ORAL Presentation
Control I
Chairs: Behzad Moshiri, University of Tehran
Gholamreza Vosoughi, Sharif University of Technology

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<th>Session time</th>
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| 11:00-11:20  | 36 WeA1.1      | Optimal synchronization of fractional-ordered chaotic systems
Reza Behinifaraz, Mohammad Ali Badamchizadeh
University of Tabriz
- An optimal controller is proposed for synchronization of different fractional order chaotic systems in this paper.
- Optimal control problem is solved by using variational calculus for fractional differential equations.
- Two system are synchronized with active control method for comparison.
- By comparing the results of two method, performance of proposed optimal controller is shown.

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<th>Session time</th>
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| 11:20-11:40  | 16 WeA1.2      | Decentralized Controller Design for Consensus in Nonlinear Multi-Agent Systems with Input Delay
Omid Nikouei Zadeh, Amir Amini, Mahdi Sojoodi
Tarbiat Modares University
- A new method for consensus in a group of nonlinear multi-agent systems with input delay using decentralized dynamic output feedback controller is proposed via an LMI approach.
- Controllers are fixed-order, then the order of controllers can be chosen arbitrarily according to the system conditions and limitations.
- To decrease the control calculations, the consensus conditions and unknown decentralized controllers parameters are derived in the form of LMIs.

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<th>Session time</th>
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| 11:40-12:00  | 127 WeA1.3     | Cooperative Control of Networked Autonomous Vehicles Using Convex Optimization
Mohsen Ahmadi Mousavi, Behzad Moshiri, Zainabolhoda Heshmati
University of Tehran
- This paper focuses on modeling of distributed and optimization-based planning framework for motion control.
- Define the framework based on Linear Time Varying Model Predictive Control.
- Use linear time varying constraints to cover obstacle avoidance and maintain connectivity missions as a multi-criteria optimization problem.
- Convert the final planning framework to a close-form convex optimization problem.

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<th>Session time</th>
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| 12:00-12:20  | 202 WeA1.4     | Modified Jacobian Transpose Control of a Quadruped Robot
Mahdi Khorram, Seyed Ali Akbar Moosavian
Center of Excellence in Robotics and Control Advanced Robotics and Automated Systems Lab, Dept of Mech Eng, K. N. Toosi Univ of Tech, Tehran, Iran
- An explicit dynamics model of an 18-DOF quadruped robot in operational space is derived.
- A stable COG trajectory generation algorithm based on the ZMP approach is proposed.
- A path for swing legs to prevent any impact between the swing legs and the ground is planned.
- Modified Transpose Jacobian (MTJ) controller is used to track the reference path.
**Robotic Mechanisms**  
**Chairs:** Hamidreza Mohammadi Daniyali, Babol Noshirvani University of Technology  
Hamid Reza Koofigar, University of Isfahan

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| 11:00-11:20   | 4       | Precision Control of Double-Gimbal Magnetically Suspended Control Moment Gyros | Behdad Geranmehr, Saeed Rafie Nekoo  
School of Mechanical Engineering, Iran University of Science and Technology (IUST)  
- This work proposes a state-dependent Riccati equation design for precision control of a double-gimbal magnetically suspended rotor control moment gyroscope.  
- Dual-gimbal magnetically suspended control moment gyros are key actuators to satellites as a complex representative of mechatronics systems.  
- The capability of the proposed method was confirmed by outstanding results of simulation. |
| 11:20-11:40   | 27      | Design of Hyper Redundant Robot using Ball Screw Mechanism Approach          | Salar Bayani$^1$, Rambod Rastegari$^2$, Farzad Cheraghpour$^3$  
$^1$Department of Mechatronic Engineering, Qazvin Branch, Qazvin, Iran  
$^2$Department of Mechanical Engineering, Parand Islamic Azad University, Iran  
$^3$Department of Mechanical Engineering, Pardis Islamic Azad University, Iran  
- 2 ball screw actuators in each section for roll and pitch rotations.  
- General design for each section that can be promote robot for 2N DOFs.  
- High stiffness, High capability to load capacity cause of ball screw mechanism. |
| 11:40-12:00   | 55      | A sensitivity-based Adaptive Sliding Mode Control for Perturbed Autonomous Underwater Vehicle | Mahnaz Abolvafaie$^1$, Hamid Reza Koofigar$^2$, Maryam Malekzade$^3$  
$^1$$^2$Department of Electrical Engineering, University of Isfahan  
$^3$Department of Mechanical Engineering, University of Isfahan  
- This paper focuses on controller design for an autonomous underwater vehicle based on the sensitivity analysis.  
- The direct sensitivity analysis method is used to determine the impact of hydrodynamic coefficients on system performance by taking standard maneuvers.  
- The adaptive control techniques are designed to estimate the most sensitive parameters.  
- The stability of the closed-loop system is guaranteed using the Lyapunov stability theorem. |
| 12:00-12:20   | 61      | DYNAMIC BEHAVIOR ANALYSIS OF FOUR-BAR LINKAGE MECHANISMS WITH JOINTS CLEARANCE | Amirhosein Javanfar, Morteza Dardel, Hamidreza Mohammadi Daniyali  
Babol Noshirvani University of Technology  
- This paper focuses on modeling and identification of clearance joints.  
- Using lankarini nikravesh method to obtain accurate results.  
- Identification of the joint clearance is an important issue in the mechanisms and robotic systems.  
- Consequently, it leads to a more accurate dynamic model for analyzing dynamic behavior of mechanisms with clearance joints. |
Flexible Robots
Chairs: Moharam Habibnejad Korayem, Iran University of Science & Technology
Khalil Alipour, University of Tehran

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| 11:00-11:20 | 112   | Trajectory Optimization of Two-Link Rigid Flexible Manipulators in Dynamic Object Manipulation Missions  
Bahram Tarvirdizadeh, Khalil Alipour  
University of Tehran |

- This paper proposes an optimal trajectory planning method of two link rigid-flexible manipulators for Dynamic Object Manipulation missions.
- Utilizing the powerful tool optimal control accomplishing a point-to-point task for two link rigid-flexible manipulators is the aim of this research.
- The pseudospectral method will be developed to satisfy the optimality conditions subject to system dynamics and boundary conditions.
- The complicated optimal trajectory planning is formulated as a nonlinear programming problem and solved by SNOPT nonlinear solver.

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| 11:20-11:40 | 115   | Best Parameters of Flexible Link Manipulator Systems for Dynamic Object Manipulation Execution  
Khalil Alipour, Bahram Tarvirdizadeh  
University of Tehran |

- This paper focuses on proposing a novel framework to find the optimum parameters of flexible link manipulators for Dynamic Object Manipulation missions.
- Three parameter-optimization problems will be solved to illustrate how the proposed framework can be exploited.
- Employing Pontryagins Minimum Principle within the suggested framework, the solution of these problems is highly intertwined to the solution of a Two-Point Boundary Value Problem.
- Consequently, the obtained results support the effectiveness of the proposed technique.

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| 11:40-12:00 | 137   | Nonlinear Bilateral Teleoperation with Flexible-Link Slave Manipulator  
Aida Rashidinejad, Seyed Kamaledin Yadav Nikravesh, Heidar Ali Talebi  
Amirkabir University of Technology |

- This paper addresses bilateral control of a nonlinear teleoperation system with flexible-link slave manipulator
- Tip position tracking of the slave manipulator is performed based on the output redefinition method, and uncertainties are compensated via a robust controller term
- A disturbance observer-force controller system is designed for the master robot to track the environmental force.
- The boundedness of the estimation and tracking errors is guaranteed by a proper choice of a Lyapunov function.

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| 12:00-12:20 | 139   | A Novel Tendon Less Back Bone Robot  
Arman Mardani, Mahdi Bamdad  
School of Mechanical and Mechatronic Engineering Shahrood University |

- This paper focuses on modeling and identification of innovative rigid mechanism used as a back bone robot.
- Using cross form mechanisms connected together in a chain provides a rigid back bone robot that has two DOF’s only in one curve.
- New mechanism is able to move in pure extension mode and pure bending mode.
- Moreover the compounded mode in possible.
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<tr>
<td>11:00-11:20</td>
<td>WeA4.1</td>
<td><strong>Sliding Mode Control of an Exoskeleton Robot for Use in Upper-Limb Rehabilitation</strong></td>
<td>Mahdieh Babaiasl¹, Saeede Nazari Goldar², Mojtaba Hadi baraghtalab³, Vahid Meigoli⁴</td>
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<td>¹University of Tabriz, ²Amirkabir University of Technology, ³Persian Gulf University</td>
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<td>- This paper focuses on mechanical design, simulation and nonlinear control of an exoskeleton robot for use in upper-limb rehabilitation.</td>
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<td>- Mechanical design of the robot is done in Solidworks and a new mechanism for third joint is proposed.</td>
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<td>- Sliding mode control is proposed to track the limb through the desired trajectories.</td>
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<td>- The optimized mechanical design and the controller outputs prove the suitability of the proposed robot for use in upper-limb rehabilitation.</td>
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<td>11:20-11:40</td>
<td>WeA4.2</td>
<td><strong>Speaker Localization in Noisy Environments: Design and Implementation of a Robotic Hearing Apparatus</strong></td>
<td>Ehsan Saffari¹, Ali Meghdari², Bahram Vazirnejhad³, Minoo Alemi⁴</td>
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<td>¹University of Tabriz, ²Amirkabir University of Technology, ³Persian Gulf University</td>
<td>⁴Islamic Azad University Tehran West Branch, Tehran, Iran</td>
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<td>- In this paper we have designed and implemented a robotic head, Ava, which turns toward the speaker in noisy environments.</td>
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<td>- No reaction to non-speech sounds in the environment, high performance of speech localization and natural turning toward speaker were all executed by Ava.</td>
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<tr>
<td>11:40-12:00</td>
<td>WeA4.3</td>
<td><strong>Designing interface for knee rehabilitation robot utilizing EMG signals of thigh muscles</strong></td>
<td>Arya Shabani, Mohamad Mahjoob, Ferdowsi University of Mashhad</td>
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<td>- This paper presents portable knee rehabilitation robot used biological signals of operator to recognize the intention of movement.</td>
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<td>- Utilizing human knee model base on hill-type model make the interface of robot capable to estimate amount of torque knee muscles contributed to every movement.</td>
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<td>- Biomechanical knee model has been calibrated during isometric contraction trials by utilizing knee muscles force as well as knee angle.</td>
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<td>- Calibrated knee model is led to estimate knee contributed torque to every movement accurately by reciving EMG signals of thigh muscles.</td>
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<td>- So, estimated torque within close loop controller is applied to the patient-operator foot in order to support the knee while it has been attached, to the robot’s arm by utilizing new orthopedic brace.</td>
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<tr>
<td>12:00-12:20</td>
<td>WeA4.4</td>
<td><strong>Fuzzy Impedance Control Strategy for Jaw Rehabilitation Using 6-UPS Stewart Robot</strong></td>
<td>Hadi Kalani, Alireza Akbarzadeh, Ali Mousari, Ferdowsi University of Mashhad</td>
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<td>- Kinematics and dynamics of an Stewart platform are discussed. An impedance filter is applied to the impedance control strategy.</td>
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<td>- The gains of the impedance filter are adjusted by fuzzy logic method to achieve the reference force. To obtain the workspace of human jaw, 6 small reflective markers were adhered to specific facial locations of three male subjects.</td>
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<td>- Reference trajectory modified by impedance filter so that reference force is precisely followed by contact force.</td>
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Regularized Least-Square Object Tracking Based on $\ell_{2,1}$ Minimization
Mohammad Amin Bagherzadeh, Mehran Yazdi
Department of Electrical Engineering, Shiraz University

- This paper presents a fast and long-term object tracking algorithm using the $\ell_{2,1}$ minimization to obtain a better tracking quality.
- In order to design a robust appearance model, we used a saliency map, image intensity and position of the target and its surrounding regions.
- Extensive experimental results on challenging image sequences demonstrate the efficiency, accuracy and robustness of the proposed tracker in comparison with state-of-the-art methods.
- The proposed tracking algorithm runs at 165 frames-per-second (FPS) in MATLAB on an i5 machine.

A neuro-fuzzy model of soft tissue in haptic simulator for training diagnosis of breast cancer
Saeed Amirkhani, Ebrahim Seidi, Ali Nahvi
1 Mechanical Engineering Department K. N. Toosi University of Technology Tehran, Iran
2 Mechanical Engineering Department, Iran University of Science and Technology (IUST)

- Soft tissue force modeling with the approach of creating a force-feedback simulator for training medical skills has been ongoing for many attempts up to now.
- In this article, using ANFIS (Adaptive Neuro Fuzzy Inference System), a neuro-fuzzy model is presented for soft tissue force modeling.
- In validating session, numerical data have been confirmed with the experimental data with an average error of less than 3. Testing session indicates root mean square error of the model to be about 0.02 (N), which shows a high degree of precision for the model.
Manipulators I
Chairs: Heidar Ali Talebi, Amirkabir University of Technology
Mehdi Tale Masouleh, University of Tehran

15:20-15:40 114 WeB2.1

Multi-task control of multi-contact manipulators during accidental interactions with robot body
Abbas Karami\textsuperscript{1}, Hamid Sadeghian\textsuperscript{2}, Mehdi Keshmiri\textsuperscript{3}
\textsuperscript{1,3}Isfahan University of Technology
\textsuperscript{2}University of Isfahan

- Dynamic multi-priority control of various tasks while accidental interactions occur with robot body.
- A general modification of momentum-observer proposed which is proper for force, position and orientation control.
- Stability of the suggested nonlinear controller-observer approach is proved. Performance of the control law in reducing disturbance effect in task execution is shown.

15:40-16:00 153 WeB2.2

A Robust Force Observer for Robot Manipulators Subjected to External Disturbance
Sahar Etedali, Heidar Ali Talebi, Ali DoostMohammadi
Amirkabir University of Technology

- The force estimation problem in robotic systems is studied in this paper.
- To isolate the effects of external disturbance on force estimation, a neural network based nonlinear disturbance observer is proposed.
- Based on the Lyapunov stability criterion, sufficient conditions to guarantee the stability of the proposed observer are derived.
- Consequently, unlike existing force observers in the literature, force estimation in the presence of external disturbances is guaranteed.

16:00-16:20 210 WeB2.3

System Identification of a Humanoid Robot Power Transmission System
Mojtaba Yazdani\textsuperscript{1}, Roya Sabbagh Novin\textsuperscript{2}, Mehdi Tale Masouleh\textsuperscript{3}
\textsuperscript{1,3}Mechanical Eng. Department, University of Utah, Salt Lake City, UT 84112 USA
\textsuperscript{2}Human and Robot Interaction Laboratory, University of Tehran
\textsuperscript{3}Electrical Eng. Department, Amirkabad University of Technology
\textsuperscript{5}Center for Intelligent Systems (CISR), Deakin University, Australia

- This paper focuses on failure-tolerant control of redundant serial manipulators.
- The proposed algorithm has been simulated and implemented on a four-link serial manipulator named as TaArm via C++ programming language in QtCreator environment.

16:20-16:40 221 WeB2.4

Dynamic Analysis of an n-Revolute Planar Serial Manipulator and Sensitivity Analysis Based on Sobols Method
Behzad Mehrafroz\textsuperscript{1}, Mohsen Mohammadi\textsuperscript{2}, Mehdi Tale Masouleh\textsuperscript{3}
\textsuperscript{1,3}Sharif University of Technology
\textsuperscript{2}Human and Robot Interaction Laboratory, University of Tehran

- This paper focuses on dynamic analysis plus the dynamic sensitivity analysis of n-R planar serial manipulator.
- An algorithm based on the so-called Natural Orthogonal Complement is devised to systematically model a n-R planar serial manipulator.
- Sobols method is employed to analyze the sensitivity of actuating torque to kinematic parameters of robot.
- The results demonstrate the sensitivity of delivering torques for a prescribed trajectory.
Aerial Robots
Chairs: Ali Khaki-Sedigh, K. N. Toosi University of Technology
Hadi Moradi, University of Tehran

15:20-15:40 11 WeB3.1
Attitude Flight Control System Design of UAV using LQG-LTR Multivariable Control with Noise and Disturbance
Ehsan Barzanoomi, Karim Salahshoor, Ali Khaki-sedigh
K. N. Toosi university of Technology

- Unmanned Aerial Vehicles (UAVs) pose a multi-input and multi-output (MIMO) dynamic structure, making their simultaneous guidance and control too complicated to be maintained via conventional scalar controllers. In this paper, a multivariable optimal controller is introduced based upon LQG-LTR design approach to effectively control the UAV attitude in the presence of noise and disturbance.
- Observations of the obtained responses through different conducted test experiments clearly indicate that the proposed LQG-LTR controller has led to very good and stable system performances. The level of interactions between channels and the system damping have generally shown suitable characteristics and yet leading to zero system steady-state error in response to the induced disturbances.

15:40-16:00 38 WeB3.2
Modeling and Control of Quadrotor System
M. T. Hussein1, M. N. Nemah2
1Department of Mechanical Engineering, University of Babylon, Babylon, Iraq
2Al-Furat Al-Awsat Technical University, Engineering Technical College, Najaf, Iraq

- This research presents the modeling and the control problem of quadrotor system.
- The nonlinear dynamic model which contains a set of equations valid for motion of the quadrotor system is derived. The derived mathematical model ensures realistic aerodynamic coefficients and actuator models.
- The mathematical model of six-degrees of freedom (6-DoF) quadrotor system will form basis for further research and development in the area.
- The challenge in controlling quadrotor system is solved by combining the inverse kinematics and transformation relations of quadrotor system with PD controllers. Two control loops are designed; outer-loop for position control and inner-loop for orientation control.

16:00-16:20 161 WeB3.3
Toward Aerial Simultaneous Target Localization and Obstacle Estimation using RSSI observations
S.M. Mehdi Dehghan, Saeid Haidari, Hadi Moradi
University of Tehran

- This paper represents simultaneous estimation of an RF source location and the location and height of an obstacle between the RF source and a UAV using RSSI observations.
- The aim is to improve the localization of the RF source by estimating the location and height of the obstacle.
- The diffraction loss is the most important reason that affects the performance of distance estimation based on general or empirical path loss model.
- By estimating the effect of obstacle on attenuation, it will be possible to improve the accuracy of distance estimation according to path loss models.

16:20-16:40 171 WeB3.4
Autonomous Trajectory Control for Limited Number of Aerial Platforms in RF Source Localization
Seyyed Ali Asghar Shahidian, Hadi Soltanzadeh
Semnan University

- In this paper, an autonomous trajectory control is presented for minimum number of Unmanned Aerial Vehicles (UAVs).
- The UAVs are equipped with Received Signal Strength Indicator (RSSI) sensors.
- Due to the nonlinear observations the location of the source is estimated using the Extended Kalman Filter (EKF).
- The objective is to determine the waypoints for the UAVs that minimize the source location uncertainty.
**Motion Planning**  
Chairs: Ellips Masehian, Tarbiat Modares University  
Mehdi Keshmiri, Isfahan University of Technology

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<tr>
<td>15:20-15:40</td>
<td>131 WeB4.1</td>
<td><strong>Modified Fast-SLAM For 2D Mapping And 3D Localization</strong></td>
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</table>
|            |         | Soheil Gharatappeh\(^1\), Mohammad Ghorbanian\(^2\), Mehdi Keshmiri\(^3\), Hamidreza D. Taghirad\(^4\)  
|            |         | Isfahan University of Technology                                    |
|            |         | • In existing methods for implementing Fast-SLAM, robot movement is considered to be totally in planar movement; while if moving on a slope changes the pitch angle of the robot, it causes errors in the algorithm.  
|            |         | • Correcting these errors will lead to a precise 2D mapping and 3D localization.  
|            |         | • This paper details the modification added to conventional Fast-Slam algorithm to accommodate this requirement by using an IMU.  
|            |         | • Simulation and experimental results shows the effectiveness of such modification. |
| 15:40-16:00 | 209 WeB4.2 | **A Fluid Dynamics Approach for Self-Reconfiguration Planning of Modular Robots** |
|            |         | Hossein Ahmaddzadeh, Ellips Masehian  
|            |         | Tarbiat Modares University  
|            |         | • This paper provides a novel approach based on fluid dynamics principles for solving self-reconfiguration planning problem in modular robots.  
|            |         | • The proposed approach is very fast and highly scalable to MRS with many modules because it is independent from configuration space.  
|            |         | • It is complete and can find a plan for self-reconfiguration regardless of the size of problem because fluids inherently flow until pressure is distributed uniformly.  
|            |         | • It does not suffer from deadlock situations such as overcrowded, hollow, and solid configurations. |
| 16:00-16:20 | 249 WeB4.3 | **Path Planning of Nonholonomic Flying Robots Using a New Virtual Obstacle Method** |
|            |         | Nazanin Mohamadnejad, Ellips Masehian  
|            |         | Tarbiat Modares University  
|            |         | • This paper presents a new algorithm for 3D path planning of winged UAVs, based on a combination of Fast Marching Method, average filter, and Virtual Obstacles.  
|            |         | • A Virtual Obstacle (VO) is a hypothetical obstacle placed around the flying robot in its first (start) and last (goal) configurations in order to meet its nonholonomic constraints.  
|            |         | • In this algorithm the environment is uniformly discretized into voxels, and the speed of the fast marching method plays an important role in the algorithms efficiency.  
|            |         | • Computational results yielded smooth and short paths for the UAV. |
| 16:20-16:40 | 250 WeB4.4 | **A Meta-module Approach for Cluster Flow Locomotion of Modular Robots** |
|            |         | Ali Shokri, Ellips Masehian  
|            |         | Tarbiat Modares University  
|            |         | • This paper focuses on the locomotion of modular robots comprised of Atron modules, and proposes a new algorithm based on meta-module formation and planning in order to accomplish cluster-flow-type locomotion.  
|            |         | • Through an iterative process of meta-module formation to termination lifecycle, modules move three-by-three (as meta-modules) and occupy the goal region, while trying to avoid collisions with obstacles and other modules, and minimizing the paths toward their final destinations.  
|            |         | • Consequently, proposed method can readily be implemented for cluster flow locomotion in real-world modular robots, since unlike existing methods -which have generally dealt with abstraction models of modular robots- realistic aspects of the environment, as well as physical and mechanical specifications of the modules, are fully considered. |
# MEMS/NEMS

**Chairs:** Hassan Ghafouri, Amirkabir University of Technology
Ali Nahvi, K. N. Toosi University of Technology

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<tr>
<th>Time</th>
<th>WeC1.1</th>
<th>Time</th>
<th>WeC1.2</th>
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<tbody>
<tr>
<td>17:00-17:20</td>
<td>The Effect of Microchannel Width on Mixing</td>
<td>17:20-17:40</td>
<td>A Mini Wearable Wireless Sensor for</td>
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<td>Efficiency of Microfluidic Electroosmotic</td>
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<td>Rehabilitation Applications</td>
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<td>Mixer</td>
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<td>Reza Abbasi-Kesbi, Alireza Nikfarjam</td>
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<td>Shahruzad Forouzanfar, Nima Talebzadeh, Siavash Zargari, Hadi Veladi</td>
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<td>University of Tehran</td>
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<td>Microsystem Fabrication Lab, Faculty of</td>
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<td>This paper presents design and fabrication</td>
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<td>Electrical Engineering, University of Tabriz, Tabriz, Iran</td>
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<td>a mini wearable wireless sensor for</td>
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<td>• This study is focused on electroosmotic</td>
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<td>rehabilitation applications. The system</td>
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<td>micromixer and the effects of driving force</td>
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<td>are investigated in the sense of different</td>
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<td>The results show that Root Mean Square</td>
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<td>field and the flow rate in the mixing</td>
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<td>(RMS) static and dynamic errors for</td>
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<td>channel are kept constant while the width of</td>
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<td>three-Euler angles are reduced to less than</td>
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<td>channel and distance between facing</td>
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<td>1.65 and 1.81 degree respectively.</td>
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<td>electrodes mounted on the sidewalls of</td>
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<td>channel are swept within 100 micro-m to</td>
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<td>300 micro-m with 50 micro-m increment steps.</td>
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<th>Time</th>
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<tr>
<td>17:40-18:00</td>
<td>Desiging a High Speed Electrostatic</td>
<td>18:00-18:20</td>
<td>Drift Cancellation of an Orientation Tracker</td>
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<td>Micro-actuator With an Electrical Stopper</td>
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<td>for a Virtual Reality Head-Mounted Display</td>
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<td>Useable for Biological Microinjection</td>
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<td>Ali Salsaeifar, Ali Nahvi</td>
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<td>Ali Gilani\textsuperscript{1}, Javad Koohsorkhi\textsuperscript{2}, Reza Askari Moghadam\textsuperscript{3}, Hassan Ghafouri Fard\textsuperscript{4}</td>
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<td>K. N. Toosi University of Technology</td>
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<td>1, 2, 3 University of Tehran</td>
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<td>This paper presents design and implementa-</td>
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<td>\textsuperscript{4} Amirkabir University</td>
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<td>tion of a drift-free orientation tracker</td>
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<td>of Technology</td>
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<td>for head-mounted displays.</td>
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<td>• This paper focuses on designing an</td>
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<td>To remove gyro drifts in the long run, a</td>
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<td>electrostatic microactuator which is</td>
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<td>able to reach high speed. Using electrical</td>
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<td>actuators it could be deflected 20micrometer.</td>
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<td>electrostatic stop-</td>
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<td>per able to stop the system and increase</td>
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<td>the reliability and repeatability. Also</td>
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<td>the springs are designed to decrease the</td>
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<td>sensitivity of system to bend. The dynamic</td>
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<td>behavior of system is simulated using</td>
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Manipulators II
Chairs: Adrian Olaru, University Politehnica of Bucharest
Hamidreza D. Taghirad, K. N. Toosi University of Technology

17:00-17:20 3 WeC2.1 Suboptimal Tracking Control of Nonlinear Systems via State-dependent Differential Riccati Equation for Robotic Manipulators
Moharam Habibnejad Korayem, Saeed Rafee Nekoo

- This paper presents SDDRE tracking design for robotic manipulators.
- Backward integration method was used to present a solution to SDDRE.
- Simulation results confirmed that backward integration and SDDRE resulted in less error rather than conventional SDRE.

17:20-17:40 60 WeC2.2 Eye-RHAS Manipulator From Kinematics to Trajectory Control
Ebrahim Abedloo, Soheil Gholami, Hamidreza D. Taghirad
K. N. Toosi University of Technology

- Robotic eye surgery allows the surgeons to perform many kinds of complicated procedures with more precision and flexibility than that with conventional techniques.
- The closed-form dynamical model of Eye-RHAS robot, eye surgery assistant robot, has been derived by Gibbs-Appell method.
- This formulation is verified through SimMechanics Toolbox of MATLAB. The robot is simulated in a real time trajectory control in a teleoperation scheme.
- The tracking errors show the effectiveness and applicability of the dynamic formulation to be used in the teleoperation schemes.

17:40-18:00 159 WeC2.3 A New Adaptive Neural Network Based Observer for Robotic Manipulators
Reza Mohammadi Asl1, Farzad Hashemzadeh2, Mohammad Ali Badamchizadeh1
1,2,3 University of Tabriz

- This paper introduces a neural network based observer for nonlinear systems.
- The proposed observer is an adaptive observer without any priori knowledge about system.
- The Lyapunov direct method is employed to show the stability and asymptotic estimating performance of the proposed neural network based observer.
- The proposed observer is applied for state estimating of a robotic manipulator.

18:00-18:20 208 WeC2.4 Application of a New Iterative Pseudo-Inverse Jacobian Neural Network Matrix Method for Controlling Geckodrive DC Motors of Manipulators
Adrian Olaru1, Serban Olaru2, Niculae Mihai3
1 University Politehnica of Bucharest
2 RomSys SA, Bucharest
3 Technoaccord Inc., Canada

- In this paper a very precise proper method has been developed to solve the inverse kinematics problem in robots with redundant chains. The method is called Iterative Pseudo-Inverse Jacobian Matrix Method (IPI-JMM) coupled with Sigmoid Bipolar Hyperbolic Tangent Neural Network with Time Delay and Recurrent Links (SBHTNN-TDRL).
- The presented method and the used virtual instrumentation (VI) are general and can be used for any robot types and application, as well as for any other conventional and unconventional space curves.
Driving Performance Analysis of a Tracked Mobile Robot on Different Terrains
Nastaran Taefi Aghdam¹, Majid Mohammadi Moghaddam²
¹²Tarbiat Modares University

This paper focuses on simulating and identification of driving performance of Tracked Mobile Robots (TMR) on different type of terrains.

Due to the complicated dynamics of TMR, it is difficult to predict the driving performance theoretically. So, Universal Mechanism software is used, as a proper software, to simulate dynamic performance of tracked vehicles more accurately.

Simulation results are analyzed to evaluate the TMR performance on four different terrains namely, agricultural soil, snow, loam and sand. The driving performance is compared utilizing performance indices such as slip, sinkage and efficiency.

By discussing on the gained results, a comparison is provided, that is shown the different driving performance of a tracked mobile robot on different terrains. Consequently, the driving performance is principally related to the specifications of the terrains.

Model Predictive Control of a Wheeled Inverted Pendulum Robot
Navid Dini, Vahid Johari Majd
Tarbiat Modares University

In this paper, a multivariable GPC model predictive control method, has been applied to a two wheeled inverted pendulum robot.

First, the dynamic equations of a Segway-like 2-wheeled inverted pendulum robot has been derived.

The GPC method has been employed so that the output of the closed loop system tracks a desired trajectory.

The comparison of the results with that of a classical tracking control method shows that the GPC controller has produced a better tracking performance for the robot.

ReMoRo; A mobile robot platform based on distributed I/O modules for research and education
Mojtaba Karimi, Alineza Ahmadi, Navid Khazae Korghorn, Edwin Babaians, Saeed Shiry Ghidary
Amirkabir Robotic Research Institute (ARRI), Amirkabir University of Technology (Tehran polytechnic)

This paper focuses on design and implementation of a low-cost mobile robot platform based on distributed I/O modules for research and education purpose.

Sensor modules, motor drivers and device communication manager (DCM) are designed based on ARM Cortex M3 microcontrollers that runs under Real-Time Operating System (freeRTOS).

With a range of different sensors, cylindrical manipulator and omnidirectional locomotion, RoMeRo can interact with environment in multiple ways, and can be used in various service robot scenarios like warehouse robots.

An H-infinity Switching T-S Fuzzy Controller Design for Position Control of Two-Wheeled Mobile Robots
Mohammadali Javaheri Koopaee, Vahid Johari Majd
Tarbiat Modares University

This paper addresses the problem of H-infinity fuzzy controller design for position control of two-wheeled mobile robots.

Because the conventional non-switching fuzzy modeling framework is not inapplicable, a switching fuzzy model is used and LMI condition for H-infinity controller design for such system is given.
# Field and Service Robotics

**Chairs:** Payam Zarafshan, University of Tehran  
Mahdi Bamdad, Shahrood University of Technology

## A Novel Design of Wall Climbing Robot for Inspection of Storage Steel Tanks

Mehdi Moniri¹, Mahdi Bamdad², Mohammad Z. Sayyadan³  
¹,²Science and Research branch, Islamic Azad University of Semnan  
²Shahrood University of Technology

- This paper focuses on a wall climbing mobile robot with permanent magnetic adhesion mechanism which can be used for tank inspection.
- To develop a new low cost wheel-driving climbing robotic platform with a high-payload capacity and maneuverability excluding complex control.
- Consequently, This robotic system consists of a mobile platform, a three-wheeled locomotion unit and adhesion mechanism that can move on vertical walls with fairly rough surfaces carrying heavy payloads. The prototype of designed robot was tested on vertical wall and perpendicular corners. As it has been expected, the robot transitioning on perpendicular corner and climbing on the vertical surface were continually.

## System Identification of a Humanoid Robot Power Transmission System

Hadi Ardiny, Stefan Witwicki, Francesco Mondada  
Ecole Polytechnique Federale de Lausanne, Lausanne (EPFL)

- We carefully define autonomous construction based on what has been done in this field to help focus in on the promising areas of research as well as to categorize the applications of robotics to construction. We describe different materials types used by robots. Materials influence the design of robots and concerning algorithms because of materials properties. Additionally, some research was based on biological inspiration to mimic behaviors of animals. From a hardware point of the view, robots and related auxiliary systems are studied. Robots are categorized into ground robots and aerial robots. Auxiliary systems like external cameras have proven to help robots tackle uncertainty and to compensate inaccurate positioning.

## Dynamics Modelling and Control of a Strawberry Harvesting Robot

Keyvan Asefpour Vakilian, Mohammad Jafari, Payam Zarafshan  
Department of Agrotechnology, College of Abouraihan, University of Tehran

- Dynamic equations of a planar mechanism with five degrees of freedom are studied to perform the desired motion of robotic harvesting systems arms to harvest the fruit from its stem.
- Design procedure of three proposed controllers including optimal, high-passed filter and low-passed filter controllers are investigated to control the displacement and angular velocity of fruit which is assumed as the last arm of the mechanism.
- Robotic techniques seem to be useful methods to be utilized in agricultural farms by establishing proper control systems.

## Person Recognition Based On Face and Body Information For Domestic Service Robots

Shaghayegh Gharghabi, Reza Safabakhsh  
Amirkabir University of Technology

- This paper reports the results of a human recognition system for domestic robots based on the individual’s face and body information.
- The basis for appropriate human-robot interaction is that the robot should be able to detect and recognize the persons presents in its vicinity.
- A robust and non-intrusive person recognition method is one of the key components of human-robot interaction.
- It is demonstrated that the combination of face and body information biometrics traits leads to a higher accuracy in establishing the user identity.
System Identification

Chairs: Aghil Yousefi-Koma, University of Tehran
Mahdi Aliyari, K. N. Toosi University of Technology

9:30-9:50 241 ThA1.1

System Identification and Model Validation of Nonholonomic Wheeled Mobile Robots
Payam Nourizadeh1, Aghil Yousefi-Koma2, Moosa Ayati3
1,2Center of Advanced Systems and Technologies (CAST), School of Mechanical Engineering, College of Engineering University of Tehran, Tehran, Iran
2School of Mechanical Engineering, College of Engineering University of Tehran, Tehran, Iran

• This paper focuses on the developing a regression model which describes linear and nonlinear behaviors of the robots.
• Several techniques of system identification such as Auto-Regression Moving Average Exogenous Input (ARMAX), Nonlinear ARMAX (NARMAX), and Least Square (LS) method are used to develop the mentioned model. In addition to numerical simulations, we applied our theoretical outcomes to experimental data and results perfectly show the validity of the proposed method.

9:50-10:10 179 ThA1.2

Gas Turbine Shaft Unbalance Fault Detection By Using Vibration Data And Neural Networks
Mostafa Tajik1, Shirin Movasagh2, Mahdi Aliyari3, Iman Yousefi4
1,2K. N. Toosi University of Technology
3University of Tokyo

• This paper focuses on shaft unbalance fault detection of heavy duty gas turbine.
• Nowadays in order to increase system reliability and security as well as decreasing system downtime and maintenance costs, fault detection of industrial systems, including gas turbines, is of great importance.
• In the next step, non-linear classifiers are used for fault detection such as MLPNN, RBFNN, etc. In these classifiers, LDA and PCA are used for dimensionality reduction and the results are compared to each other. Employing FAR and MAR criteria, proposed technique shows great performance in gas turbine shaft unbalance fault detection.

10:10-10:30 178 ThA1.3

Parameter Identification of Nonlinear Systems using Indirect Solution of Optimal Control Problem
Mojtaba Moradi1, Amin Nikoobin2, Mahyar Naraghi3
1,2Amirkabir University of Technology
2Semnan University

• This paper describes a novel offline approach to estimate the parameters of a nonlinear system using the optimal control theory.
• The proposed method here is based on the least square error of both output and input.
• To do this, the problem is first stated as a tracking problem with some unknown parameters.
• The problem is deployed as an effort optimal control problem which finally leads to a two point boundary value problem, which applied on one link manipulator and nonlinear model of dc motor.

10:30-10:50 14 ThA1.4

System Identification of a Humanoid Robot Power Transmission System
Aminollah Khormali1, Hasan Yahyaeii2, Iman Yousefi3, Mahdi Aliyari4
1,2,4K. N. Toosi University of Technology
3The University of Tokyo

• This paper presents a novel identification method for a heavy duty industrial gas turbine (HDGT).
• It has 162.1 MW nominal power and 50 Hz nominal frequency.
• A simplified and most commonly used model of the heavy-duty gas turbines is used for gray box identification of the GT. This model represents the mechanical behavior of the gas turbine.
• To achieve this, the multi-objective differential evolution optimization algorithm is used. By choosing the appropriate parameters in each condition, this model will give a favorable estimation of the gas turbine in loading condition.
### Sensing

**Chairs:** Mehdi Taleh Masouleh, University of Tehran  
Alireza Akbarzadeh, Ferdowsi University of Mashhad

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| 9:30-9:50  | ThA2.1  | **Constrained Optimization of Sensors Trajectories for Moving Source Localization Using TDOA and FDOA Measurements**  
Sajjad Adelipour\(^1\), Mohammad Hamdollahzadeh\(^2\), Fereidon Behnia\(^3\)  
\(^{1,2,3}\)Sharif University of Technology  
• This paper examines the problem of determining optimal sensors trajectories for localization of a moving radio source based on Time Difference of Arrival (TDOA) and Frequency Difference of Arrival (FDOA) measurements in situations in which sensors are constrained both in their movements and regions of operation  
• By considering the movement of the source and constrained movement of the sensors, a constraint problem is formed which is solved to determine optimal trajectories of the sensors for source tracking.  
• The validity of the proposed algorithm is assessed by two different simulation scenarios and the results verify its proper operation with estimation error decreasing in consecutive steps. |
| 9:50-10:10 | ThA2.2  | **Loop Closure Detection by Compressed Sensing for Exploration of Mobile Robots in Outdoor Environments**  
Alireza Norouzzadeh Ravari, Hamidreza D. Taghirad  
K. N. Toosi University of Technology  
• In this paper, the compressed sensing approach is exploited to detect loops from few sensor measurements.  
• Based on the compressed sensing approach, a sparse signal can be recovered from few linear noisy projections by l1 minimization.  
• Based on the multiple measurement vector technique, the loop closure detection is performed by comparison of few sensor observations. |
| 10:10-10:30| ThA2.3  | **Design, Construction & Calibration of a Novel Human-Robot Interaction 3-DOF Force Sensor**  
Mohammad Sharifzadeh, Mehdi Tale Masouleh, Ahmad Kalhor  
Human and Robot Interaction Laboratory, Faculty of New Sciences and Technologies, University of Tehran  
• This paper goes through the design, construction and calibration of a novel, low-price 3-DOF force sensor for Human-Robot Interaction applications.  
• Taking advantages of load cells is a common method to determine the applied force amount, both in researches and industry.  
• Similar to any load cell-based force sensor, an interface circuit is provided to provide the applied force data.  
• Consequently, in order to obtain the sensor behavior model, an innovative calibration setup is introduced. Taking advantage of the latter setup, a data base is gathered and based on Least Square (LS) identification method, the behavior of the sensor was modeled. |
| 10:30-10:50| ThA2.4  | **Effect of Structural Design Parameters of a Six-Axis Force/Torque Sensor Using Full Factorial Design**  
Amin Valizadeh, Alireza Akbarzadeh, Mohammad Hosein Tashakori Heravi  
Center of Excellence on Soft Computing and Intelligent Information Processing (SCHIP), Mechanical Engineering Department  
• This paper presents an investigation on the effect of thickness, width and length of elastic cross-beams of the six-axis force sensor on the cross coupling interference.  
• The finite element analysis is carried out for full factorial design experiments and the signal to noise ratio as well as analysis of variance is calculated and discussed.  
• Finally, The statistical analysis of results shows that the thickness of the cross-beams has the most remarkable effect on minimizing the cross coupling error. |
### Legged Roboics

**Chairs:** Majid Nili Ahmadabadi, University of Tehran  
Majid Mohammadi Moghaddam, Tarbiat Modares University

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| 9:30-9:50  | 113     | **Balance Recovery of a Quadruped Robot**                           | Mahdi Khorram, Seyed Ali Akbar Moosavian  
*Center of Excellence in Robotics and Control Advanced Robotics and Automated Systems Lab, Dept of Mech Eng, K. N. Toosi*  
Univ of Tech, Tehran, Iran |
| 9:50-10:10 | 150     | **Modeling, Control and Gait Design of a Quadruped Robot with Active Spine Towards Energy Efficiency** | Soroush Maleki, Atoosa Parsa, Majid Nili Ahmadabadi  
University of Tehran |
| 10:10-10:30| 154     | **Optimal and Stable Gait Planning of a Quadruped Robot for Trotting Over Uneven Terrains** | Mahdi Khorram, Seyed Ali Akbar Moosavian  
*Center of Excellence in Robotics and Control Advanced Robotics and Automated Systems Lab, Dept of Mech Eng, K. N. Toosi*  
Univ of Tech, Tehran, Iran |
| 10:30-10:50| 242     | **An Improvement on Impedance Control Performance of an Exoskeleton Suit in the Presence of Uncertainty** | Hossein Shahi¹, Aghil Yousefi-Koma², Majid Mohammadi Moghaddam²  
¹²University of Tehran  
²Tarbiat Modares University |

- Maintaining the balance or stability of legged robots in natural terrains is a challenging problem.
- In this paper, a push recovery framework for restoring the robot balance against external unknown disturbances is demonstrated.
- The whole body dynamic model is utilized to study push recovery of the robot.
- To calculate main body acceleration to recover robot balance, an optimization problem is defined so that the stability, friction condition is considered as its constraints.
- Simulation study shows that the robot can restore its balance against the large disturbance solely through the adjustment of the position and orientation of main body.

- In this paper, a quadruped robot with 12DOF with an active spine is modeled and controlled.
- The controlling strategy is based on feedback-linearisation and works for parallel manipulators.
- Gait design is based on GA optimization which leads to more energy efficient gait.

- In this article, the path planning of a quadruped robot in the motion over uneven terrains is investigated.
- A condition to guarantee the robot stability over uneven terrains is developed.
- A linear quadratic regulator with stability constraint and fixed final states is proposed to obtain the COG path which results in minimum acceleration.
- The tip of swing foot path planning will be fulfilled so that the generated path leads to avoid any collision with the environment. Furthermore, the path of swing legs is designed with minimum acceleration.
- The simulation results confirm the validity of proposed methods in terms of stability and the improvement of the consumption energy over uneven terrains.

- In recent years, different exoskeleton devices have been developed to provide the users with the mechanical power required in augmentation and rehabilitation applications.
- The exoskeleton control is one of the most challenging issues causes widely attention of researches during recent decade.
- Although different methods of control have been presented, there are several issues which have not been answered yet.
- The convergence of the closed loop system to the desired impedance in the presence of uncertainty is verified by Lyapunov theorem.
### Parallel Robots I

**Chairs:** Hamidreza D. Taghirad, K. N. Toosi University of Technology  
Mehdi Tale Masouleh, University of Tehran

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| 9:30-9:50     | ThA4.1  | Optimization of KNTU Delta Robot for Pick and Place Application      | Amin Khorasani, Soheil Gholami, Hamidreza D. Taghirad  
*K. N. Toosi University of Technology* |
| 9:50-10:10    | ThA4.2  | Multi-Criteria Design of 6-DoF Fully-Constrained Cable Driven Redundant Parallel Manipulator | Ali Nasr, Seyed Ali Akbar Moosavian  
*Center of Excellence in Robotics and Control, K. N. Toosi University of Technology* |
| 10:10-10:30   | ThA4.3  | Static Analysis of a 3-RRS and a 3-RSR Spherical Parallel Robots     | Alireza Abbasi Moshaii, Mehdi Tale Masouleh, Esmail Zarezadeh  
1 Tarbiat Modares University  
2 Human and Robot Interaction Laboratory, University of Tehran  
3 AmirKabir University  
4 Khatamol Anbia University |
| 10:30-10:50   | ThA4.4  | An Experimental Study on Open-loop Position and Speed Control of a 3-RRR Planar Parallel Mechanism | Azadeh Doroudchi, Mohsen Heydarzadeh, Mehdi Tale Masouleh, Masume Moghimi Esfandabadi  
*Human-Robot Interaction Laboratory, Faculty of New Sciences and Technologies, University of Tehran* |

- In this paper, the desired configuration for installation of Delta robot is formulated as an optimization problem and has been solved to reach to the highest rate of pick and place operation.
- The optimization is performed considering the actuators speed and acceleration limitation of the robot within the workspace.
- Furthermore, energy consumption is considered next as the other optimization objective.
- As a proof of concept, KNTU Delta robot is designed and implemented in practice by using the optimal configuration.

- The purpose of this paper is to optimize dimensions of KNTU 6-DoF cable driven redundant parallel manipulators.
- This optimization is based on different performance indices including the singularity measure, the kinematic sensitivity, the stiffness and free collision workspace. Stiffness of the cable is also taken into consideration because of its effect on kinematic stiffness of moving platform manipulators performance.
- Points with cable collision, singular or actuator wrench infeasible configuration characteristic are eliminating from entire workspace.

- This paper investigates the static analysis of two spherical parallel robots with 3-RRS and 3-RSR as kinematic arrangements.
- Static analyzes is an important step in designing robotic mechanical systems.
- In this paper, static analysis are performed by two approaches.
- The compatibility between them shows the correctness of analysis.

- This paper describes design, construction and control of a 3-RRR planar parallel mechanism.
- The focus is on experimental control methods using inverse kinematic problem in order to gain more accuracy and smooth movement during the control process.
- In order to control the mechanism, two main control methods are used namely, position control and speed control, which are considered as open-loop control methods. A Joy-stick is added to the system, in order to provide the ability for the user to control the mechanism directly.
Control II

Chairs: Mohammad Eghtesad, Shiraz University
Moharam Habibnejad Korayem, Iran University of Science & Technology

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<th>11:10-11:30</th>
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<tr>
<td>Design of Model Predictive Control of Two-Wheeled Inverted Pendulum</td>
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<td>Niloufar Minouchehr¹, Seyyed Kamal Hosseini-Sani²</td>
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<td>¹,² Ferdowsi University of Mashhad</td>
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- This paper describes the design of Model Predictive Control (MPC) for Two Wheeled Inverted Pendulum (TWIP) robot.
- TWIP robot is considered as an underactuated nonlinear system subjected to disturbances.
- MPC is a control strategy that uses an explicit model of a process to optimize the performance of the system.
- In this work, first, the nonlinear model of a TWIP is linearized around its unstable equilibrium point. Then, by using a decoupling unit, two MPC controllers are designed according to the linear model.
- Due to the feed forward control of the MPC, the performance of the control system is improved to compensate for measurable disturbances.
- As a conclusion, MPC controller has better performance in comparison with LQR controller in the presence of disturbances.

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<tr>
<td>CPG-Based Gait Planning Of a quadruped robot for Crossing Obstacles</td>
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<td>Farhad Asadi, Mahdi Khorram, Seyed Ali Akbar Moosavian</td>
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- Gait planning algorithm based on Cartesian CPG-based controller for a quadruped robot in order to cross different planar obstacles will be developed.
- In proposed approach, the rhythmic patterns in central pattern generator are modulated by feedback signals which encode foothold positions in respect to the planar obstacles.
- By using these feedback signals the frequency of oscillation will be adjusted so that desired gait avoids the obstacles then The obtained gait results in the swing and stance sequences and also step length for each foot. Then, the trajectory of the swing legs in Cartesian space will be computed based on the CPG output data.
- proposed algorithm will be tested for crossing planar obstacles in different size and distance. Obtained results show the effectiveness of the proposed approach in crossing obstacles with different size and distance to each other.

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<tr>
<td>Boundary Controllability of a Micropolar Elastic Body</td>
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<td>Ali Najafi¹, Mohammad Eghtesad², Ramin Vatankhah³, Farhang Daneshman⁴</td>
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<td>¹ Faculty of Mechanical Engineering, K. N. Toosi University of Technology</td>
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<td>²,³,⁴ School of Mechanical Engineering, Shiraz University</td>
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- This paper focuses on boundary controllability of a elastic Micropolar Media.
- The controllability has been obtained utilizing Hilbert Uniqueness Method.
- In fact, from Observability of the dual system, the controllability of the main system has been obtained.
Robust Control of Piezoelectric Micro positioning Actuator Using Self-Sensing Method
Navid Fallahinia\textsuperscript{1}, Mohammad Zareinejad\textsuperscript{2}, Heidar Ali Talebi\textsuperscript{3}, Hamed Ghafarirad\textsuperscript{4}
\textsuperscript{1,3,4}Amirkabir University of Technology
\textsuperscript{2}New Technologies Research Center of Amirkabir University of Technology

• This paper focuses on proposing a precise position self-sensing circuit in order to measure the position of piezoelectric actuators.
• Self-sensing is a technique which allows a single piece of piezoelectric material to concurrently use both as sensor and actuator.
• Lastly, the designed controllers are implemented for experimental verification. The results demonstrate the effectiveness of the position self-sensing circuit and robust controller.

Leakage Fault Classification in Hydraulic Actuators via Multiple Trained Transformations
Amir Hossein Agha Seyed Mirzabozorg, Ali Tivayi, S. Mehdi Rezaei
Amirkabir University of Technology

• This paper focuses on describing a specific signal-based method to detect internal leakage faults in hydraulic actuators that is based on a training algorithm.
• Early detection of faults can play an important role in reducing the cost of maintenance and increasing the operational safety of such systems.
• For reaching this goal, it is desirable to implement a fault diagnosis subsystem as a part of the maintenance of hydraulic systems.
• By using the test data of the hydraulic system, the training algorithm leads us to a transform that maximizes the difference between the faulty and healthy signals.

Multiple-Surface Sliding Mode Control of Pneumatic Actuator with mismatched uncertainties
Farzan Soleymani\textsuperscript{1}, S. Mehti Rezaei\textsuperscript{2}, Abdolreza Rahimi\textsuperscript{3}, Mohammad Zareinejad\textsuperscript{4}, Ali Kamali\textsuperscript{5}
\textsuperscript{1,2,3,4,5}Amirkabir University of Technology
\textsuperscript{4}New Technologies Research Center of Amirkabir University of Technology

• This paper focuses on position control of a double acting pneumatic actuator in presence of mismatched uncertainty due to unmodeled friction dynamics.
• Identification of friction parameters require effort and accuracy therefore using simple model for friction such as Striebeck model results in simplicity of identification procedure.
• Considering a bounded uncertainty owing to unmodeled friction dynamics that appear as mismatched uncertainty necessitate to use a proper control scheme.
Top-Down attention control for device communication manager on mobile robot platform

Alireza Ahmadi, Mojtaba Karimi, Navid Khaazae Korghond, Edwin Babaians, Saeed Shiry Ghidary
Amirkabir University of Technology (Tehran Polytechnic)

- Attention control; mobile robot platform; distributed modules; Device communication manager (DCM); Exponential Moving Average (EMA).
- In this paper, we present the results of our recent work about design and implementation of a top-down attention control model in Device Communication Manager (DCM) layer on an omnidirectional mobile robot platform.
- Attention control enables us to focus our consciousness on purposes and events that are related to our immediate aims. In other words, attention control can be described as a separate skill to concentrate. Device communication manager on middle layer manages the connected device, which they just are available in one of the internal buses.

SLAM Using UKF with Adaptation of Scaling Parameter

Seyed Masoud Sotoodeh Bahraini, Mohammad Bozorg
Yazd University

- An Adaptive Unscented Kalman Filter (AUKF) algorithm is presented for SLAM, based on adaptation of scaling parameter.
- A comparison between UKF and AUKF algorithms is given through both simulated and experimental datasets.
- The simulation results are obtained over 100 Monte Carlo runs for fixed value and three adaptive choices of scaling parameter.
- The Mean Square Error (MSE) is calculated over location and orientation of the vehicle for both UKF and AUKF algorithms.
- The well-known Victoria Park dataset is utilized to compare the AUKF approach with standard UKF.
- The variation of scaling parameter is plotted during SLAM simulation and experiment.


Saeed Ebrahimi, Arman Mardani
Department of Mechanical Engineering, Yazd University, Yazd, Iran

- This paper focuses on modeling and identification of an innovative self stable two-wheeled mobile robot.
- This new platform can be stable naturally due to its mechanical design.
- The promoted platform is able to use center of mass as a balancing part.
- This two-wheeled mobile manipulator can be stable without any control effort to keep it in a stable position.
## Parallel Robots II

**Chairs:** Gholamreza Vossoughi, Sharif University of Technology  
Mahdi Bamdad, Shahrood University of Technology

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<tr>
<th>Time</th>
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<th>Authors</th>
<th>Institutions</th>
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<tbody>
<tr>
<td>11:10-11:30</td>
<td>87</td>
<td><strong>Adaptive characterisation of the human hand model as it interacts with a telemanipulation system</strong></td>
<td>Mojtaba Esfandiari, Soroush Sadeghnejad, Farzam Farahmand, Gholamreza Vossoughi</td>
<td>School of Mechanical Engineering at Sharif University of Technology</td>
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<td></td>
<td></td>
<td><em>This article introduces an adaptive identifier to estimate the impedance characteristic of a human operator as it interacts with a single translational degree of freedom mechanism.</em></td>
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<td>Sharif University of Technology</td>
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<td></td>
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<td><em>The five parameter model, including an extra spring and damper for a better approximation of the dynamic behavior of the human arm, has been used.</em></td>
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<td><em>An adaptive architecture with normalized least square method with forgetting factor has been used for on-line investigation of these five unknown impedance parameters of the human arm.</em></td>
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<tr>
<td>11:30-11:50</td>
<td>95</td>
<td><strong>Modeling of a novel cable driven robot for upper limb rehabilitation</strong></td>
<td>Mahdi Bamdad, H. Zarshenas</td>
<td>Shahrood University</td>
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<td><em>This paper introduces a novel upper limb rehabilitation robot which is based on cable-driven mechanism.</em></td>
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<td><em>The main idea is based on using a series of cables with single tension motor as power supply to control motion of multi-joint arm.</em></td>
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<td><em>An open loop impedance control which is equipped with feed-forward PD controller considered as control strategy to provide back-drivability feature for simulated mechanism which has been evaluated in comparison to human arm stiffness.</em></td>
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<td>11:50-12:10</td>
<td>167</td>
<td><strong>A New Development of Homotopy Continuation Method, Applied in Solving Nonlinear Kinematic System of Equations of Parallel Mechanisms</strong></td>
<td>Amir Salimi, Ahmad Kalhor, Mehdi Tale Masouleh</td>
<td>Human and Robot Interaction Laboratory (TaarLab), Faculty of New Sciences and Technologies, University of Tehran</td>
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<td><em>This paper presents an alternative approach which is based on Homotopy Continuation method, in order to solve nonlinear system of equations.</em></td>
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<td><em>The proposed approach, called Collision-Based Homotopy Continuation (CBHC). It has been demonstrated that in the case of collision points, upon resorting to hyper order terms of variation equations more accurate solutions could be obtained.</em></td>
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<td><em>So, for the sake of comparison, the aforementioned nonlinear system of equation was solved by Bertini solve. The results revealed that CBHC is more accurate to find solutions, however it was not fast enough like Bertini solver.</em></td>
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<td>12:10-12:30</td>
<td>212</td>
<td><strong>Hybrid System Approach to Analysis of Parallel Robots: An Effective Hybrid Modeling of 4–RP R Planar Parallel Manipulator</strong></td>
<td>Masoud Ghanbari, Babak Tavassoli</td>
<td>K.N. Toosi University of Technology</td>
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<td><em>In this paper an open hybrid modeling of parallel manipulators is studied in detail.</em></td>
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<td><em>In the proposed method, parallel manipulators are considered to have joint space and task space as two independent subsystems.</em></td>
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<td><em>As it is analytically intractable to deal with modeling of parallel robots with complex structures, this method can significantly contribute to the ease of computations.</em></td>
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<td><em>Finally, performance of hybrid model is evaluated through simulation.</em></td>
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POSTER Presentation
Optimal Trajectory Generation for Energy Consumption Minimization and Moving Obstacle Avoidance of a 4DOF Robot Arm
Mohammad Mahdavian\textsuperscript{1}, Aghil Yousefi-Koma\textsuperscript{2}, Masoud Shariat-Panahi\textsuperscript{3}, Amirmasoud Ghasemi-Toudeshki\textsuperscript{4}
\textsuperscript{1,2,4}Center of Advanced Systems and Technologies, University of Tehran
\textsuperscript{3}University of Tehran

- In this paper, trajectory generation for a 4 DOF arm of SURENA III humanoid robot with the purpose of optimizing energy and avoiding a moving obstacle is presented.
- For this purpose, first, kinematic equations for a four DOF manipulator are derived. Then, using the Lagrange method, an explicit dynamics model for the arm is developed.
- Finally, in order to obtain the most reliable solutions for trajectory generation, many optimizations with various parameters are conducted and the results are presented and discussed.

Dynamics of a 9-DoF Robotic Leg for a Football Simulator
Masoud Vahidi, Seyed Ali Akbar Moosavian
Center of Excellence in Robotics and Control, K.N. Toosi University of Technology

- This paper focuses on a robotic human-like leg. This robot was designed and modeled for task of kicking soccer ball to desired target.
- Applications of this robot have been explained and its kinematics and dynamics equations have been developed.
- Kinematic analysis has been done using Denavit-Hartenberg method and dynamics equations of this robot have been written using recursive Lagrange method.
- Kinematics and dynamics equations of robot are verified using a numerical simulation in MATLAB simmechanics.

Adaptive Motion Planning with Artificial Potential Fields Using a Prior Path
Javad Amiryan, Mansour Jamzad
Sharif University of Technology

- In this paper, we aim to resolve these deficiencies by a novel approach which employs a prior path between origin and goal configuration of the robot.
- Therefore, the planner guarantees to lead the robot to goal area while the inherent advantages of potential fields remain.
- For path planning stage, we intend to use randomized sampling methods such as Rapidly-exploring Random Trees (RRT) or its derivatives, however, any path planning approach can be utilized.
- An optimization procedure for evolving the motion plans is designed and applied to find smoother, safer and shorter plans.
- In our experiments, we apply a simulated vehicle in Webots simulator to test and evaluate the motion planner.

Generating an Efficient Hub Graph for Self-Reconfiguration Planning in Modular Robots
Parisa Parhami, Hadi Moradi, Masoud Asadpour, Khalil Taheri
Control and Intelligent Processing Center of Excellence and School of Electrical and Computer Engineering at University of Tehran

- In this paper, we propose a human-inspired approach that speeds up the self-reconfiguration planning of modular robots in the form of a graph search in which the nodes are configurations.
- In this method, we create a hub-graph containing the major nodes of the graph, which are called the hubs. We propose an RRT-based approach to select the hubs which efficiently cover the configuration space.
- Experiments show 5 to 8 fold speed up in search time, while founded solutions are near-optimal. Also it has been shown that the transition graph is scale free therefore using hubs is extendable to larger number of modules.
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<th>15:30-16:30</th>
<th>244 ThC.5</th>
<th>15:30-16:30</th>
<th>260 ThC.6</th>
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<td><strong>Estimation of elbow joint angle by NARX model using EMG data</strong>&lt;br&gt;Armin Ehrampoosh(^1), Aghil Yousefi-Koma(^2), Moosa Ayati(^3)&lt;br&gt;(^1)1, 2Center of Advanced Systems and Technologies (CAST), School of Mechanical Engineering, College of Engineering, University of Tehran&lt;br&gt;(^2)School of Mechanical Engineering, College of Engineering, University of Tehran&lt;br&gt;(^3)School of Mechanical Engineering, College of Engineering, University of Tehran&lt;br&gt;• Myoelectric control has a key role in human-machine interface applications such as orthosis control and teleoperation. Myoelectric signals are bio signals that are detectable from surface of the skin, and contain useful information about users moving intention.&lt;br&gt;• This paper presents a methodology to estimate elbow joint angle from muscles data using neural network (NN).&lt;br&gt;• Proposed methodology can be expanded to estimate any joint angle by recording muscle activities concerning with the joint.</td>
<td><strong>An Object-Oriented Framework for Interoperability of Industrial Robots and CNC Machines Tools</strong>&lt;br&gt;Pouyan Jahanbin, Mahmoud Houshmand, Omid Fatahi Valilai&lt;br&gt;Department of Industrial Engineering, Sharif University of Technology, Tehran, Iran&lt;br&gt;• This paper focuses on establishing the interoperability between industrial robots and CNC machine tool in Flexible Manufacturing Systems (FMS) for establishing the flexibility and enhancing the efficiency of the whole system.&lt;br&gt;• Consequently, it leads to a more accurate dynamic model for the robotic systems, and dynamic behavior of the system can be more predictable. In addition, the object-oriented architecture of the framework makes it extendable to enable industrial robots for other machining tasks.</td>
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<th>15:30-16:30</th>
<th>229 ThC.7</th>
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<th>66 ThC.8</th>
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<td><strong>The Analysis and Simulation of a Tethered Segway</strong>&lt;br&gt;M.H Salehpour, Hadi Moradi&lt;br&gt;University of Tehran&lt;br&gt;• In this paper we present the design and analysis of a tethered Segway designed for moving over steep surfaces such as dome shaped structures. This robotic platform, inspired from human climbers who use a cable to keep themselves stable on steep surfaces, consists of a simple Segway and a mechanism used to tether the robot to the top of the steep surface.&lt;br&gt;• The mathematical model of the robot is derived using Lagrangian approach and the control is developed based on a state feedback gain. Main purposes of the controller is to provide the Segways stability, control the position, and control its vertical angle by manipulating the input.&lt;br&gt;• The system has been simulated and the results show that the controller can move the robot around while keeping its stability on steep surfaces up to 75 degrees.</td>
<td><strong>CPG-Based Gait Transition of a Quadruped Robot</strong>&lt;br&gt;Farhad Asadi, Mahdi Khorram, Seyed Ali Akbar Moosavian&lt;br&gt;K. N. Toosi University of Technology&lt;br&gt;• This paper focuses on modeling and designing of a Cartesian CPG-based controller for the gait generation and the transition between them for quadruped robot. By Using CPG-based controller, the step length, duration of swing and stance phases of all legs, relative phase between the legs and the sequence of leg lifting can be adjusted smoothly especially by the duration of gait transition. By using output gait diagram of CPG, trajectories of swing legs along the x- and z- axes and then The reference ZMP path based on the the footprints of legs is obtained and then, The COG trajectories will be calculated with a preview servo controller. so, simulations are conducted to verify the effectiveness of the proposed approach both in the gait generation and smooth gait transition for a quadruped robot.</td>
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# Poster

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<td>15:30-16:30</td>
<td>78 ThC.9</td>
<td>Bilateral Adaptive Control of a Teleoperation System Based on the Hunt-Crossley Dynamic Model</td>
<td>Hamidreza Kolbari¹, Soroush Sadeghnejad¹, Mohsen Bahrami², Ali Kamali², Amirkabir Robotic Institute</td>
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<td>149 ThC.10</td>
<td>Adaptive Control of Unknown Robotic Systems Cooperating on Handling of an Unknown Object</td>
<td>Esmaeil Mehrabi¹, Kasra Esfandiari², Heidar Ali Talebi³, Mohammad Zareinejad⁴, Amirkabir university of Technology</td>
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<td>1 ThC.11</td>
<td>Nonlinear Suboptimal SDRE Controller for Cooperative Manipulators to Increase Dynamic Load Carrying Capacity</td>
<td>Moharam Habibnejad Korayem, Saeed Raee Nekoo, Robotic Research Laboratory, School of Mechanical Engineering, IUST</td>
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<td>164 ThC.12</td>
<td>Lyapunov Stability Analysis of a Bilateral Teleoperation System Interacting with Active Environment</td>
<td>Keyvan Mohammadi, Heidar Ali Talebi, Mohammad Zareinejad, Amirkabir University of Technology</td>
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- In this research, an adaptive haptic control for a one degree of freedom (DOF) master slave teleoperated device has been proposed. The position and force controller are designed for both master and slave sides. A Lyapunov function design provides a way to guarantee stability in presence of uncertain parameters in master, slave and environment dynamics.

- This paper presents an adaptive control scheme for robotic systems, cooperating in grasping and manipulation of an unknown object. By utilizing the passive decomposition technique, the overall system is decomposed into decoupled shaped and locked systems. An adaptive control methodology is designed based on the Function Approximation Technique (FAT). Stability of the closed-loop system is investigated based on passivity concept and Lyapunov’s direct method, which ensured asymptotical convergence of the tracking errors.

- This paper presents control design of cooperative manipulators using state-dependent Riccati equation. Cooperation in robotics will lead to an increase in dynamic load carrying capacity. Simulation of two planar arms in trajectory tracking confirmed the effectiveness of the design.

- This paper focuses on stability analysis of a bilateral teleoperation system interacting with active environment. Active Environments adds extra energy to the system, which they can be a source of instability. Passivity conditions of the human operator and environments are restrictive conditions in bilateral teleoperation systems and they have been relaxed in this paper. By introducing a novel nonlinear controller, it has been shown that the closed loop system remains stable in the presence of active environments and time delay. Moreover, the convergence of position signals have been proved.

- The two channel PEB architecture is employed which it does not need any force sensors. In addition, the active energy of the environment is not canceled locally, which makes it appropriate for many tasks such as teleoperated rehabilitation in active therapy.
**Poster**

### 15:30-16:30 177 ThC.13

**Developing a Controller for a Spatial Bending Micro Module Actuated By Shape Memory Alloys: Modeling and Experiment**  
Ali Reza Hadi, Hossein Akbari  
*University of Tehran*

- In this paper modeling and simulation of a continuum and flexible module is implemented.
- A control strategy is developed to set a desired position for the two degree of freedom module.
- The module is manufactured and through the provided test bed, the developed controller results are experimentally verified.

### 15:30-16:30 262 ThC.14

**A Fast Fuzzy Path Tracking Controller for Mobile Robots**  
Mohsen Ahmadi Mousavi  
*University of Tehran*

- In this paper we proposed a simple but robust fuzzy logic path tracking controller for a mobile robot in a deterministic environment.
- Introduce two independent controllers with one input variable and one output variable.
- Comparison of the proposed method with the other previous works shows the higher speed lower complexity.

### 15:30-16:30 220 ThC.15

**Nonlinear Disturbance Observer Based Adaptive Control for Nonlinear Teleoperation Systems**  
Bahareh Aboutalebian¹, Heidar Ali Talebi², Amir Abolfazl Suratgar³  
¹,²,³Amirkabir University of Tehran  
²Yasouj University of Technology

- In this paper, the stability and tracking control problem of a task space nonlinear bilateral teleoperation system is addressed interacting with an unknown environment.
- The controllers consist of adaptive controller and nonlinear disturbance observer to deal with uncertain dynamic model of manipulators, environmental and operators forces, respectively, in the presence of time delay.
- A lyapunov function is employed to prove stability of closed-loop system and tracking properties of position, velocity. Consequently, it leads to a more accurate tracking performance for the robotic systems in presence of unknown environmental forces.

### 15:30-16:30 173 ThC.16

**Nonlinear Adaptive Control for Teleoperation Systems Transitioning Between Soft and Hard Tissues**  
Hamidreza Kolbari¹, Soroush Sadeghnejad², Mohsen Bahrami², Ali Kamali²  
¹,²Amirkabir Robotic Institute  
²Mechanical Engineering Department, Amirkabir University of Technology

- In this research, a nonlinear adaptive control for one degree of freedom endoscopic teleoperation system has been proposed.
- The force and position controllers are designed for both master and slave sides.
- Lyapunov theory has been used to guarantee stability and performance of the system, in presence of unknown environmental stiffness. Numerical simulations are presented on teleoperation system to demonstrate the effectiveness of the proposed scheme.
Poster

**15:30-16:30 257 ThC.17**

Dynamics Formulation and motion Control of a Planar Parallel Manipulator
Mehran Farhadmanesh, Ebrahim Abedloo, Amir Molaei
K. N. Toosi University of Technology

- Dynamic analysis of the planar PRP parallel robot has a vital role in mechanical design, model-based controller, and identification applications. In this paper:
  - A closed form dynamic model for PRP mechanism is extracted
  - The obtained analytical model is verified with that of simulation software
  - Based on the closed form dynamic model a model based controller is designed and its performance is investigated in which the obtained results verify the suitability of the proposed control scheme for tracking applications.

**15:30-16:30 207 ThC.18**

Collision-free Path Planning of a Novel Reconfigurable Mobile Parallel Mechanism
Pouria Nozari Porshokouhi¹, Mehdi Tale Masouleh², Hossein Kazemi³, Roya Sabbagh Novin⁴
¹,² Department of Mechanical Engineering, Sharif University of Technology
³,⁴ Human and Robot Interaction Laboratory, University of Tehran

- This paper initially focuses on design and kinematic modeling of a novel reconfigurable tripod parallel mechanism and then deals with the collision-free path planning for this mechanism.
- This mechanism, the so-called Taar Reconfigurable ParaMobile (TRPM), is a tripod parallel mechanism consisting of three customized mobile robots as its main actuators, connected to an end-effector by three links, with a US kinematic arrangement.
- Consequently, substituting the desired position and orientation of the end-effector into the kinematic equations at each instant, the desired position and orientation of the individual mobile robots will be obtained.

**15:30-16:30 219 ThC.19**

Path Planning of 3-RRR Parallel Robot by Avoiding Mechanical Interferences via Artificial Potential Field
Hossein Kazemi¹, Mehdi Tale Masouleh², Pouria Nozari Porshokouhi³, Roya Sabbagh Novin⁴
¹-³ Department of Mechanical Engineering, Sharif University of Technology
⁴ Human and Robot Interaction Laboratory, University of Tehran

- This paper focuses on obstacle avoidance of a single mobile robot by utilizing Artificial Potential Field approach. The proposed obstacle avoidance algorithm is extended to be applied on 3-RRR planar parallel mechanism. The objective consists in avoiding the most likely collisions in the mechanism, i.e., the collision of the 3-RRR with obstacles as well as the collisions among the links and the end-effector.

**15:30-16:30 97 ThC.20**

Direct Kinematics Solution of 3-RRR Robot by Using Two Different Artificial Neural Networks
Hamed Safari, Javad Enferadi
Azad University of Mashhad

- In this paper, direct kinematics problem of a 3-RRR planar parallel robotic manipulator, is solved by using two different models of artificial neural networks, one a back propagation neural network and the other one a radial basis neural network.
- The proposed networks use training data set which is made by solving the inverse kinematics of the robot.
- After making the database for training the networks, different parameters of the neural networks are changed in a wide range and finally the best ones for each of BPNN and RBFNN models are selected.
- The designing approach of the proposed solution is presented in detail, and effectiveness of the solution is demonstrated by comparing a simulated spiral path with its real path.
On the Kinematics Analysis of a Novel Spherical Robot with Unlimited Rotation Around an Axis

Javad Enferadi, Omid Reza Haghi
Department of Mechanical Engineering, Islamic Azad University Mashhad Branch

- A new spherical parallel robot for orientation applications is proposed.
- The proposed robot can completely rotate about an axis.
- Using the genetic algorithm, the dimensional optimization to maximize the workspace of the robot is performed.
- A method to specify the acceptable direct kinematics problem of the manipulator is proposed.

Comparison of Motion Control Techniques for a 3RPS Parallel Manipulator

Hannaneh Z. Arabshahi, Alireza B. Novinzadeh
K. N. Toosi University of Technology

- In this paper, three motion control techniques are discussed for 3RPS parallel robot.
- The main purpose of this research is to study the model-based control techniques to determine whether these techniques are capable of reducing the tracking error considering the measurement noise and external disturbance.
- Performance of the controller have been examined through simulation. It is observed that the adaptive inverse dynamics control is capable of providing suitable motion tracking, while high amount of uncertainties in model is considered.

Optimal Balancing of Planar Cable Robot in Point to Point Motion using the Indirect Approach

Amin Nikoobin, Mojtaba Royahi Vezvani, Mojtaba Ahmadie Khanesar
University of Semnan

- In this paper, a new balancing approach is presented for planar cable robot based on optimal control.
- An optimal trajectory planning problem is outlined in which states, controls and the values of counterweights must be determined simultaneously in order to minimize the given performance index.
- By developing the obtained optimality conditions, a two-point boundary value problem is achieved which can be solved with bvp4c command in MATLAB.
- The results show that optimal balancing in comparison with the unbalancing and static balanced methods can reduce the performance index significantly.

System Identification of a Humanoid Robot Power Transmission System

Hassan Bayani¹, Rasoul Sadeghian², Mehdi Tale Masouleh³, Ahmad Kalhor⁴
¹Human and Robot Interaction Laboratory, Faculty of New Sciences and Technologies, University of Tehran, Iran
²Department of Mechatronics Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran

- This paper presents different classical control approaches for planar cable-driven parallel robots.
- PD and PID controllers are designed for planar cable-driven parallel robots based on the concept of pole placement method.
- Toward optimization and tuning the controller parameters of planar cable-driven parallel robot, Differential Evaluation, Particle Swarm Optimization and Genetic algorithms are applied as optimization techniques.
Optimal Synthesis of a Planar Slider-Crank Mechanism with Clearance Joints
S. Mojtaba Varedi-Koulaei, Hamidreza Mohammadi Daniali, Milad Shafiei
1 University of Shahrood, 2 Babol University of Technology, 3 University of Tehran

- Clearances in mechanism are unavoidable due to wear, assembly and manufacturing tolerances. Performances of mechanisms in reality are deviated from the ideal mechanisms due to joint clearances.
- Moreover, joint clearance can lead to impulsive forces. These forces not only create increasing vibration amplitude, but also reduce system reliability, stability and life.
- This paper presents an optimization method for simultaneously kinematic and dynamic synthesis of a planar slider-crank with clearance at the joints.
- Numerical solution and simulation results on ADAMS software clearly reveal that the path generation error is reduced.

Computed Torque Control of a Cable Suspended Parallel Robot
Ali Aflakiyan, Hassan Bayani, Mehdi Tale Masouleh
University of Tehran

- The main concern of this paper is modeling and control of cable-suspended parallel robots.
- Alongside lots of benefits, a major open issue in the design of these robots is ensuring tensile cable forces for any admissible motion. The latter problem is particularly challenging when under-constrained configurations are considered. In this paper kinematics, statics and dynamics model of the cable-suspended parallel robots is introduced in a general form.
- Towards ensuring positive and bounded cable tensions in under-constrained robot Fmincon function of Matlab is used. The proposed method, uses cables tension limits and jacobian matrix.
- The controller take benefits from computed torque method which is powerful method for dynamic models.

Design, Analysis and Construction of a Novel Flexible Rover Robot
Mohammad Safary Taze Kand, Rasoul Sadeghian, Mehdi Tale Masouleh
1, 2 Department of Electrical, Biomedical and Mechatronics Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran, 3 Human and Robot Interaction Laboratory, Faculty of New Sciences and Technologies, University of Tehran, Tehran, Iran.

- This paper presents the construction of a novel rover robot called Patrol-s. The main contribution of constructing this robot is based on reducing the vibrations which are effected on the robot body from the movement surface.
- In order to improve the control performance several sensors are applied on the robot body to provide better information from the situation of the proposed robot.

Improvement of the Vehicle stability using simultaneous traction and braking control in the vehicles utilizing active differentials
Omid Hajfathali, Seyed Mahdi Abtahi

- This paper investigates the improvement of the vehicle dynamic performance. An intelligent two-layered control system was designed to control the direct rotational torque via an active differential placed at the rear axle. The top layer of the controller commanded the amount of transfer torque in the rear differential and the yaw generated by the braking system of front wheels to subsystems to adjust with the vehicle good values using an optimal method of controller. With respect to the two mentioned values, the torque transferred to the active differential and the braking torque of the front wheels were applied to the vehicle on the 2 nd layer. The simulation results by 9-DOF nonlinear vehicle dynamic model reveals that the controller designed has the ability to maintain vehicle stability in all movement and road conditions.
Design of an Adaptive Sliding Mode Controller For a Novel Spherical Rolling Robot
Rasoul Sadeghian, Hassan Bayani, Mehdi Tale Masouleh
1Department of Electrical, Biomedical and Mechatronics Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran.
2Human and Robot Interaction Laboratory, Faculty of New Sciences and Technologies, University of Tehran, Tehran, Iran.

This paper presents a novel spherical rolling robot and the design procedure of an adaptive sliding mode controller implemented on the latter robot.

Towards modeling the uncertainties, the sliding mode controller is utilized and simulation tests represent the effectiveness of this method.

Dynamic Modeling and Parametric Analysis of Dual Arm Manipulator with Revolute-Prismatic Joints mounted on a nonholonomic mobile base
Ebrahim Seidi, Saeed Amirkhan, Ali Mohammad Shafei, Moharam Habibnejad Korayem
1,4Iran University of Science & Technology
2K. N. Toosi University of Technology
3Shahid Beheshti University of Kerman

This paper focuses on the study of dynamic modeling and parametric analysis of nonholonomic wheeled mobile robotic manipulators, which consist of two serial manipulators with revolute-prismatic joints and an autonomous wheeled mobile platform.

To systematically derive the equations of motion and improve the computational efficiency, a recursive algorithm has been used in the modeling of the system.

Control of Humanoid Robot Walking by Fuzzy Sarsa Learning
Faezeh Tavakoli, Vali Derhami, Ali Kamalinejad
1,2Yazd University
3Tarbiat Modares University

This paper proposes applying Fuzzy Sarsa Learning (FSL) algorithm to the biped walking controller of a humanoid robot for having a stable walking motion.

To evaluate stability of the biped walking in the control problem, the robot has been designed by using the Zero Moment Point (ZMP) criterion based on the inverted pendulum model.

The FSL controller has been applied in order to decrease ZMP error and consequently enhance the stability of biped walking through trunk motion.

Consequently, the simulation results demonstrate the better stability and control of the walking motion by the FSL method compared with Fuzzy Q-learning (FQL) controller and basic Fuzzy controller.

Multi-modal locomotion wheeled mobile robot with compounded mobility and manipulation
Arman Mardani, Mahdi Bamshad, Khalil Alipour
1,2School of Mechanical and Mechatronics Engineering Shahrood University
3Department of Mechatronics Faculty of New Science and Technologies University of Tehran

This paper focuses on modeling and identification of innovative multimode mobile robot.

New platform can move in various modes like two wheeled mode and four wheeled mode.

Due to new design of platform the middle point of body can be utilized as a manipulator.

New idea is to compound locomotion and manipulation in a platform.
Gyrostabilized Two Wheeled Inverted Pendulum Robot
Ali Mahvan, Alireza Akbarzadeh
Ferdowsi University of Mashhad

- In this paper, a two wheeled inverted pendulum personal transporter is considered. This system is inherently unstable.
- The ordinary control theory says to maintain robot balance during its motion, a specified torque should be exerted to the robot wheels.
- To assist the control system, a mechanical controller or a gyrostabilizer is added to this robot.
- Both Eulers equations and modified Eulers Equations are derived to prove that the gyrostabilizer can improve robot stability.

Design, Dynamic Modeling and Fabrication of a Bio-Inspired Quadruped Robot
Arman Nikkhah, Aghil Yousefi-Koma, Hossein Keshavarz, Seyed Saeid Mohtasebi
University of Tehran

- In this paper, offline path planning for walking of a quadruped robot is investigated by designing and fabricating of a 18 Degrees of Freedom model.
- Full dynamic model is calculated using Lagrange and Kane methods and Comparing the results of Lagrange and Kane methods shows the correctness of our dynamic modeling.
- The Static Stability Margin (SSM) was defined for a given support polygon as the smallest of the distances from the COG projection to the edges of the support polygon.
- The effectiveness of the proposed method is demonstrated by comparing the results obtained from the simulation and the experiment on the quadruped robot.

Dynamic Modeling and Construction of a Two-Wheeled Mobile Manipulator, Part II: Modified Obstacle Climbing
Arman Mardani, Saeed Ebrahimi
Department of Mechanical Engineering, Yazd University, Yazd, Iran

- This paper focuses on modeling and identification of an innovative obstacle climbing robot.
- The new platform can be stable naturally due to mechanical design.
- The promoted platform is able to use the manipulator and body to climb an obstacle.
- As an important element, the center of mass of the robot body roles to stabilize the robot in climbing.

Distinguishing Tip-Toe Walking from Normal Walking Using Skeleton Data Gathered By 3D Sensors
Mohsen Ebrahimi¹, Meysam Feghhi², Hadi Moradi³, Maryam Mirian⁴
University of Tehran ¹,²,³, University of British Columbia ⁴, Shahid Beheshti University ⁵

- Extracting features suitable for distinguishing between tip-toe walking and normal walking.
- Developing a system for gait classification using off-the-shelf markerless 3D sensor.
- Making dataset of 75 different people that walking on tip-toe.

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2015 RSI International Conference on Robotics and Mechatronics (ICROM)
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<td>Developing a bio inspired steerable robot actuated by shape memory alloy springs</td>
<td>Alireza Hadi, Mohammad Javad Davari, Mohammad Mehdi Bahmani</td>
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<td>15:30-16:30</td>
<td>42 Design and Fabrication of an Autonomous Octorotor Flying Robot</td>
<td>S. Jamal Haddadi¹, Payam Zarafshan²</td>
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<td>¹Department of Electrical, Computer and IT Engineering, Qazvin Islamic Azad University</td>
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<td>²Department of Agrotechnology, College of Abouraihan, University of Tehran</td>
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<td>Design procedure of a new Octorotor with coaxial motors was studied.</td>
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<td>The design procedure separated to two mechanical and electronic design sections.</td>
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<td>PID control algorithm is implemented and parameters are fine adjusted to achieve high hover flying performance.</td>
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<td>The Design and Implementation of a Hotline Tracking UAV</td>
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<td>This paper assesses practicality of power line inspection with UAVs using state of the art methods.</td>
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<td>An image processing step using steerable filters has been implemented to detect power lines in the image.</td>
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<td>Visual data from image processing phase is being fed into an UKF to track the relative location of power line.</td>
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<td>A backstepping controller is designed to control and stabilize maneuvers of the system.</td>
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<td>228</td>
<td>Three Dimensional Fuzzy Carrot-Chasing Path Following Algorithm for Fixed-Wing Vehicles</td>
<td>Seyed Amir Hossein Tabatabaei¹, Aghil Yousefi-Koma², Moosa Ayati³</td>
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<td>¹Center of Advanced Systems and Technologies, School of Mechanical Engineering, University of Tehran</td>
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<td>²School of Mechanical Engineering, University of Tehran</td>
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<td>This paper focuses on designing a new three dimensional path following algorithm for fixed-wing vehicles.</td>
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<td>The 3D path following algorithm is presented using a combination of the carrot-chasing geometric algorithm, fuzzy logic and genetic algorithm optimization method.</td>
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<td></td>
<td>Consequently, Simulation results show significant superiority of the proposed 3D fuzzy carrot-chasing algorithm over both the carrot-chasing and vector field methods.</td>
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A Hybrid Fuzzy approach for landing of a quad-rotor MAV based on a novel vision localization method
S.N. Bani Hashemi¹, AmirAli Paedar²
¹Malek Ashtar University
²Qazvin IAU University

- The aim of this paper is to present a practical method to land a Quadrotor MAV (Micro Arial Vehicle) on a landing pad or charger dock station.
- High level fuzzy controller and a low level PID stabilizer along with fast and optimized vision localization method is proposed.
- For implementation the proposed method we built a low cost experimental robot platform hardware which were designed for outdoor environments.
- The proposed algorithm also tested by SITL (Software In The Loop) method and the results of simulation prove the proposed algorithm’s performance.

Design and Fabrication of a Robotic Hand Using Shape Memory Alloy Actuators
Ali Ahmadi, Aghil Yousefi-Koma, Mohammad Mahdavian, Fatemeh Alidoost, Nafiseh Faridi-Rad, Mohammad Ali Bazrafshani
Center of Advanced Systems and Technologies, University of Tehran

- In this paper design and fabrication of a Robotic Hand using shape memory alloy (SMA) actuators has been discussed.
- The robot has close similarity to shape of a real hand and has been designed based on human hand model.
- In order to fabricate the robot parts with high level of accuracy, a 3D printer has been used. Moreover, SMA springs are being used as the actuators and by actuating the SMA springs, fingers can bend or open.
- The mechanism is designed such that helps springs to open and bend the fingers easily.

Design and Construction of a Linear-Rotary Joint for Robotics Applications
Ali Mousavi, Alireza Akbarzadeh, Morteza Shariatee, Salman Alimardani
Ferdowsi University of Mashhad

- This paper focuses on the mechanical design process of a special linear-rotary joint for a SCARA robot, called FUM SCARA.
- Main features of the joint are overall 0.03 mm and 0.02 degrees repeatability and 0.5 seconds full pick and place cycle time.
- The effectiveness of the presented joint is investigated through applying cycle time trajectory.

Time Optimized Digital Image Processing of Ball and Plate System Using Artificial Neural Network
Center of Excellence in Robotics and Control, K.N. Toosi University of Technology

- Regarding robot interaction with moving objects and the necessity for robot controller to react in a timely manner having the objects current position, finding an efficient positioning method has always been a challenge.
- As ball and plate system is considered to be a standard experimental system in control laboratories. The system is consisted of the following pieces: a horizontal plate which gets tilted along each horizontal axes.
Poster

15:30-16:30 24 ThC.45

**Numerical and Neural Network Modeling of Motors of a Robot**

Hami Tourajizadeh, Soleiman Manteghi\(^1\), Saeed Rafiee Nekoo\(^2\)

Department of Mechanical Engineering, Faculty of Engineering, Kharazmi University

\(^1\) College of Computer and Mechatronics Engineering, Islamic Azad University Branch of Science and Research

\(^2\) School of Mechanical Engineering, Iran University of Science and Technology (IUST)

- In this paper parametric and numerical model of the motors of a robot are extracted.
- Parametric model of the motors are derived by conducting standard tests like locked rotor test and step and sine wave input test.
- Results of the numerical and parametric model are compared and validated by experimental tests.

15:30-16:30 155 ThC.46

**3D visual stabilization for Robotic Assisted Beating Heart Surgery Using a Thin-plate Spline Deformable Model**

Ameneh Sheikhjafari, Heidar Ali Talebi, Mohammad Zareinejad

Amirkabir university of Technology

- The specialty of the method proposed in this paper is the visual stabilization of the beating heart motion by combining a modified version of 3D tracking algorithm based on a TPS deformable model with a developed 3D visual stabilization.
- A type of RBF, the TPS, has been successfully applied to non-rigid and rigid deformation modeling.
- Consequently, the proposed 3D visual stabilization method significantly reduced motion in the video stream while preserving variation of color and texture.

15:30-16:30 196 ThC.47

**Variable Impedance Control For Rehabilitation Robot using Interval Type-2 Fuzzy Logic**

Vahab Khoshdel, Hamid Moenfard, Alireza Akbarzadeh

Center of Excellence on Soft Computing and Intelligent Information Processing, Ferdowsi University of Mashhad

- In this study, a novel variable impedance control for a lower-limb rehabilitation robotic system using voltage control strategy is proposed.
- Most existing control approaches are based on control torque strategy, which require the knowledge of robot dynamics as well as dynamic of patients.
- Furthermore how impedance parameters must be selected is a serious question in control system design for rehabilitation robots. To resolve these problems this paper, presents a variable impedance control based on the voltage control strategy. Variable impedance parameters based on interval type-2 fuzzy logic (IT2Fl) is proposed to effectively control the system.

15:30-16:30 118 ThC.48

**Design and Development of One Degree of Freedom Upper Limb Exoskeleton**

Borhan Beigzadeh, Mahdi Ilami, Sohrab Najafian

Iran University of Science and Technology

- Exoskeleton robots are categorized as rehabilitating and assisting robots which could be applied in other applications such as power augmentation, haptic, and virtual reality systems.
- In this paper a simple upper limb exoskeleton with one degree of freedom is studied and developed.
- Kinematic parameters of the upper limb are needed to design the robot, thus a mechanism is designed to derive this set of data.
- Finally, the performance of robot is evaluated using a test-rig mechanism which examines how the kinematical parameters of arm could be tracked by our approach.
Poster 15:30-16:30 138 ThC.49

A Cooperative Remote Rehabilitation System
Fatemeh Koochaki, Iman Sharifi, Ali DoostMohammadi, Heidar Ali Talebi
Amirkabir University of Technology, Tehran, Iran

- In this paper a new architecture for robotic rehabilitation is introduced. The mutual interaction between the therapist and patient is accomplished with robots.
- The architecture divides the system into three subsystems: therapist, patient, and virtual environment, which is controlled locally ensuring that it is input to state stable (ISS).
- Finally, the interconnection of these subsystems are shown to be stable in the presence of communication time delays.
- The patient is considered to be generative in the first stage of the rehabilitation process, which means that she/he moves the interacted robot without help from the therapist, until losing her/his strength. Afterward, in the second stage the therapist assists her/him to continue the movement.
- Therefore, the patient is active at the first stage and switches to passive mode in the second stage. Hence, the controllers should deal with active robots in the teleoperation as well as passive ones.
- Finally, simulation results are given to validate the performance of the proposed structure.

Poster 15:30-16:30 197 ThC.50

Design and Fabrication of a 3DoF Upper Limb Exoskeleton
Mohammad Mahdavian, Aghil Yousefi-Koma, Amirmasoud Ghasemi-Toudeshki
Center of Advanced Systems and Technologies, University of Tehran

- Abstract In this paper, design and fabrication of a 3DoF upper limb exoskeleton robot have been discussed.
- The main application of this robot is for rehabilitation purposes.
- Therefore, the necessary components for studying the interaction between robot and human body have been implemented on the robot.
- Moreover the ability to adjust links length based on patient's body and controlling structure have been considered for the robot.
- In order to measure the force between human body and robot, strain gage sensors have been used at each arm connector.

Poster 15:30-16:30 52 ThC.51

Integrated Active and Passive Gravity Compensation Method for a Cable-Actuated Elbow Rehabilitation Robot
Mahdi Bamdad1, Farhad Parivash2
1,2 School of Mechanical and Mechatronic Engineering, Shahrood University, Shahrood, Iran

- This paper introduces an integrated gravity compensation method which has advantage of both passive and active gravity compensation methods.
- Integrated method provides robustness and low active power in the rehabilitation robot simultaneously.
- Passive method improves inherent safety of the elbow rehabilitation robot while robust active method eliminates deficiencies of passive method and doesn’t counteract the advantage of passive method.
- Robust active method provides a safe and comfortable interaction with patient during rehabilitation.
- The proposed integrated method gives a safe and reliable solution to the full gravity compensation problem of rehabilitation exoskeletons.

Poster 15:30-16:30 230 ThC.52

Mechanical Design, Fabrication, Kinematics and Dynamics Modeling, Multiple Impedance Control of a Wrist Rehabilitation Robot
Mohammad Reza Sajjadi1, Ali Nasr2, Hassan Zohoor3
1 Center of Excellence in Mechatronics, University of Tabriz, Tabriz, Iran.
2 Center of Excellence in Robotics and Control, ARAS Lab., K.N. Toosi University of Technology, Tehran, Iran.
3 Center of Excellence in Design, Robotics and Automation, Sharif Univ. of Tech. Tehran, Iran.

- Rehabilitation is the best approach for patients who suffer physical disability of their upper-limbs. Maintaining the intensity of exercise during treatment is the main factor that makes the robots suitable for rehabilitation since robots do not get tired and do the exercises with constant intensity under supervision of the doctor. Two main categories of rehabilitation robots are End-Effector based robots and wearable robots.
Adaptive Estimation of Robot Environmental Force Interacting with Soft Tissues
Maryam Sharifi, Heidar Ali Talebi, Masoud Shafiee
Amirkabir University of Technology

- Position control of a robot’s end-effector, by proposing an estimation mechanism for the interaction force between robotic tools and a soft tissue is presented.
- The proposed scheme considers a dynamic model for the environment. For this purpose, a viscoelastic model is adopted for the environment rather than an elastic one.
- The proposed approach is using an adaptive strategy to provide the estimated force for achieving convergence of position and velocity tracking errors to zero.

Design and Fabrication of a Worm Robot Prototype
Mohammad-Reza Sayyed Noorani, Ahmad Ghanbari, Sina Aghli
University of Tabriz

- Movement in narrow channels or uneven terrains is one of the challenges concerning the robotic engineering.
- We have focused on imitating the caterpillar worms’ locomotion by a crawling robot prototype.
- Similar to the caterpillars, progress in our crawling robot is achieved by propagating a trapezoidal wave from tail to head in the vertical plane.
- Experimental tests of the fabricated robot prototype indicate a good performance in moving forward.

Skeleton and Visual Tracking Fusion for Human Following Task of Service Robots
Edwin Babaians, Navid Khazaee Korghond, Alireza Ahmadi, Mojtaba Karimi, Saeed Shiry Ghidary
Amirkabir University of Technology (Tehran Polytechnic)

- Kalman Filter; OpenTLD; Skeleton Tracker; Microsoft Kinect; Service Robot; Sepanta Service Robot
- In this paper, we propose a novel method to overcome some of the weaknesses of typical skeleton trackers which use depth data for the task of human following in robotics.
- In our novel approach we combine typical skeleton tracker with state of the art OpenTLD visual tracker using Kalman filter.
- We used our service robot, Sepanta, for evaluations.
- We do not use any classification methods directly so we do not need any training data before robot operation and robot can perform the human following task autonomously exactly after the first skeleton is tracked by skeleton tracker.

A Simplified Method in Human to Robot Motion Mapping Schemes
Samira Nazari, Mostafa Charmi, Maryam Hassani, Ghazale Ahmadi
University of Zanjan

- In this paper, a simplified method in human to robot motion mapping schemes is proposed and a prototype has been implemented.
- The proposed design contains two arms, a sample arm and a teach pendant robotic arm which will be taught to replicate the desired position.
- Two image processing techniques including Hough transform and color detection are used during the process.
- Consequently, After doing some calculations, the robotic arm moves to get the same shape as the sample arm.
Effects of Toe-off and Heel-off Motions on Gait Performance of Biped Robots

Mahdokht Ezati, Majid Khadiv, Seyed Ali Akbar Moosavian
K. N. Toosi University of Technology

- It is highly proposed to take into account of both heels and active toe joints during the walking of a biped robot with 7-DOF legs.
- Considering heels and active toe joints, six different walking patterns are presented, while the main purpose is minimizing the maximum knee joint torques and the total energy consumption.
- The most efficient pattern in terms of the maximum torque of knee joint and the total energy consumption is specified.

Hysteresis Modeling for a Shape Memory Alloy Actuator using Adaptive Neuro-Fuzzy Inference System

Nafiseh Faridi-Rad1, Aghil Yousefi-Koma2, Moosa Ayati3, Farzam Tajdari4, Hamid Baseri5, Mehdi Jokar6

1, 2, 3, 5, 6 Center of Advanced Systems and Technologies (CAST), School of Mechanical Engineering, College of Engineering, University of Tehran
4 School of Mechanical Engineering, Amirkabir University of Technology

- In this paper, an adaptive neuro-fuzzy inference system (ANFIS) is developed to compensate for the hysteretic non-linearity in a mechanism actuates by shape memory alloys (SMA) wires. Experimental data obtained from the mechanism are used to train the ANFIS model. Past output of the system is fed to the model as an input.

Vision-Based Kinematic Calibration of Spherical Robots

Pedram Agand, Hamidreza D. Taghirad, Amir Molaei
K. N. Toosi University of Technology
Advanced Robotics and Automation System (ARAS)

- This paper focuses on calibration of spherical-workspace robots with a single camera.
- Nonlinear transformation of robots end-effector position to lens pixel is proposed and sensitivity of the provided measurement method is examined.
- An optimization of the camera position is targeted subject to prescribe benefit function with a sub-optimal solution.
- Consequently, the efficiency of this method is evaluated by experimental analysis on Diamond eye surgery robot as a case study.

A Low-Cost Vision-Based System for Displacement Analysis in Earthquake Research

Bijan Binaee, Mahyar Khayatkhoei, Hadi Moradi
University of Tehran

- Measuring linear and angular displacement at high accuracy requires expensive equipment and may interfere with the measurements due to sensors weight and size. In this paper, we propose a low cost vision based approach that can make the earthquake research more affordable.
- To keep detecting process as fast as possible and meet real-time processing demands, a typical marker with a peculiar color inside chooses and all instruction performed by Intel CVLib filters. Accordingly to the tests if the minimum requirement are met, with the proposed method the detecting rate can go up to 25 frames per second.
- Finally, a prototype software implemented to analysis functionality and accuracy of proposed algorithm.
Repeatability Analysis of a SCARA Robot with Planetary Gearbox

Ali Mousavi, Alireza Akbarzadeh, Morteza Shariatee, Salman Alimardani
Ferdowsi University of Mashhad

- This paper focuses on repeatability calculation method presented by ISO standard.
- Repeatability is investigated deeply as one of the main features of an industrial grade robot, called FUM SCARA.
- Although applied planetary reducers have pre-defined backlash, experimental results show satisfactory repeatability for the FUM SCARA robot.
- A simple and intelligible ideal model is presented in order to show the low effect of backlash in repeatability calculation.

A Numerical Study on Characteristics of the Magnetohydrodynamic Micropumps

Javid Azimi, Manizheh Zakeri, Milad Javidfard
University of Tabriz

- This paper focuses on performance of the magnetohydrodynamic flows in rectangular ducts in micro scale pumps.
- As electric current density is not uniform at the entire electrodes, modeling of Lorentz force as an external body force is a precise approach to simulate the magnetohydrodynamic flows in micropumps.
- The effects of geometrical parameters, width and depth of the channel, on maximum flow rate, maximum pressure generation, and energy consumption rate are studied.
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