In the name of the absolute power and the absolute knowledge

Social and Cognitive Robotics

Chapter 1: Introduction, definitions, and basic concepts

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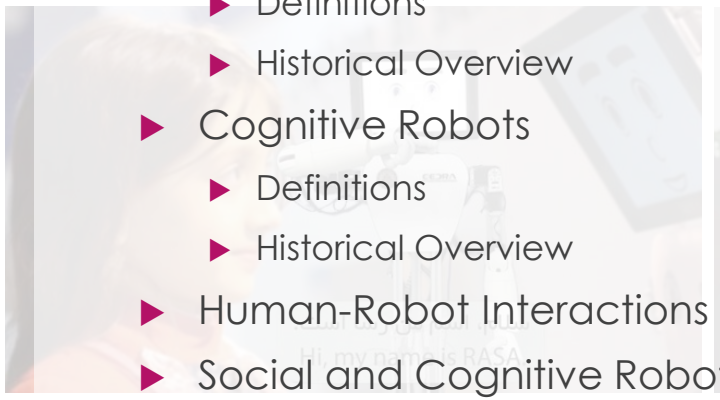
Outlines

- *Chapter 1:* **Introduction, definitions, and basic concepts**
  - Robot
    - Definitions
    - Historical Overview
  - Social Robots
    - Definitions
    - Historical Overview
  - Cognitive Robots
    - Definitions
    - Historical Overview
  - Human-Robot Interactions (HRI)
  - Social and Cognitive Robots
  - Applications of Social Robots




Introduction, definitions, and basic concepts

Let's start with

Social and Cognitive **Robots**

Robot Definitions

- **Webster's Dictionary:**

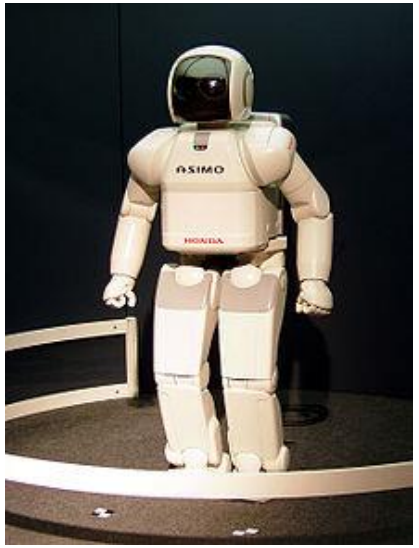
"An automatic apparatus or device that performs functions ordinarily ascribed to human beings" *(not a very accurate description, Ex: washing machines, traffic lights, etc.)*.

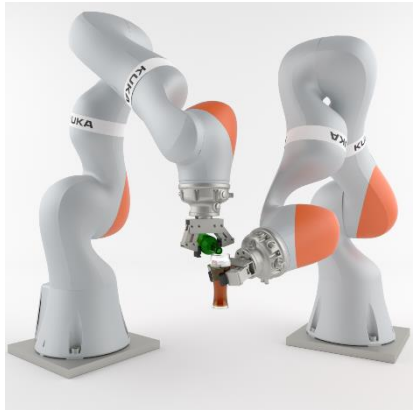
- **Robotics Institute of America:**

"A re-programmable multifunctional manipulator designed to move materials, parts, tools, or specialized devices, through variable programmed motions for the performance of a variety of tasks".

- **لغت نامه آبادیس:**

ربات، یک دستگاه الکترومکانیکی یا یک نرم افزار هوشمند برای جایگزینی با انسان به هدف انجام وظایف گوناگون است. *(دانشنامه عمومی)*





Robot Definitions *(cont.)*

- **Oxford English Dictionary:**

"A robot is a machine—especially one programmable by a computer—capable of carrying out a complex series of actions automatically".

- **Working Definition:**

"Physical agent that has an intelligent connection between sensors and actuators".

Let's consider this one: **a Robot is an Entity that can Sense, Think, and Act.**

موارد ذکر شده فقط بخش کوچکی از تعاریف ارائه شده و موجود برای کلمه «ربات» در واژه نامه های مختلف می باشند.

Robot; *Historical Overview*

- Human desire has always been to duplicate/copy himself *(mechanical dolls to play music mid-1700)*.

- Great civilizations of the past *(Romans, Greeks, Egyptians, Persians)* were based on Slavery!
  - Robots can act as slaves without injustice. They can eliminate many of today's economic injustices.



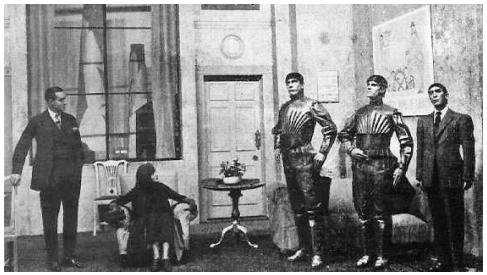
Robot; *Historical Overview* *(cont.)*

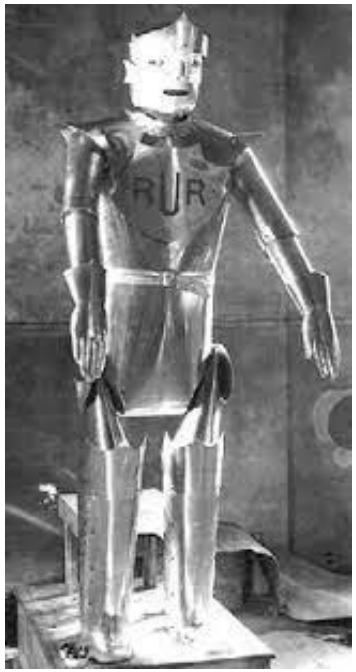
در سال ۱۹۲۳ میلادی کارل چاپک نویسنده اهل کشور چک برای اولین بار از کلمه «ربات» در نمایش نامه خود به عنوان آدم مصنوعی استفاده کرد.

- In 1920s, the word **Robot** was first used in a play by Karel Capek entitled "Rossum's Universal Robots (R.U.R)" performed in Paris. In this play small artificial creatures strictly obeyed their master's orders.

- *In Czech and Russian, they were called Robotnic, from "Robota" meaning hard work and drudgery.*
- These robots eventually turned against their creators!
  - *… and two of them named Primus and Helina fell in love with each other!!*
- The first robots were thought to be evil human-looking machines

(Cohen J., Human Robots, 1966; Kato I., Robotica J. 1983)



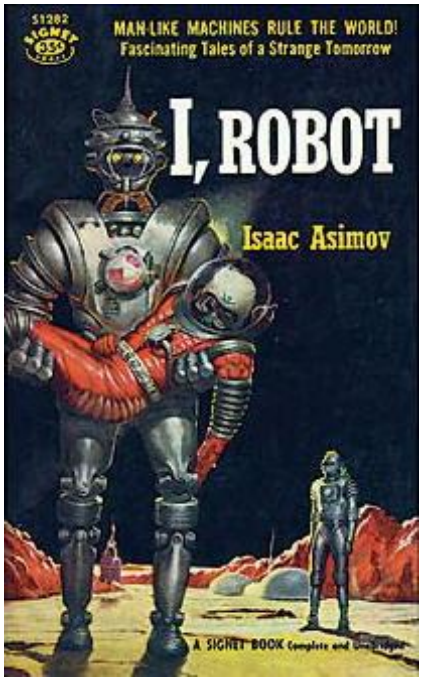


Robot; *Historical Overview* *(cont.)*

- "**Robotics**" as a term, on the other hand, was introduced later in 1942, by Isaac Asimov in the story "Runaround" *(included in the 1950 collection I, Robot)*.

- Asimov's Laws of Robotics
  - A robot may not injure a human being or, through inaction, allow a human being to come to harm.
  - A robot must obey the orders given it by human beings except where such orders conflict with the First law.
  - A robot must protect its own existence as long as such protection does not conflict with the First or Second law

~Wikipedia



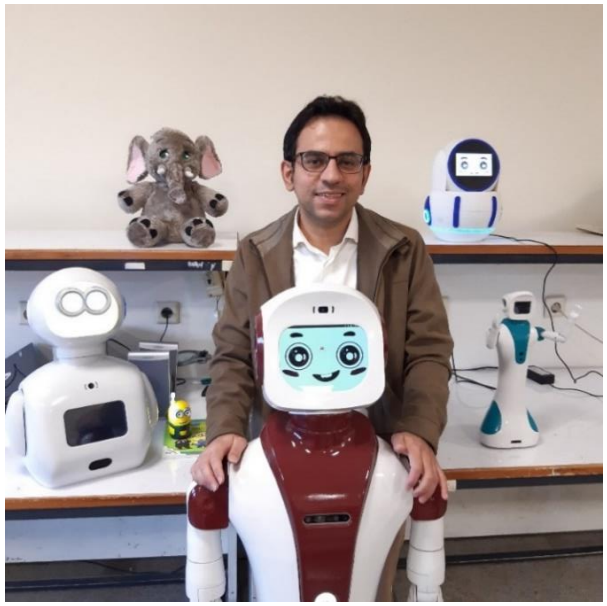
Introduction, definitions, and basic concepts

Let's continue with

Social and Cognitive Robots

Social Robot Definition

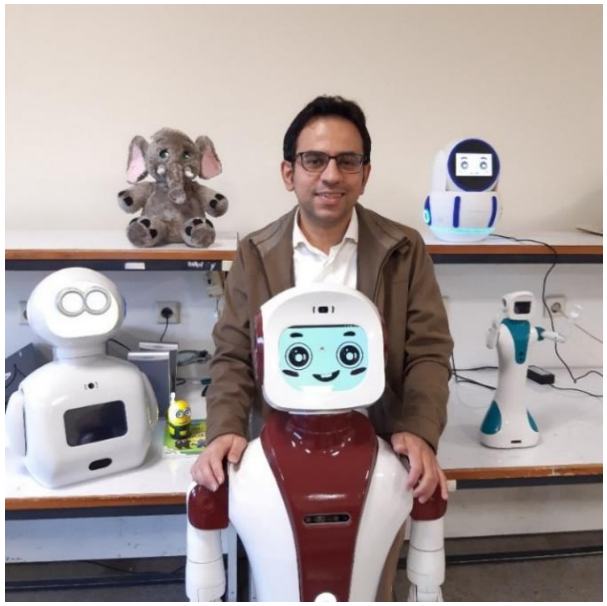
- *A social robot is an autonomous robot that interacts and communicates with humans or other autonomous physical agents by following social behaviors and rules attached to its role (~Wikipedia).*
- **A Social Robot is an Entity that can "not only Sense, Think and Act", "but also must be able to Communicate with humans and/or other social robots".**



- رباتیک اجتماعی، به عنوان یک مفهوم جوان در ادبیات پژوهشی رباتیک، صحبت از ربات هایی دارد که با انسان ها (و یا با یکدیگر)، **تعاملات** عاطفی، کلامی و غیر کلامی، شنیداری/دیداری (نیمه/تمام هوشمند) و ... داشته و به عنوان دوست، همدم، دستیار معلم و یا کمک درمانگر وارد زندگی افراد (به خصوص کودکان با نیازهای ویژه و یا سالمندان) می شوند.

Social Robot Definition

- *A social robot is an autonomous robot that interacts and communicates with humans or other autonomous physical agents by following social behaviors and rules attached to its role (~Wikipedia).*
- **A Social Robot is an Entity that can "not only Sense, Think and Act", "but also must be able to Communicate with humans and/or other social robots".**



Social Robot Definition *(cont.)*

- *One subarea of robotics, termed social robotics, involves robots that engage in some form of social interaction with humans, through speech, gestures, or other media.*
- *Another subarea of robotics is assistive robotics, which generally involves robots that aid people with special needs (in contrast to service robotics, which involves any type of helpful robot). Assistive robotics applications have historically involved hands-on treatment or support for physical disabilities; for example, a robot can help a patient perform repetitive therapeutic motions as a physical therapist would.*
- *At the intersection of social robotics and assistive robotics lies **Socially Assistive Robotics (SAR)**, which involves robots that are designed to help through social, rather than physical, interaction.*
- *SAR is a young but rapidly developing field. SAR systems face challenges different from those faced by other social or assistive robots.*

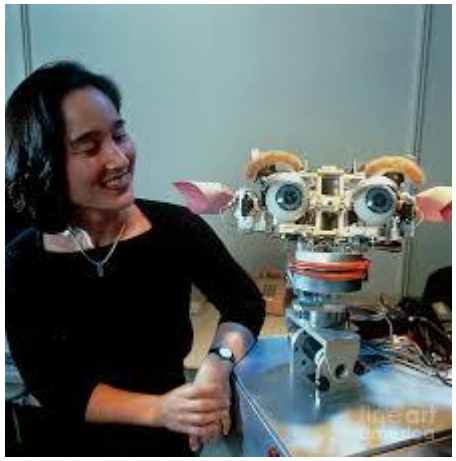
Ref: Scassellati, B., Admoni, H., & Matarić, M. (2012). Robots for use in autism research. Annual review of biomedical engineering, 14, 275-294.

Social Robot Definition *(cont.)*

- *Just for your information,* other definitions of social robots or related concepts have also been used in the literature:
  - Socially evocative robots: Robots that rely on the human tendency to anthropomorphize and capitalize on feelings evoked, when humans nurture, care or involve with their 'creation' *(Breazeal 2002, 2003)*.
  - Socially situated robots: Robots that are surrounded by a social environment which they perceive and react to. Socially situated robots are able to distinguish between other social agents and various objects in the environment *(Fong et al. 2003)*.
  - Sociable robots: Robots that proactively engage with humans in order to satisfy internal social aims (drives, emotions, etc.). These robots require deep models of social cognition *(Breazeal 2002, 2003)*.
  - Socially intelligent robots: Robots that show aspects of human-style social intelligence, based on possibly deep models of human cognition and social competence *(Dautenhahn 1998)*.
  - Socially interactive robots: Robots for which social interaction plays a key role in peer-to-peer HRI, different from other robots that involve 'conventional' HRI, such as those used in teleoperation scenarios *(Fong et al. 2003)*.

Ref: Dautenhahn, K. (2007). Socially intelligent robots: dimensions of human–robot interaction. Philosophical transactions of the royal society B: Biological sciences, 362(1480), 679-704.

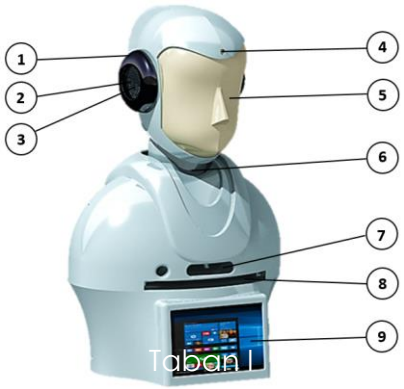
Social Robots; *Examples*

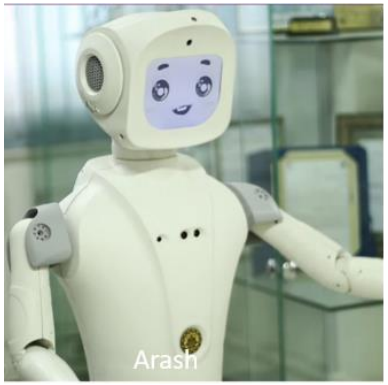


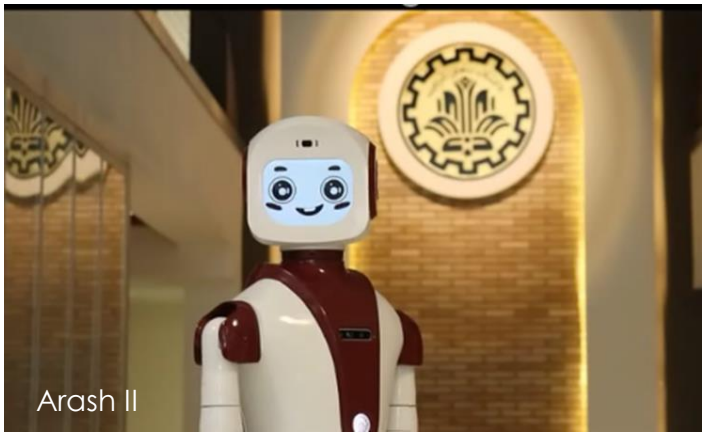



Social Robots; *Examples* *(cont.)*

Proudly Designed and Fabricated at the Social and Cognitive Robotics Lab., Sharif University of Technology







Social Robots; Historical Overview

- The first mention of "social robot" in print was in 1935, when it was used as a derogatory term for a person having a cold and distant personality!

Toadying and bootlicking his autocratic superiors, he is advanced to preferment. He is a business success. But he has sacrificed all that was individual. He has become a social robot, a business cog. *(Sargent, 2013)*

- In 1978, the first mention of "social robot" was made in the context of robotics. An article in Interface Age magazine described how a service robot, in addition to skills such as obstacle avoidance, balancing, and walking, would also need social skills to operate in a domestic setting. The article calls this robot a "social robot".

Ref: Bartneck, C., Belpaeme, T., Eyssel, F., Kanda, T., Keijsers, M., & Šabanović, S. (2020). Human-robot interaction: An introduction. Cambridge University Press.

Social Robotics and I !

ICSR 2017
NINTH INTERNATIONAL CONFERENCE ON SOCIAL ROBOTICS
NOV 22-24, 2017 TSUKUBA, JAPAN
EMBODIED INTERACTIVE ROBOTS

!!!

در حاشیه...

با دفاع از پایان‌نامه بررسی تاثیر ربات‌های انسان‌نما در درمان کودکان اوتیسم؛

اولین دانشجوی دکترای رباتیک اجتماعی در کشور فارغ‌التحصیل شد

اولین دانشجوی دکترای کشور در حوزه رباتیک اجتماعی پس از 5 سال پژوهش مستمر در دانشگاه صنعتی شریف از پایان‌نامه خود دفاع کرد.

به گزارش ایسنا، علیرضا طاهری اولین دانشجوی دکتری کشور در حوزه میان رشته‌ای رباتیک اجتماعی، تحت حمایت و راهنمایی دکتر علی مقداری، دکتر حمیدرضا پوراعتماد و دکتر مینوعالمی، از پایان نامه خود تحت عنوان«مدلسازی، طراحی و بررسی تأثیر رباتهای انسان‌نما در درمان کودکان مبتلا به اوتیسم (درخودماندگی)» دفاع کرد.

این دانشجوی دانشگاه صنعتی شریف در خصوص پژوهش‌های پنج ساله خود می‌گوید: بر اساس آمارهای موجود نرخ وقوع اختلالات اوتیستیک از دهه ۱۹۶۰ میلادی رو به افزایش است و در کشور ما نیز این مشکل وجود دارد.

این اختلالات با نارسایی‌های کیفی در تعاملات اجتماعی، مهارت ارتباطی و خلاقیت اجتماعی مشخص می‌شود و در سال‌های اخیر استفاده از ربات‌ها در تشخیص و درمان مبتلایان به اوتیسم در دنیا رشد چشمگیری داشته است و در

لینک خبر

Introduction, definitions, and basic concepts

Let's finish with

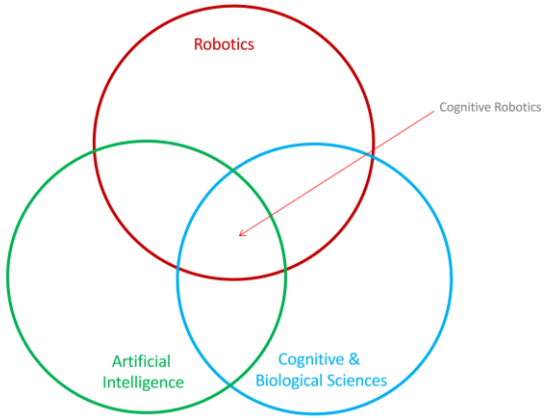
Social and **Cognitive** Robots

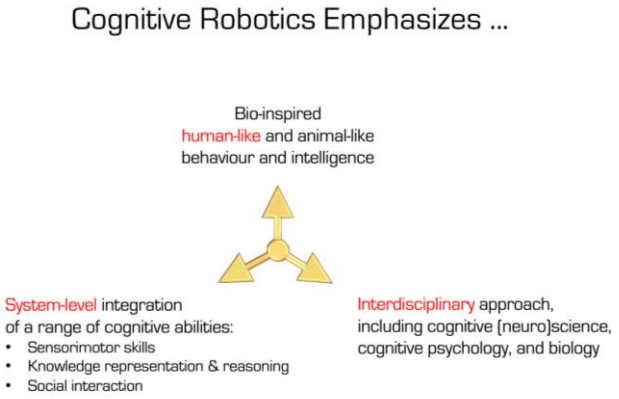
The corresponding slides have been adapted from "Introduction to Cognitive Robotics" by **David Vernon**, Carnegie Mellon University Africa

Prof. Vernon and I, ICRA, 2015

Cognitive Robots; Definition

- "Cognitive Robotics is the field that combines insights and methods from robotics, AI, and cognitive and biological sciences to design an integrated cognitive system combining the sensorimotor behavior and higher-level functions and social capabilities of an intelligent robot"



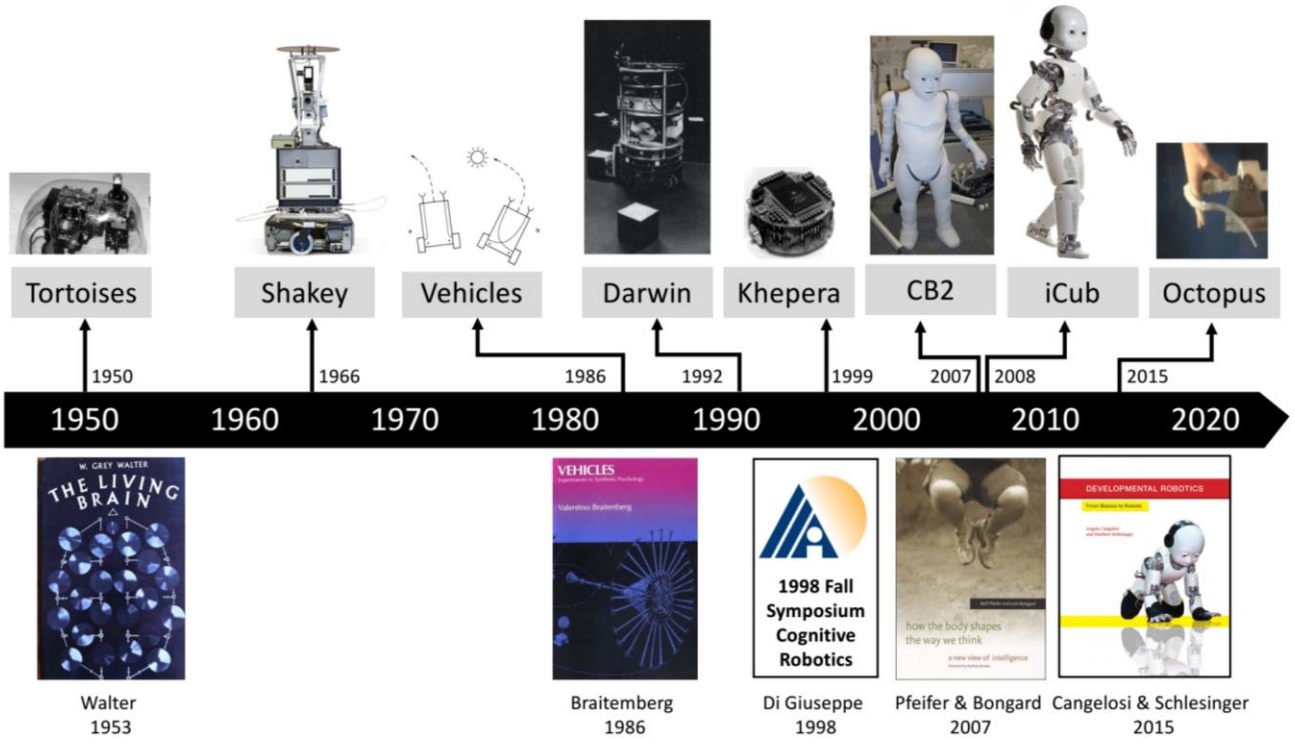


علوم شناختی مطالعه‌ی علمی ذهن است. در این تعریف منظور از ذهن مجموع هر آن چه که نمودهای هوشمندی و آگاهی هستند مانند تفکر، ادراک، حافظه، احساس، استدلال و نیز تمام روندهای ناآگاهانه شناختی است. گاهی علوم شناختی را به صورت «مطالعه‌ی علمی شناخت» نیز تعریف می‌کنند و شناخت را مجموع حالت‌ها و فرآیندهای روانی مانند تفکر، استدلال، درک و تولید زبان، دریافت حواس پنجگانه، آموزش، آگاهی، احساسات و... در نظر می‌گیرند. به طور کلی پرسش‌هایی مانند این که ذهن چگونه کار می‌کند یا مغز چگونه هوشمندی را ایجاد می‌کند، از جمله پرسش‌هایی هستند که در این شاخه‌ی علمی بررسی می‌شوند.

Cognitive Robots; Definition *(cont.)*

- "The word cognition derives from the Latin verb cognosco, a composition of con (meaning related to) and gnosco (to know). Cognitive robotics, then, is the branch of robotics where knowledge plays a central role in supporting action selection, execution, and understanding.
- It focuses on designing and building robots that have the ability to learn from experience and from others, commit relevant knowledge and skills to memory, retrieve them as the context requires, and flexibly use this knowledge to select appropriate actions in the pursuit of their goals, while anticipating the outcome of those actions when doing so.
- Cognitive robots can use their knowledge to reason about their actions and the actions of those with whom they are interacting, and thereby modify their behavior to improve their overall long-term effectiveness.
- In short, cognitive robots are capable of flexible, context-sensitive action, knowing what they are doing and why they are doing it."

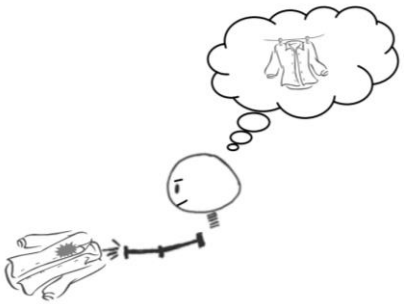
Cognitive Robotics; Historical Overview



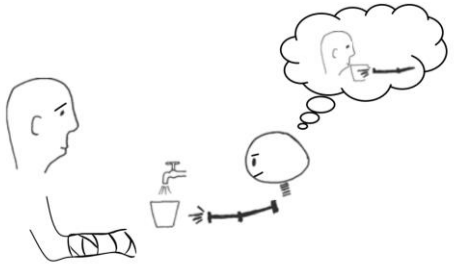
A. Cangelosi and M. Asada, Cognitive Robotics, Chapter 1, MIT Press, in press.

Cognitive Robot; at a glance

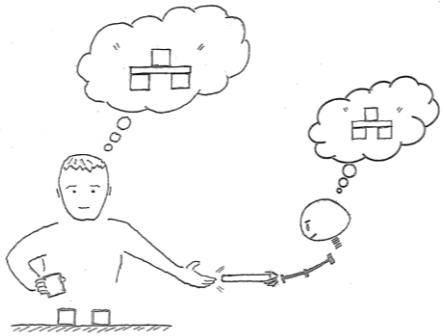
- A Cognitive Robot does this by dynamically recruiting several core cognitive abilities: perception, attention, action selection, memory, learning, reasoning, metacognition, prospection.
- It can also **adapt** to changing circumstances; Adjusting existing action policies or Creating new one



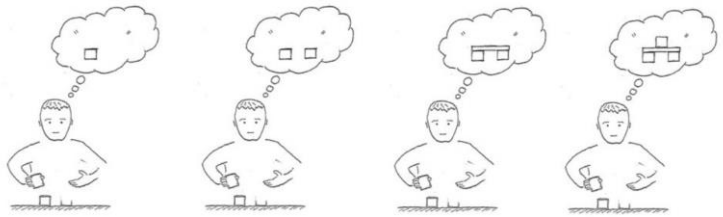
Everyday activities: apparently routine but often complex and demanding



Anticipate the needs of others



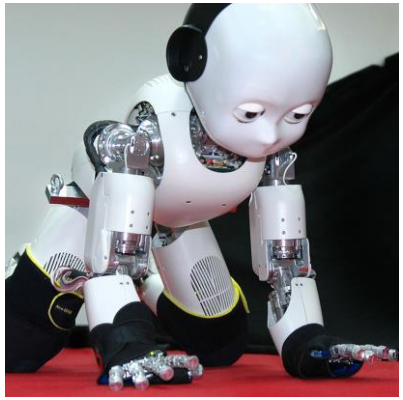
Interact, assist, and collaborate with others

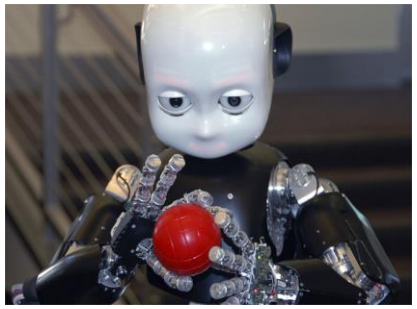


The Future

Cognitive Robots; *Example*

iCub Robot





Human-Robot Interaction (HRI)

- Human–robot interaction is the study of interactions between humans and robots in the social world.
  - for a robot, all social rules and norms are unknown and require the attention of the robot designer.
  - HRI focuses on developing robots that can interact with people in various everyday environments.
- HRI offers the unique opportunity to study human affect, cognition, and behavior when confronted with social agents other than humans.

Social and Cognitive Robots; *wrap up*

رویای من اینه ...

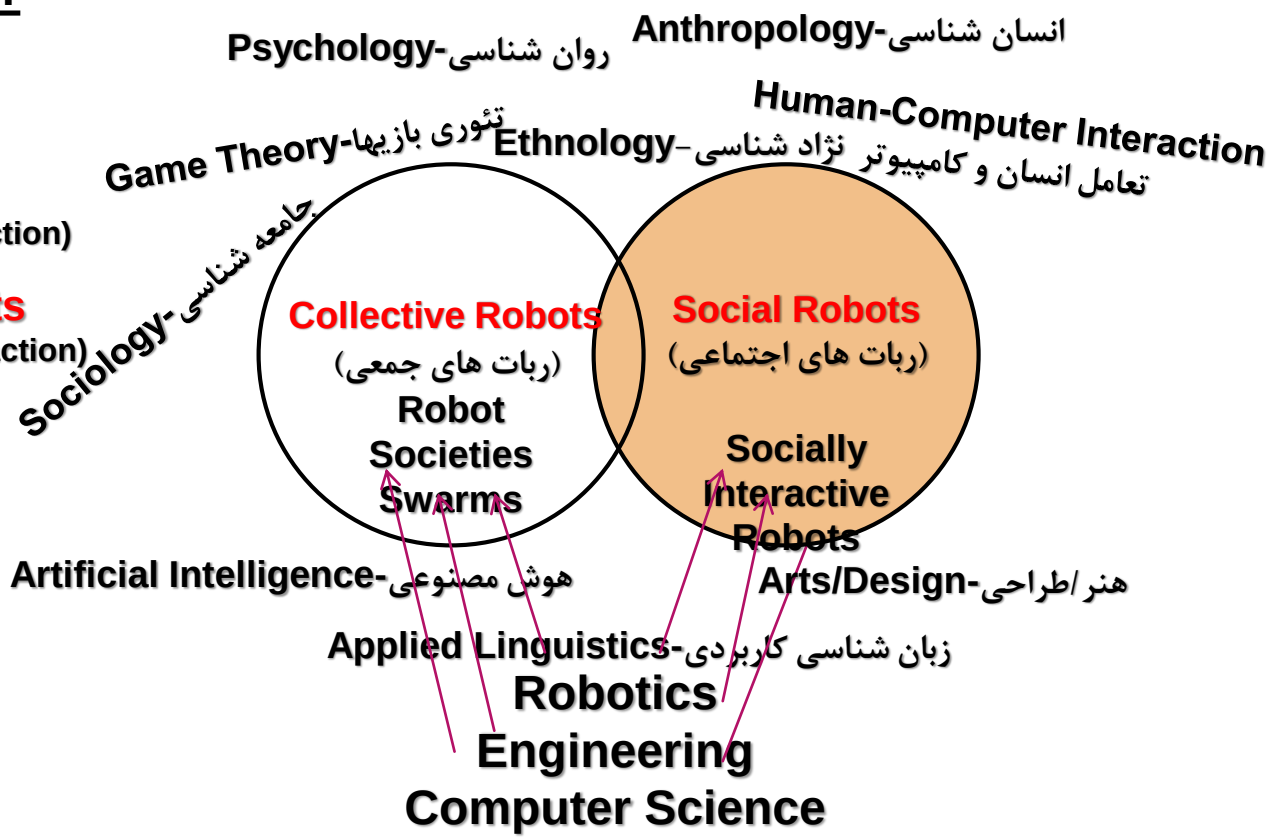
- ربات های اجتماعی و شناختی، ربات هایی هستند که برای تعامل با انسان ها و یا با یکدیگر طراحی می شوند و در تعاملات انسانی، تقریباً مشابه انسان ها عمل می کنند.
- هدف از طراحی و ساخت ربات های اجتماعی و شناختی و تعامل آن ها با انسان، ایجاد هم افزایی در سیستم های ترکیبی انسان-ربات است.
- قرار نیست تا این ربات ها جایگزین انسان ها شوند؛ بلکه آنها با توانایی های خود، قدرت اجتماعی و شناختی انسان ها را افزایش می دهند.
- این ربات ها دارای حافظه از مشاهدات و تجربیات خود در زمان های مختلف بوده، صریحاً با یکدیگر تعامل داشته و از هم می آموزند.
- این حوزه تحقیقاتی (به شدت) بین رشته ای بوده و تخصص های مختلف در آن درگیر می باشند (مهندسین مکانیک، کامپیوتر، برق، روانشناسان، متخصصین علوم شناختی، زبان شناسان، فلاسفه و ...).

Social and Cognitive Robots

A Multi disciplinary Area of Research

Fields of Major Impact:

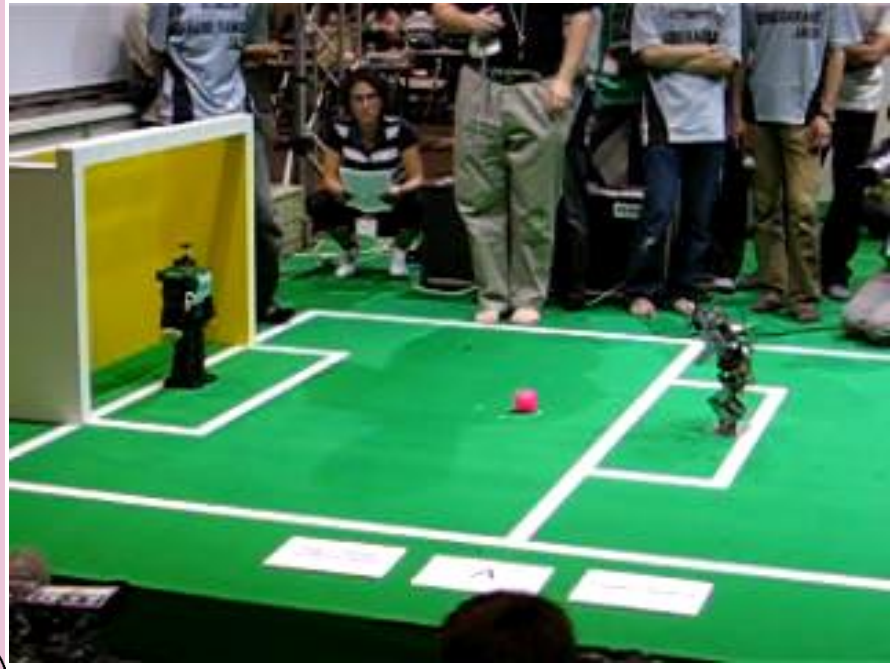
- **Collective Robots**
  (Robot-Robot Interaction)
- **Social Robots**
  (Human-Robot Interaction)



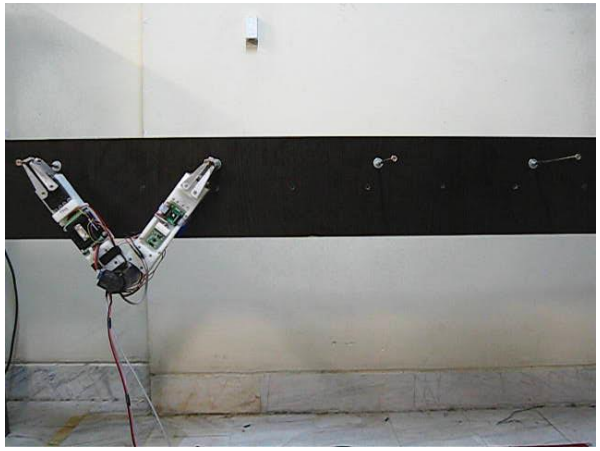
Collective Robots

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

اولین ربات انسان نمای ایرانی درشریف- (۱۳۸۴)



Collective Robots



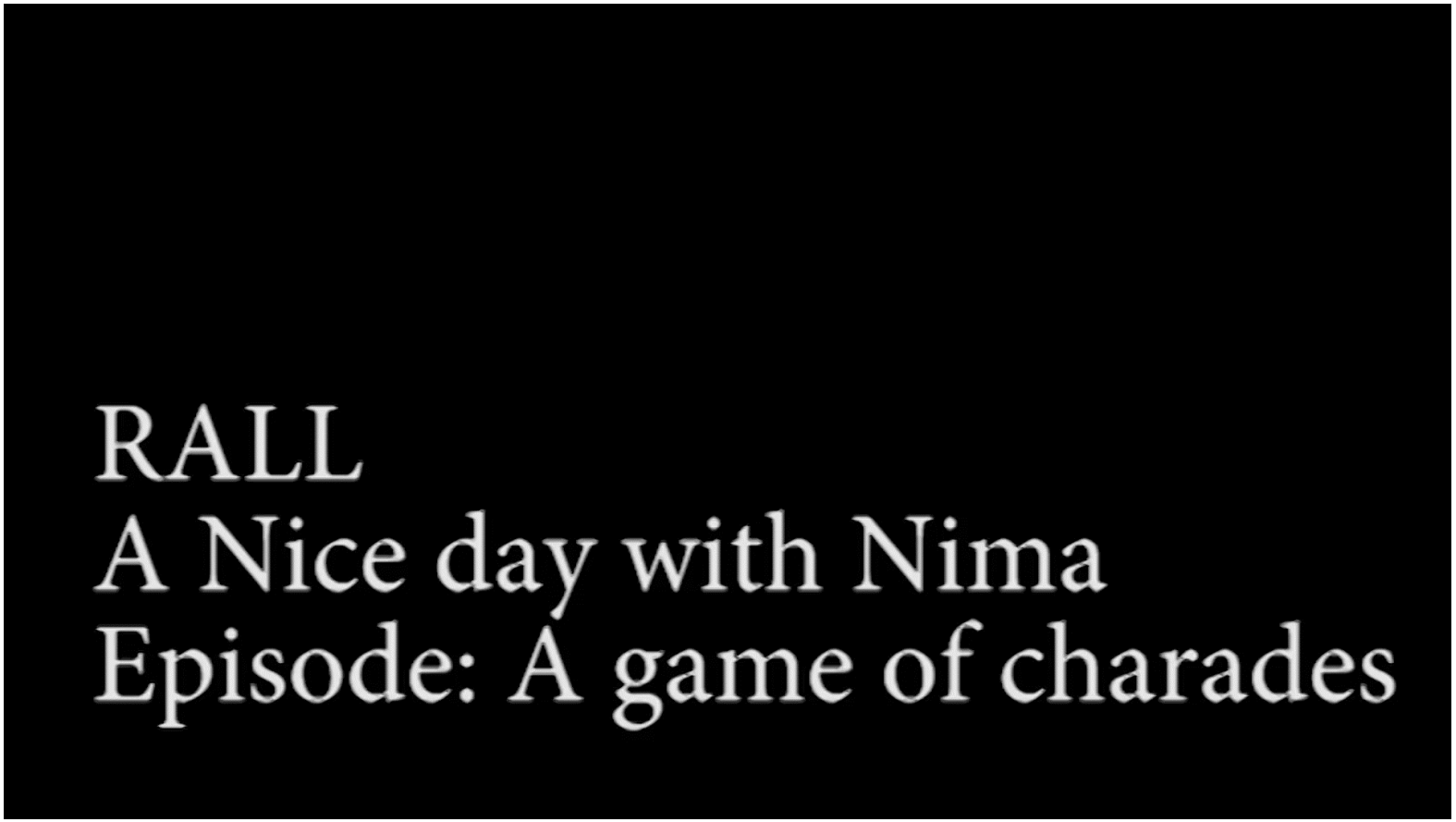
Applications of Social Robots

- Assistive Healthcare, Rehabilitation, Nursing care *(co-therapist)*
- Education *(TA, co-teacher)*
- Entertainment
- Elderly Care
- Story telling
- Tour Guides
- Office/Hotel Assistants
- Companion in the home
- Agriculture, Cleaning, Firefighting
- Space Robots
- …




Applications of Social Robots

Robot Assisted Language Learning (RALL)

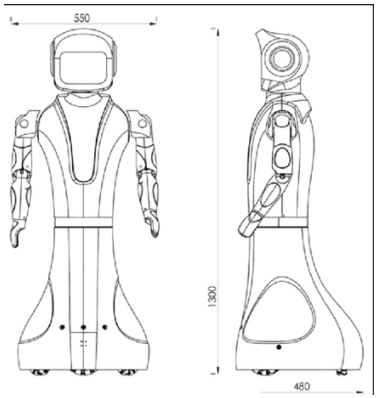


Applications of Social Robots

Social Robots for education of children with cancer

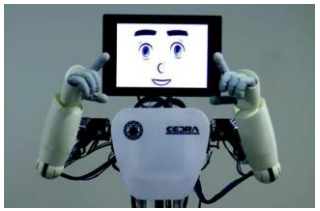
Applications of Social Robots

Arash-I Robot; A Mobile Social Robot for Educational and Therapeutic Intervention in Pediatric Cancer



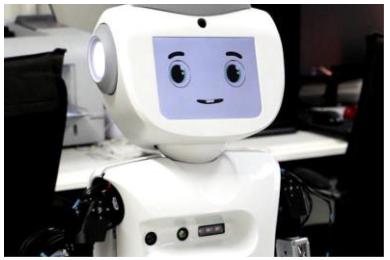
Applications of Social Robots

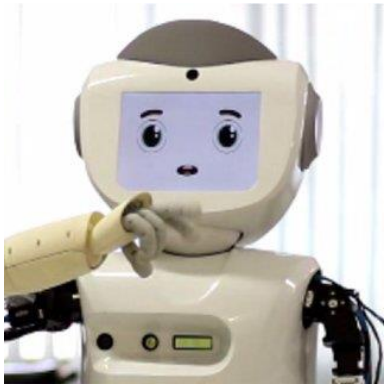
RASA-I Robot; A Sign-Language Teaching Assistant Social Robot



Applications of Social Robots

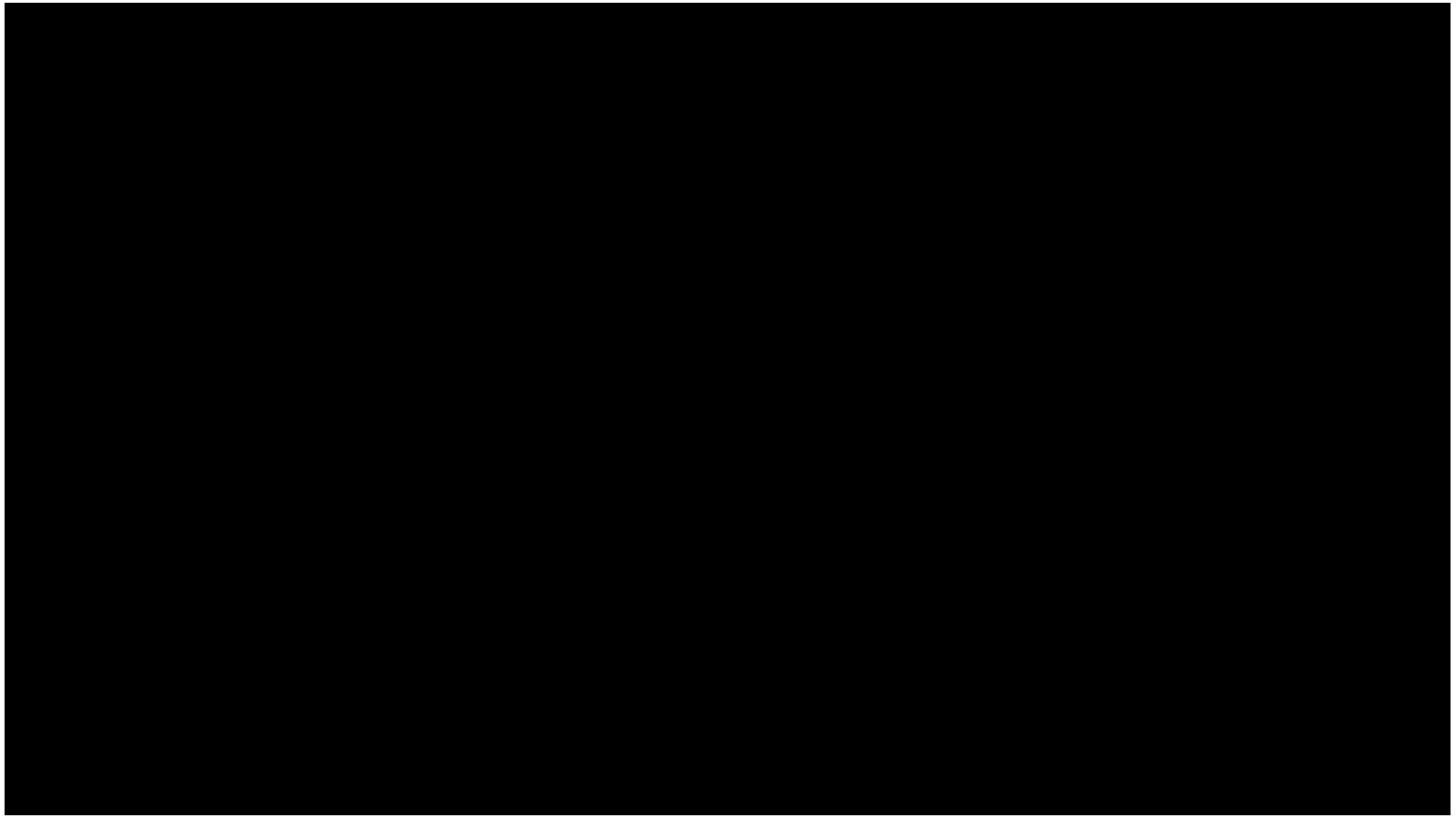
RASA-II Robot; A Sign-Language Teaching Assistant Social Robot





Applications of Social Robots

Maya Robot; An Intelligent Robotic Toy



Applications of Social Robots

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

Interview

Prof. Ali Meghdari, Sharif University of Technology

Sharif University of Technology

EMERITUS PROFESSOR ALI MEGHDARI

Professor 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 accepted the position of Assistant Professor of Mechanical Engineering at Sharif University of Technology (SUT) in Tehran, and in 1997, he achieved the rank of Full-Professor. During 1996-1999, he chaired the Department of Mechanical Engineering at SUT. During 1993-94, he was a visiting research faculty at the AHMCT center of the University of California-Davis, and from 1999-2000 he served the IBDMS research centre at the Colorado School of Mines, and the Rocky Mountain Musculoskeletal Research Laboratory (RMMRL) as a visiting research professor. Ali Meghdari has performed extensive research in the areas of social and cognitive robotics, mechatronics, and modelling of biomechanical systems. He has supervised over 100 M.Sc. Theses and 25 Ph.D. Dissertations, 5 Post-Docs and has published over 300 technical papers in international journals and conferences. He has been the recipient of various 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 served as the Provost and Vice-President of Academic Affairs at Sharif University of Technology, and he had a key role on the establishment of SUT's International Campus in Kish Island. He was the founder and Director of the Languages and Linguistics center (LLC) in SUT from 2009-2012. From 2013-2015 he served as the Dean of Center for Faculty Hiring and Promotions at the Islamic Azad University (IAU). From 2015-2018 he was the General Director for Office of Education, Research, and Technology (Ministry of Energy, M.o.E). He was the Founder and Director of the Center of Excellence in Design, Robotics and Automation (CEDRA) from 2000-2020. He is on the editorial board of various engineering journals, Special Issue Editor for Socio-Cognitive Engineering (SCE) and Engineering Education Research (EER) journals of Springer (SNAS). 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-Freshtegan International Branch) to serve students with special needs, primarily the deaf and blind. As of September 2020, he eagerly decided to retire from SUT and take the honorable title of Emeritus Professor.

Related Links:

Sharif university of technology

Department of Mechanical Engineering

Center of excellence in Design,Robotics and Automation

Ava & Nima Social Robotics Co.(Dr. Robot)

IAU-Fereshtegan International Branch

Wikipedia: Ali Meghdari

http://meghdari.sharif.edu/

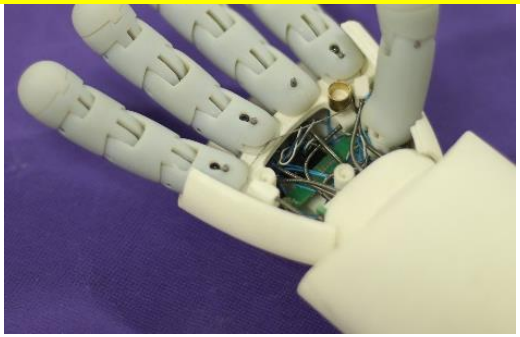
Interview

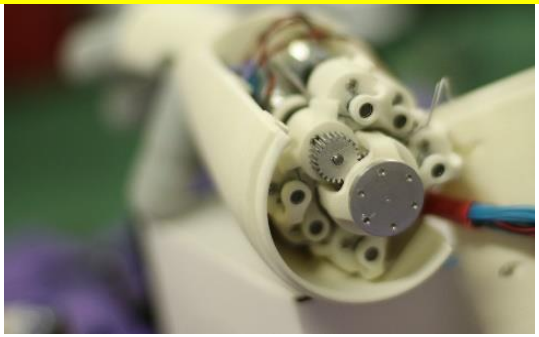
Prof. Ali Meghdari, Sharif University of Technology

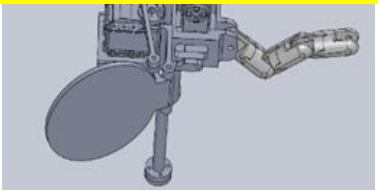
https://drive.google.com/file/d/1ov6Y0hseTFkT0QOb7DN7pqfNsUEGdh6O/view?usp=sharing

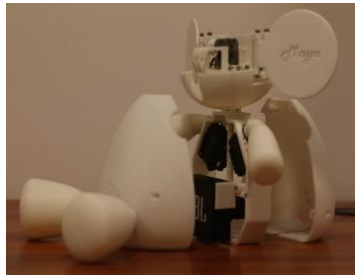
Physical appearance of robots

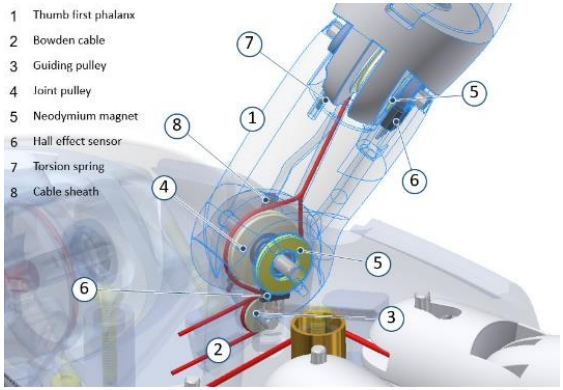
Next Session …

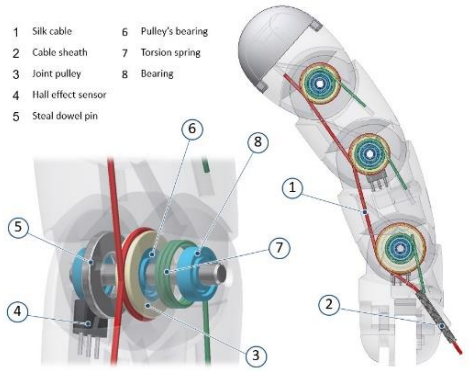












CEDRA
Center of Excellence in Design, Robotics & Automation

Thanks for your attention