Robotic technologies in the service of society and cultural heritage

Dr. Dimitrios Giakoumis

Research Associate

Information Technologies Institute

Centre for Research and Technology Hellas

Thessaloniki, September 2018

Robot

- *"An **actuated mechanism** programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks"*

- **Autonomy**: the ability to perform intended tasks based on current state and sensing, without human intervention

Service Robot

- *"A robot that performs useful tasks for humans or equipment **excluding industrial automation application"***

Personal Service Robot

- *"Service robot used for a **non-commercial** task, usually by **lay persons"***

- Examples: domestic servant robot, automated wheelchair, personal mobility assist robot

Professional Service Robot

- *"a service robot used for a **commercial task**, usually operated by a **properly trained operator"***

- Examples: cleaning robot for public places, delivery robot in offices or hospitals, fire-fighting robot, rehabilitation robot, surgery robot in hospitals, field, space robots, agriculture, milking

SPARC Robotics MAR

Perception

Navigation

Cognition

Manipulation

Communication

Robotic Assistant for MCI Patients at home

- ## H2020 Research Project
  - Research and Innovation Action (RIA)
  - Horizon 2020 – PHC-19-2014
    - Advancing active and healthy ageing with ICT: Service robotics within assisted living environments
  - Project duration: 2015 - 2018

The RAMCIP Vision of future assistive service robots

Future service robots capable of:

- Providing **safe, proactive and discreet assistance** in a series of significant aspects of the person's daily life
  - From food preparation, medication and eating activities to managing the home and keeping it safe
  - The robot should also assist the user to maintain positive affect and also exercise cognitive and physical skills

ASSIST IN...			Safe, Proactive and Discrete Assistance
Food preparation	Eating activities	Dressing activities	
Socialization	Lower-body treatment activities	Taking medication	
Managing the home and keeping it safe	Maintaining positive affect	Exercising cognitive and physical skills	

HOW TO ASSIST	High-level cognitive functions		
	Home Environment and Human Activity Modelling and Monitoring	**Human Robot Communication**	**Safe Manipulations**
		Multimodal / -Touch screen	Object Grasping/ Manipulation/Handover High object Reaching pHRI
		Adaptive / -Speech -Gestures	
		Empathic / -AR	

The RAMCIP project aimed to develop a novel service robot, capable to **proactively assist** the target older end users in a range of daily activities

RAMCIP target end users: MCI and early AD patients

- **Robot purpose**: To facilitate the end user's daily activities
  - Related to nutrition, medication, usage of electric appliances, socialization, as well as safe domestic locomotion

- **Through**: User activities monitoring and robot interventions
  - To facilitate the user in corresponding tasks and help counteract for observed abnormalities

**…to substitute the human caregiver for
limited periods of time**

- *Mobile base*
  - **Mobile platform** with torque interface to the drives that make compliant mobile manipulation possible
  - **Elevation mechanism** allowing the robot to reach objects at increased height.
  - Developed by **ACCREA**
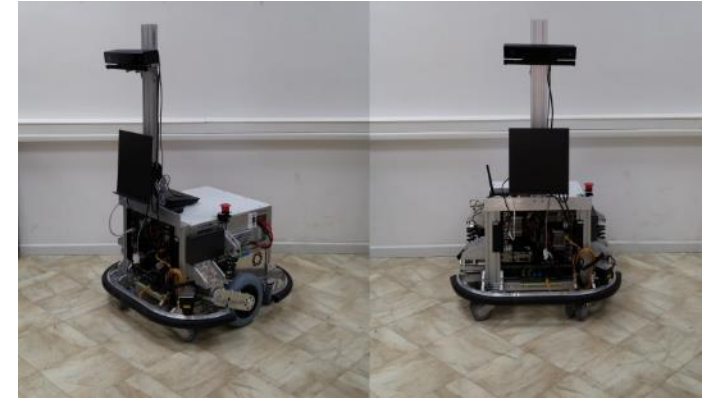
- *Robotic Arm*
  - Suitable for application in the household and pHRI
  - Developed by **ACCREA**

- *Robotic Hand*
  - Developed by **SHADOW**

RAMCIP robot
Innovations

- **Robot Perception and Cognition**
  - Based on **user and home environment modelling and monitoring**
  - Robot decides **when** and **how** to assist the user in a **proactive and discreet** way

- Adaptive **multimodal human robot communication interfaces**
  - Including **empathic communication and augmented reality displays**

Real Mug (grey)

Simulated Highlight
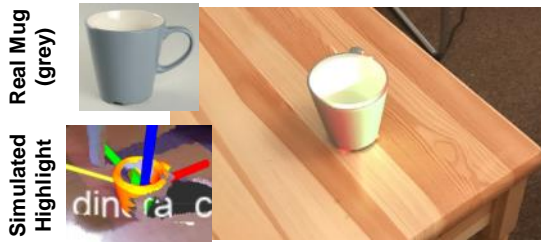
- **Dextrous** and **safe** robotic manipulation capabilities
  - Enabling **grasping and manipulation** of a variety of home objects and safe **physical HRI**

Extended elevation mechanism

Folded elevation mechanism
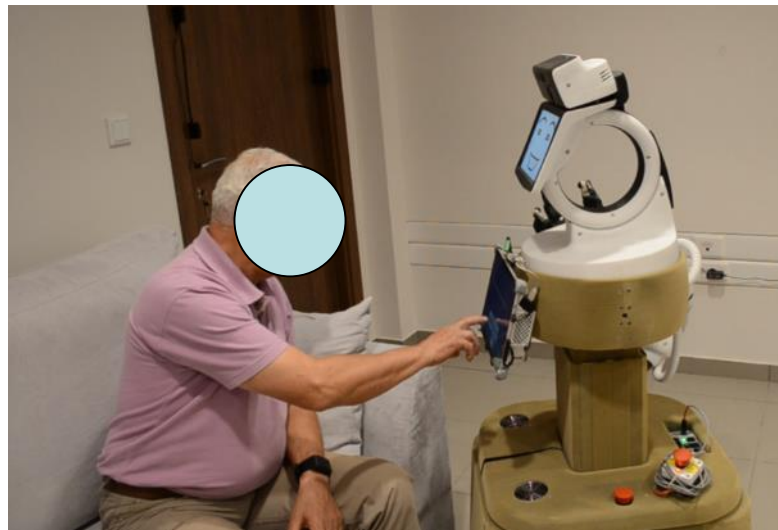
RAMCIP in action
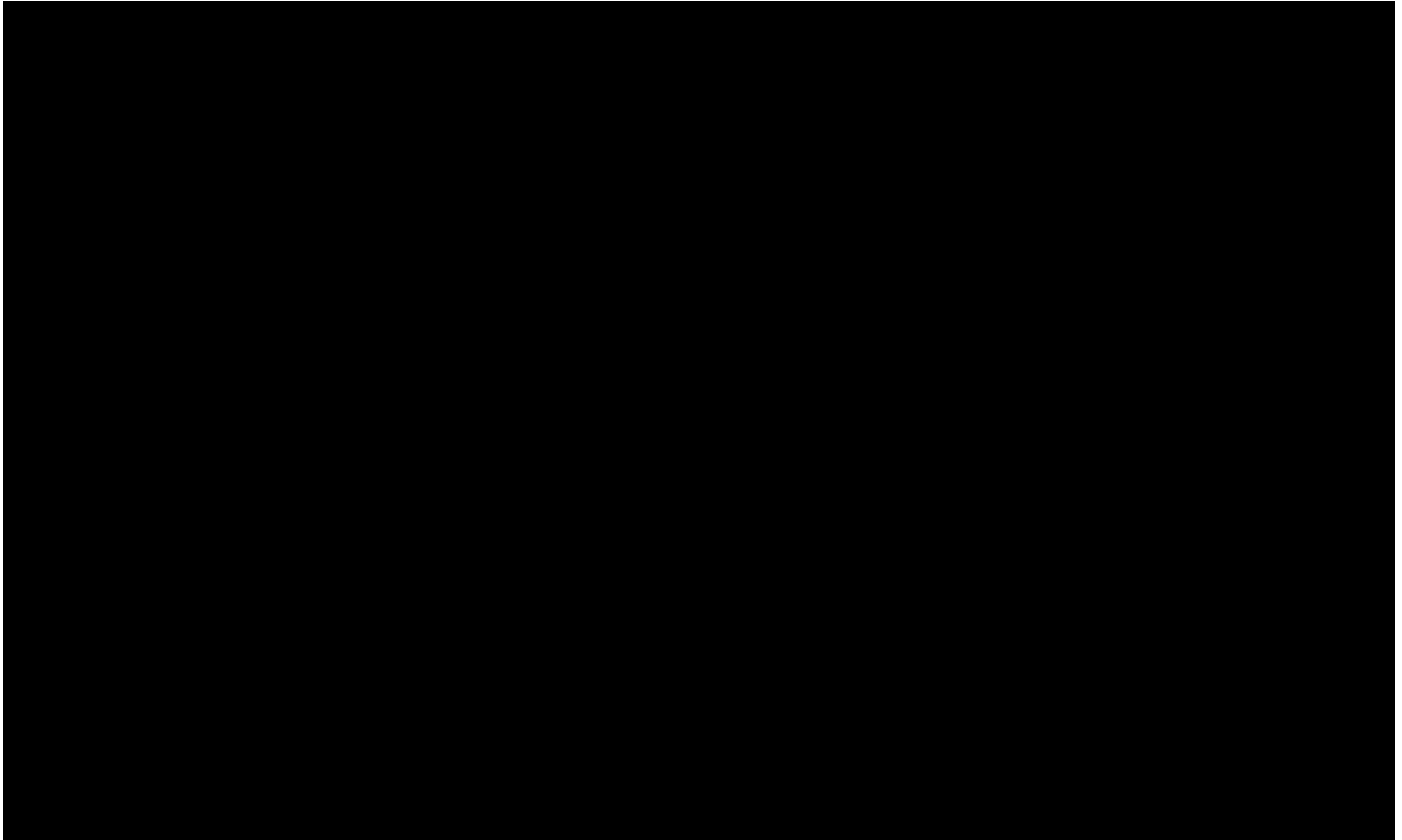
A dedicated motorized Mechanical Arm

- provides
  - Mechanically enhanced sensory data acquisition for diagnosis and conservation planning.
  - Accurate multi-sensorial 3D scanning of Cultural Heritage objects.
- facilitates
  - The processes of preservation, conservation and restoration of cultural heritage assets even in-situ.
- aims to
  - Assist conservation scientists.

Scan4Reco Mechanical Arm

*Allows to **mount sensor probes** and to **move them to positions** relative to the cultural heritage object under observation.*

Multi-axis positioning system setup:

- X stage
- Y stage
- Z stage
- Rotary stage
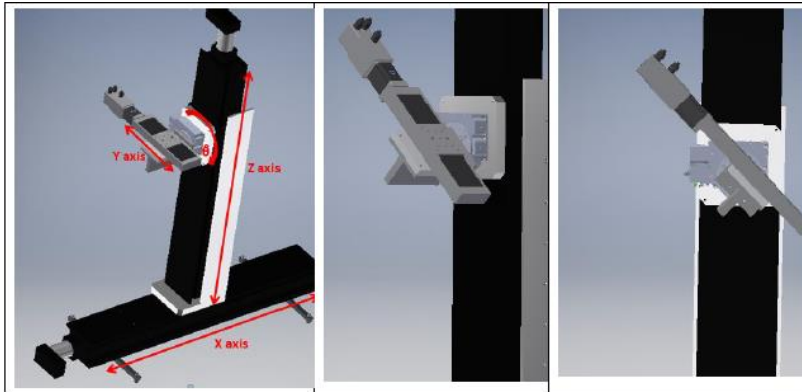
Scan4Reco Mechanical Arm
Data acquisition Modalities & Sensors (1/2)

✓ **3D (Global) Scanning & Registration**

– A global 3D coarse-resolution geometric and chromatic representation through:

  • Depth camera setup for capturing color and depth information (quick)

  • High Resolution colour sensor (high resolution)

– Registration of the local, punctual measurements performed by other sub-systems onto the global 3D resolution geometrical proxy

✓ **Surface Acquisition & Characterization** of materials through:

– Optical micro-profilometer

– Multispectral Reflectance Transformation Imager (MS-RTI)

✓ Perform **sub-surface acquisition & characterization** through:

– Acoustic microscope

– Infrared camera

– Fourier Transform Infrared spectrometer

– Raman spectrometer

– UltraViolet/Visible spectrophotometer

– X-ray Fluorescence spectrometer

Depth - sensor

Profilometer

UVVIS- Raman Sensor
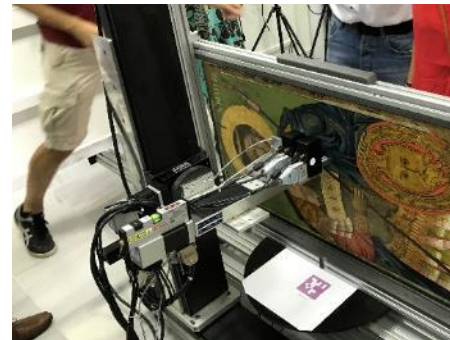
Scan4Reco Mechanical Arm
Data acquisition Modalities & Sensors (2/2)

3D Photometry

FTIR sensor
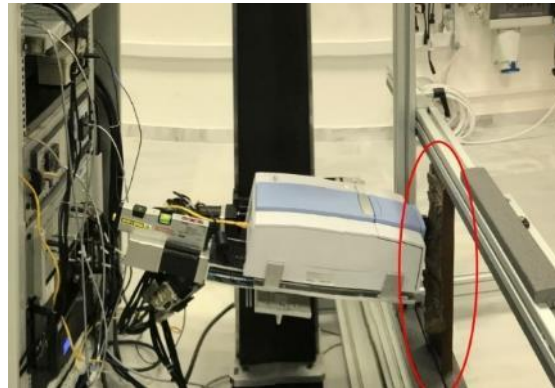
RTI sensor

IR sensor
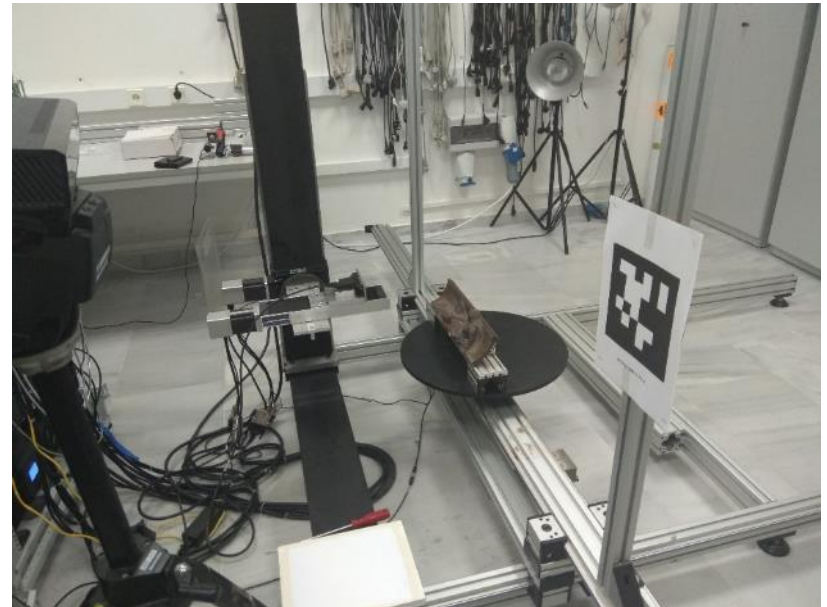

Ultrasound
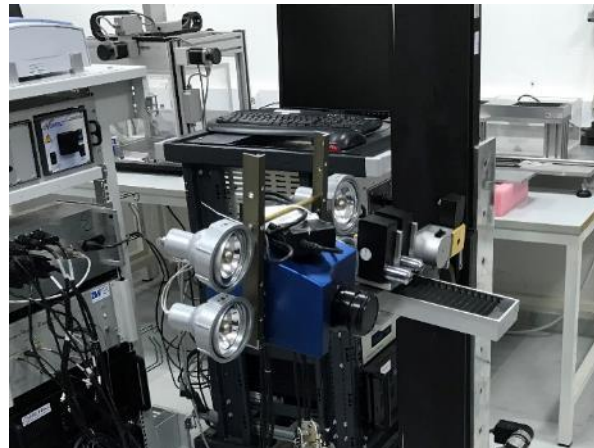
Mechanical arm control from Scan4Reco Platform

Scan4Reco Mechanical Arm
Motion Planning module of Scan4Reco Platform

- **Motion Planning module** -> responsible for the mechanical arm scanning of areas on the surface of CH 3D models.

Scan4Reco Motion Planning Module
Procedure description

- The **user selects a specific point** on the 3D CH model extracted from the Scan4Reco 3D Reconstruction module.

- The **point** and the **3D CH model mesh** are sent to the motion planning engine along with the mechanical **arm's joint current positions**.

- The motion planning system responds with **a determined motion plan**, a sequence of positions for the mechanical arm to follow and reach the selected point.

- The user takes the intended **measurement**.

Scan4Reco Mechanical arm in action

Scan4Reco Pilot Trials

Ormilia Premises - 26- 27th of July 2018

Paintings related Pilot:

- Scanning of two **icons**
  - Icon of St. Dimitrios
  - Icon of Archangel Michael

Metallic objects related Pilot
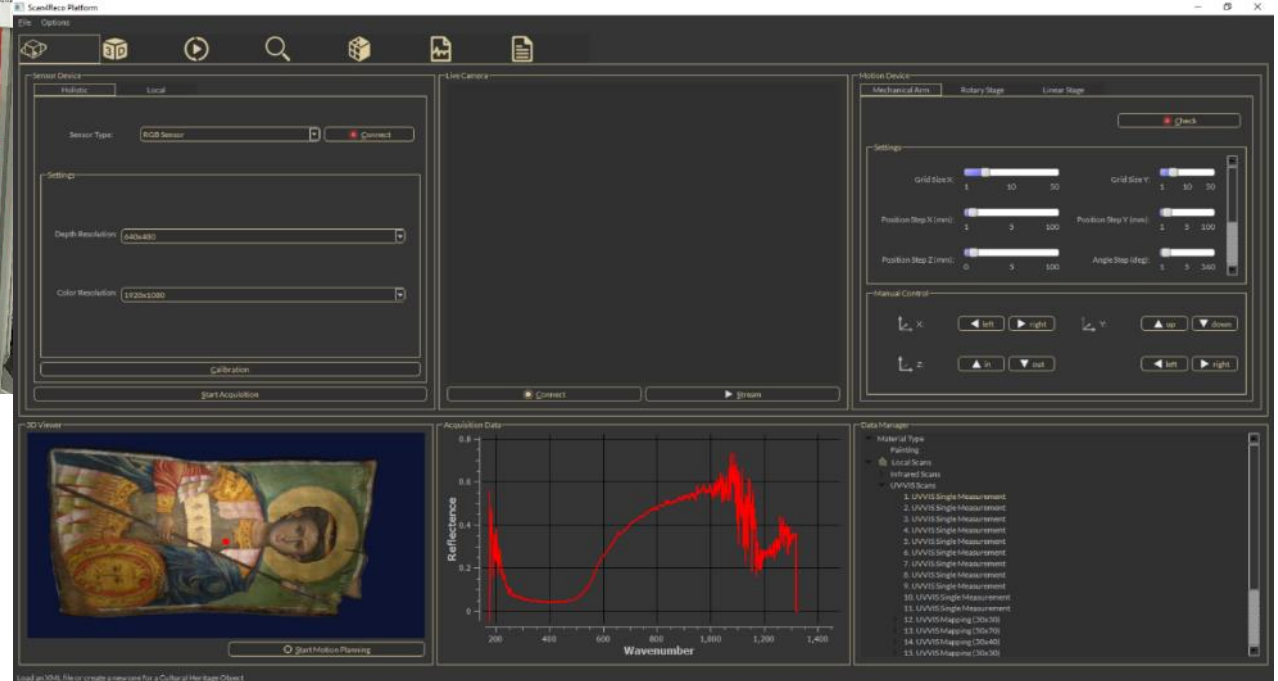
- Scanning of two **metallic objects**
  - Bronze replica of a high-relief of the Porta del Paradiso by Ghiberti
  - Pescatorello statue

UVVIS measurement

IR measurement

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Thank you

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