

# Overview of Recent LARICS Research

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Head of LARICS

*University of Zagreb*

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*Unska 3, 10000 Zagreb, Croatia*

Bansko, Bulgaria  
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# Introduction to LARICS

## People

### Lecturers, researchers, students

#### Lecturers:

- Prof.dr.sc. Zdenko Kovačić (1958)
- Prof.dr.sc. Stjepan Bogdan (1965)
- Assist.prof.dr.sc. Matko Orsag (1983)
- Assist.prof.dr.sc. Tamara Petrović (1984)

#### Postdoctoral researchers:

- Dr.sc. Goran Vasiljević
- Dr.sc. Frano Petric

#### Full-time researchers (Ph.D. students):

- Barbara Arbanas, mag.comp.
- Ana Batinović, mag.el.
- Marko Car, mag.el.
- Ivan Hrabar, mag.el.
- Antun Ivanović, mag.el.
- Juraj Oršulić, mag.el.
- Marsela Polić, mag.el.
- Bruno Marić, mag.el.
- Lovro Marković, mag.el.
- Ivo Vatavuk, mag.el.
- Ante Zglav, mag.el.



#### Students:

- 3 Ph.D. students (Glumac, Vrhovski, Goričanec)
- 50+ mentored undergraduate students

# Introduction to LARICS

## International Collaboration

### Universities

The mission of LARICS researchers is to go abroad, apply for research stipendships and thus build collaboration bridges with many leading laboratories and experts in the field.

LARICS has established long-term collaboration with the following international entities:

- University of Texas at Arlington, USA, Automation and Robotics Research Institute
- University of New Mexico, Albuquerque, USA
- Drexel University, Philadelphia, USA, Drexel Autonomous Systems Lab (DASL)
- Technische Universität Wien, Austria, Institut für Handhabungsgeräte und Robotertechnik
- Universität Rostock, Germany, Fachbereich Elektrotechnik, Institut für Automatisierungstechnik
- Technical University of Crete, Greece
- Univerza v Mariboru, Slovenia, Fakulteta za elektrotehniko, računalništvo in informatiko
- Shanghai Jiao Tong University, People's Republic of China, School of Electronic, Information and Electrical Engineering, Department of Automation
- Chinese Academy of Sciences, Beijing, China
- EPFL, Lausanne, Switzerland
- University of Seville, Spain
- Imperial College London, UK
- The Royal Institute of Technology in Stockholm (KTH), Sweden

# Introduction to LARICS

## Industry Collaboration

### Croatia & Abroad

LARICS has established long-term collaboration with the following Croatian companies:

- HRID – NDT, Zagreb
- ENIKON Aerospace, Zagreb
- Croatian Power Utility (HEP)
- INTECO Robotics, Zagreb

LARICS has also established collaboration with the following foreign companies:

- Euroimpianti, Vicenza, Italy
- Phoenix Lidar systems, Los Angeles, USA
- RV Automation, Hong Kong, China

# Introduction to LARICS

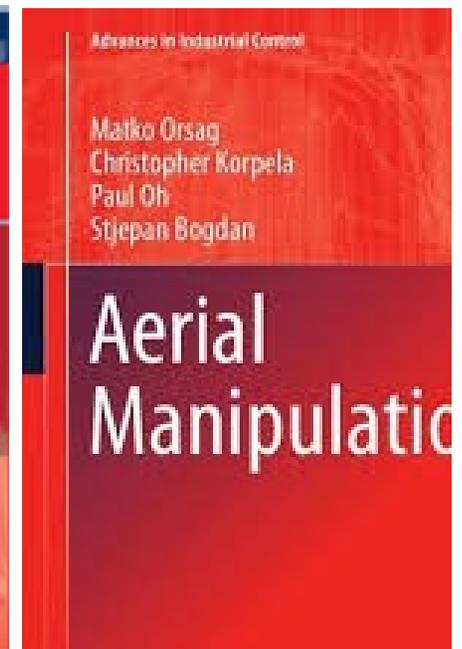
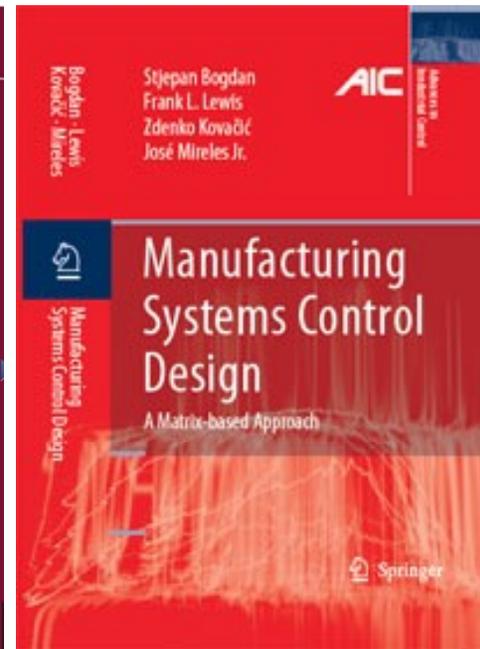
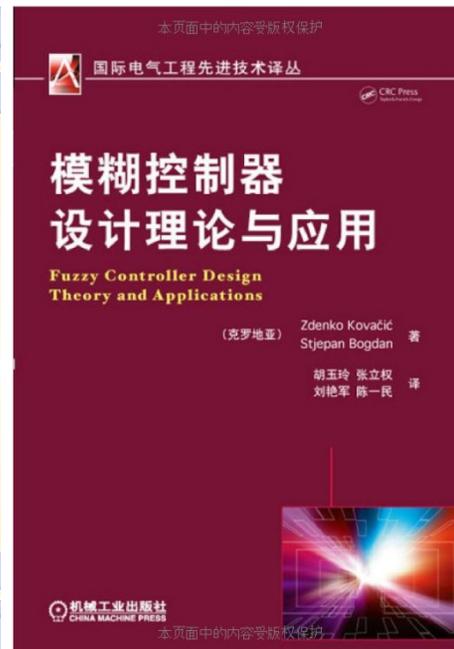
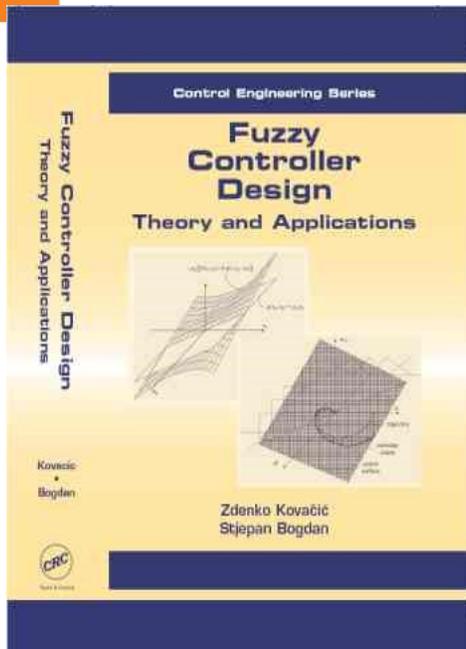
## Research Interests

### Control, robotics, intelligence

Main research topics:

- Unmanned Aerial Systems (UAS)
  - Aerial Manipulation
  - Aerial Inspection
- Control of Multi-Agent Systems
- Robots for Industry 4.0
  - Automated Warehousing
  - Control of Flexible Manufacturing Systems (Task Planning and Scheduling)
  - Soft robotics solutions
- Heterogeneous Robot Systems (water, ground and air)
  - Augmented HMI for Multi-channel Robot Control
  - Estimation and Control for Safe & Secure Wireless High Mobility Cooperative Systems
- Service Robotics (Professional Service Robots)
  - Robots in Agriculture
  - Robots in Civil Engineering
  - Robots in Medicine
    - Assistive Robots in Surgery
    - Robots in Autism Diagnostics
    - Assistive Robots for People with Disabilities
- Bio-inspired Robotics (Humanoids, Walking Robots)
- Emerging Technologies in Robotics (IoT, mixed bio-tech systems)
- Application of AI in Robot Control
- Integrated Robot & Process Control

# Publications



- Period 2013-2018 - About 100 publications
  - 1 scientific monography
  - 5 book chapters
  - 20 journal papers
  - 76 conference papers

# Overview of Selected LARICS Projects

## EU-H2020

Project title	Funding
<b>ENCORE</b> ENergy aware BIM Cloud Platform in a COst-effective Building RENovation Context (36 months: 2018-2021)	<i>EU H2020 Project no. 820434 EU H2020-NMBP-EEB-2018</i>
<b>AeRoTwin</b> Twinning coordination action for spreading excellence in Aerial Robotics (48 months: 2018-2022)	<i>EU-H2020 Project no. 810321 Program H2020 Twinning</i>
<b>ENDORSE</b> Effective Robotic GriNDing of Surface Areas through HORSE framework (9 months: 2018-2019)	<i>Funded from EU-H2020 Project HORSEno.</i>
<b>subCULTron</b> Submarine cultures perform long-term robotic exploration of unconventional environmental niches (48 months: 2015-2019)	<i>EU-H2020 Project no. 640967 FETPROACT-2-2014: Knowing, doing, being: cognition beyond problem solving</i>



# Overview of Selected LARICS Projects

## EU-FP7

Project title	Funding
<b>ASSISIBf</b> Animal and robot Societies Self-organise and Integrate by Social Interaction - bees and fish (60 months: 2013-2018)	<i>Funding from EU-FP7 Project no. 601074. Objective ICT-2011.9.10: Fundamentals of Collective Adaptive Systems – FOCAS</i>
<b>EuRoC Challenge 3: Plant Servicing and Inspection</b> (12 months: 2015-2016) - 'Wind generator remote inspection system'	<i>Funding from EU-FP7 Project no. 608849</i>
<b>EC-SAFEMOBIL</b> Estimation and Control for Safe Wireless High Mobility Cooperative Industrial Systems (54 months: 2011-2016)	<i>Funding from EU-FP7 Project no. 288082</i>
<b>ACROSS</b> Centre of Research Excellence for Advanced Cooperative Systems (42 months: 2011-2015)	<i>Funding from FP-7 Capacities "Research Potential" program [285939, FP7-REGPC 2011-1]</i>



# Overview of Selected LARICS Projects

## Other sources of funding (international)

Project title	Funding
<b>MORUS</b> Unmanned System for Maritime Security and Environmental Monitoring (36 months: 2015-2018)	<i>Funding from NATO – The Science for Peace and Security (SPS) Programme supported by: The Office of Naval Research Global (ONR Global)</i>
<b>MBZIRC Challenge 2018</b> Mohamed Bin Zayed Robotics Challenge (21 month: 2018-2020)	<i>Mohamed Bin Zayed Foundation</i>
<b>ADELE</b> Advanced evolutionary learning based methods for optimal characterisation of non-linear aftertreatment technologies (36 months: 2016-2019)	<i>Funding from FORD Global University Research Programs (URP), USA</i>
<b>3D Indoor/Outdoor SLAM Optimization</b> (12+ months: 2017-20xx)	<i>Funding from Phoenix Lidar Systems, USA</i>
<b>European Robotics League ERL</b>	



**MORUS**



**MBZIRC**

تحدي محمد بن زايد العالمي للروبوت  
 Mohamed Bin Zayed International Robotic Challenge  
 Innovative Minds. Challenging Robotics. عقول تتحدى. روبوتات تتحدى.

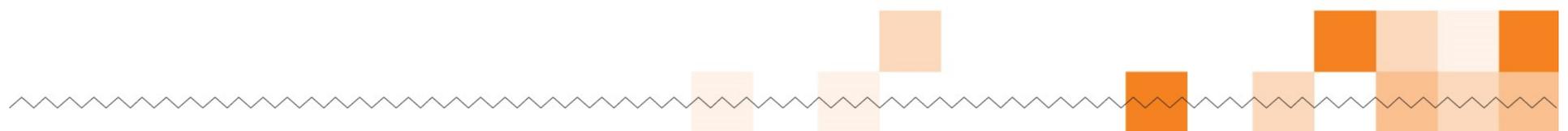
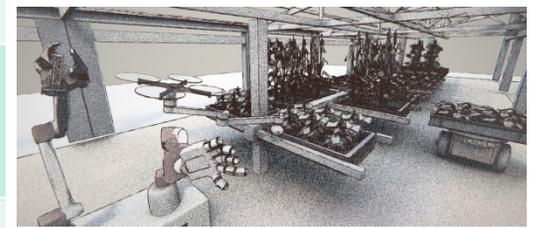


**PHOENIX**  
 LIDAR SYSTEMS

# Overview of Selected LARICS Projects

## Other sources of funding (domestic)

Project title	Funding
<b>Non-destructive dual robot-based inspection in nuclear power plants</b> (12+ months: 2017-20xx)	<i>Funding from HRID-NDT Ltd., Zagreb, Croatia</i>
<b>ADORE</b> <b>Autism Diagnostic Observation with Robot Evaluator</b> (53 months: 2014-2019)	<i>Funding from Croatian Science Foundation</i>
<b>SPECULARIA</b> <b>Structured Ecological Cultivation using Autonomous Robots in Greenhouses</b> (48 months: 2018-2022)	<i>Funding from Croatian Science Foundation</i>
<b>Drone-based inspection of power lines – Study</b> (6 months, 2018)	<i>Funding from Croatian Power Utility (HEP)</i>



# LARICS Project Proposals

Project title	Funding
<b>AGRIWARE</b> Integration of Digital Platforms for Interoperable, Open Secure and Sustainable Agriculture Ecosystems (36 months: 2019-2022)	<i>Funding from EU-H2020 Program</i>
<b>ESMERA - ARMIGO</b> Autonomous Robot for Mobile Inspection of Gas and Oil Sites (18 months: 2019-2020)	<i>Funding from EU-H2020 Program</i>
<b>ACROSS – Centre of Excellence for Autonomous and Cooperative Robotic Systems</b> (84 months: 2019-2025)	<i>Funding from EU-H2020 Program</i>
<b>ORTHOBOT</b> Robot-assisted orthopedic surgery (36 months, 2019-2022)	<i>Funding from European Structure Fund (ESF)</i>
<b>UPLINE</b> Inspection of power lines using autonomous unmanned aerial vehicles (36 months, 2019-2022)	<i>Funding from European Structure Fund (ESF)</i>
<b>HEKTOR</b> Heterogeneous autonomous robot system in viticulture and mariculture (36 months, 2019-2022)	<i>Funding from European Structure Fund (ESF)</i>
<b>ASAP</b> Autonomous system for reviewing and predicting the integrity of the transport infrastructure (36 months, 2019-2022)	<i>Funding from European Structure Fund (ESF)</i>
<b>DRONEPORT</b> Drone base for traffic surveillance (36 months, 2019-2022)	<i>Funding from European Structure Fund (ESF)</i>



# ADDORE

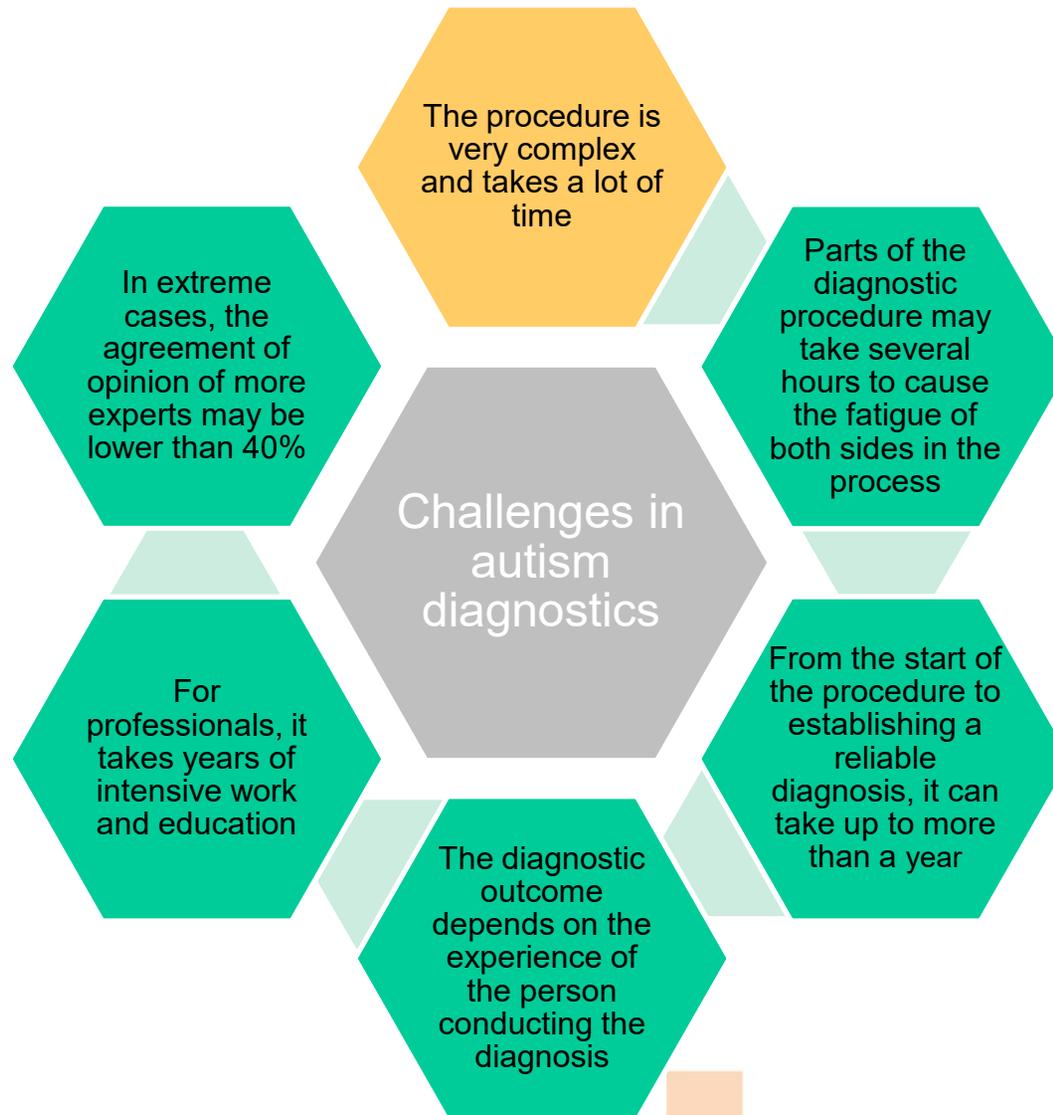
autism diagnostic observation with robot evaluator

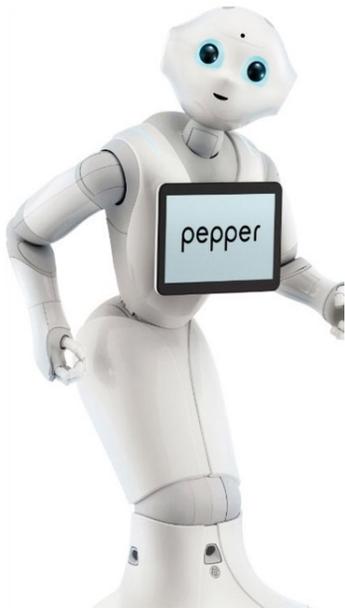
**Z. Kovačić**  
**University of Zagreb, Faculty of EE&C**

**Strategic Workshop**  
**Increasing the Well-being of the population by R&ICT-based Innovative Education**  
Bansko, Bulgaria, 25-28.11.2018.

# ADORE Info

Project leader:	Prof. Zdenko Kovačić (FER)
Duration:	01. 09. 2014. - 31. 01. 2019.
Researchers:	Dr. Frano Petric (FER), Dr. Damjan Miklič (FER), Dr. Domagoj Tolić (FER), Dr. Omar Nour (FER), Prof. Sanja Šimleša (ERF), Prof. Maja Ceganec (ERF), Prof. Jasmina Stošić (ERF)
Project info:	<a href="http://larics.fer.hr/?page_id=967">http://larics.fer.hr/?page_id=967</a> <a href="http://www.hrzz.hr/default.aspx?id=2280">http://www.hrzz.hr/default.aspx?id=2280</a> (in Croatian)
Budget:	1 million HRK (135.000 EUR)
Equipment:	6 NAO robots, 2 Pepper robots





Modern robot systems have the potential to **improve the process of collecting and processing** multimodal information

Robots are able to **consistently repeat incentives** to interact on any of the usual channels of communication (image, sound, gesture)

**Robot as assistant in diagnostics – can we do that?**

Sensory capabilities of robots and the possibility of parallel monitoring of multiple data with a precise time stamp can complement expert observations and help in making the diagnosis more efficient

The robots NAO and Pepper from SoftBank Robotics are used within the ADORE project

# The main goal of the ADORE project:

- Development of robotically assisted diagnostic protocol and assessment of protocol effectiveness in clinical conditions with children from two to six years



# The diagnostic protocol ADOS-2

- The most commonly used method of diagnosing autistic spectrum disorders

## Observation/Coding

### 1. Free Play

#### 1a. Free Play—Ball

### 2. Blocking Toy Play

### 3. Response to Name

### 4. Bubble Play

#### 4a. Bubble Play—Teasing Toy Play

### 5. Anticipation of a Routine With Objects

#### 5a. Anticipation of a Routine With Objects—Unable Toy Play

### 6. Anticipation of a Social Routine

### 7. Response to Joint Attention

### 8. Responsive Social Smile

### 9. Bath Time

#### 9a. Bath Time—Ignore

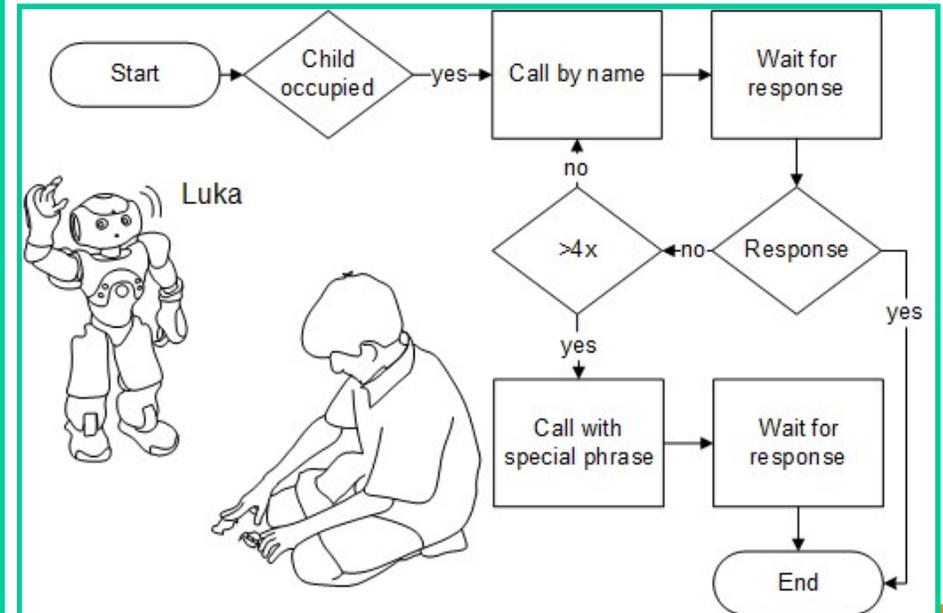
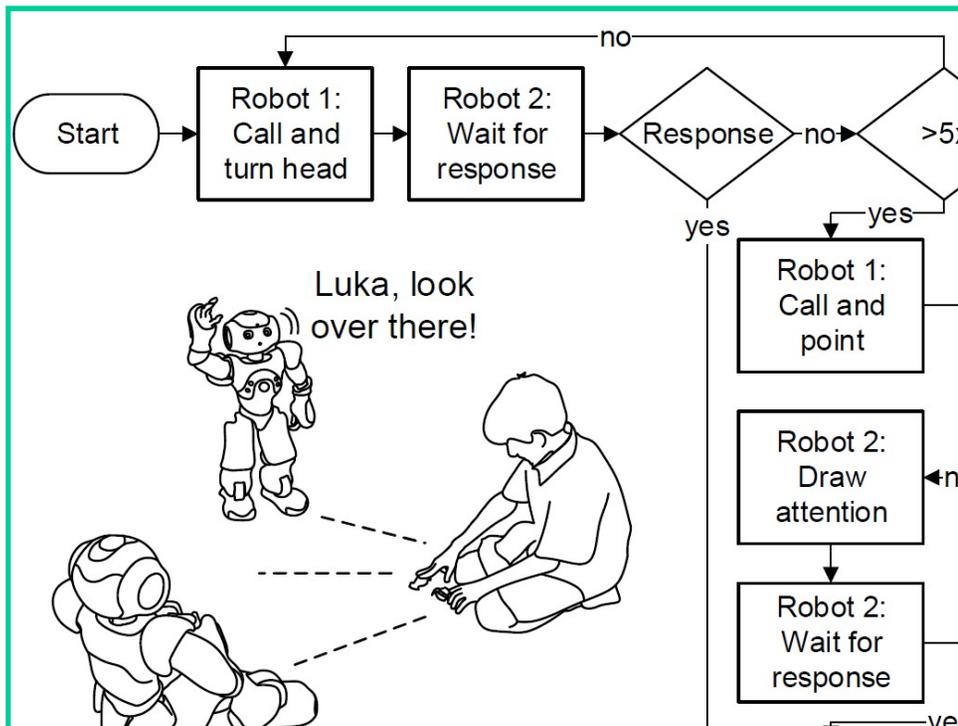
### 10. Functional and Symbolic Imitation

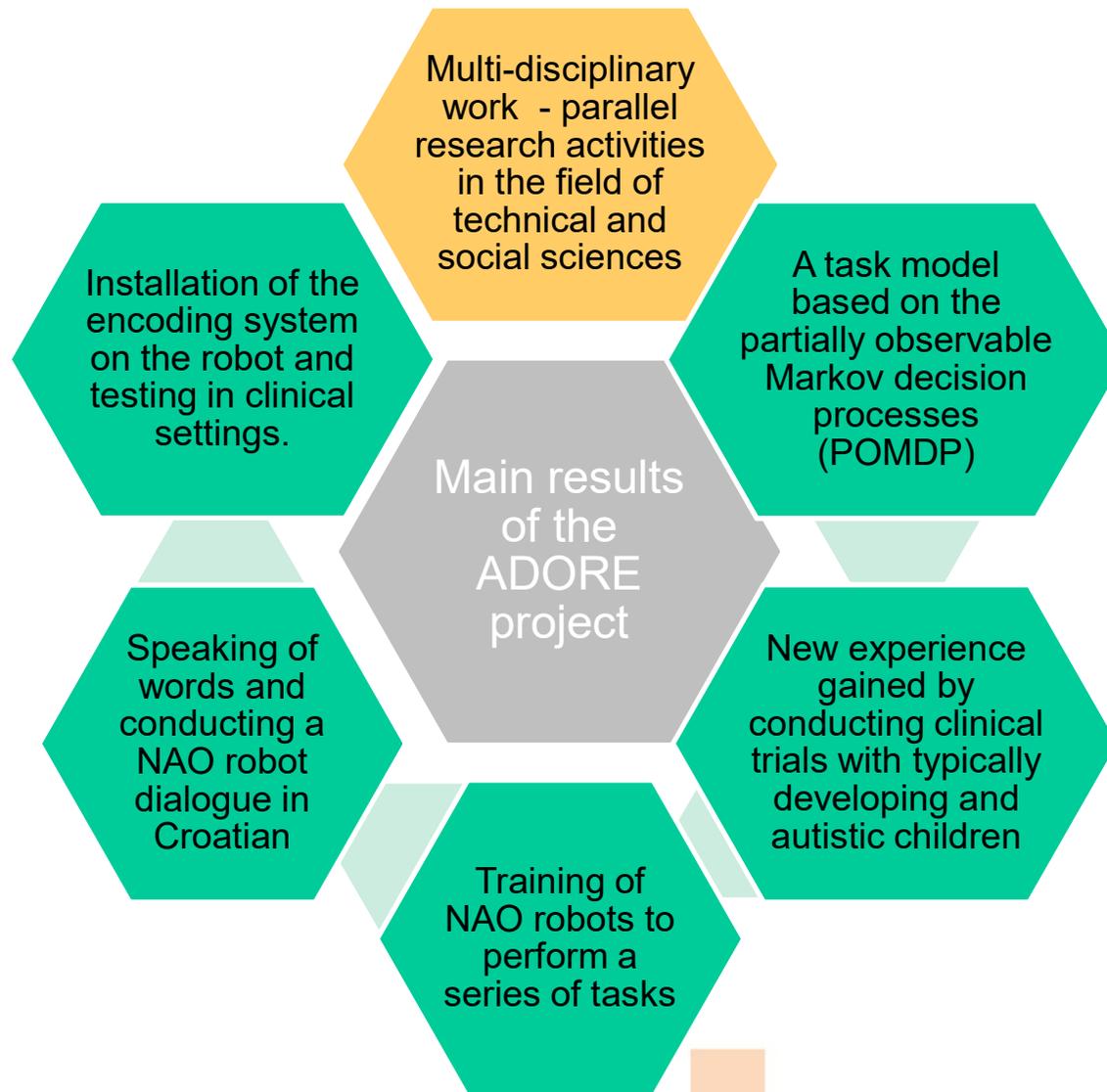
### 11. Snack

It was necessary to extract the tasks from the protocol that can be run by the NAO robot

# Four (five) diagnostic tasks of NAO robots

- ❑ Response to name (3rd task from ADOS-2)
- ❑ Simultaneous multimodal communication (6th task)
- ❑ Response to joint attention (7th task)
- ❑ Functional and symbolic imitation (10th task)
- ❑ Free play (1st task) – work on it has started recently





# Dissemination of project results 2017-18

- ❑ Petric, F.; Miklič, D.; Kovačić, Z., **POMDP-based Coding of Child-robot Interaction within a Robot-assisted ASD Diagnostic Protocol**, [International Journal of Humanoid Robotics](#), World Scientific Publishing Company, Vol. 15, No. 2, pp. 1850011-1-23, 2018.
- ❑ Petric, F.; Kovačić, Z., **No data? No problem! Expert System Approach to Designing a POMDP Framework for Robot-assisted ASD Diagnostics**, in HRI '18 Companion: [2018 ACM/IEEE International Conference on Human-Robot Interaction Companion](#), Session: Late-Breaking Reports, pp. 209-210, March 5–8, 2018, Chicago, IL, USA.
- ❑ Kokot, M., Petric, F.; Ceganec, M.; Miklič, D.; Bejić, I., Kovačić, Z., **Classification of Child Vocal Behavior for a Robot-Assisted Autism Diagnostic Protocol**, [Proceedings of the 26th Mediterranean Conference on Control and Automation](#), Zadar, Croatia, pp. 27-32, 19-22 June 2018.
- ❑ Presečan, M., Petric, F., Kovačić, Z., **Object Classification for Child Behavior Observation in the Context of Autism Diagnostics Using a Deep Learning-based Approach**, [Symposium on Robotic and ICT Assisted Wellbeing](#), Split, Croatia, 13-15 September 2018 (submitted for review).
- ❑ Petric, F.; Miklič, D.; Ceganec, M.; Cvitanović, P.; Kovačić, Z., **Functional Imitation Tasks in the Context of Robot-assisted Autism Spectrum Disorder Diagnostics: Preliminary Investigations**, in Proceedings of [the 26th IEEE International Symposium on Robot and Human Interactive Communication \(RO-MAN 2017\)](#), pp. 1471-1478, Lisbon, 2017.
- ❑ Petric, F.; Miklič, D.; Kovačić, Z., **Robot-assisted autism spectrum disorder diagnostics using POMDPs**, in Proceedings of the HRI PIONEERS 2017 Workshop, [The 2017 Conference on Human-Robot Interaction \(HRI 2017\)](#), Vienna, 2017.

# Visibility of project results

- ❑ All source codes of the project as a software solution are available on publicly available services:
  - ❑ Solution for processing audio signal and distinguishing unarticulated voice from child speech - <https://github.com/larics/nao-sound-classification>
  - ❑ Realization of gesture (plane flight, frog jumping) and actions (drinking from the glass) - GitHub platform - <https://github.com/larics/nao-object-gesture>
  - ❑ Realization of name-calling - <https://github.com/adore-hrzz/nao-response-to-name>
  - ❑ Paying attention from one robot to another - <https://github.com/adore-hrzz/nao-joint-attention>

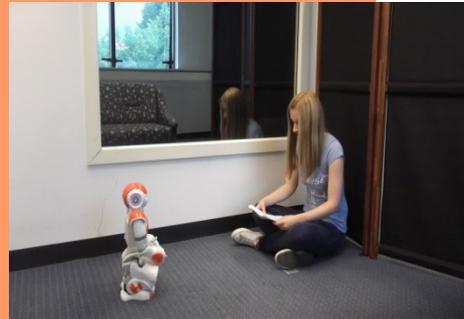
# Additional pilot studies with children

## Tasks of research of preference

### ROBOT - OBJECT



### ROBOT - HUMAN



### DIFFERENT LOOKING ROBOTS



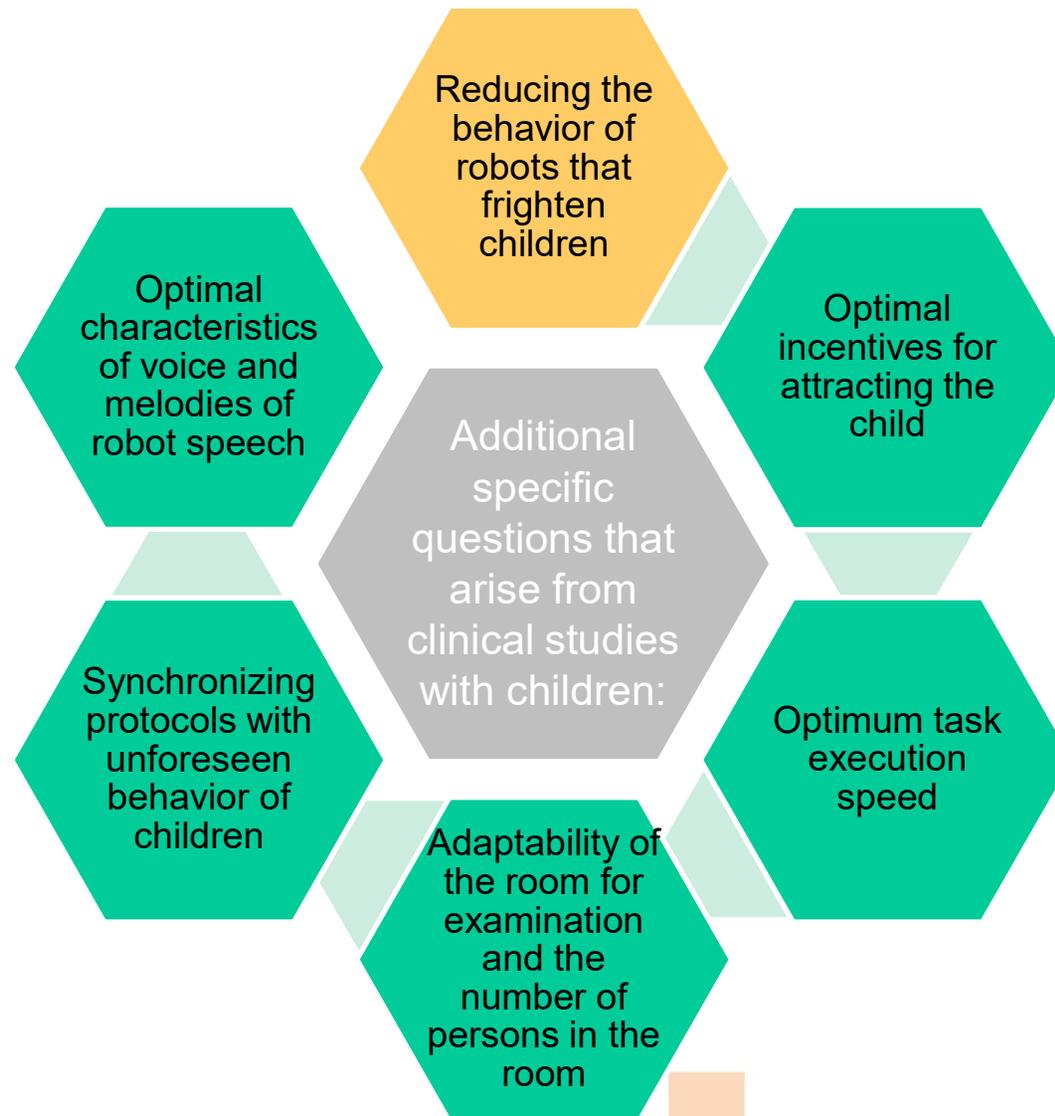
## Tasks of social perception of the robot

Do the children see the robot as a living being?

*e.g. → If a robot falls, are they trying to lift it or do something else?*

To what extent do children communicate spontaneously with others about the robot?

*e.g. → Are children spontaneously commenting on robot actions? Do they try to draw the parents' attention on the robot?*



# Performing clinical trials with robots

- ❑ Testing the functionality of robots in laboratory conditions in the FER ACROSS laboratory → Practical demonstration of functional imitation tasks
- ❑ Clinical trials at the Croatian Institute for Brain Research → Video no. 1



An example of a successful gesture of frog jumping

# Performing clinical trials with robots

- ❑ Clinical trials at the Croatian Institute for Brain Research → Video no. 2
- ❑ An example of an unsuccessful gesture of drinking from a cup



# Thanks for listening!



We are grateful to the Croatian Science Foundation which with its support has enabled these researches to focus on the quality of life of children with diagnosed autistic spectrum disorder at their earliest age!

# Proposal for possible joint research work: **Humanoid Pepper robots as teachers (instructors) for people with disabilities**

- Currently, it is informal research work done in cooperation with the **Association of Teachers in the Catering Education Zagreb, Croatia**  
(UNUO - <http://www.unuo.hr/kontakt.html>)
- The association deals with education of persons with different types of disabilities in the field of catering with the aim of their training for work and employment and the creation of conditions for independent life and integration into society.

# Proposal for possible joint research work: **Humanoid Pepper robots as teachers (instructors) for people with disabilities**

- The motivation lies in the fact that catering is an area that has long-term development prospects in Croatia, and offers a wide range of employment opportunities, depending on the capabilities of people with disabilities
- A group of six LARICS Masters students are currently working on the proof of concept using a Pepper robot
- Research topics: Human-robot interaction, AI, multi-channel communication, cognitive and cooperative robotics, new educational methods, ...

# Proposal for possible joint research work: Humanoid Pepper robots as teachers (instructors) for people with disabilities

- The work of Prof. Vedran Habel, founder of UNUO with his students in the restaurant Kornat in Vienna, Austria



Source of photos: <https://www.vecernji.hr/vijesti/prof-habel-i-osobe-s-invaliditetom-odusevili-becane-1263784>