Mechanical Engineering Department Distinguished Speaker Series

Socially Assistive Robots Serving Children with Autism, Cancer, and Deafness/Hearing Loss

Tuesday, Aug. 20

2 p.m. - 3 p.m.

H.M. Comer 1026

Prof. Ali Meghdari
Professor and Director,
Social & Cognitive Robotics Laboratory,
Center of Excellence in Design, Robotics & Automation (CEDRA)
School of Mechanical Engineering
Sharif University of Technology,
Tehran, Iran

Abstract

One of the main challenges in social and cognitive research is relevant to our understanding of how to perceive and interact with others in the world around us. With the dramatic growth of emerging technologies in our societies, such as social robots, computer graphic generated avatars, and virtual reality devices, the complexity of this challenge is growing. As a result, interdisciplinary researchers strive to determine the extent neurocognitive mechanisms, which support human interaction with artificial agents and tools, have evolved. Hence, a growing number of researchers working within the field of social robotics and engineering are engaged in collaboration with other scientists to utilize their expertise in social cognition, neuroscience, linguistics, and psychology with mutual interests that benefits naturally developing children as well as children with some form of disability and/or illness (i.e. Kids with: autism, cancer, deafness/hearing loss, down syndrome, diabetes, etc.).

With the advancement of robotics technology, robots applications have been extended to more general-purpose practices in society such as: the use of robots in clinical and rehabilitation, nursing and elderly care, search and rescue operations, etc. However, for robotics technology to be successful in such environments it is necessary to gain new levels of strength, robustness, physical skills, and improved cognitive ability and intelligence. One faces many challenges on the path to design and construction of social-cognitive robots, the biggest is to build robots that comply with the needs and expectations of the human mind. How we communicate with machines with a higher quality physical and life-like appearance would differ with the way we interact with a computer, cell phone, or other smart devices.

The talk will briefly discuss the emerging field of social and cognitive robotics with its impact on education and therapeutic settings and will further share our recent works and accomplishments in this exciting field in Iran.

Biography

Ali Meghdari received his Ph.D. in Mechanical Engineering from the University of New Mexico (UNM) in 1987. He then joined the robotics group of Los Alamos National Laboratory (LANL) as a Post-Doctoral research collaborator. In 1988, he took the position of Assistant Professor of Mechanical Engineering at Sharif University of Technology (SUT) in Tehran. From 1993-94, he was a visiting research faculty at the AHMCT center of the University of California-Davis, and during 1999-2000 he served the IBDMS research center at the Colorado School of Mines, and the Rocky Mountain Musculoskeletal Research Laboratory (RMMRL) as a visiting research professor. Professor Meghdari has performed extensive research in the areas of robotics, social and cognitive robotics, mechatronics, bio-robotics, and modelling of biomechanical systems. He has supervised over 90 M.Sc. Theses and 20 Ph.D. Dissertations, 5 Post-Docs, and has published over 280 technical papers in refereed international journals and conferences. He has been the recipient of various scholarships and awards, the latest being: the 2012 Allameh Tabatabaei distinguished professorship award by the National Elites Foundation of Iran (BMN), the 2001 Mechanical Engineering Distinguished Professorship Award from the Ministry of Science, Research & Technology (MSRT) in Iran, and the 1997 ISESCO Award in Technology from Morocco. He is a Fellow of the American Society of Mechanical Engineers (ASME) since 2001. From 2001-2010, he was the Vice-President of Academic Affairs at Sharif University of Technology. He is currently the Director of the Centre of Excellence in Design, Robotics and Automation (CEDRA). He is on the editorial board of various engineering journals, Guest Editor of Transaction on Socio-Cognitive Engineering; Scientia-Iranica International Journal. Since 2005 he has been elected as an affiliate member of the Iranian Academy of Sciences (IAS). In 2018, he proposed and successfully received approval from MSRT and Islamic Azad University (IAU) to establish the 1st university in Iran and the Middle-East (IAU-Freshtegaan International Branch) to serve students with special needs, primarily the deaf and blind.

Socially Assistive Robots Serving Children with Autism, Cancer, and Deafness/Hearing Loss

Ali Meghdari, Ph.D., Professor & Director

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THE UNIVERSITY OF ALABAMA

Tuesday-August 20, 2019

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Outline

- Introduction & Educational Challenges
- New Roles for Educators and/or Clin. Psychologists
- Social & Cognitive Robots/Sample Projects
- Social Robots & VR Technology in RALL
- Introducing *Arash* & *Rasa* Social Robots
- Introducing *Maya* & *Taban* Social Robots
- Closing Remarks

RASA

Arash

Introduction

Educators know that truly transformative ideas begin with a question - at the moments where challenge becomes opportunity.

- How can traditional education models adjust to meet new demands – especially for students with some form of illness or disability?
- Are the traditional university models fit for purpose – or swiftly becoming outdated?
- How can we reimagine learning to facilitate new learner-student dynamics? (PBL?)
- How can modern technologies be used to educate and prepare children with chronic disease about their illness and treatment procedures?
- Does a multidisciplinary team working on topics enhancing the quality-of-life affect the social impact of our efforts as educators?
- Does social robotics engage instructors & students in Problem/Project Based Learning (PBL)?

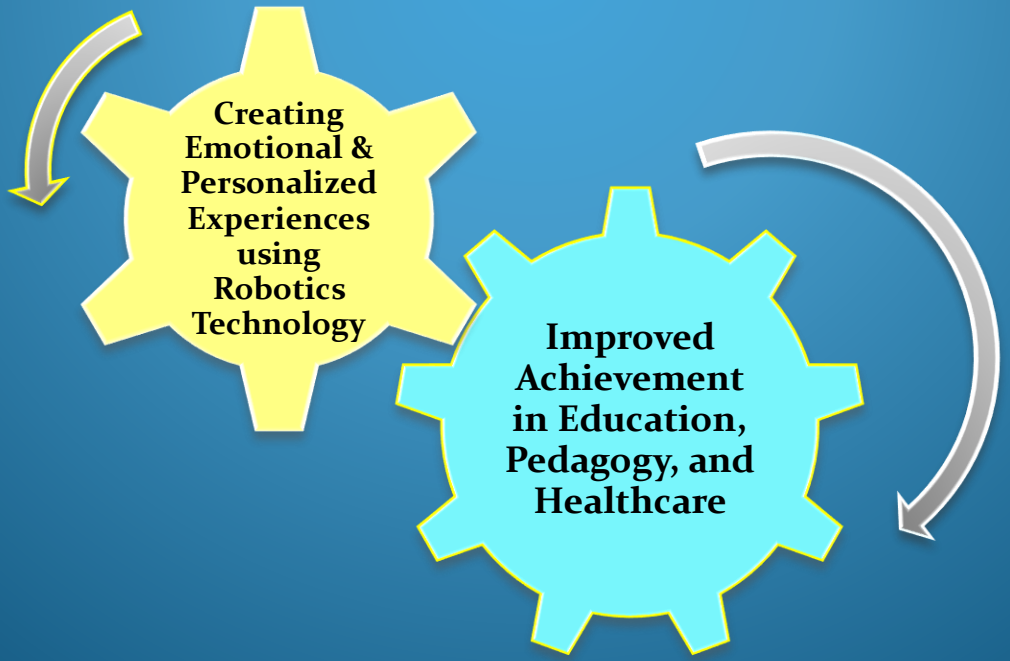
Educating Normal/Typically Developing Children, Pediatric Patients, and Students with Disabilities

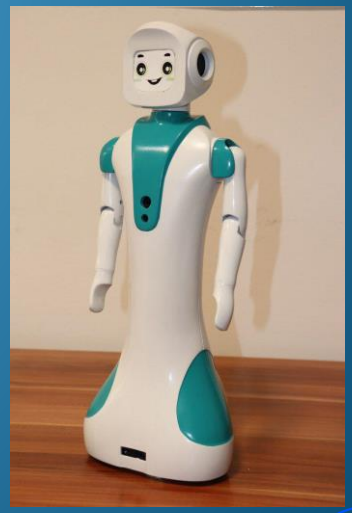
With so much amazing contents and modern technologies available, what will be the new role of Educators/Clinical Psychologists?

Key Steps and Issues

Use robotics technology to create more engaging/emotional connections with learning materials/illness & treatment process/disability:

- A great example of this is **Gamification in Education**. Gaming focuses on emotion (i.e. funny games, scary games, and entertaining games)
- Games offer a wide range of benefits such as challenge, progression, reward and access to personalized real-time experiences.





Armin

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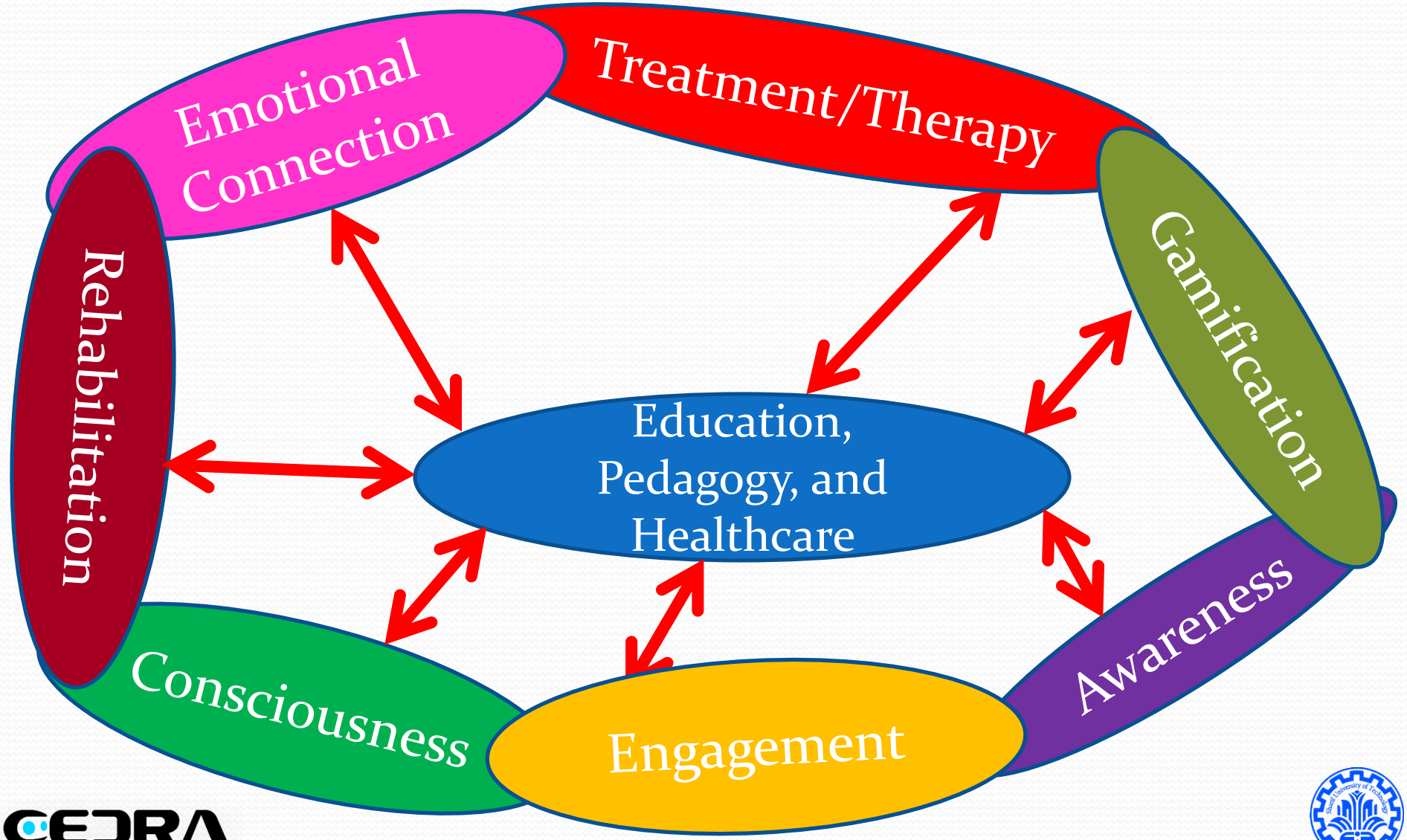
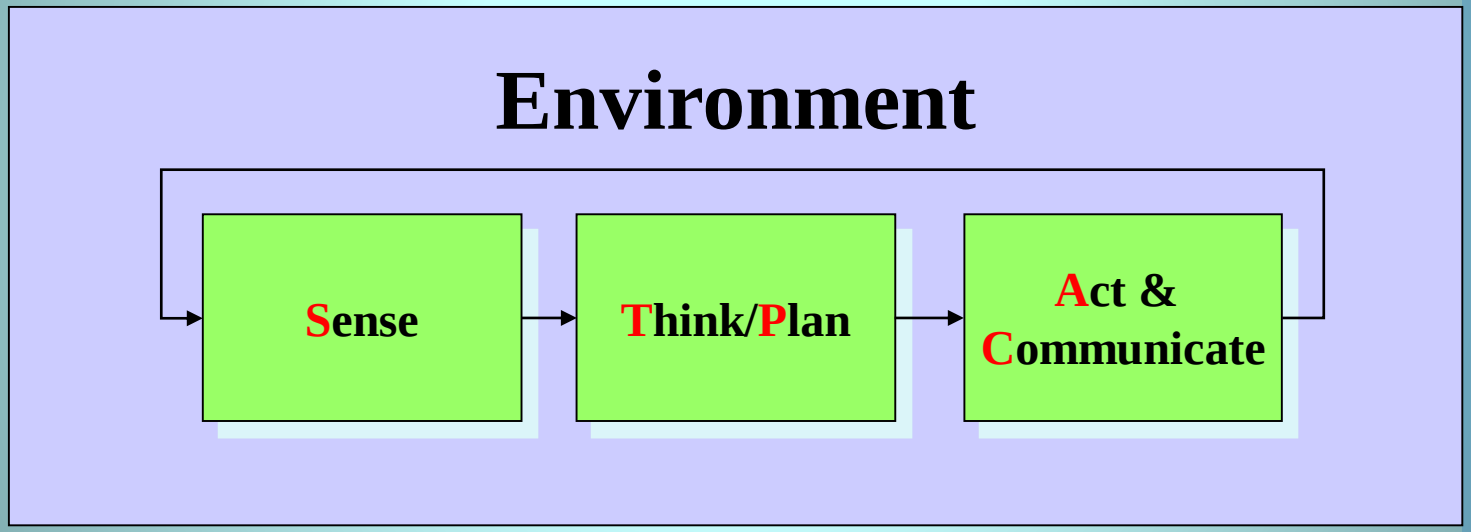
Recent Sample Research Projects



- A **Social Robot** is an **E**ntity that can not only **S**ense, **T**hink and **A**ct, but also must be equipped with **one/multiple Languages** and be able to **C**ommunicate with humans and/or other social robots.



What's Next? Social & Cognitive Robotics…

Robots are not considered as pure tools/appliances, but often as Social Actors over a wide range of morphologies and behaviors…

smart dolls

entertainment

babysitters

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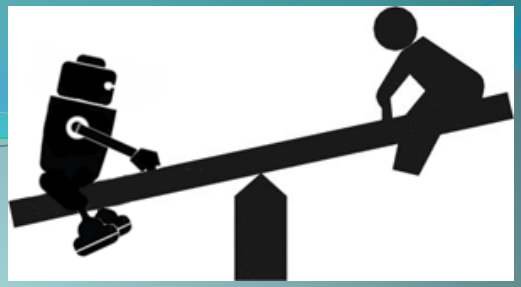
What is Social Robotics?



- **Social robots** are designed in various forms and appearance to live and interact with humans in society.
- **Social Robotics** is the science pertaining to the design and utilization of robots for direct communication with humans in a way that involves verbal, motor, or physical interaction.
- **Example:** Educational Robots, Rehabilitation Robots, Entertainment Robots, etc.

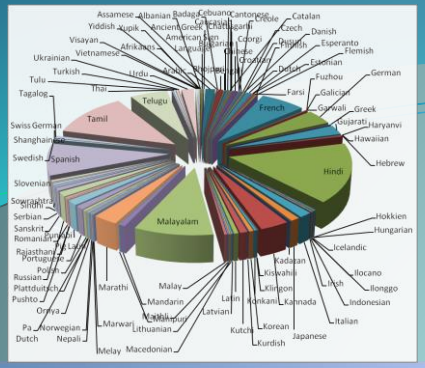
However, we are mostly interested in **Children-Robot Interaction (CRI)**

What is Cognitive Robotics?

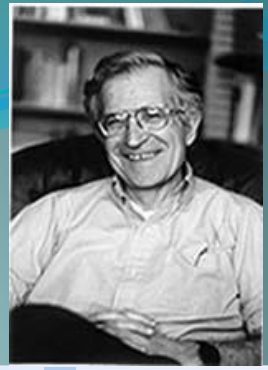
- Applying Cognitive Psychology to design and build robots with mammalian and/or human cognitive abilities. Robots that can learn from experience, human teachers, themselves, and communicate effectively in a complex environment.

- They are robots or software agents with high-level cognitive functions like: reasoning, planning, perceptions, mental states, collaborative tasks, complex motor coordination, etc.

Source: http://en.wikipedia.org/wiki/Cognitive_robotics.
(biased towards 'animal cognition' instead of AI techniques…)



What is Language?



- **Our spoken, written, or gestured words and the way we combine them to communicate meaning.**
- **Two conditions must be met:**
- **SEMANTICS (معناشناسی)**: Arbitrary units (Words) which have Meanings.
- **SYNTAX (نحو یا ترکیب)**:Words are organized together according to rules.
- ***Chomsky:*** “it is syntax that is innately human. Animals can learn words (perhaps) but cannot have a grammar.”

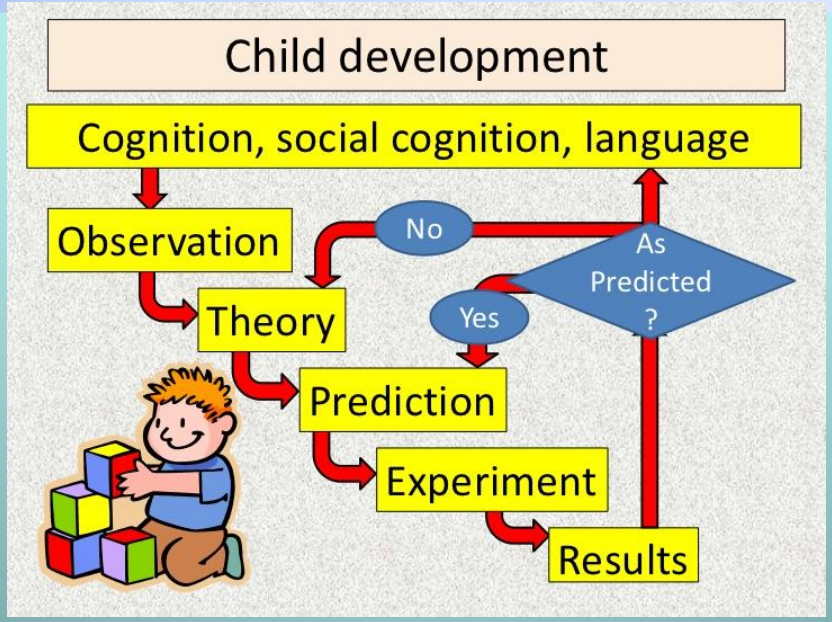
What is Communication?

The act of transmitting information from one place/person to another:

- **Verbal** (face-to-face, telephone, radio and television, and other media).
- **Non-verbal** (body movements, clothing, actions, fragrance, etc.).
- ***Text*** *(letter, email, books, magazines, internet, etc.)*
- **Visual** (charts, tables, drawings, pictures and videos …)

Cognition vs. Language & Communication

- Children's linguistic and cognitive abilities usually appear together.
- If the language of a child is advanced, so is his/her ability to do other tasks; and if his/her language is delayed, his/her cognition abilities will also be weak.

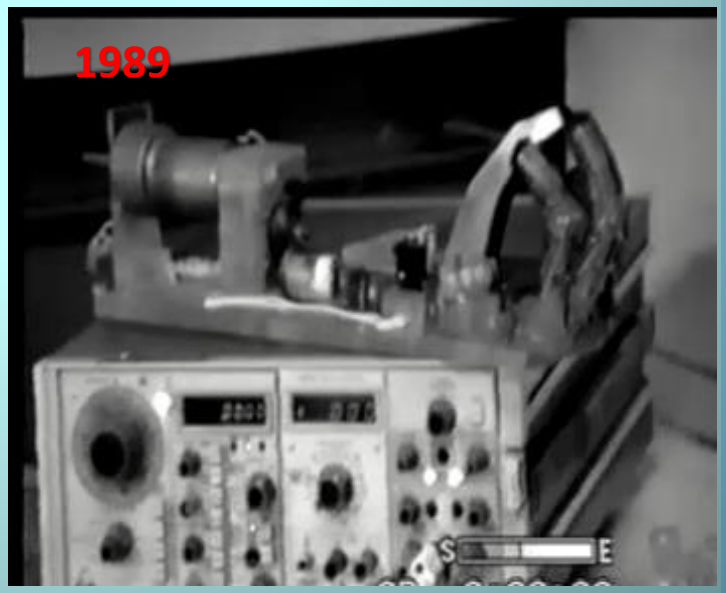


Communication Skills

- Find the right vocabulary when speaking.
- Being concise and clear when talking.
- Stay on topic when talking.
- Understand what others are saying.
- Understanding and memorizing.
- Ability to read and write.
- Observe and maintain appropriate social interactions.
- Display a range of emotions/facial expressions

Robotic cognitive capabilities shall include:

- Perception Processing,
- Attention/Memory Allocation,
- Anticipation, Planning,
- Complex Motor Coordination,
- Communication and Use of Language
- Learning, Reasoning and Problem Solving
- Social Interaction



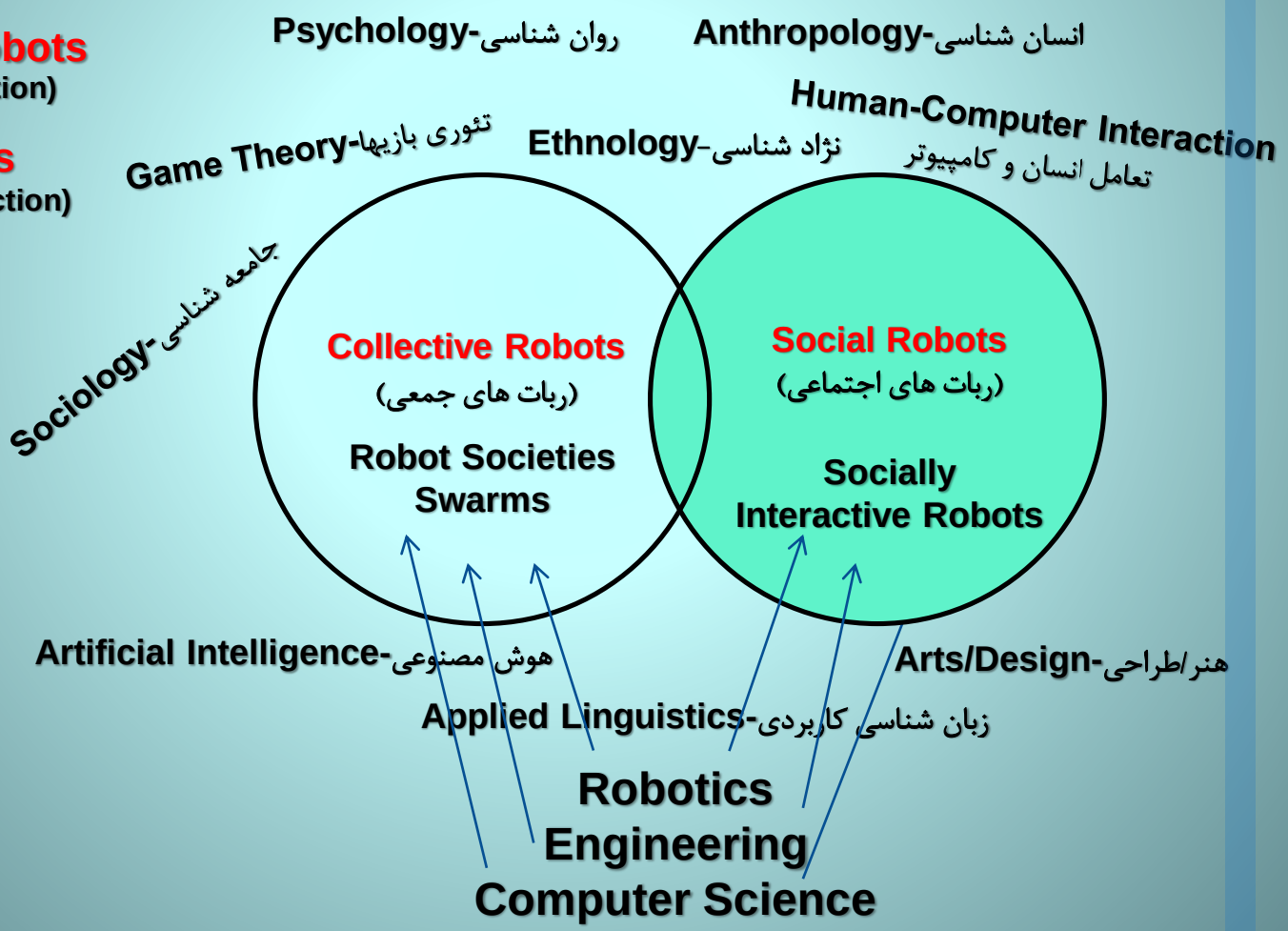
Source: http://en.wikipedia.org/wiki/Cognitive_robotics

Socio-Cognitive Robotics (SCR)

A Multi disciplinary Area of Research

Fields of Major Impact:

- **Collective Robots**
(Robot-Robot Interaction)
- **Social Robots**
(Human-Robot Interaction)



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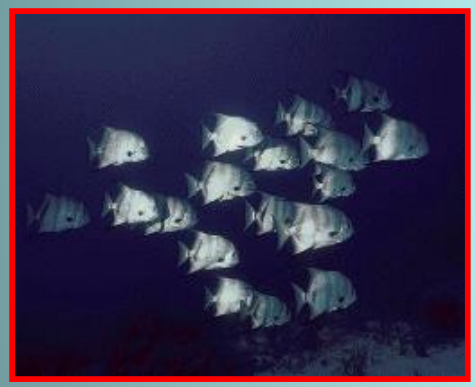
Collective Robots Sample

The 1st Humanoid Robot built in Iran (SUT-2005)

اولین ربات انسان نمای ایرانی درشریف– (1384)

Collective Robots Sample

Swarm Robots, 1389 (2010)



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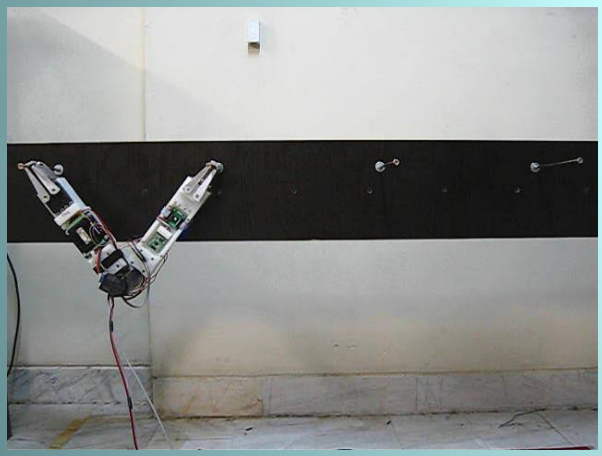
Collective Robots Sample

Brachiation Robot, 1387 (2008)



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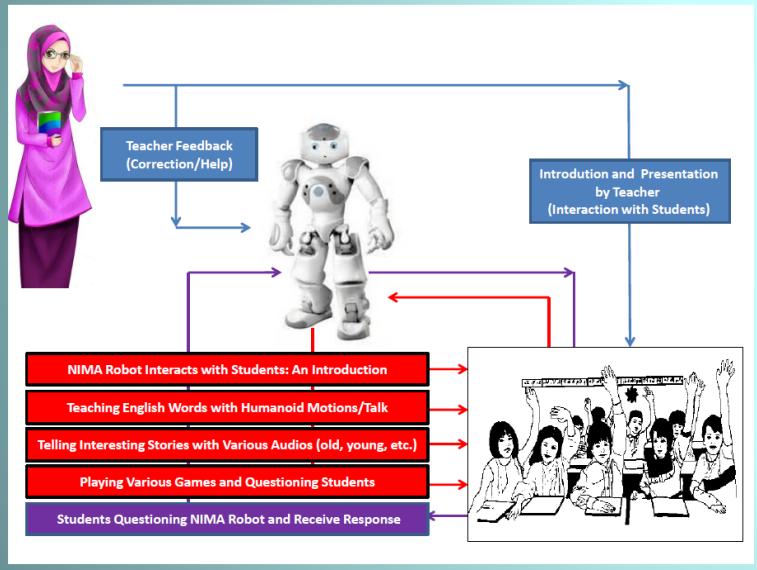
Robotics Assisted Language Learning (RALL)

M. Alemi, A. Meghdari, … 1392 (2013)

The perspective according to which students can practice and learn a foreign language through communication with a Social Robot as a Teaching Assistant.



Results: Longer Vocabulary Retention, Rapid Learning, Reduce Anxiety, Student-Robot Engagement in Conversation Practices….

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Young EFL Learners' Attitude towards RALL: An Observational Study Focusing on Motivation, Anxiety, and Interaction

Minoo Alemi, Ali Meghdari, Nafiseh Sadat Haeri

The Effect of Applying Humanoid Robots as Teacher Assistants to Help Iranian Autistic Pupils Learn English as a Foreign Language

Minoo Alemi, Ali Meghdari, Nasim M. Basiri

Autism Spectrum Disorders (ASD)

- A lifelong developmental disability
- Affects the way a person communicates and relates to people around them.
- Individual with autism often enjoy interacting with intelligent devices and social robots!

The Effect of Applying Humanoid Robots as Teacher Assistants to Help Iranian Autistic Pupils Learn English as a Foreign Language

Minoo Alemi, Ali Meghdari, Nasim M. Basiri

Participants	S1	S2	S3*	S4*
Age	10	9	7	7
Gender	Male	Male	Male	Male
Diagnosis	High-functioning autism	High-functioning autism & hyper active	High-functioning autism & hyper active	Low-functioning autism
English Background	Little	Little	None	None

Results:

- **The ability of high-functioning autistic children in learning English language has been observed.**
- **Specific teaching strategies were necessary such as usual greetings and sitting order, etc.**
- **Obtained new insights about their communication patterns, and their language learning process at the presence of a robot in class.**

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The Effects of Robot Assisted Language Learning (RALL) on English Vocabulary Learning among Individuals with Down syndrome

M. Alemi, A. Meghdari, S. Bahramipoor

CONCLUSION:

- ✓ RALL group made more advances in English vocabulary learning from the time of pre-test to post-test and also showed more retention at the time of delayed post-test
- ✓ People with DS can benefit from using robots in the realm of English learning

- ➢ **Participants:** 2 groups of 5 adults with DS (RALL and RALL)
- ➢ **Instruments:**
- NAO humanoid robot (NIMA)
- 4 English tests at different points of 8 teaching sessions (pre-test, mid-test, post-test, delayed post-test)
- SPSS (*t*-test)

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Impact of a Social Humanoid Robot as a Therapy Assistant in Children Cancer Treatment

M. Alemi, A. Meghdari, … 1393 (2014)

Best Paper Award, 6th International Conference on Social Robotics, Sydney, Australia

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What is Distress in Cancer?

Primary Levels: Vulnerability, Sadness, and Fear.
Debilitating Levels: Depression, intense anxiety, isolation from society, spiritual and existential crises.
Physical Symptoms: Lack of appetite, weight loss, anticipatory nausea.
In kids: Nightmares, selective mutism
Main reasons: physical and psychological pain due to repetitive injections and blood drawing, painful bone marrow procedures, surgeries, staying in hospital for a long time

Treating Distress in Psychology

1) **Psychological intervention**: group or individual sessions
2) **Behavioral Techniques:**

- *Relaxation*
- *Distraction*
- *Hypnosis*
- *Systematic Desensitization*
- *Emotive Imagery*

Study Questions & Intervention Items

- The anxiety, anger, and depression levels of the children with cancer before and after Social Robot-Assisted Therapy (SRAT) and Psychotherapy?
- Any improvement in SRAT and Psychotherapy groups regarding their anxiety, anger, and depression levels after their therapies?

Participants?

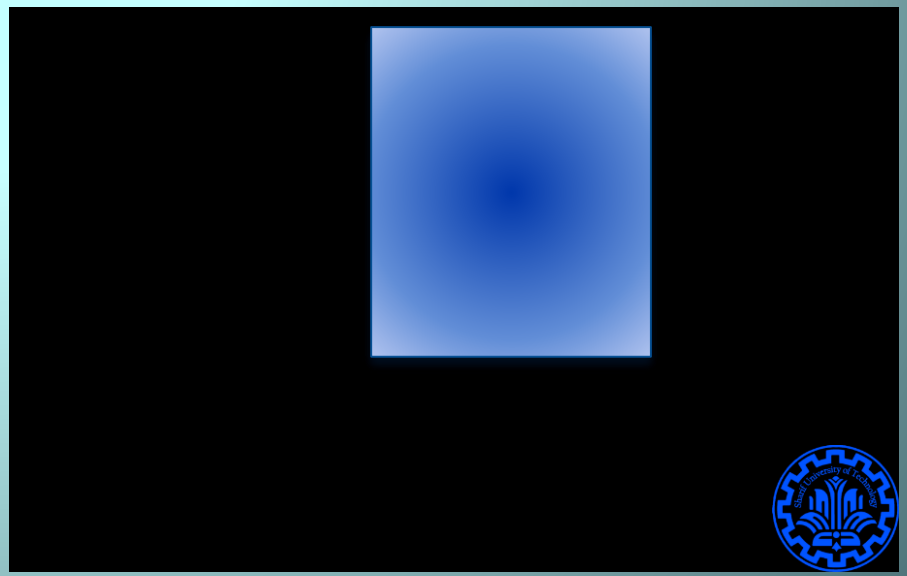
- Participants (7-12 years old) participated in 8-sessions at *MAHAK* hospital in Tehran.
- 5 kids in experimental group
- 5 kids in control group

Intervention Sessions

- Introduction
- Nima as a doctor
- Nima as Chemo-hero
- Nima as a nurse
- Nima as a cook
- Nima as an ill child
- Hopes and dreams
- Saying goodbye!

Study Results

• Conventional psychological intervention techniques are used for distress management and decreasing its symptoms.
• Considering the positive reactions from the children to a social robot present at intervention sessions and observing the statistical results indicate that robots as assistants to psychologists can enhance this procedure and motivate kids to be more interactive.
• Social robot was shown to be significantly useful in teaching children about their illnesses, treatment process, and instructing them the methods (relaxation or any other techniques) to confront their distress themselves, and take control of their situation.



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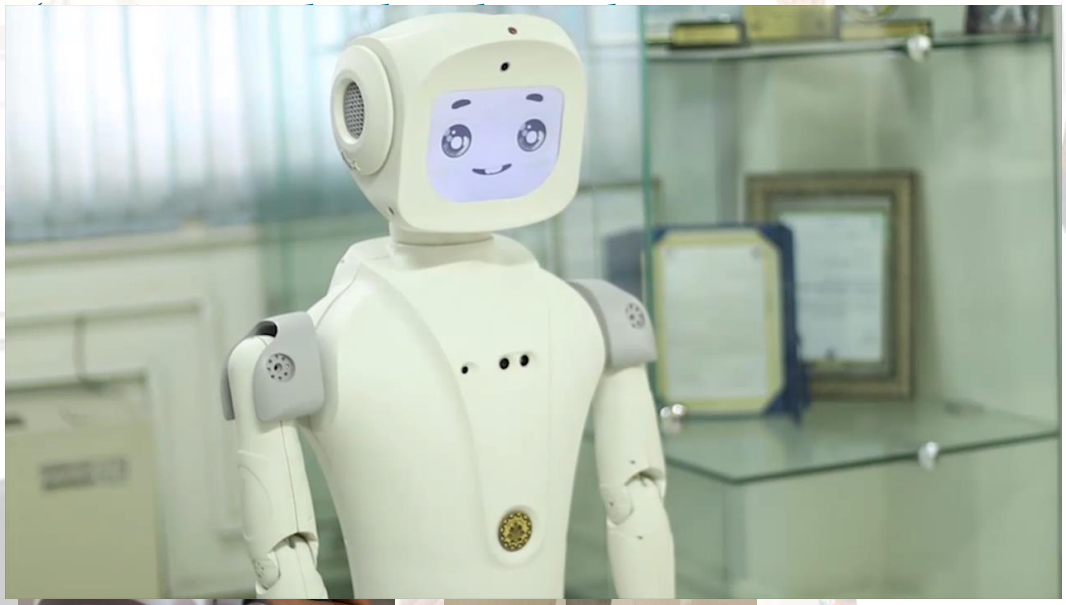
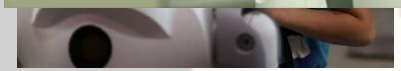
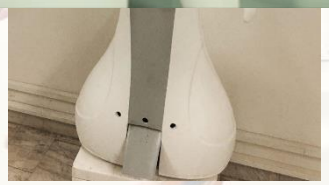
Arash: A Mobile Social Robot for Educational and Therapeutic Intervention in Pediatric Cancer

A. Meghdari , M. Alemi, A. Amoozandeh, A. Shariati, E. Ahmadi, M. Khamooshi, B. Mozafari, A. Eidi

Features:





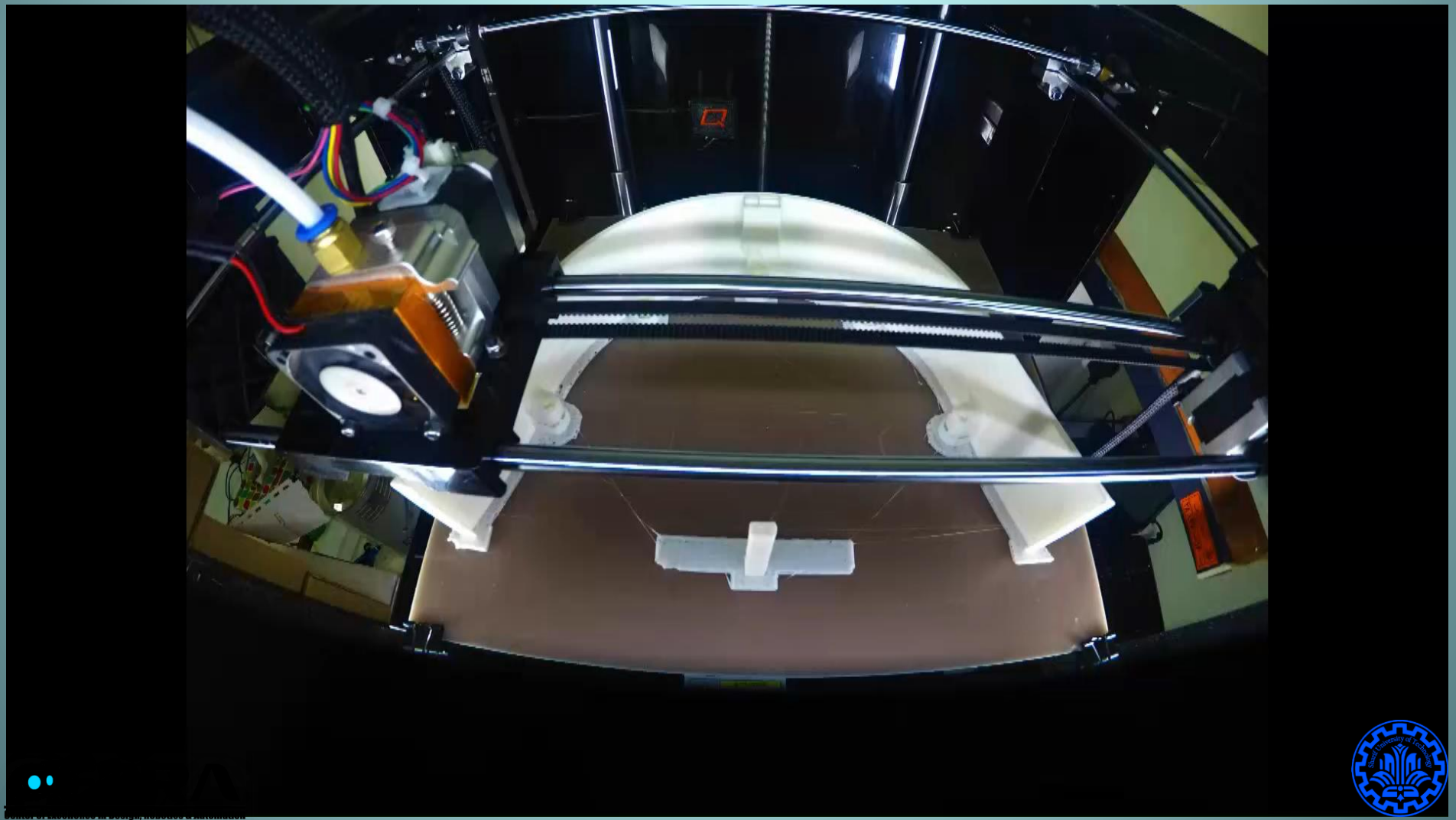


- ✓ Designed by a group of artists, industrial designers, education specialists, psychologist, and engineers.
- ✓ Five out of about thirty sketches were drawn and the final design was selected by about fifty children with cancer.

Arash in action :

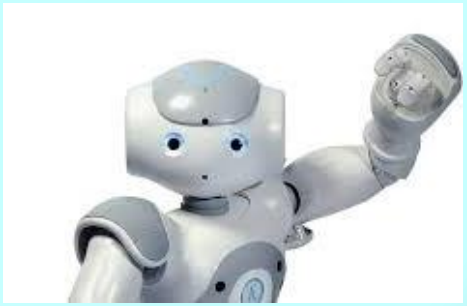
- ✓ Teaching and interacting semi-autonomous in pediatric hospitals, performing scenarios written by psychologist.

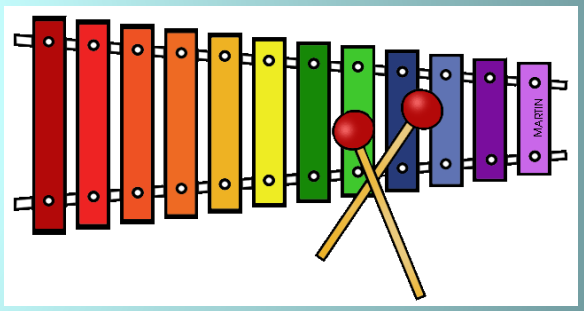
Arash Social Robots: Fabrication & Assembly



Social Robots and Teaching Music to Children with Autism: Myth or Reality

- *Aim:* Teach the fundamental concepts of how to play the drum and xylophone to children with autism using a NAO robot.





- *Research Questions:*
  - Does a humanoid social robot have the ability to teach music to children with autism?
  - Can a humanoid robot improve social and cognitive skills in children with autism through music education?

Social Robots for Education and Rehabilitation of Children with Autism

A. Taheri, A. Meghdari, M. Alemi, H. Pouretemad, (2013-2018)

- Clinical Application of Social Robots as Assistants in Autism Therapy:

Findings:

- **Improvement in Social and Cognitive Skills of the participants with autism**
- **Reduction in autism severity of the subjects**

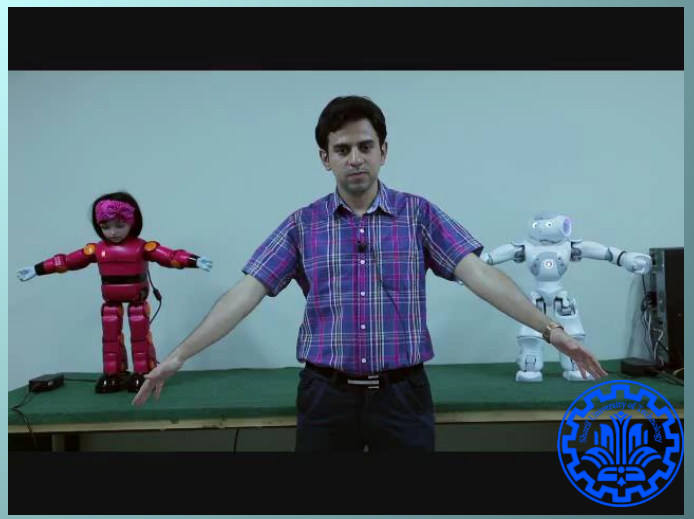
Social Robots and Teaching Music to Children with Autism: Myth or Reality

This preliminary work strongly suggests …

- Robots do have the ability to teach music to children with autism
- Improvement in fine motor imitation and rhythm identification
- Reduction in autism severity and parent's stress
- Notes/musical sentences can be played by High-functioning ASDs
- Decrease in stereotyped behaviors of low-functioning participants
- Noticeable improvements in social/cognitive skills as well as the positive effect on fine motor imitation skills of two subjects after the interventions.

Limitation: Small number of the autistic participants

Imitation games by robots



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Xylotism: A Tablet-Based Application to Teach Music to Children with Autism

- M. T. Elahi, A. H. Korayem, A. Shariati, A. Meghdari, M. Alemi, E. Ahmadi, A. R. Taheri, R. Heidari

- The application is named *Xylotism*.
- *Xylotism* is the combination of two words: *Xylophone* as a basic music-learning tool and *Autism*
- All parts of the program are written in the *Java* programming language.
- The Application can be used in all Android tablet devices.
- Reinforcement of imitation, hand-eye coordination and teaching music.

Xylotism Initial Stage

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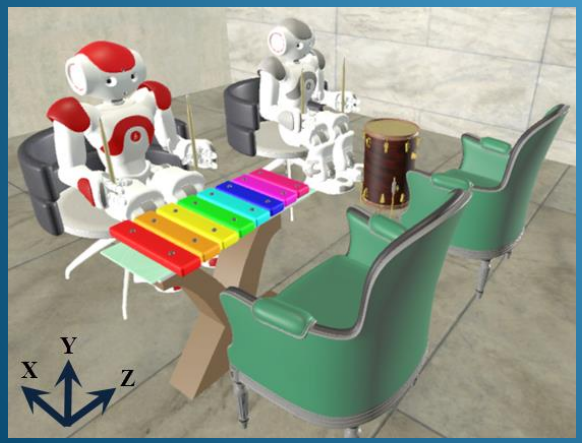
Social Virtual Reality Robots (V2R): A Novel Concept for Education & Rehabilitation of Children with Autism

M. Shahab, A.R. Taheri, M. Mokhtari, S.R. Hosseini, A. Meghdari, M. Alemi,
H.R. Pouretemad, A. Shariati, A. Ghorbandaei Pour

- The components of virtual room :
  - ✓ Two virtual humanoid robots (Nima and Sina)
  - ✓ Virtual Xylophone/Drum
  - ✓ The Room Environment and Decorations.
- The game included three tasks (you can see in the video):
  1) imitating *Nima* in playing the virtual drum,
  2) imitating *Sina* in playing the virtual xylophone
  3) responding to *Sina* pointing to different pictures in the virtual room (joint attention).
- Reinforcement of imitation, joint attention and teaching music

Virtual Reality Environment



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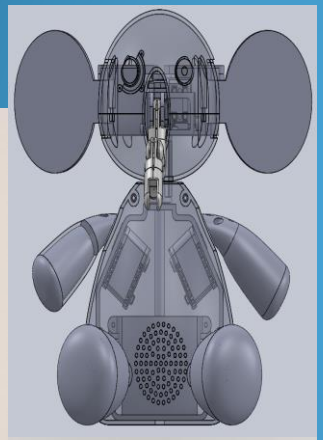
“MAYA: An Intelligent Robotic Toy” Designed for Interaction with Autistic Children and Kids with Cancer

A. Meghdari, M. Alemi, E. Ranjkar, R. Rafatnejad, A. Amoozandeh



- 5 DOF, 2 Kg, Camera, Speaker,
- Facial Recognition,
- Facial Expression Recognition,
- Low-Cost

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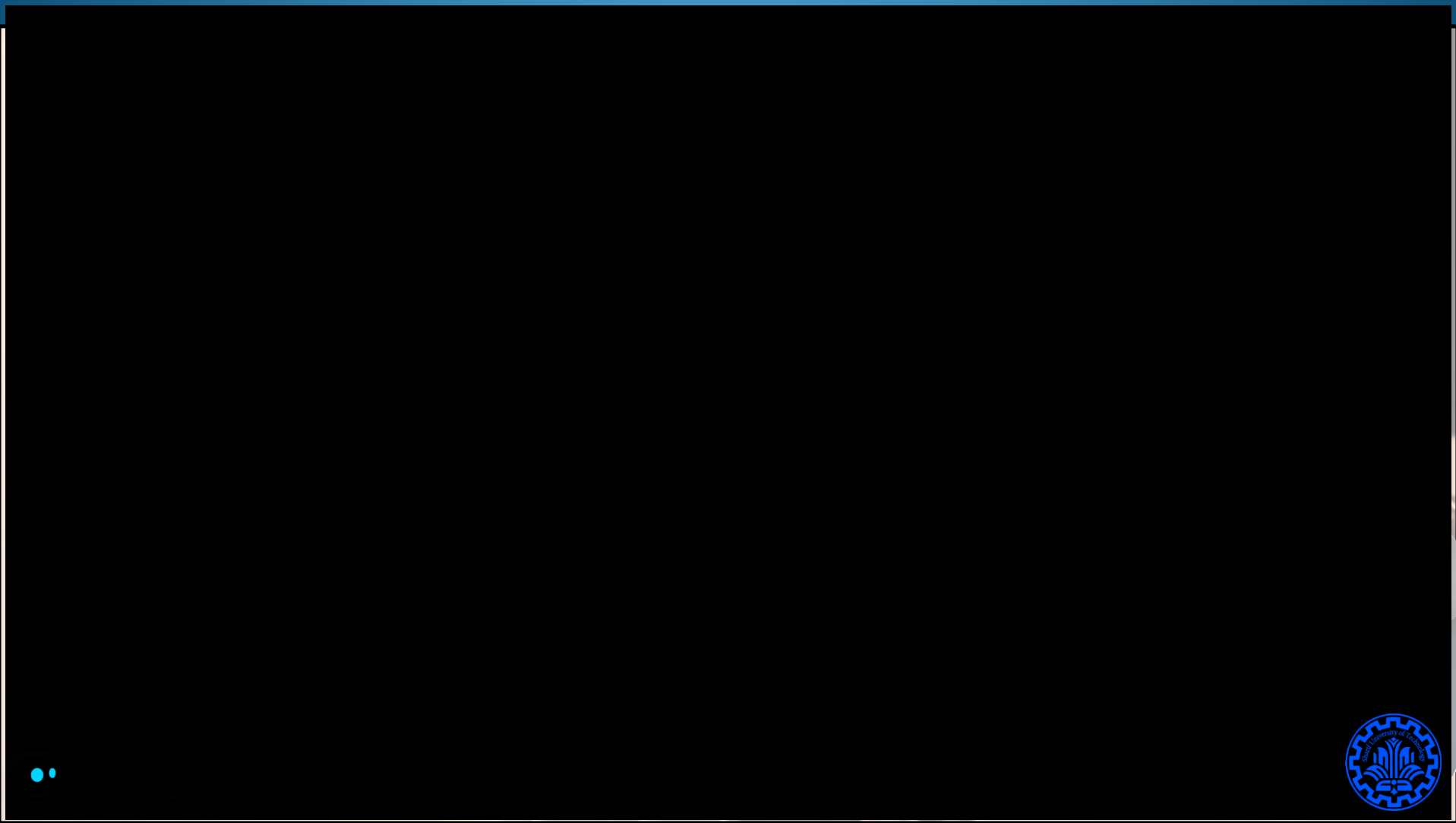
RASA: A Sign-Language Teaching Assistant Social Robot

A. Meghdari, M. Alemi, M. Zakipour, S.R. Hosseini, P. Aliasghari, A. Taheri, A. Kashanian



RASA-I Social Robots: PSL and Interactions

RASA-1 and Children

RASA-1 and PSL Words

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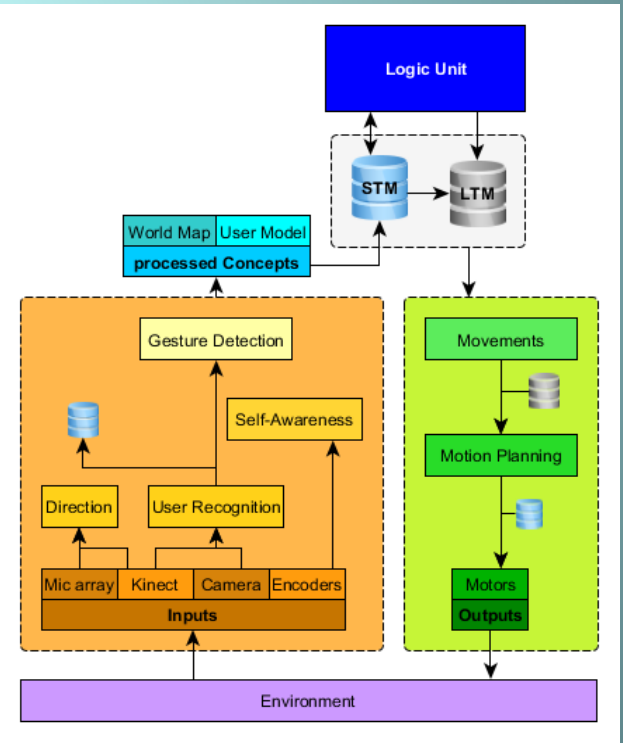
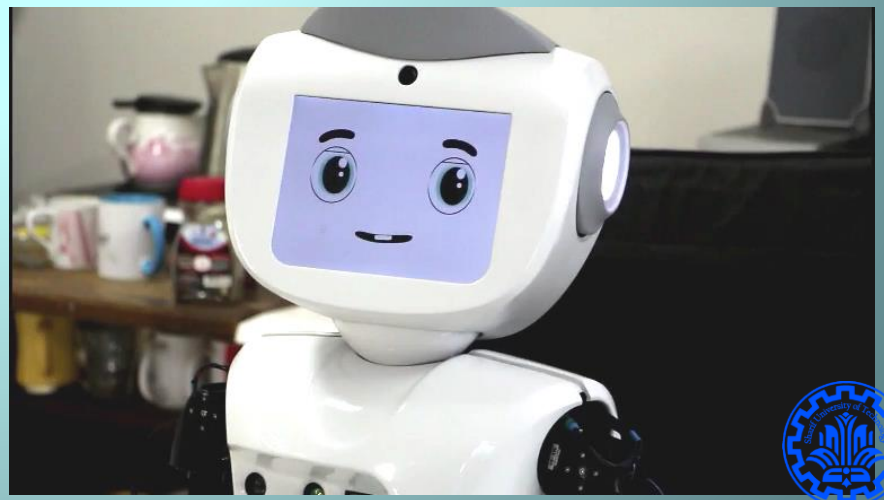
Implementing a Gaze Control System (GCS) for Multi-Person Interactions with RASA social robot

- **Perception Unit aware of: 1) speaking, 2) hand-waving, 3) pointing, 4) being engaged (paying attention to the robot) 5) entering 6) leaving**
- **Logic Unit with an enhanced algorithm for target selection is compared to previous studies**
- **Quantitating the effects of distance and orientation on grabbing humans' attention in addition to the inherent importance of each cue in communications**



Implementing a Gaze Control System (GCS) for Multi-Person Interactions with RASA social robot

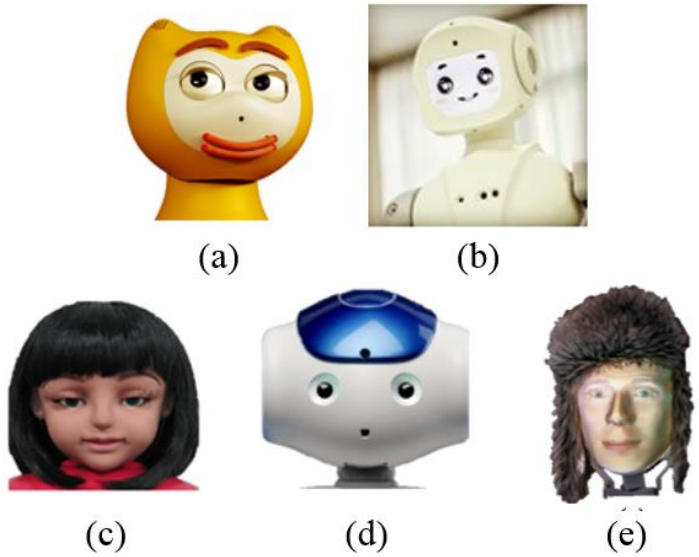
- **Evaluation of the system:**
  - **76.9% matching between the gaze shifts of the robot and the recorded gaze of a group of humans in an 80-second real-life scenario.**
  - **People felt like sometimes the RASA robot really looked at them with a score of 4.35/5.**



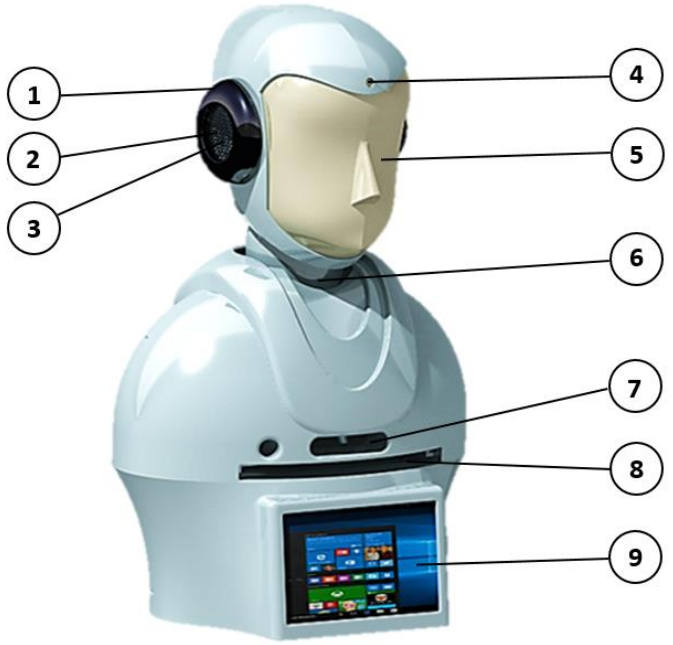
“Taban”: A Retro-Projected Social Robotic Head for Human Robot Interaction

Different types of robotic heads:

(a) mechanical head
(b) head with a tablet face
(c) head with an android face
(d) head with fixed simple facial features
(e) projector head



1) **ear**
2) **speaker net**
3) **Speaker**
4) **Camera**
5) **translucent mask**
6) **2 DoFs neck mechanism**
7) **Kinect sensor**
8) **microphone array**
9) **tablet**



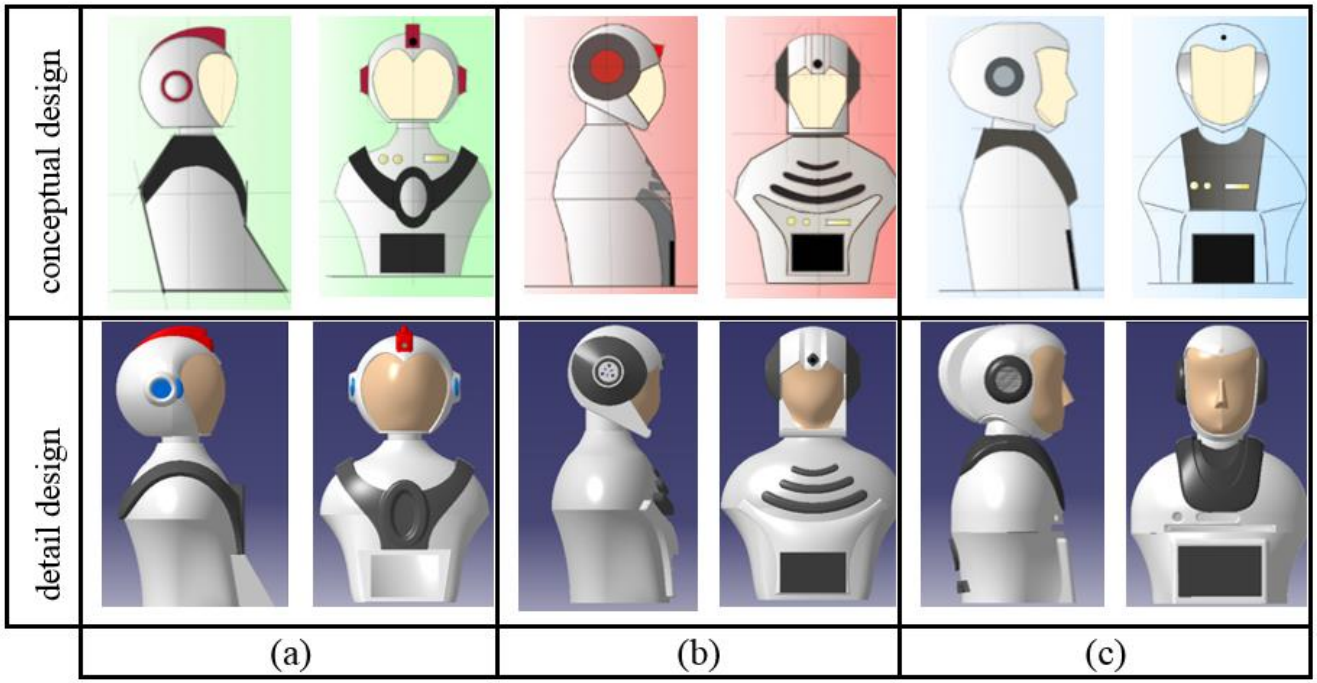
"Taban": A Retro-Projected Social Robotic Head for Human Robot Interaction

Conceptual and Engineering design

(a) First robot design

(b) Second robot design

(c) Third (final) robot design



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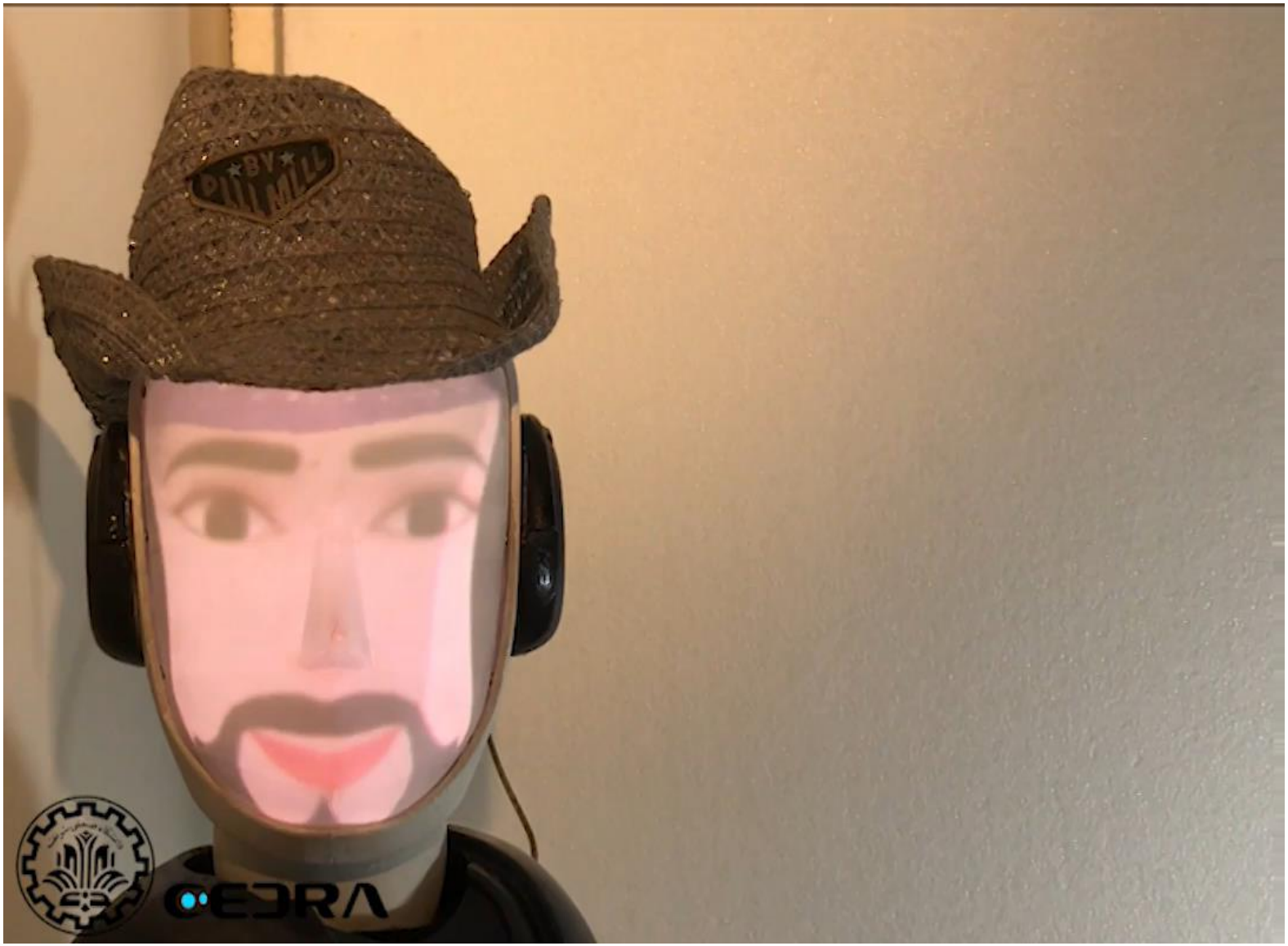
“Taban”: A Retro-Projected Social Robotic Head for Human Robot Interaction



Closing Remarks

- Modern technologies like social robots as assistants/tools are going to have a significant impact on teaching, learning, and pediatric care and rehabilitation.
- The power of modern and more intelligent devices are going to make anytime, anywhere learning more routine and accessible.
- Defining problems and projects based on real social demands and searching for appropriate solutions is the key for multidisciplinary team work and project/problem based learning (PBL).
- With the design and development of "low-cost" educational tools now becoming universal, the role of up-to-date educators and healthcare specialists are going to evolve and become more important than ever.
- Material and content development which employs modern tools/devices to build emotional and engaging connections with learning subjects is a challenging effort by educators wishing to keep their classrooms exciting in a competitive world.
- Ethics and Morality issues play an important role in using social robots/modern technologies specially in education and healthcare. Adding ethical codes/norms/scopes to social robots and machines is one of the most important challenges that shall be addressed by researchers in humanities and social science.
- Finally, societies must be consciously prepared for entering the new human-robot world!

The Main Contributing Team Members (class of 2013-2019)

- Alemi, Minoo, Ph.D., Associate Professor
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- Hosseini, S. Ramezan, Ph.D. Student
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- Shahab, Mojtaba, Ph.D. Student
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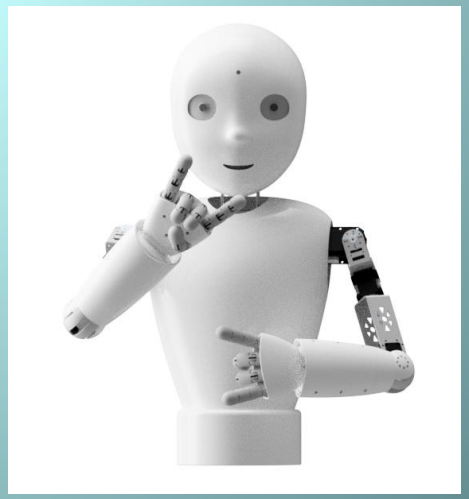
Thank You



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Recent Publications

- Meghdari, A., Alemi, M., Ghazisaedy, M., Taheri, A.R., Karimian, A., Zandvakili, M. (2013). Applying Robots as Teaching Assistant in EFL Classes at Iranian Middle-Schools, Proc. of the Int. Conf. on Education and Modern Educational Technologies (EMET-2013), Venice, Italy.
- Alemi, M., Meghdari, A., Ghazisaedy, M. (2014). Employing Humanoid Robots for Teaching English Language in Iranian Junior High-Schools, **Int. Journal of Humanoid Robotics**, Vol. 11, No. 3.
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- Taheri, A.R., Alemi, M., Meghdari, A., Pouretemad, H.R., Holderread, S.L. (2014). Clinical Application of a Humanoid Robot in Playing Imitation Games for Autistic Children in Iran, Proc. of the 14th Int. Educational Technology Conference (IETC), Chicago, USA.
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- Taheri, A., Meghdari, A., Alemi, M., Pouretemad, H., Poorgoldooz, P. (2016). Social Robots and Teaching Music to Autistic Children: Myth or Reality?, **Lecture Notes in Computer Science: Social Robotics,** 9979 (0302-9743), 541-550.
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- Meghdari, A., Alemi, M., Khamooshi, M., Amoozandeh, A., Shariati, A., (2016).Conceptual design of a social robot for pediatric hospitals, IEEE Robotics and Mechatronics 4th International Conference (ICROM) , 566-571.
- Meghdari, A., Alemi, M., (2016). COGNITIVE-SOCIAL ROBOTICS: MYSTERIES AND NEEDS**, Iranian Journal of Engineering Education,** 18 (70), 55-76.
- Taheri, A., Meghdari, A., Alemi, M., Pouretemad, H. (2017). Human–Robot Interaction in Autism Treatment: A Case Study on Three Pairs of Autistic Children as Twins, Siblings, and Classmates, **International Journal of Social Robotics**, 1-21, Online.
- Meghdari, A., Alemi, M., Rezaie, S. (2017). Effect of Virtual Social Robots on Improving Students' Cognitive Performance on a Vigilance Assignment, **J. of Educational Technology**, 11 (4), 363-375.
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- Alemi, M., Meghdari, A., Saffari, E., Zibafar, A., Faryan, L., et al., (2017). RoMa: A Hi-tech Robotic Mannequin for the Fashion Industry, **Lecture Notes in Computer Science (Social Robotics)**, 10652, 209-219
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- A. Meghdari, A. Shariati, M. Alemi, A. Amoozandeh Nobaveh, M. Khamooshi, B. Mozafari, "Design Performance Characteristics of a Social Robot Companion "ARASH" for Pediatric Hospitals", **Int. Journal of Humanoid Robotics**, Vol. 15, No. 5, October 2018.
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- A. Shariati, M. Shahab, A. Meghdari, AA. Nobaveh, R. Rafatnejad, "Virtual Reality Social Robot Platform: A Case Study on Arash Social Robot", Proc. Int. Conference on Social Robotics, pp. 551-560, November 2018, Springer, Qingdao, China.
- M. Alemi, A. Meghdari, et al., "Clinical and Educational Effects of Social Robots in the Process of Treating Children with Cancer", (in Persian), **Tabriz University Journal of Mechanical Engineering**, Vol. 47, No. 4, pp. 173-182, February 2018.
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