Mohammad Ali Bazrafshani

Center of Advanced Systems and Technologies (CAST)
School of Mechanical Engineering
Mechanical Engineering
University of Tehran, Tehran, Iran

Email: bazrafshani.ali@gmail.com

Research Interests

I believe that robust mechanical design forms the foundation for the performance and success of all other components within a project. My interests lie in mechanical design, bioengineering, robotics, mechanism design and analysis. Currently, my work focuses on robotic mechanical design using analytical and optimization methods, actuator design and integration, structural and topological optimization, and biomechanical systems. Throughout all my projects, I have consistently aimed to bring innovation into the design process to improve both functionality and efficiency. Although many of my designs have supported broader systems, each has served as a personal platform for creativity and exploration within my field of interest. Over time, my journey in mechanical design has grown into a deeply imaginative and innovative process—one that reflects not just a technical pursuit, but a lifelong passion.

- Bio-Mechanical & Robotic Design
- Robotic Gripper, Hand, Arm and Manipulating Mechanical Design

Education

M.Sc. Mechanical engineering, University of Tehran, Tehran, Iran, 2023

B.Sc. Mechanical engineering, Shahid Bahonar University of Kerman, kerman, Iran, 2015

Publications

Conferences Papers

- **M. A. Bazrafshani**, A. Yousefi-Koma, A.Amani, B. Maleki, S. Batmani, A. Dehestani Ardakani, S. Taheri, P. Yazdankhah, M. Nozari, A. Mozayyan, A. Naeini, M. Shafiee, A. Vedadi, "SURENA-V: A humanoid robot for human-robot collaboration with optimization based control architecture," **2024 IEEE-RAS International Conference on Humanoid Robots**, 2024-November, pp. 615-622.
  DOI: 10.1109/Humanoids58906.2024.10769592 [Paper Access Link]
- A. Yousefi-Koma, B. Maleki,H. Maleki, A.Amani, and **M. A. Bazrafshani**, H. Keshavarz, A. Iranmanesh, A. Yazdanpanah, H. Alai, S. Salehi, M. Ashkavari, M. Mousavi, M. Ashtiani, "SURENA IV: Towards a cost-effective full-size humanoid robot for real-World scenarios," **2021 IEEE-RAS International Conference on Humanoid Robots**, 2021-July, pp. 142-148.
  DOI: 10.1109/HUMANOIDS47582.2021.9555686 [Paper Access Link]
- A. Ahmadi, M. Mahdavian, N. F. Rad, A. Yousefi-Koma, F. Alidoost and **M. A. Bazrafshani**, "Design and fabrication of a Robotic Hand using shape memory alloy actuators," **2015 3rd RSI**

International Conference on Robotics and Mechatronics (ICROM), Tehran, 2015, pp. 325-329.
DOI: 10.1109/ICRoM.2015.7367805 [Paper Access Link]

- N. F. Rad, A. Yousefi-Koma, H. Rezaei and **M. A. Bazrafshani**, "Design and fabrication of a gripper actuated by shape memory alloy spring," **2016 4th International Conference on Robotics and Mechatronics (ICROM)**, Tehran, 2016, pp. 455-458.
DOI: 10.1109/ICRoM.2016.7886783 [Paper Access Link]

- Sahel Salehi, Aghil Yousefi-Koma, Farzad AyatollahzadehShirazi and **Mohammad Ali Bazrafshani**. "Design and Fabrication of a Low-cost Multi-function Prosthetic Hand." ISME 2017, Tehran, May 2-4, 2017. [Paper Access Link]

- Faridi Rad, Nafise; Aghil Yousefi-koma; Mossa Ayati and **Mohammad Ali Bazrafshani**, "On Design of an Ankle Prosthesis with a Series and Parallel Elastic Actuator for Sagittal Movement and a Passive Inversion-Eversion Joint", **ISME 2017**, Tehran, May 2-4, 2017.

Research Experiences

Projects

Robotic Hand Research (2010 – current) [See Portfolio for details]

- Development of "Slip Sensors" to Detect Slip on the Surface of the Robotic hand (2016 – present) [See Portfolio for details]
- Development of "Touch Sensor" for Multidimensional Force Recognition (2017 – present) [See Portfolio for details]

Research Assistant in CAST (Center of Advanced systems and technologies) under the supervision of Aghil Yousefi-koma at Tehran University, Iran. (2015 – current)

- Member of the Mechanical Design Team of the "Surena IV humanoid robot" (2015– present) [See Portfolio for details]
- Design and development of "Robotic Actuators" including torque Servo Motor, Harmonic Drive component set and Position Sensors to use in "Surena IV humanoid Robot" (2015 – 2016) [See Portfolio for details]
- Design and assembling of "Novel Wrist Mechanism" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2018) [See Portfolio for details]
- Design and assembling of "Novel hip mechanism" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]
- Design and assembling of "arm" for "Surena IV humanoid robot", outsourcing manufactured (2017– present) [See Portfolio for details]
- Designed and assembling of "hand" for "Surena IV humanoid robot", outsourcing manufactured (2017– present) [See Portfolio for details]
- Design "hand" for "Surena III humanoid robot" (2017– present) [See Portfolio for details]
- Design, pack, and assembling of "knee actuator" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]

- Design, pack, and assembling of "Ankle actuator" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]

- Design, pack, and assembling of "Hip Pitch actuator" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]

- Design, pack, and assembling of "Hip Roll actuator" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]

- Design, pack, and assembling of "Hip Yaw actuator" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]

- Design, pack, and assembling of "Body Trunk actuator" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]

- Design, pack, and assembling of "Elbow actuator" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]

- Design, pack, and assembling of "Shoulder actuator" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]

- Design, pack, and assembling of first version of an "exoskeleton actuator" for "Simon Fraser University", Canada, outsourcing manufactured (Fall 2017) [See Portfolio for details]

-Design and assembling of "Pelvis (Hip) structure" for "Surena IV humanoid robot", outsourcing manufactured (2016 – 2017) [See Portfolio for details]

- Designed, manufactured, and assembling of Upper-Body structure for "Surena IV humanoid robot" (2016 – 2017) [See Portfolio for details]

- Cooperation and consultation in the design and construction process of Ms. Salehi's M.Sc. thesis titled "Design and feedback control of a 6 DOF below elbow myoelectric prosthetic hand for grasping" (Fall 2017) [See Portfolio for details]

- Cooperation and consultation in the design and construction process of Ms. Faridi rad's M.Sc. thesis titled "Design and control of an active ankle prosthesis to mimic walking gait with intact leg" (Fall 2017) [See Portfolio for details]

- Cooperation and consultation in the design and construction process of Mr. Janati's M.Sc. thesis titled "Design and control of an active knee prosthetic" (Fall 2017) [See Portfolio for details]

- Cooperation and consultation in the design and construction process of Mr. Pouriaye vali's B.Sc. thesis titled "Design and control of an active knee prosthetic" (Fall 2017) [See Portfolio for details]

- Cooperation and consultation in the design and construction process of Ms. Arghavani's B.Sc. thesis titled "A novel multi functional tactile finger" (summer 2017) [See Portfolio for details]

- Cooperation and consultation in the design and construction process of Mr. rafie's M.Sc. thesis titled "Design and control of a nylon actuator based gripper" (summer 2017) [See Portfolio for details]

- Design of a "SMA robotic hand" (spring 2015) [See Portfolio for details]

- Design of a "SMA robotic gripper" (spring 2016) [See Portfolio for details]

- ROBOCON 2014 mechanical designer robotic competition (summer 2014) [See Portfolio for details]

- Created an excel code to calculate and design Helical gears (2013) [See Portfolio for details]

Teaching experience

Rapid protyping

Rapid prototyping workshop by "Solidworks", University of Tehran, Iran. (27-28 December 2017)

Rapid prototyping course by "Solidworks", University of Tehran, Iran. (Marh-April 2018)

Industrial R&D Experiences

Projects

Mechanical Engineering Research and Development Researcher in Pooyesh Darou Biopharmaceuticals company under the supervision of Eng. Hamed Tabatabaei (2019 – current)

- Development of "Insulin Pen assembly Machine" (2019 – present)

- Development of "Feeder machine for Insulin Pen assembly Machine" (2020 – present)

- Development of "SCARA Robot as feeder machine" (2020 – present)

- Development of "Cartoning Machine" (2025)

- Development of "Labeling Machine" (2023)

- Development of "IP68 packaging for DPT(Differential Pressure Transmitter) device" (2022)

Skills

CAD/ CAE/ CAM Softwares

SolidWorks, SolidWorks simulation, Abaqus, topology optimization by solidthinking inspire, SolidWorks and NX, SolidCAM, 3D printer software, Artcam, turning CNC course

Elecrical & computer engineering softwares

Arduino, Hercules, proteus, familar with keil and STM microcontroler family

Programming

C, Mathematica, Matlab, Calculating code by MS office Excel

Other

LaTeX, MS office (Word, Excel, Power Point)

References

Aghil Yousefi-Koma

Professor, School of Mechanical Engineering, University of Tehran/ Iran

Email: *aykoma@ut.ac.ir*
Phone: +98 912 536 9624

Hessam Maleki

Head of Locomanipulation Platform at Humanoid,Ex-Sanctuary AI, Humanoid AI, Vancouver/ Canada
Email: *hes.maleki@gmail.com*
Phone: +1 778 889 7360

Mohammad-Ali Nikouei Mahani

Senior Machine Learning Engineer, Autonomous Driving Campus, BMW AG, Tübingen/ Germany
Email: *mohammad-ali.nikouei-mahani@bmw.de*

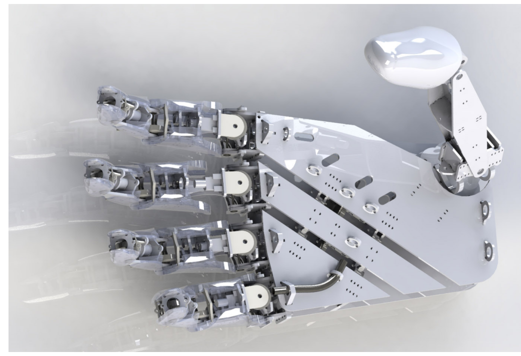
Majid Sadedel

Assistant Professor, Department of Mechanical Engineering, Tarbiat Modares University/ Iran
Email: *majid.sadedel@modares.ac.ir*
Phone: +98 21 82884987

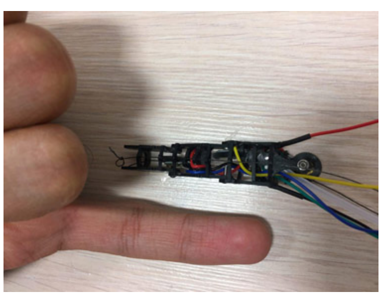
Research projects and experience *(Portfolio)*

I. Bio-mechanic design

Robotic finger hand for precision manipulation and grasping (2010- present)



Precision manipulation and grasping is my favorite field of research in the last few years, focusing on developing a more precise finger mechanical design method to achieve much more controllability. My work summary includes the development of a way to redesign robotic fingers and hand. The hand I have worked on has 22 degrees of freedom, 4 degrees for each finger and 2 degrees in the palm, which is the most important point of my design and research. My experience in these years of activity on robotic hand projects showed me that our biggest problem with a hand as a gripper is that we could not produce different gestures with it. We could not have a functional robotic hand with a precise manner unless we have a trustworthy mechanical testbed with a perfect controllability. If you implement a perfect complex control method on a robotic hand, it may not guarantee a perfect response if you have unwanted clearance in your system. Or even worse, you do not have enough degree of freedom so you could not get your desired movement. With these mechanical modifications, the stiffness of each finger joint can be independently controlled with a very high frequency. This means that we can reach each position of joints by the tendon driven method with a minimum number of actuators, and simply control the stiffness of each joint. Nearly seven years of experience in designing and reviewing different methods to achieve the main goal has led my current method to consider the maximum number of parameters that affect the output. I have had some important constraints in the way of developing like the simplicity of mechanical mechanism, reliability and the possibility of production in microscopic size for "micro robotic surgery" in the future.

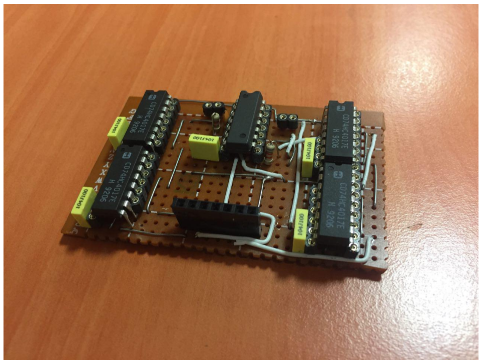


The robotic finger I've reached to this development stage is a finger with four degrees of freedom, which consists of two controllable DOF in "MCP joint" and one DOF in other tow joints, "PIP and DIP joints". Each of the joints has a 0.022 degrees precision, this means there are 14 bits of accuracy in reading the joints angles. The independence of each degree of freedom from the other degrees with a minimum number of actuators is the distinctive feature of this design. Each mechanical design becomes more complete when all aspects are taken into consideration. The system's final function was clear to me, so for this purpose, I had to consider sensors issues in my design. My assumption was always that it is blind and should do its tasks only by its sensors. So I developed some sensors like proximity sensor, touch sensor and slip sensor for this mechanical design. Proximity sensor to sense how close to object it is, touch sensor to measure how much pressure and in which direction is on the hand and finger skin and at last, slip sensor to understand when the object is slipping through the skin so that it could react. Based on the studies and more importantly, the experiences that I had gathered in collaborating with student's thesis at the CAST laboratory, I developed two types of sensors to use in this design. Tactile sensor based on multidimensional pressure detection and slip sensor to detect sliding of the object on robotic hand skin surface, as well as detecting the distance between the surface and the object.

Document links: Primary design 3D pdf [Use Adobe Acrobat Reader for 3d pdf]; Basic structure 4 DOF video

II. Slip Sensor

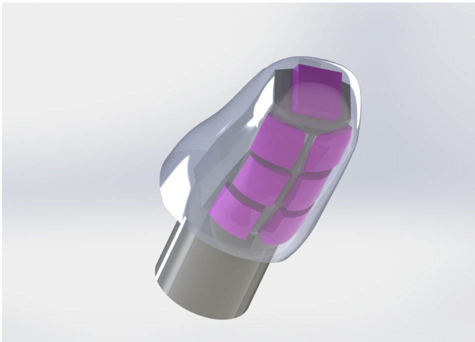
Developing a sensor to detect objects sliding on robot skin (2016 – present)



With more researcher and experience, I realized that in order to have a proper grip with sufficient force, we need to have feedback from the skin of the robot. Cooperation in Ms. Salehi's M.SC. thesis gave me a lot of great ideas and valuable experiences which led me to think about other new creative solutions. As a result of my researches, I became acquainted with the idea of Theremin. By reviewing and combining this idea with my own design, I decided to use a "relaxation oscillator" with a simplified R-C circuit. By studying this circuit and parameters there, I began to optimize it based on its use. The features that matter to me was high precision and low sensitivity of the sensor in different conditions, and secondly, its robustness and simplicity and also the possibility of making it in microscopic sizes. This sensor only includes series of parallel wires which are isolated from each other. Up to this stage, I have achieved the ability to detect slip of a paper sheet. I intend to use the smallest available IC packages for this purpose in the future, analyze its output data, and ultimately optimize the structure. A very important point of this sensor's application is the ability to detect the distance from the surface of the object, which should be calibrated to become usable.

III. touch Sensor

Sensor develop for to detect objects force direction (2017 – present)

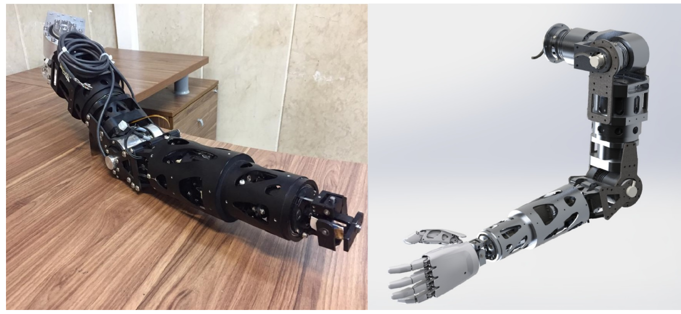


A sensor to understand the touching process is one of the challenges that I've always struggled to find a solution for. Since this sensor and its structure have a direct impact on the overall design of the mechanism, its connection and structural nature must be determined. I developed an idea of using the pressure sensor in an elastic enclosure after I had collaborated with design and construction of Mr. Pouraye Vali thesis. Finally, by modifying the type of the pressure sensor (BMP pressure sensor series), designing a method for constructing elastic enclosures, I found a method to measure and detect force and its direction. This sensor is an array of sensor chambers that form the outer skin of the finger. The arrangement of sensors in an array form has the advantage to generate an understanding of direction and amount of force. How to build this arrays for optimal performance is the most important challenge for this design and also is my interest. This project is currently in the form of Ms. Jafari's bachelor thesis while I'm completing and calibrating alongside her. The method of making the mold and selecting the elastic resin-forming component of the sensor is being investigated.

Reference: CAST Laboratory, Research assistant: **Zeinab jafari**
Email: zeinabjafari95@gmail.com
Document links: Sensor first test video

IV. Mechanism design

Surena IV humanoid robot arm design (2017 – present)



"Surena IV arm" was defined as a sub-project of Surena original project. This arm, along with the forearm, had 7 degrees of freedom, which became challenging when the overall size of the robot decreased. shoulder roll and shoulder pitch actuator are located on the shoulder joint, but shoulder yaw actuator should be connected in a way to stand alone against the bending moment caused by the weight of the hand structure and not affect the performance of it. Therefore, at the end of the actuator, secondary support was used to tolerate the torque produced during rotational motion of the actuator. The lack of wiring space and mechanical barriers, though annoying, made my mind more prepared and skilled for later stages. In this structure, the combination of aluminum alloy 6061 and 7075 and carbon fiber composite was used. The " Topology optimization method " was also used to optimize the design.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Surena IV humanoid robot arm 3D PDF [Use Adobe Acrobat Reader for 3d pdf] ; Surena IV arm Video

V. Mechanism design

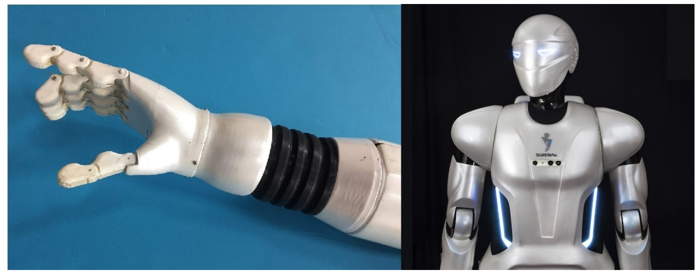
Surena IV humanoid robot hand design (2017 – present)

With the start of the "Surena IV" project, based on previous experiences and the future that was considered for the project, we concluded that each robot's hand had six independent degrees of freedom. Based on the experiences of cooperation and participation in the construction of the thesis by Ms.Salehi and based on the linkage mechanism, Surena IV hand was designed with six degrees of freedom. This time, in contrast to the previous method, instead of designing and constructing a linear actuator, a linear servo actuator was bought and used. This design was done in a modular manner so that each finger was an independent unit which could be removed and repaired. In this case, for the purpose of reducing the number of communication wires, an intermediate PCB was used at the back of the hand, in which all sensors and actuators were connected to it and the board transmitted data through a four-way protocol to the central control system of the Robot. In each hand, six current sensors are used to manage force control process while the data is being transmitted by the main protocol to the central control system.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Surena IV humanoid robot hand 3D PDF [Use Adobe Acrobat Reader for 3d pdf]

VI. Mechanism design

Surena III humanoid robot hand design (Spring 2015)

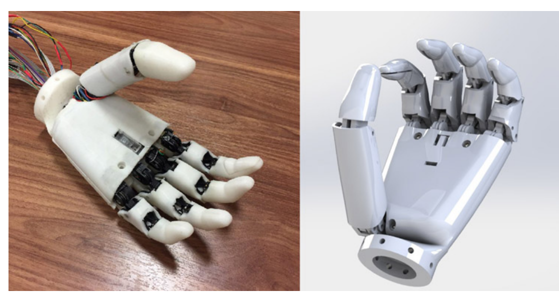


By completing my undergraduate education, my first experience as a research assistant at " CAST Laboratory " started with the design and manufacturing project of the "Surena III" humanoid robot hand. This was a hand with one degree of freedom that we wanted to provide its movement only by one actuator. The harmonic motion between the fingers was an important issue, but since the hand actuator had already been selected, we had to redesign and rebuild the system on the basis of this conditions. After this design, the number of DOF in arm and forearm increased from 6 to 7 degrees by adding new actuator in wrist position. This caused some trouble to connect wrist to forearm. Transferring the actuator of the fingers to the arm and transmitting force using a cable and also using an elastic coating as a channel for cable hand tendons was our solution. My success in this project began my collaboration with the " CAST laboratory " as a research assistant.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Surena III IEEE Spectrum

VII. Design Consultation

M.Sc. thesis "Design and feedback control of a 6 DOF below elbow myoelectric prosthetic hand for grasping" at university of Tehran (fall 2017)

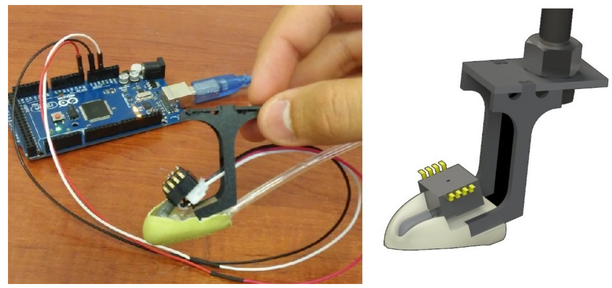


CAST Lab under the supervision of professor Yousefi-Koma has two sections; dynamic and control laboratory, and vibration laboratory. In centers such as "CAST" there is a great need for a mechanical designer to give required suggestion and guidance. One of the greatest opportunities that I had got in CAST lab was collaboration with Ms. Salehi's master thesis including the construction and control of a robotic hand. this project included position control, force control, as well as slip detection. It had six degrees of freedom, each finger had one degree of freedom and thumb had two degrees of freedom which were controlled by linear actuators. Minimization of structure to get proper control was one of the main challenges of this design. The tasks done during this project were designing and manufacturing a linear actuator for fingers and a sensor to determine the angle of joints in mechanisms and position of fingertips. The tests that were performed had acceptable results.

Reference: M.Sc. graduate, University of Tehran: **Sahel salehi**
Email: *salehisahel@gmail.com*
Document links: Sliding test video; Pinch test video; Designed actuator first test video

VIII. Design Consultation

B.Sc. thesis "A novel multi functional tactile finger" at university of Tehran (Spring 2017)



The B. Sc. thesis which was done by Hamed Pouriaye vali was about designing and customizing a sensor to understand touch and slide. The sensor mainly consisted of a rigid body (bone) and a flexible cover (skin). The empty space in the body, which was covered by flexible skin, was filled with fluid. When the finger had touched a surface, the skin deformed and the pressure difference in the fluid was measured by an off-the-shelf pressure sensor. Designing manufacturing method, Using epoxy resin to mold and using "SolidCAM plugin" to generate 3D machining code were new experiences of this project. Patterns on the outer surface of the skin generated vibrations in pressure signal, while the finger was being moved along a textured surface. This feature gave the finger the ability to detect slip.

Reference: M. Sc. student, University of British Columbia, Canada: **Hamed Puriaye Vali**
Email: *hamedpouriayevali@gmail.com*

IX. Mechanism design

Humanoid robot wrist mechanism design (2016 – 2018)

One of the best innovative mechanisms that I have ever dreamed up was a complex mechanism that was used in "Surena IV" robot wrist. This design was inspired from a concept which was designed to actuate a three-degree-of-freedom camera at the end of a narrow cylinder. Although this concept of the camera has never been built, but its idea was used in this mechanism. This mechanism has a two-degree-of-freedom joint that is axially aligned at one point. By using links, linear bearings and linear actuators, joint's actuators were moved in a few steps to a more distant point, thus allowed the joint to be much smaller than the actuators. In this mechanism like "shoulder yaw actuator" should be connected in a way to stand alone against the bending moment caused by the weight of the hand structure and not affect the performance of wrist yaw mechanism. The implementation of this mechanism in this robot and its innovation proved its concept. It was one of my most successful novel mechanism design experiences.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Download wrist mechanism 3D PDF [Use Adobe Acrobat Reader for 3d pdf]
Download wrist mechanism concept video; Download wrist mechanism video

X. Biomechanic design

Robotic hand mechanism design (summer 2011)

Hand Mechanism design is my favorite area and I have always tried to find a reliable methodology to simulate and design hand movements from the outset. These efforts, in line with my personal interest, were prior to entering the university. Using tendon system to move fingers and placing actuators was the main important goal that I had to solve to get experiences I needed. With several attempts, constructions and tendon path examinations, finally, I made a prototype using a linear actuator. The tests that were carried out proved the reliability of this method. This hand, in spite of the simplicity of it, is so efficient and has the ability to produce a lot of force in pulling tendons.

XI. Mechanism design

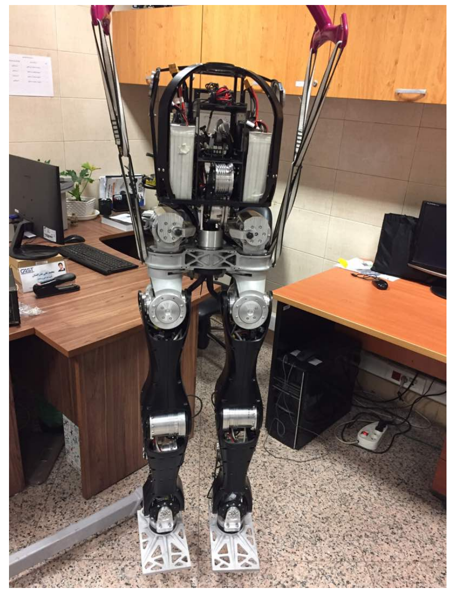
SMA mechanism design (spring 2015)

My first acquaintance and experience with smart actuators relate to shape-memory alloys(SMA) which should be used as a linear actuator for a robotic hand. Since these actuators have a small displacement lower than our requirements, it was decided to use a spring shape SMA for these actuators. In this case, there were two topics to be disused. First, these spring-shaped actuators move only in one direction and return to their initial length after pulling. Hence, in order to solve this problem, the two-directional motion of the springs was used in series that pulled more than their initial length. In this way, when a spring is pulled, another spring is charged, which makes it possible for the mechanism to be functional. The next issue was heat transfer control of the springs. warming up should be controllable and do not subjected to severe impact. The general structure of the robot should not be affected by warming up the springs.

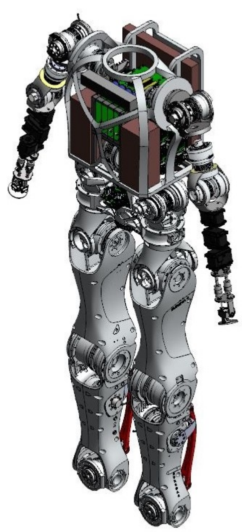
Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Project conference Paper

XII. Bio mechanic design

Surena IV Humanoid robot design (2015 – present)



Based on the experiences from "Surena III", the "Sorena IV" project began. It was decided to refine the mechanical design as far as possible, so we created a general plan for designing the robot. The mechanical design of the robot was divided into several parts. One: actuators, two: legs and ankle mechanism, three: hip and its mechanisms, four: chest and placement of its components, five: shoulder to hand, six: head and shell of the robot. Each of these sections had an appropriate approach and methodology of its own. For example, in head design, the main constraint was about appearance, so mechanical issues were in the second step so that the design process started with the industrial and artistic design team and proceeded with the collaboration of the mechanical design team. I attended the project "Sourena IV" as a member of the design and manufacturing team. In this project, coordination was needed between the other sections to complete the project. For example, constraints related to location of some electronic parts, boards and circuits, wirings, and location of batteries and power system was in coordination with the electronic team, placement of IMUs and mechanisms and actuators conditions was in coordination with the dynamics and control team, location of cameras and audio sensors was in coordination With the software team and taking into account overall constraints of design and appearance was in coordination with the artistic and industrial design team.

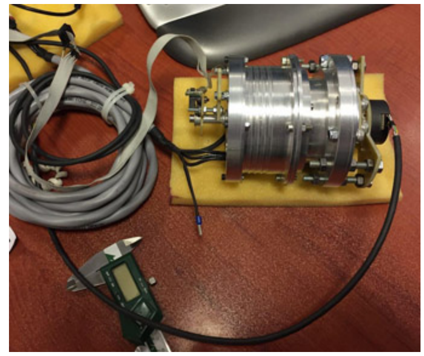


Due to the fact that mechanical constraints and structural strength issues were one of the most important elements in the robot structure, coordination between our team and other teams was carried out back and forth, and in each phase of the project information between the teams were updated. Location of ports needed to connect the robot to the outside, main switches, shell connections, and at the same time, Constant consideration of the weight of the robot were some of the challenges that despite the simplicity of them, brought me a lot of valuable experiences. The advantages of teamwork and interaction with other project groups, time management, resources management, interaction with external suppliers were some of the most important experiences that I accumulated during this project. Apart from the design of the legs that I acted as the design consultant, I had a direct role in the design process of rest of the parts, which were very large and complicated, it made me skillful. All parts of the project were being designed at the highest level of innovation and creativity, while we always looked at past experiences, "Surena III", and resources management. The robot's total weight was one of the issues that I invented a new way to minimize it. In this method, an online excel file with weights of all robot components was provided to all teams, which was regularly updated. Also, several meetings To minimize them were held continuously.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*

XIII. Actuator design

Humanoid robot Prototype actuator packing design (2015 – 2016)



With start of the "Surena IV" project, based on experiences from "Surena III" actuators, it was decided to review and study other existing robots, so that we could design the new ones with better functions. Actuators have a motor, power transmission system and feedback sensors. Each actuator contains a "RoboDrive" servo torque motor, a non-housing " Harmonic Drive component set ", a magnetic incremental encoder on the motor side for positioning the system, a Hall effect sensor to zero the incremental sensor error at high speeds, and a magnetic absolute sensor on the main output side to indicate original reference. Each section of the actuator had its own specific challenges that was examined and solved in this early version. The "RoboDrive" servo motors which were used in this design included a stator and a rotor ring.

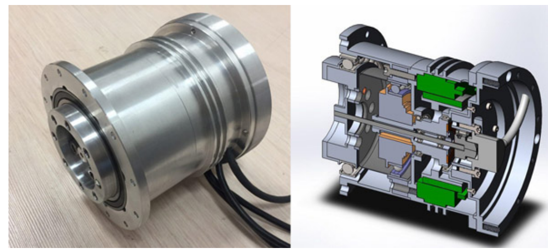
We had questions about designing motor unit housing, shaft, bearing set selection, cooling condition, sensors assembly, connectors and assembling motor to Harmonic set that should be answered. By reviewing technical documents, designing along with the analysis of each of the components started until the optimized design was achieved which was a very valuable experience in designing the actuator and assembly. One of the issues that I encountered with, was that the electronics and control team had to select different sensors based on their control conditions, while there were no experiences about the use of these sensors. Therefore, at this step, close to ten different types of sensors were added to the prototype system in different types of connecting methods that in many cases was very complex. After that, each sensor was checked out. Finally, the best sensor was selected and its related considerations were derived from the experience.

The harmonic drive is very important as a part that generates a ratio to the actuator system and exits final torque. The design of the Harmonic Drive unit was a challenge in a number of ways. For instance, in all actuators being designed, the largest diameter was related to the circular spline of Harmonic Drive, which complicated the connection of motor unit toward Harmonic Drive unit. One of the experiences that were very frustrating in the early steps of work, was the "wave generator" axial force, which I did not know about its importance until I encountered it. These experiences about motors and Harmonic Drive tolerances and some other details about design and construction of this actuators had been obtained during this prototype tests. Many of the ideas and innovations used in the actuator design in the later steps were based on these experiences. For example, absolute encoder sensor was moved to the opposite side of the motor output. Actuator design project started from the earliest point while innovations and endeavors in these designs last to the end of the construction period.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*

XIV. Actuator design

Surena IV humanoid robot knee actuator packing design (2016 – 2017)

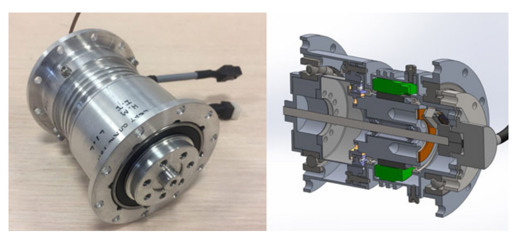


Before starting to design "Surena IV" actuators, one sample actuator was produced with a harmonic drive and a motor which was used again in the main knee actuator. At that stage, the technology of constructing these actuators was achieved and also many concerns were solved. Thus, for the main knee actuator, we just had to redesign that prototype actuator according to robot construction. This actuator was the largest actuator in the robot and the most challenging of them in terms of weight. Based on the knee geometric constraints, the actuator was designed and built using a RD 85 Robo Drive torque motor and a CSG HarmonicDrive component set. This actuator was compared in terms of weight with "ARMAR 4" robot actuator which was about 10 grams lighter than "ARMAR 4" robot knee actuator with the same motor and harmonic drive. The incremental and absolute encoders set were mounted on one side of the actuator on its end cap. This placement made it easy to separate and test sensors easily and independently from the rest of the actuator. The calculations of the bearings on the output side of the actuator and the idler side took into account the optimal weight conditions. The knee joint force conditions make it very critical in terms of stress. some of the important accomplishments of this design were accurate calculations for transferring forces to the bearings of refractory structures and minimizing the internal stresses of the actuator housing components.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Download Knee Actuator 3D PDF [Use Adobe Acrobat Reader for 3d pdf]; Knee actuator first test video

XV. Actuator design

Surena IV humanoid robot Ankle actuator packing design (2016 – 2017)

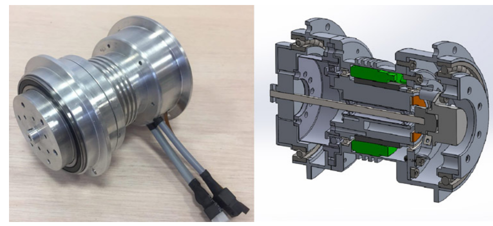


Robot's ankle and its actuator required special design due to special conditions and appearance of the robot. Based on experiences achieved from the knee actuator, this one was designed. There were two new constraints about this actuator. First, its size and conditions of its placement in the structure, which should have been designed simultaneously with the robot leg structure. The next issue was "CPL Components Set" harmonic drive type used in this actuator which its "Wave Generator" was a flange, and its connection to the motor set was a new experience. On the other hand, the input diameter of harmonic drive "Wave Generator" and the rotor diameter of the "RD 50 RobDrive" torque motor was nearly equal to main shaft diameter. So, their assembly was a major challenge to select main motor shaft bearings. During minimization process of ankle actuator size, the length of the actuator, the method of connecting the idler bearing set to the system was changed and replaced to withstand the forces at the junction of the steel structure. Both ankle actuators, ankle pitch actuator, and ankle roll actuator are structurally similar But differ only in output flange.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Download Ankle Actuator 3D PDF [Use Adobe Acrobat Reader for 3d pdf]

XVI. Actuator design

Surena IV humanoid robot Hip pitch actuator packing design (2016 – 2017)

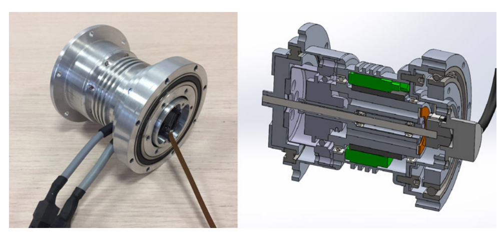


Each robot's leg has three degrees of freedom at the hip joint. Hip pitch actuator is one of the determinant actuators of the robot because their output torque tells us how fast the robot can walk. Moreover, legs connect to their output shaft directly which means they bear all of the leg's weight. Diameter difference from "RD 50 RoboDrive" torque motor to "CPL component set" harmonic drive which brings us some challenges in design and assembly. This difference in diameter made the design of the motor and selecting bearings very complicated. Because the diameter of the harmonic drive was larger than the diameter of the motor shaft, therefore, in place of the interchangeable bearings, unlike other actuators, the hip pitch actuator was assembled from front area, while in other actuators it was done from behind. Therefore, the design and assembly of the motor changed completely. Due to critical conditions of the actuator and calculations for the main bearings, the general design of the system was formed in a Dumbbell shape. Assembling the motor stator and connecting it to its housing, according to this form of structure, brought up with new challenges, which was a great experience. Many changes were made to optimize the design at the junction of hip pitch actuator in the hip mechanism and also in the fixed flanges on the actuator body. Finally, the adjustable part of the absolute encoder shaft was placed on the outer side of the foot so that it was easily accessible.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: Hes.maleki@gmail.com
Document links: Download Hip Pitch Actuator 3D PDF [Use Adobe Acrobat Reader for 3d pdf]

XVII. Actuator design

Surena IV humanoid robot Hip roll actuator packing design (2016 – 2017)

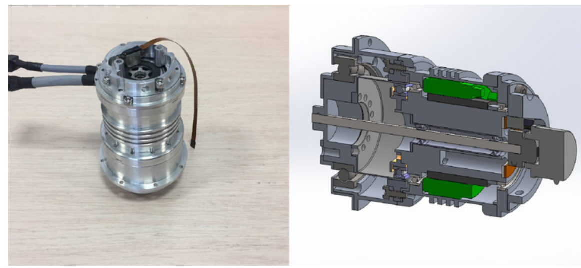


The top of the leg at the hip joint position should be hip pitch, roll, and yaw rotation axis intersection. Hip pitch actuator is located at its place according to the order of actuators function. To get a good function from hip roll actuator like passing the axis of joint rotation, special constraints should be considered for this actuator design. Although this actuator had a "RoboDrive RD 50" torque motor, but I used a "cobaltline HarmonicDrive component set series" in this experience. This type of HarmonicDrives increases the overall length of the actuator while we needed to minimize the overall length because the whole hip roll actuator rotates around the yaw axis which means the longer the actuator's length, the greater the circular diameter of the actuator in that space. Besides, connection method is totally different in this type of harmonic drive. Due to all conditions I've mentioned above, I did a trick to insert a part of the Harmonic Drive wave generator into the overall design of the motor. But again, entering HarmonicDrive wave generator part to the motor shaft and how to connect the shaft to the front bearing brought me a sweet challenge to solve. Flattening actuator's end surface to connect the link of hip mechanism was the easiest and also at the same time, the most effective method to reduce the actuator's length and minimize the diameter of rotation circle.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: Hes.maleki@gmail.com
Document links: Download Hip Roll Actuator 3D PDF [Use Adobe Acrobat Reader for 3d pdf]

XVIII. Actuator design

Surena IV humanoid robot hip yaw actuator packing design (2016 – 2017)

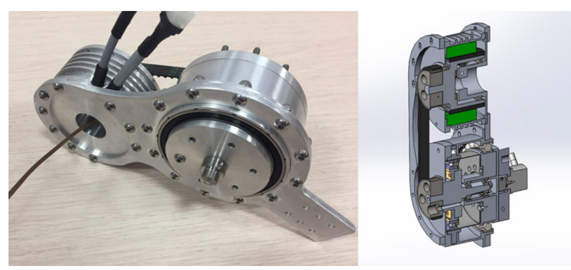


Hip yaw actuator is important since it is the only lower-body actuator having one single support connection to the pelvis structure to rotates the leg structure around yaw axis using a single link. This actuator was on the back of the robot's pelvis and was connected to the structure through its front-end flange. Since the motor and hall sensor cables come out from the end of the actuator, it was necessary to separate the actuator into two pieces to be connected to the pelvis structure. So, the actuator was split into two separate parts from the HarmonicDrive position and re-assembled after being placed in the body. In this actuator, a bearing was applied to the main output of the system to bear axial forces and also an independent cap to fix bearing against this forces. We transferred the torque needed for yaw rotation through a link. That link had a little distance from the bearing which caused an unwanted torque on the bearing around its radial axis. To overcome this problem, we needed a special type of bearings called " Crossed " bearings but as we didn't have access to these pieces, Thus we tried to minimize the effect of this problem by choosing the right deep groove ball bearing through calculations. We used a " RoboDrive RD50 " torque motor and a" CPL component set " HarmonicDrive in this actuator.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: Hes.maleki@gmail.com
Document links: Download Hip Yaw Actuator 3D PDF [Use Adobe Acrobat Reader for 3d pdf]

XIX. Actuator design

Surena IV humanoid robot body Trunk pitch actuator packing design (2016 – 2017)



The complexity and compaction of "Surena IV" humanoid robot hip mechanism made it difficult to design body trunk pitch actuator. This actuator, using "RoboDrive RD70" torque motor and "Cpl component set" Harmonic Drive, has been designed in two parallel axis due to lack of sufficient longitudinal space. We had to minimize the length of the Harmonic Drive, so an innovative trick was used. Harmonic Drive has one dependent input and one independent output shaft. to make the input independent it needed to seat on another shaft which was idler with help of one bearing in the center of the output shaft. In other words, we made a hole at the center of the output shaft, put a bearing there and passed the input shaft through this bearing. Therefore, the input became idler toward the output. At the end, two separate parts of the actuator, main motor and the Harmonic Drive, were connected with a timing belt and provided a good performance. With regard to the relative movement of the upper body and lower body and also location of trunk motor, the other challenge was how to connect absolute sensor of the actuator to main coordinate.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: Hes.maleki@gmail.com
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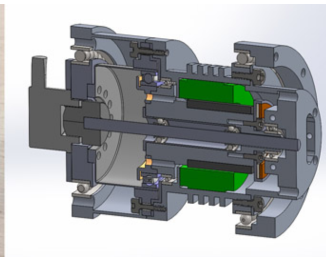
XX. Actuator design

Surena IV humanoid robot Elbow actuator packing design (2016 – 2017)



The smallest actuator being designed for "Surena IV" humanoid robot is elbow and shoulder yaw actuator. They are the same in design and specifications. These actuators have a "RoboDrive RD 38" torque motor and a "Cpl component set" HarmonicDrive. The small motor diameter and compact design made a new challenge. In this actuator, unlike the other ones, the main incremental sensor was not directly connected to the main motor shaft but on a coaxial disk toward the main shaft at its end because the diameter of the incremental sensor was larger than the main shaft. The main motor shaft has two problems, first; has a small diameter, second; it was hollow. As you see in the picture, a coaxial disk was installed to the end of the main motor shaft, then shaft diameter severely decreased and passed through a small bearing. Next challenge was To connect the absolute encoder which could not seat at the end of the motor shaft due to design constraints. So, it was added to the front end of the actuator, at the input side and encoder shaft passed through the entire actuator and got fixed to the stator. Hollowing the motor's main shaft with its low diameter and new different connection method of absolute encoder was the main innovations in this design. The speed of this series of motors was more than 10,000 rpm which was an exciting new experience for me.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
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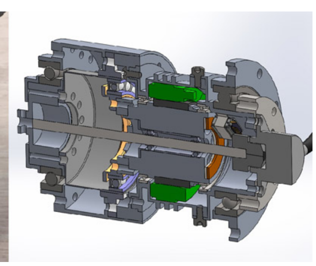
XXI. Actuator design

Surena IV humanoid robot shoulder actuator packing design (2016 – 2017)



Shoulder pitch and roll actuators are one of my most distinct design experiences. Based on initial selections, "CPL 17 component set" Harmonic Drive and a "RoboDrive RD50" torque motor were bought. Then, the motor shell was designed, packed and motor stator was glued to its housing. After these steps, size of the Harmonic increased to "CPL20 component set". This correction was done due to actuator simulations for torque and speed specifications. As I said, we glued the stators to the motor shell but the change of circular spline of Harmonic flange didn't let us install it into the motor flange. We had this problem for the main motor shaft and wave generator too. But as we couldn't buy a new motor, I had to find a new way to manage this maladjusted parts. Adding a part to the shaft head and redesigning the overall design of the Harmonic Drive housing were one of my most different experiences in refining and re-designing a piece. This actuator was upper-body actuator series which did not have critical conditions, so this kind of edition could be done.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
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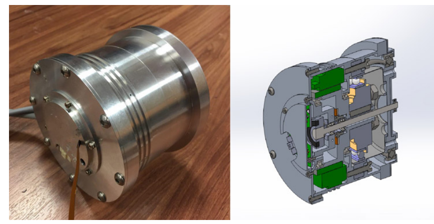
XXII. Actuator design

Simon Fraser University Canada exoskeleton actuator packing design (fall 2017)

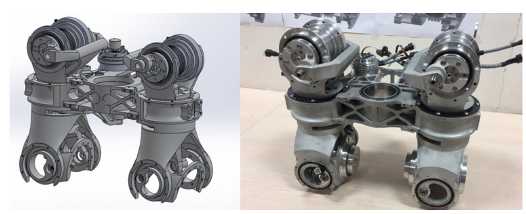


Using experiences of "Sourena IV" actuators design, in the fall of 2017, I was offered an actuator design for an exoskeleton by CAST's technical manager and a former student of CAST laboratory who currently studies at "Simon Fraser University" in Canada. Initially, I began reviewing their specifications for the actuator and suggesting a few things that could be done. This actuator was placed in the same place at the structure joints, But it didn't have a swivel part to withstand joint forces. So all these forces would be transfered to the output of the actuator which is not good. This was one of the main challenges in this actuator design. The final actuator included a RoboDrive RD85x13 torque motor, a hall sensor, and a CSG25-2A harmonic drive component set. Due to the special use of this actuator in its dimension conditions, as well as its connection method, many innovations were made. The final diameter of the actuator was 99mm, length was 85mm and the final weight was 1.5kg, which was highly optimized for this design. Other innovations to be mentioned are the use of crossed roller bearings, which were designed based on the type of connection between actuator and structure, and also the new type of absolute encoder on the actuator output side.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Motor unit Assembly Guide video; Harmonic drive unit Assembly Guide video

XXIII. Mechanism design

Surena IV humanoid robot hip mechanism design (2016 – 2017)



One of the most challenging design processes of the humanoid robot is the hip mechanism design. There are three points here. First: hip must present a good performance, Second: it needs sufficient workspace and Third: it should have the highest degree of similarity to a human posture not a rough industrial mechanisms. So, in the "Sourna IV" project it was decided to redesign and modify the mechanism of the hip. Hip Roll and Hip Yaw actuators use a link to transmit their torque to their joints. Using the links allows us to move actuator out of the joint, but at the same time create much more complexity for the mechanism. In humans hip three axis have an intersection at one point. Trying to simulate and design this action was my challenge at this stage. Moreover, the length of the legs are about one meter which cause considerable bending torque in joint positions. Designing a mechanism to manage all of these problems and also minimize the size and the structure deflection in an innovative way was my goal. After concept design, using topology optimization method, initial design was started based on the constraints of the structure , including the amount of angles required for each joint, started. Ultimately, the final design was achieved by carrying out simultaneous analysis. The use of links in limited and small spaces for mechanisms, their assemblies and the consideration of manufacturing processes are some of the success in this design.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Hip mechanism 3D PDF [Use Adobe Acrobat Reader for 3d pdf]; Hip mechanism Video
Hip roll mechanism Video

XXIV. Structure design

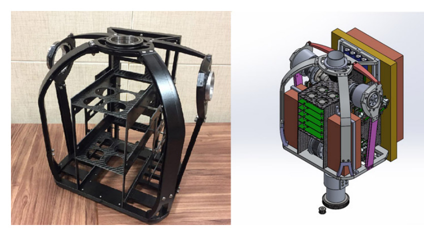
Surena IV humanoid robot pelvis structure design (2016 – 2017)

Pelvis (Hip) structure in humanoid robots is a junction between legs and body trunk and one of the most critical parts in the structure. In the previous version of "Sourna", "Sourena III", this part of the structure had many technical challenges like a deflection. Design of the hip structure was a mixture of previous efforts and experiences and new creative ideas. The main method was to put basic components and mechanisms together to use "topology optimization" method for optimization. For this purpose, two softwares were used. First: "Inspire-solidThinking", second: "Siemens NX" software to validate the results of "Inspire-solidThinking" software in the previous step as well as to find other possible solutions based on our assumptions. with the release of "Topology Optimization" Plugin in "SolidWorks", all previous steps were checked again. The final output was not manufacturable so the structure revised with respect to manufacturing methods. After all the steps mentioned, it was necessary to analyze the component in terms of loads. This iterative procedure happened many times in order to get the optimum structure design. The final weight of the structure was 1.3 kg using the 7075-T6 aluminum alloy which was an acceptable amount for this fateful component.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: Pelvis structure 3D PDF [Use Adobe Acrobat Reader for 3d pdf]; Pelvis structure Video

XXV. structure design

surena IV upper body design (2016 – 2017)



The resonant frequency in the cage structure above the trunk was one of the coolest design challenges I have ever faced. The cage was integrated but had a low resonant frequency which was not acceptable for robot conditions. Minimizing natural frequencies of the cage was the main goal in this design. In addition to this, minimizing the total weight of the structure was also very important. With this in mind, the top structure was designed based on experiences from the previous version of "Surena" robot and other new experiences and results obtained during the project. The design and cut-off of the chest at the top should have been such that they take into account the construction constraints and assemblies, and that the single components and the natural frequency set be far more than the frequencies in the system, so harmonics would be prevented. By redesigning and adding suitable bearings at the joints, the vibrations produced by the joints were minimized. At the point of attachment of the head, I used two parallel bearings to reduce head structure's vibrations. Locating various components that were very compact, as well as the two degrees of freedom in the waist, and more importantly the connection between shoulders and head to the upper body structure, added complexities to the design. The placement of shunt regulators was also a challenging task in the chest assembly. The box of the regulators was heavy and large but played an important role in the heat transfer of the system as a free convection. By performing heat transfer calculations and equating heat loss to the system, regulators boxes were replaced with fans to created forced convection.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: *Hes.maleki@gmail.com*
Document links: upper body 3D PDF [Use Adobe Acrobat Reader for 3d pdf]; upper body structure video

XXVI. **Design Consultation**

M. Sc. thesis "Design and Control of an Active Ankle Prosthesis to Mimic Walking Gait with Intact Leg" at university of Tehran (fall 2017)

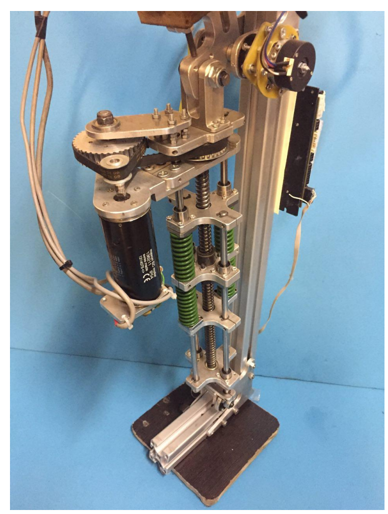
One of my most exciting experiences in bioengineering design was my collaboration in "active ankle prosthesis" design which was important to be practical and usable. Most of the CAST laboratory projects were in control field, But as my research field was about mechanical design and its constraints and feasibility study of them, I look at this projects from this point of view. In other words, any project I worked on was a research in my favorite field. Nafise Faridi Rad's M. Sc. thesis was a novel design for ankle prosthesis with one passive joint for ankle inversion and eversion (Roll) movement and one active joint for dorsiflexion and plantar flexion (pitch) of the ankle. These movements were created by employing Series and Parallel Elastic Actuators (SPEA). Determination of overall manufacturing method, complicated CNC machining code generation by SolidCAM plugin and designing fixtures, changing spring load direction, designing timing pulley mechanism, designing and selecting ball screw and bearings, using cam follower as one side fixture, isolating the structure due to electrical noises that changed sensors behavior and many more were my experiences in this project as a mechanical design consultant.

This thesis has been done in CAST Lab under supervision of professor Yousefi-koma.

Reference: M. Sc. graduate, University of Tehran: **Nafise Faridi Rad**
Email: n.faridirad@yahoo.com
Document links: Manufacturing sample video

XXVII. **Design Consultation**

M. Sc. thesis "Active knee prostheses" at university of Tehran (fall 2017)



Cooperation in design and manufacturing of active artificial knee prosthesis was another of my experiences in the field of mechanical design of Bio-Engineering. This artificial active knee was Mr. janati's M. Sc. thesis which was designed based on elastic series. This elastic series has been actively working to rebuild the knee mechanism by changing the direction of force from rotational in the knee position to linear along the length of the leg, using a power screw and a set of linear springs. The transfer of torque in two stages using timing belts, the design of the elastic series mechanism based on springs and linear bearings, and the isolation of sensors based on previous experiences were one of my most important experiences in this collaboration.

This thesis has been done in CAST Lab under supervision of professor Yousefi-koma.

Reference: M. Sc. graduate, University of Tehran: **Shayan Janati**
Email: shayanjannati1992@yahoo.com

XXVIII. Design Consultation

Elastic series design (summer 2017)

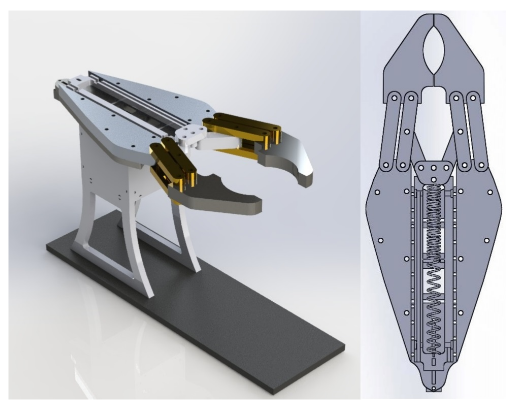
In designing "measurement systems" two points are important. First: uniformity, second: trustworthiness. My experience in an example of this kind of design is going back to Ms. Arghavani's B.Sc. thesis. She asked me to guide her through design and construction of her bachelor thesis. She wanted to use elastic series to measure the amount of torque passing through the system. This system rotates so this rotation brings much more challenges that should be considered at all stages of design. The final design was a stellar arrangement, and it was a very interesting challenge. Choice of springs and designing based on the linear range of deformation was one of the most important experiences in this thesis. The triple-star arrangement was selected to design arms and connect the springs to each other. The outer housing of the system was designed and built seamlessly which was one of the longest and most complicated manufactures. Eventually, the assembly stage of the six springs together was very interesting and different. After the tests, the behavior of this system was very acceptable.

This thesis has been done in CAST Lab under supervision of professor Yousefi-koma.

Reference: M. Sc. student, Concordia University Montreal, Canada: **Boshra Argahvani**
Email: *boshra.arghavani@gmail.com*
Document links: Mechanism test video

XXIX. Mechanism design

SMA gripper design (spring 2015)



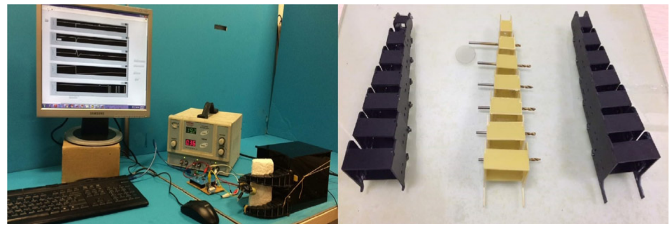
Ms. Faridi rad, teacher assistant of smart material course, needed a practical and functional mechanism for defining the final project problem of smart materials course. For this purpose, we decided to design a gripper using smart material actuators. I had the experience to design and produce robotic hand with this kind of actuators. This design had sensitive constraints like reversibility frequency that should have been in the maximum possible amount in environmental condition. For this purpose, the previous idea was used for this work too. In this method, we had two springs in series, and their interconnection point was the location of linear force output. Each spring was pulled by the other one so they moved to one side of the system on the opposite side. This method was very efficient and produced maximum possible frequency control. Another interesting experience in this design was a lever-based mechanism to synchronous two jaws' motion of the gripper.

This course was held by professor Yousefi-koma.

Reference: M. Sc. graduate, University of Tehran: **Nafise Faridi Rad**
Email: *n.faridirad@yahoo.com*
Document links: Project conference Paper

XXX. Mechanism design

Design and force control a nylon actuator based gripper with multi joint finger (summer 2017)



I had a corporation with a member of CAST laboratory that was a start point for me getting to know nylon thermal actuators. In order to get function from nylon actuators, in Mr. rafiee's M.Sc. thesis at CAST lab, we needed to design a gripper mechanism. Due to special conditions of heat transfer for these actuators the mechanism must have been designed in a way that thermal conditions of nylons become controllable. Relative temperature uniformity of actuators and control of conductivity conditions at different points of the actuators were the most important design constraints. The system provided acceptable performance at the testing stage.

This thesis has been done in CAST Lab under supervision of professor Yousefi-koma.

Reference: M. Sc. graduate, University of Tehran: **Soroush rafiee**
Email: srshrafiee92@gmail.com

XXXI. CAM Experience

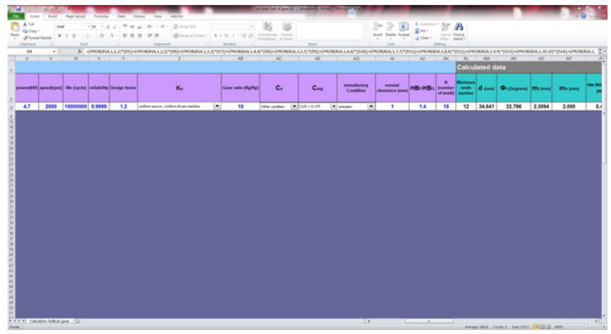
Manufacturing process by CAM software, 3D printer,5-axis machining (2016 – 2017)

A mechanical designer has some attributes like knowing manufacturing processes, distinguishing feasibility of the manufacturing processes and also the ability to design economically. It is not possible to achieve this experiences except by doing multiple tasks with strong desire. As time went by, I found that CAM software was an inseparable part of a good design. In 2011, I took part in a course of turning CNC and eventually improved my ability in manufacturing processes vision. It was a good opportunity for me to use milling CNC machine in my office after I entered into CAST laboratory in 2015. Use of different materials in my designs and constructions, practicing to use geometric tolerances, standards and details of manufacturing processes were some of my most important experiences at that stage of learning. Using the 3D printer and its software is another experience as a mechanical designer. Solidworks and SolidCAM plugin are software that I use to make manufacturing processes. Manufacturing strategy and machine code generation for 5-axis machining are some other prominent experiences.

Reference: CAST Laboratory, Technical Manager: **Hessam Maleki**
Email: Hes.maleki@gmail.com
Document links: Manufacturing sample video

XXXII. Calculating Program

Excel code for calculating Helical Gears (2013)

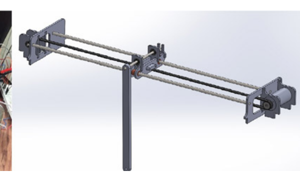


In 2013, when I was a bachelor student, I wrote an Excel file about Gears. After studying gears chapter of "Shigley's mechanical engineering design" reference book, because of the attractiveness of this subject, I tried to create a solution to do trail and error for optimum design. For this aim, I started doing curves fitting on Shigley's data and finding functions related to gears and eventually collected them in an Excel file for calculating helical gears design. In this program, you enter assumption information about the problem, such as speed and power transmission of the gear system, gear geometry and the material needed to build and then the program suggests you the best answer from trial and error solution. Considering all the issues is the most important advantage of this program. The final output is on a continuous data "gear hardness" and can be any number in its possible range.

Document links: Download calculate helical gears.xls

XXXIII. Design workshop

Design vision and rapid prototyping by SolidWorks workshop (27-28 December 2017)

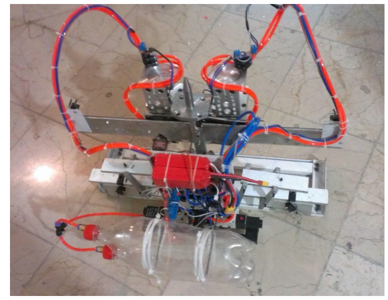


A two days workshop by Scientific Association of Mechanical Engineering (SAME) in the University of Tehran for "Mechanical Design Vision" and "Rapid Prototyping by Manufacturability Approach" Using SolidWorks to visualization and edit ideas was held. The major goal of this workshop was the instruction to manufacturing processes, choosing materials and components and electrical system considerations. I chose an On rail inverted pendulum design for this course. Course topics included challenges to design parts that should be cut from plates, choosing linear and rotary bearings by catalogs, choosing and designing timing belt and its pulley, designing fastener methods and finally housing design and its adjustment for "AS4058B absolute magnetic encoder" for position feedback. Besides, using this encoder is an interesting challenge because of its special structure that has two independent components to adjust.

Reference: Scientific Association of Mechanical Engineering(SAME), University of Tehran, Iran
Homepage: http://utsame.com

XXXIV. mechanism Design

Robotic mechanical design for ROBOCON 2014 competition (summer 2014)



In the late spring of 2014, I was offered to join the ROBOCON (Asian-Oceanian College robot competition, 2014-Pune, India) team. I entered the team when the project was in its last month. I was given the task of designing a moving robot across multiple disks that should be suspended using four number of grippers. During the first ten days, eight different designs were made and eventually a design in which a robot with pneumatic actuators was accepted to be made as the final version. The rest of the designs were based on power screw, magnets and rack and pinion mechanisms. In this design, we needed a longitudinal displacement for grippers along the robot so a linear bearing rail and rack and pinion mechanism was employed. This was my first experience in mechanical design based on pneumatic elements and was one of my best practices because our device did a very acceptable performance despite its small size and weight. This robot was designed and built in my last year of Bachelor studies, and it was the first time I introduced myself as a robotic mechanical designer to others. In addition to this project, Mr. Behnam Maleki (Surena's Team mechanical designer) saw my job and was me offered to join CAST laboratory as a mechanical designer. This was my start in the projects under the supervision of Dr. Yousefi Koma at the Faculty of Mechanical Engineering, University of Tehran, Iran.

Homepage: on-line competition poster
