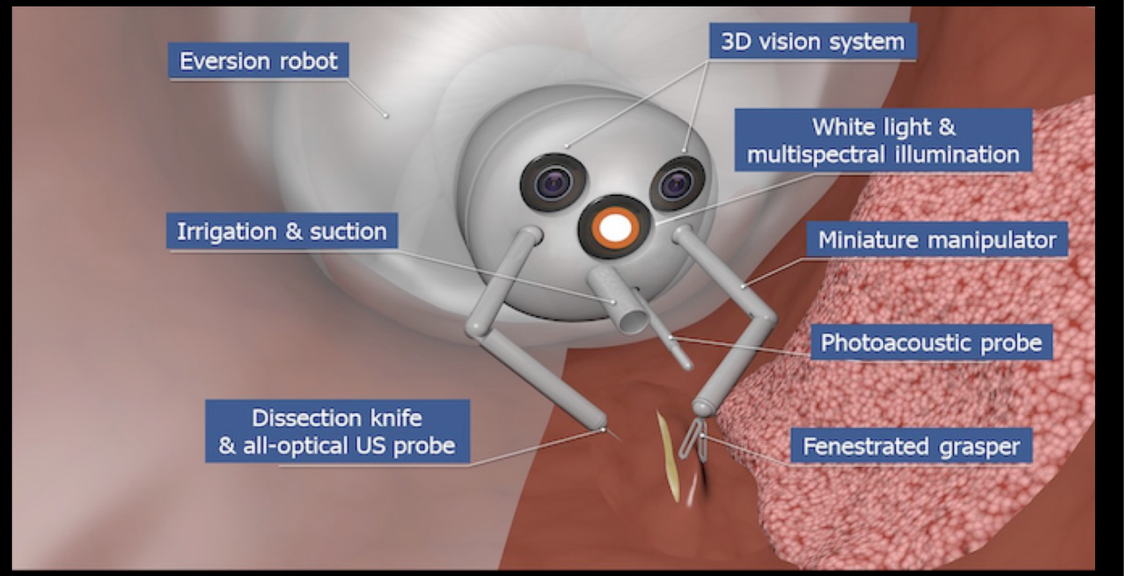
- ✓ *50 K€ in 12 months*

- ✓ *Training setup composed of a da Vinci Xi system, master console and slave robot hosted in one room, and a tutor console placed in adjacent room*
- ✓ *Adoption of 5G as cutting-edge technology for transmission of real-time multimedia flows (audio, video, data) across the Internet — constant latency*
- ✓ *Haptic feedback data generated by control components on the operating tools*

Towards Intelligent Robotic Endoscopic Dissection (TI-RED)

MUR

- ✓ *Novel robotic surgery and medical imaging system for endoscopic dissection of colorectal early cancer lesions*
- ✓ *207 K€ in 24 months*
- ✓ *2 Institutions*
  - ❖ *UniTo*
  - ❖ *UniNa*



SyG proposal under evaluation

ENDO THERANOSTICS

erc

- ✓ *One-stop shop theranostic procedure for treatment of colorectal polyps*
- ✓ *10 M€ in 60 months*
- ✓ *4 Institutions*
  - ❖ *UniTo*
  - ❖ *QMUL*
  - ❖ *KCL*
  - ❖ *UniNa*

Thank You!

"For surgical robots, one key aspect is that the treating physician is still in control to a significant extent."

Delitti in materia di violazione del diritto d'autore (Art. 25-novies, D.Lgs. n. 231/2001) [articolo aggiunto dalla L. n. 99/2009]

- Messa a disposizione del pubblico, in un sistema di reti telematiche, mediante connessioni di qualsiasi genere, di un'opera dell'ingegno protetta, o di parte di essa (art. 171, legge n.633/1941 comma 1 lett. a) bis)
- Reati di cui al punto precedente commessi su opere altrui non destinate alla pubblicazione qualora ne risulti offeso l'onore o la reputazione (art. 171, legge n.633/1941 comma 3)
- Abusiva duplicazione, per trarne profitto, di programmi per elaboratore; importazione, distribuzione, vendita o detenzione a scopo commerciale o imprenditoriale o concessione in locazione di programmi contenuti in supporti non contrassegnati dalla SIAE; predisposizione di mezzi per rimuovere o eludere i dispositivi di protezione di programmi per elaboratori (art. 171-bis legge n.633/1941 comma 1)
- Riproduzione, trasferimento su altro supporto, distribuzione, comunicazione, presentazione o dimostrazione in pubblico, del contenuto di una banca dati; estrazione o reimpiego della banca dati; distribuzione, vendita o concessione in locazione di banche di dati (art. 171-bis legge n.633/1941 comma 2)
- Abusiva duplicazione, riproduzione, trasmissione o diffusione in pubblico con qualsiasi procedimento, in tutto o in parte, di opere dell'ingegno destinate al circuito televisivo, cinematografico, della vendita o del noleggio di dischi, nastri o supporti analoghi o ogni altro supporto contenente fonogrammi o videogrammi di opere musicali, cinematografiche o audiovisive assimilate o sequenze di immagini in movimento; opere letterarie, drammatiche, scientifiche o didattiche, musicali o drammatico musicali, multimediali, anche se inserite in opere collettive o composite o banche dati; riproduzione, duplicazione, trasmissione o diffusione abusiva, vendita o commercio, cessione a qualsiasi titolo o importazione abusiva di oltre cinquanta copie o esemplari di opere tutelate dal diritto d'autore e da diritti connessi; immissione in un sistema di reti telematiche, mediante connessioni di qualsiasi genere, di un'opera dell'ingegno protetta dal diritto d'autore, o parte di essa (art. 171-ter legge n.633/1941)
- Mancata comunicazione alla SIAE dei dati di identificazione dei supporti non soggetti al contrassegno o falsa dichiarazione (art. 171-septies legge n.633/1941)
- Fraudolenta produzione, vendita, importazione, promozione, installazione, modifica, utilizzo per uso pubblico e privato di apparati o parti di apparati atti alla decodificazione di trasmissioni audiovisive ad accesso condizionato effettuate via etere, via satellite, via cavo, in forma sia analogica sia digitale (art. 171-octies legge n.633/1941).

Torna all'inizio