m o n d a y

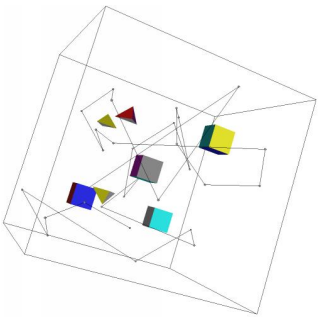
April 24, 2000

Monday, April 24th

Path Planning
Chairs: Greg Chirikjian, Zvi Shiller

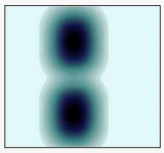
Randomized Planning for Short Inspection Paths
T. Danner and L. Kavraki
Rice University

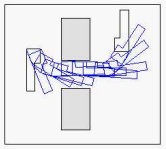
- Path planning for mobile observer robots
- Inspection paths for known environments
- Visibility constraints on range and incidence
- Implementation results in two and three dimensions



A new potential field method for robot path planning
Yunfeng Wang and Gregory S. Chirikjian
The Johns Hopkins University

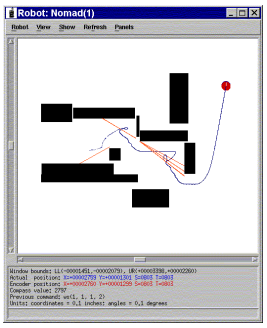
- Path planning of non-spherical single body robots.
- Model the artificial potential field using heat transfer with variable thermal conductivity.
- Propose a path optimality method using the concept of heat resistance.
- Reduce a search on RnXSO(n) to one on Rn followed by a search on SO(n).





Virtual Obstacle Concept for Local-Minimum Recovery in Potential-Field Based Navigation
Liu Chengqing[1], Marcelo Ang Jr.[1], Hariharan Krishnan[1] and Lim Ser Yong[2]
[1]National University of Singapore and [2]Gintic Institute of Manufacturing Technology

- Local minima problem in reactive motion planning using potential field
- Virtual obstacles created during encounters with concave-shaped obstacles
- Heuristics for getting out of traps
- Simulation results on Nomad 200



Obstacle Traversal for Space Exploration
Zvi Shiller
University of California, Los Angeles

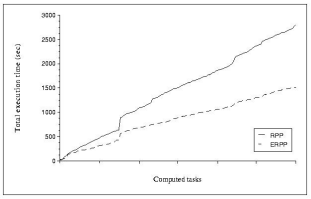
- Traditional obstacle avoidance fails to climb over obstacles when necessary.
- A deterministic traversability measure is introduced that considers safe speeds along the terrain.
- The optimal path is found by a global optimization that considers robot dynamics and terrain topography.
- The optimal traversal path is generally safer than the shortest path.

RRT-Connect: An Efficient Approach to Single-Query Path Planning
J. J. Kuffner Jr.[1] and S. M. LaValle[2]
[1]Stanford University and [2]Iowa State University

- Practical search of high-dimensional C-spaces
- Randomized approach combining bidirectional RRTs & greedy heuristic
- Experiments include interactive task-level character animation
- Fast, general technique

ERPP: An Experience-based Randomized Path Planner
S. Caselli and M. Reggiani
Universit di Parma

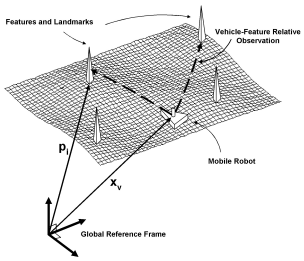
- multiple planning tasks in the same environment often needed
- heuristic planner & random competition, exploit experience
- remarkable reduction in planning time and variance vs. RPP
- benefits of combining potential field and roadmap



Mapping and Localization 1
Chairs: Illah Nourbakhsh, T. Tsubouchi

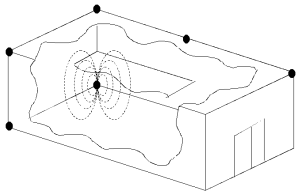
A Computationally Efficient Solution to the Simultaneous Localisation and Map Building (SLAM) Problem
Gamini Dissanayake
University of Sydney

- Robot location without apriori maps
- Efficiency through features with most information
- Experiments on indoor robot with a laser
- Progress towards real-time SLAM



An Indoor Absolute Positioning System with No Line of Sight Restrictions and Building-Wide coverage
E. Prigge and J. How
Stanford University

- Provides 'go-anywhere' freedom for mobile robots
- Beacons installed throughout building create magnetic fields
- CDMA techniques applied
- Initial experimental accuracy of 2.5 cm, 2.5 degrees

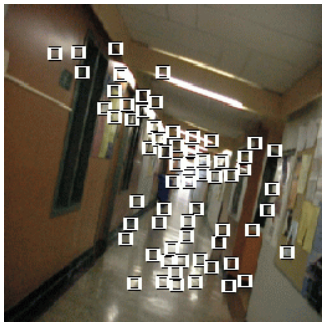


Appearance-Based Place Recognition for Topological Localization
Iwan Ulrich and Illah Nourbakhsh
Carnegie Mellon University

- Topological Localization Indoors and Outdoors
- Histogram Matching of Panoramic Color Images
- Correct Confident Classifications: 87-98
- Incorrect Confident Classifications: 0

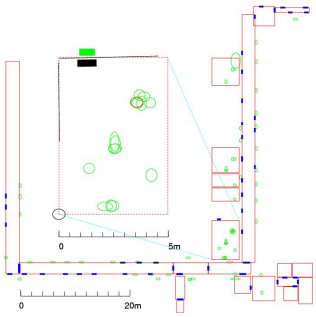
Robust Place Recognition using Local Appearance based Methods
G. Dudek and D. Jugessur
McGill University

- Making appearance based recognition (using PCA) more robust.
- Recognition is performed in the frequency domain using multiple sub-windows (eigenwindows).
- Scences and rooms can be recognised with varying backgrounds, irrespective of planar rotations and under occluded conditions.
- Promising results are obtained using the proposed methods. PCA is made more robust.



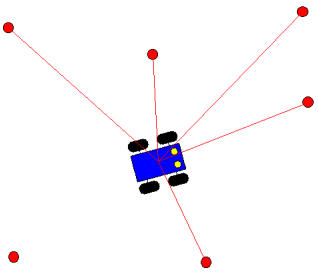
Using Multiple Gaussian Hypotheses to Represent Probability Distributions for Mobile Robot Localization
D. Austin and P. Jensfelt
Royal Institute of Technology

- Multiple gaussian hypotheses are used
- Tree of data association decisions
- Algorithms for tree pruning presented
- Results are given illustrating effectiveness



Invariant Filtering for Simultaneous Localization and Mapping
Matthew C. Deans and Martial Hebert
Carnegie Mellon University

- Localization and mapping from landmark bearings and odometry
- Dual location- and relation-based representations
- Computation & memory limited by enforced independence
- Results shown for simulated and real environments



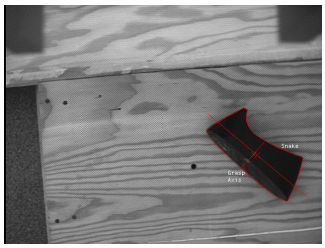
Grasping and Manipulation
Chairs: Nikos Papanikolopoulos, K. Yokoi

Intelligent Soft Contact Surface Technology with MEMS in Robotic and Human Augmented Systems
Geng Wang and Imin Kao
SUNY Stony Brook

- Introduce Smart Anthropomorphic Contact Surface Technology (SACST)
- SACST with MEMS in Robotics and Human Augmented Systems
- Application of Robotics Research Results of Soft Contact and Pressure to SACST
- Ongoing Research Results and Conclusions

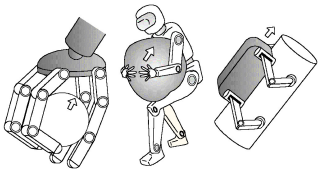
Unknown Object Grasping Using Statistical Pressure Models
Doug Perrin[1], Christopher E. Smith[2], Osama Masoud[1] and Nikolaos Papanikolopoulos[1]
[1]University of Minnesota and [2]University of Colorado

- Grasping of objects
- Region growing snakes to find object contours and simple heuristics to compute grasp pose.
- Grasps of a variety of planar projection objects are shown.
- Region growing dynamic contours have matured to the point where they are useful for real-time vision and control.



A Sufficient Condition for Manipulation of Envelope Family
Makoto Kaneko, Kensuke Harada and Toshio Tsuji
Hiroshima University

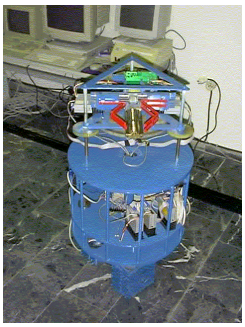
- Motivation: Manipulation of an object (or body) in envelope style.
- Approach: Combination of position and torque controlled chains.
- Problem: Given a desired motion, obtain a set of joint torque.
- Result : A sufficient condition for moving an object along chains.


Envelope family

A New Approach to Motion Planning for Disc-Shaped Robots Manipulating a Polygonal Object in the Plane
A. Sudsang and J. Ponce
University of Illinois

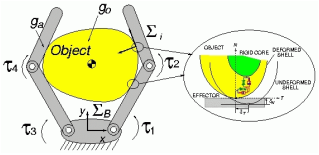
Event-Driven Parts Moving in 2D Endogeneous Environments
C. S. Karagoz[1], H. I. Bozma[1] and D. E. Koditschek[2]
[1]Bogazici University and [2]University of Michigan

- Problem Statement
- Proposed Approach
- Experimental Results
- Conclusion



Dynamic Simulation for Grasping and Whole Arm Manipulation
P. Song, M. Yashima and V. Kumar
University of Pennsylvania

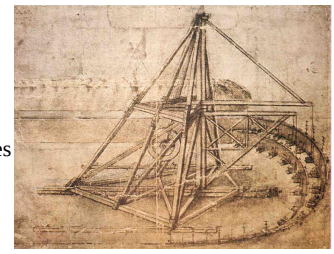
- Difficulties in dynamic simulations of frictional grasps.
- Discussion of different contact models.
- Proposed an integrated simulation approach that combines LCP model and compliant contact model.
- Simulation results of whole arm grasps.



Kinematics
Organizers & Chairs: Jean-Pierre Merlet, Joel Burdick

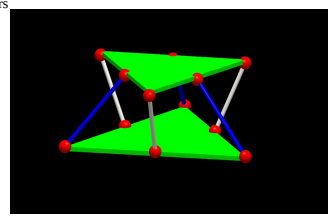
Kinematics' not dead!
J-P Merlet
INRIA, Sophia- Antipolis

- Position paper on the use of kinematics
- -still many open problem
- -for improving the performances of robots
- for the optimal design of robots



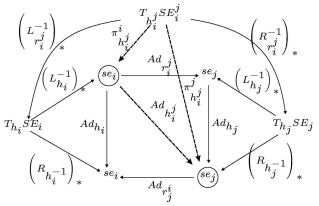
Self-Motions of Friffis-Duffy Type Parallel Manipulators
Manfred Husty[1] and Adolf Karger[2]
[1]Montan University Leoben and [2]Charles University

- Self-motion of a parallel manipulator, as shown in the figure to the right, is defined as finite mobility when all actuators are locked. Manipulators having this feature are of limited practical use.
- Using kinematic mapping we show that this special type of Stewart-Gough platform has a self motion in every point of its work space.
- The dgree of self motion is crucially dependent on the leg parameters and therefore on position and orientation of the platform. It can be from degree 4 to degree 40.
- It is believed that an enumeration of critical cases is essential for future design of parallel platforms .



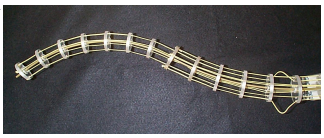
Non-Intrinsicity of References in Rigid Body Motions
Stefano Stramigioli and Herman Bruyninckx
Delft University of Technology

- Coordinate-free treatement of rigid body motions
- "Not intrinsicity" of references
- General commutation diagram explaining result
- Relation with Lie Groups



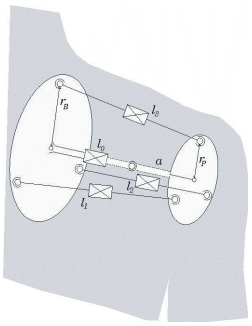
Kinematic Transformations for remotely-actuated planar continuum robots
Ian A. Gravagne and Ian D. Walker
Clemson University

- Examine Multiple-Section Continuous Backbone Robots
- Discuss Redundancy Resolution Techniques
- Apply Wavelet Theory to Aid in the Shape Control Problem
- Simulation Results and Images of Prototype Robots



Kinematic design of a humanoid robotic shoulder complex
J. Lenarcic[1], M. M. Stanisic[2] and V. Parenti-Castelli[3]
[1]The "Jozef Stefan" Institute, [2]University of Notre Dame and
[3]University of Bologna

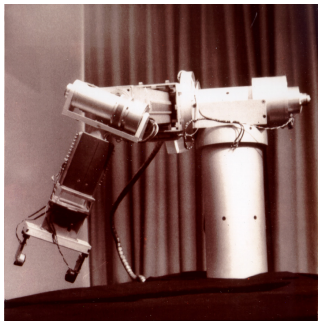
- A parallel mechanism is used which replicates the function of the human shoulder
- An experimental mechanism was developed possessing four driven legs
- It provides the shoulder flexion, abduction, longitudinal rotation and elongation



Mechanisms
Organizers & Chairs: Shigeo Hirose, Victor Scheinman

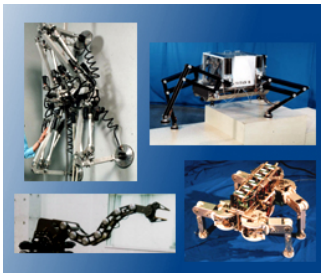
Robots I have Known
Victor Scheinman

- From Alien Robots to Robot Worlds
- Bernie, John, Joe, Marvin
- Servos, Sensors, Software, Systems
- ARPA - Applications - Automation - Automatix



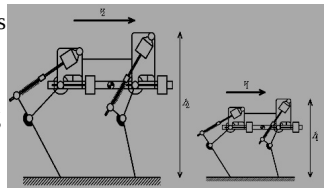
Coupled and Decoupled Actuation of Robotic Mechanisms
Shigeo Hirose and Keisuke Arikawa
Tokyo Institute of Technology

- Introduction of Coupled and Decoupled Actuation, or CDA.
- Maximization of robotic performance by CDA.
- Examples of optimal mechanical design by CDA.
- Examples of optimal motion control by CDA.



Scaling of Robotic Mechanisms
K. J. Waldron and C. Hubert
Ohio State University

- Designing from similar systems
- Biomimetic implications
- Geometric & kinematic scaling
- Scaling actuator performance



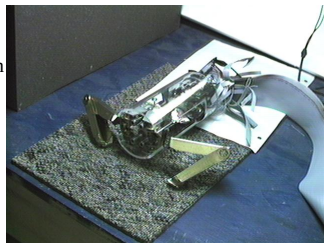
A Mechatronics Approach to the design of light-weight arms and multifingered hands
G. Hirzinger, J. Butterfass, M. Fischer, M. Grebenstein, M. Haehnle, H. Liu, I. Schaefer and N. Sporer
German Aerospace Center (DLR)

- Introduction
- DLR's light weight robot concepts including programmable impedance: the second generation is available now
- Development of four-fingered hands (DLR hands I and II), integrating twelve actuators
- Resume

Mechanism Synthesis Theory and the Design of Robots
J. Michael McCarthy
University of California, Irvine

TerminatorBot: A Robot with Dual-Use Arms for Manipulation and Locomotion
Richard Voyles
University of Minnesota

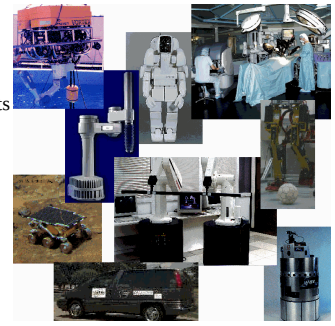
- Small, resource-constrained robots require innovation
- Dual-use limbs provide manipulation and locomotion
- Novel gaits were created for the novel mechanism
- Locomotion demonstrated, adaptive manipulation under investigation



Architectures
Organizers & Chairs: Eve Coste-Maniere, Reid Simmons

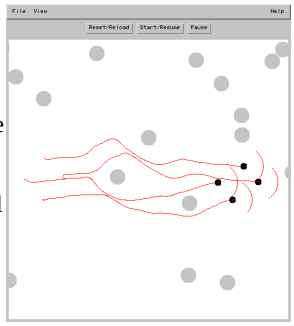
Architecture, the Backbone of Robotic Systems
E. Coste-Maniere[1] and R. Simmons[2]
[1]INRIA Sophia Antipolis and [2]Carnegie Mellon University

- ARCHITECTURE: To manage the complexity of robotic systems
- SPECIFICATION: Modularity & reuse, programming environments – VALIDATION: Test & verification
- EXECUTION: Real-time, autonomy/decision, reliability, interactions
- TRENDS FOR THE FUTURE: System integration & standards



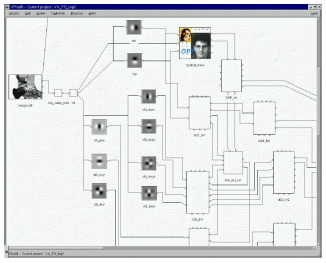
Social Potentials for Scalable Multi-Robot Formations
Tucker Balch and Maria Hybinette
Carnegie Mellon University

- New class of potential functions for group navigation
- Enables homogeneous large-scale formations
- Integrated with other navigational behaviors
- Demonstrated in simulation



PredN : Achieving efficiency and code re-usability in a programming system for complex robotic applications
O. Stasse and Y. Kuniyoshi
Electrotechnical Laboratory, ETL

- Real-time, distributed architectures, portability and code re-usability
- Application model which avoids overspecification, general platform modelization
- Real-time visual attention system. 70 us latency between objects
- Trade-off between software generality and pure modelization

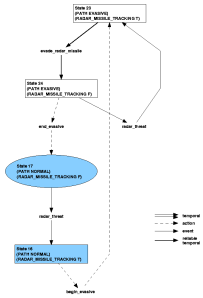


Around the lab in 40 days...
Rachid Alami, Raja Chatila, Sara Fleury, Matthieu Herrb, Felix Ingrand, Maher Khatib, Benoit Morissett, Philippe Moutarlier and Thierry Simeon
LAAS/CNRS

- LAAS: LAAS'Architecture for Autonomous System
- A functionnal and a decisional level
- Example: implementation of a robust navigation system
- Contribution: concepts and software tools

Using Model Checking to Guarantee Safety in Automatically-Synthesized Real Time Controllers
David J. Musliner, Robert P. Goldman and Michael J. Pelican
Honeywell Technology Center

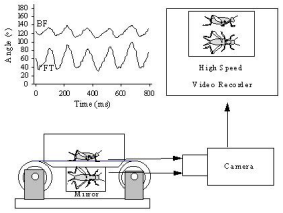
- Motivation: Mission-critical autonomous systems (UAVs, spacecraft)
- Approach: Automatically build guaranteed real-time controllers, on-line
- Details: Plans are verified using model checking techniques
- Result: Novel application of formal methods yields reliable, self-adaptive controllers



Micro Robots
Chairs: Fumihito Arai, Il Hong Suh

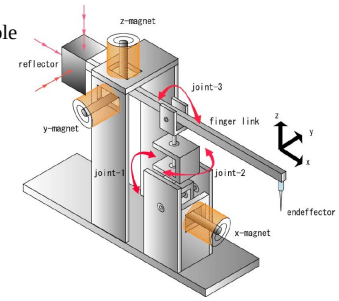
Biomechanics and Simulation of Cricket for Microrobot Design
S. Laksanacharoen, A. J. Pollack, G. M. Nelson, R. D. Quinn and R. E. Ritzman
Case Western Reserve University

- Biologically based microrobot design
- High-speed video analysis of cricket leg structure and movement
- Derivation of three dimensional patterns of leg movements
- Simplification of animal legs for robot maintaining jumping and walking locomotion capability



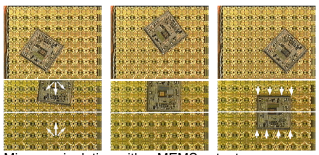
A Micro Operation Hand and its Application to Microdrawing
Tatsuya Nakamura, Yoshiyuki Kogure and Koichiro Shimamura
Tokyo Metropolitan University

- Development of Force-Controllable Micro-Operation Hands
- Use of Magnetic Suspension Technology
- Applied to Micro Drawing Using One Finger Subsystem
- Characteristics of the System were Analyzed



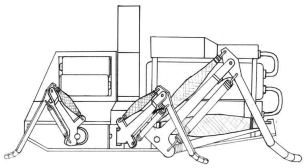
Fully Programmable MEMS Ciliary Actuator Arrays for Micromanipulation Tasks
J. W. Suh[1], R. B. Darling[2], K. F. Bohringer[2], B. R. Donald[3], H. Baltes[4] and G. T. Kovacs[1]
[1]Stanford University, [2]University of Washington, [3]Dartmouth College and [4]ETH Zurich

- Manipulation with individually addressable MEMS actuator arrays
- Integrated CMOS and polyimide thermal bimorph actuators
- Distributed manipulation with programmable force fields
- Complex manipulation tasks: positioning, orienting, ...


Micromanipulation with a MEMS actuator array.
Top row: translation of a 3 x 3 mm² chip.
Bottom row: centering in a squeeze field.
www.ee.washington.edu/research/mems/Projects/CiliaArrays

Design of a Cricket Microrobot
M. C. Birch, R. D. Quinn, C. Hahm, S. M. Phillips, B. Drennan, A. Fife, H. Verma and R. D. Beer
Case Western Reserve University

- Design a two-inch robot that can walk and jump.
- Use cricket for inspiration in the robot's design.
- Control of prototype rear leg was successful.
- Technologies needed for robot have been tested.



The Effect of Material Properties and Gripping Force on Micrograsping
Yu Zhou and Bradley J. Nelson
University of Minnesota

Planning a Microassembly Task in a Flexible Microrobot Cell
Sergej Fatikow, Airat Faizullin and Jorg Seyfried
University of Karlsruhe

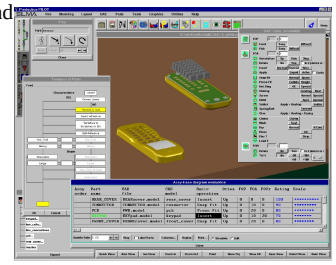
- Microrobot-based assembly of hybrid microsystems
- Bottom-up assembly planning using specific criteria
- Assembly planning of the worldwide smallest micromotor
- Automation of microassembly by flexible microrobots

Manufacturing System Design
Chairs: Tamio Arai, N. Viswanadham

Using Assembly Scoring as an Entry into Production Line Design

R. Guptill and M. C. Cheng
Adept Technology, Inc.

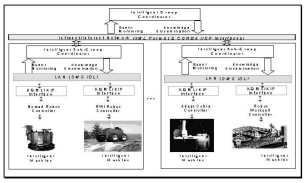
- Shorter production cycles demand better planning tools.
- Product Designers can influence production line design.
- Sony DAC assembly scoring system is well established.
- Integration with Line simulator speeds up final line design.



A Framework for the Development of Agile Manufacturing Enterprises

R. Kolluru, S. Smith, R. Logananthraj, T. Chambers, G. Seetharaman and T. D'Souza
University of Louisiana at Lafayette

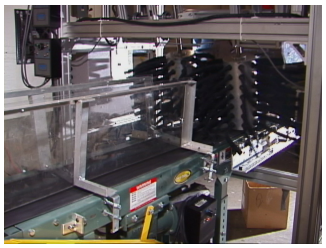
- Control and Communications framework for manufacturing enterprise agility
- Distributed intelligence / information framework
- CORBA / Java / KQML and XML



Design Criteria for Developing an Automated Live Bird Transfer System

Kok-Meng Lee
Georgia Institute of Technology

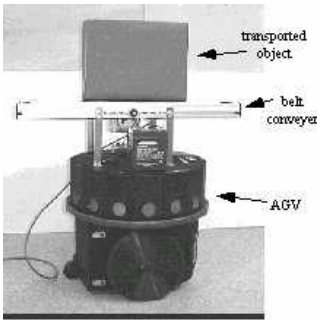
- The repetitive task of transferring live objects, which typically characterized by varying sizes and shapes, and have natural reflexes, is often laborious and hazardous. We present the method to automate the process of transferring singulated live birds from a moving conveyor onto a processing line without causing damage or stress.
- The system uses revolving flexible fingers to manipulate the leg kinematics of the bird on a moving conveyor so that both legs of the bird are inserted into the shackle. We use motion simulation to trade-off between the bird stability and the insertion requirement for a range of size variation.
- Twelve different experimental trials were conducted with 120 novice broilers from a poultry processing plant to examine the effects of key design parameters and to evaluate the system performance. The experiment shows that the bird's visual reflex and initial posture have significant effects on the system performance.
- The design principles for developing an automated live-bird transfer system have been developed. Along with the identification of key parameters that significantly affect the system performance, the system was experimentally evaluated using live broilers. The system has the ability to accommodate a limited range of varying sizes, shapes, and some natural bird's reaction to grasping.



Flexible Transport System by Cooperation of Conveyer-Loaded AGVs

Jun Ota, Kousuke Inoue, Ryousuke Chiba, Tomokazu Hirano and Tamio Arai
University of Tokyo

- A new module for flexible material handling
- A module integrating a conveyer and an AGV
- Hand-over operation between the two modules to avoid deadlock
- Transport simulation of model factory environments



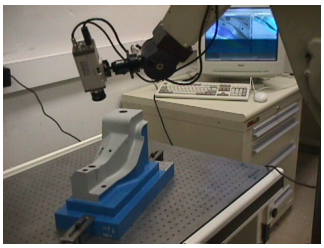
Design of Synchronized Supply Chains: A Six Sigma Tolerancing Approach

Y. Narahari[1], N. Viswanadham[2] and R. Bhattacharya[1]
[1]Indian Institute of Science and [2]National University of Singapore

Automated CAD-Guided Automobile Part Dimensional Inspection

W. Sheng[1], N. Xi[1], M. Song[2], Y. Chen[2] and J. S. Rankin III[2]
[1]Michigan State University and [2]Ford Motor Company

- Camera positioning for part dimensional inspection
- Novel approach combining generate-test and synthesis methods
- Experimental evaluation using automobile parts
- Straightforward and easy to implement with low computational cost

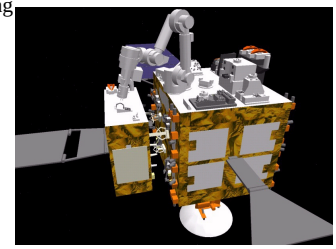


Space Robots and Rovers
Chairs: Richard Volpe, Kazuo Tanie

State Identification for Planetary Rovers: Learning and Recognition
Oliver Aycard[1] and Richard Washington[2]
[1]Leibniz-Imag and [2]NASA Ames Research Center

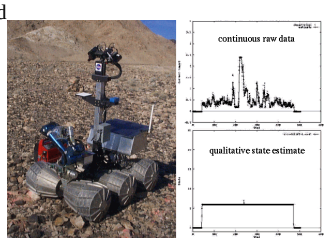
Autonomous Satellite Capture by a space Robot
Noriyasu Inaba and Mitsushige Oda
National Space Development Agency of Japan

- Highly required satellite capturing technique in space
- Space experiments on Japanese satellite
- Successful results of automatic capture using visual servo
- The demonstrated technique applied for future missions



On-Board Real-Time State and Fault Identification for Rovers
Richard Washington
NASA Ames Research Center

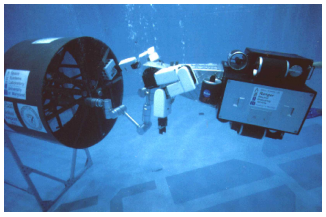
- Rovers must infer state from noisy, continuous data with limited computation
- Combination of Kalman Filters and POMDP belief states
- Prototype tested on Marsokhod planetary rover with broken wheel gear
- Computationally efficient hybrid state identification method



On-board Task Scheduling Algorithm for Spacecraft
I. J. Jeong[1], G. Papavassilopoulos[1] and D. S. Bayard[2]
[1]University of Southern California and [2]California Institute of Technology

Dynamic Tool Vectors for Robo-Centric Control
C. R. Carignan, D. L. Akin and J. Corde Lane
University of Maryland

- Free-flying robots need kinematic strategy which is independent of vehicle state
- Dynamic tool vectors allow tool and base to switch roles without redefining coordinates
- Simulation and experiment show strategy is effective for video/grapple arm operations
- Variable tool vectors allow arms to function in multiple roles in robot-centered coordinates



Recent Progress in Local and Global Traversability for Planetary Rovers
S. Singh, K. Schwehr, R. Simmons, T. Smith, A. Stentz, V. Verma and A. Yahja
Carnegie Mellon University

Autonomous Robots
Chairs: Hajime Asama, Maria Gini

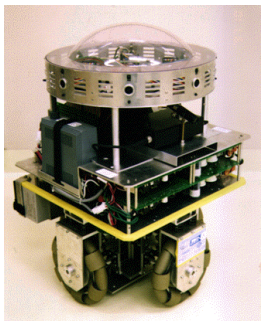
World Modeling and Behavior Generation for Autonomous Ground Vehicles
S. Balakirsky[1] and A. Lacaze[2]
[1]National Institute of Standards and Technology and [2]University of Maryland, College Park

- Design of a course vehicle motion planner for UGV's over rough terrain
- A description of our world model is presented
- A description of our behavior generator is presented
- Real vehicle implementation results are presented

Design, Experiments and Motion Planning of a Spherical Rolling Robot
S. Bhattacharya and S. Agrawal
University of Delaware

A Motion Generation Approach for an Onmidirectional Vehicle
I. Paromtchik and H. Asama
The Institute of Physical and Chemical Research (RIKEN)

- Motivation and Objective
- The Mobile Robot and Its Control Architecture
- Proposed Motion Generation Approach
- Experimental Results

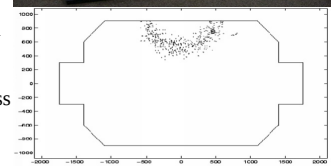


A localization method based on two omnidirectional perception systems cooperation
A. Clerentin, L. Delahoche, C. Pegard and E. Brassart
Institut Universitaire de Technologie - Amiems

- An absolute localization paradigm is reported.
- It is based on the cooperation of two sensors :
- - an omnidirectional vision system composed of a conical mirror and a CCD camera
- - a low cost panoramic range finder system.

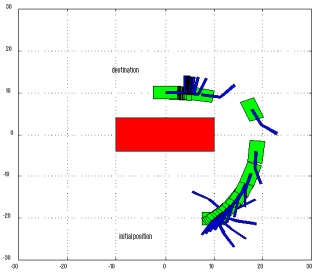
Sensor Resetting Localization for Poorly Modelled Mobile Robots
Scott Lenser and Manuela Veloso
Carnegie Mellon University

- Localization of poorly modelled, limited CPU robots is hard.
- Approach: add error detection and recovery to localization
- Results: quick, robust localization despite errors in model
- Error recovery increases robustness and decreases CPU cost.



Nonholonomic Motion Planning for Mobile Manipulators
Herbert Tanner and Kostas J. Kyriakopoulos
National Technical University of Athens

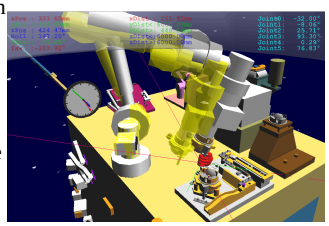
- Nonholonomic motion planning for mobile manipulators
- Discontinuous feedback law with potential fields
- Numerical simulations
- Real time implementation issues



Space and Underwater Robots
Chairs: E. Freund, Nilanjan Sarkar

Application of Automatic Action Planning for Several Work Cells to the German ETS-VII Space Robotics Experiments
E. Freund, K. Hoffmann and J. Rossmann
Universitat Dortmund

- Intuitive Control and Supervision of the robot arm ERA
- Virtual Reality, Action Planning and Multi-Robot-Control
- Simultaneous control of multiple virtual and real robots
- Improvement of the operability

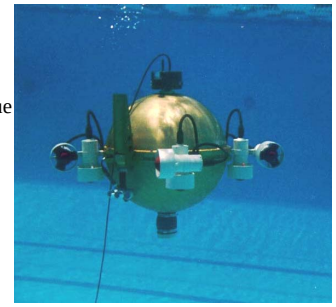


Exact Tracking Control for an Autonomous Helicopter in Hover-like Manouvers
R. Mahony and R. Lozano
Univeriste de Technologie de Compiegne(UTC)

- An Idealized Dynamic Model of a Helicopter
- An Equivalent Model in Block Pure Feedback Form
- Feedback Control to obtain Exact Tracking
- Conclusions

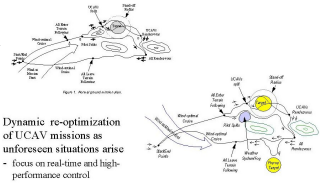
Fault Tolerant Control of an Autonomous Underwater Vehicle Under Thruster Redundancy: Simulations and Experiments
T. Podder, G. Antonelli and N. Sarkar
University of Hawaii at Manoa

- Fault tolerant control of an AUV
- Weighted pseudoinverse technique
- Simulation and experimental results
- Successful tracking of the trajectory with two thruster faults



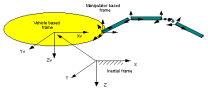
Active Multi-Model Control for Dynamic Maneuver Optimization of Unmanned Air Vehicles
D. Godbole, T. Samad and V. Gopal
Honeywell Technology Center

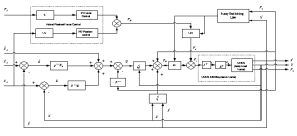
- Problem: Develop dynamic maneuver optimization algorithms for UAVs
- Solution: Wavelet-based multi-resolution maneuver optimization
- Use of evolutionary computing & interior point based optimization techniques
- Allows incremental optimization. Near term trajectory can be designed with detailed models.



A Unified Force Control Approach to Autonomous Underwater Manipulation
Y. Cui and N. Sarkar
University of Hawaii at Manoa

- A unified force control scheme for an autonomous underwater robotic system is proposed
- Fuzzy switching is employed to combine the two force control outputs
- Simulation results indicate that UVMS can contact with the underwater environment in a stable manner and follow the desired force trajectory by the same controller
- A unified force control scheme developed can be used for underwater manipulation





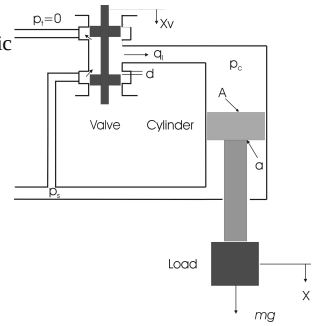
Mission Path Following for An Autonomous Unmanned Airship
J. Azinheira, E. de Paiva, J. Ramos and S. Bueno
Informatics Technology Center, Brazil

- In this article, the authors propose two novel strategies for guidance control of an unmanned airship.
- The first one is based on an H-infinity control technique and the second one is based on PI control.
- Simulated case studies show that both approaches exhibit similar path tracking behavior.
- The H-infinity controller presents a superior performance with respect to disturbance rejection.

Control 1
Chairs: Roberto Horowitz, Tzyh-Jong Tarn

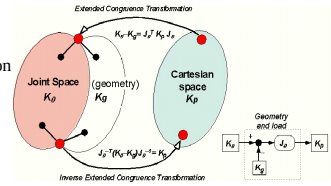
On the Nonlinear Control of Hydraulic Servo-systems
M. R. Sirouspour and S. E. Salcudean
The University of British Columbia

- Position tracking control of hydraulic actuators is addressed
- Nonlinear controllers developed using backstepping
- Simulation and experiments of the schemes presented
- Provably stable method with better performance than PD



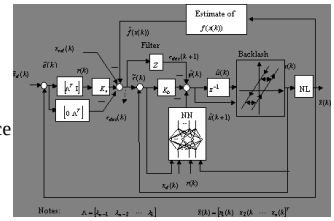
Simulation of Conservative Congruence Transformation: Conservative Properties in the Joint and Cartesian Spaces
Shih-Feng Chen and Imin Kao
SUNY Stony Brook

- Nonconservative Conventional Formulation of Robot Grasping Under Stiffness Control
- Conservative Congruence Transformation (CCT)
- Simulation Results of a Two-link Planar Manipulator
- The CCT Is the Correct Mapping for Stiffness Control in Robotics



Backlash Compensation in Discrete Time Nonlinear Systems Using Dynamic Inversion by Neural Networks
J. Campos, F. L. Lewis and R. Selmic
The University of Texas, Arlington

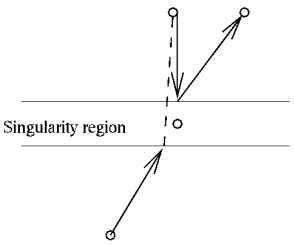
- Backlash is a common problem found in control actuators
- Dynamic inversion by neural networks
- Simulations show better performance over standard PD
- On-line tuning,stability analysis and small tracking errors



A 3-Step Set-Point Control Algorithm for Robot Arms
N. H. Quach and M. Liu
Monash University

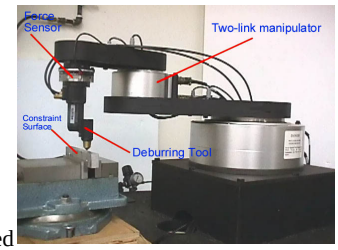
Channel Algorithm of Transversal Passing Through Singularities for Non-Redundant Robot Manipulators
Ignacy Duleba
Wroclaw University of Technology

- Find an effective method to pass smoothly through singular configurations.
- The channel algorithm enables to jump through singularity and uses a basic Newton algorithm only. The modified SVD algorithm is used to check successful passing.
- Simulations on the 2-pendulum and the PUMA robot.
- The algorithm enables to smoothly pass through singular configurations.



Design and Experimental Evaluation of a Stable Transition Controller for Geometrically Constrained Robots
P. R. Pagilla and B. Yu
Oklahoma State Universtiy

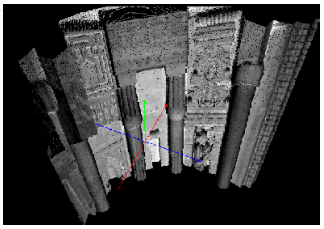
- Robot transition control from free to constrained motion
- A new discontinuous control algorithm is proposed
- Experiments for a complete robot task with constraint uncertainty
- Stable transition with improved performance is achieved



Range Sensing
Organizers & Chairs: Martial Hebert, Larry Matthies

Active and Passive Range Sensing for Robotics
Martial Hebert
Carnegie Mellon University

- Survey of current trends and results in the area of range sensing, including:
- Time of flight ranging
- Passive stereo
- Active triangulation

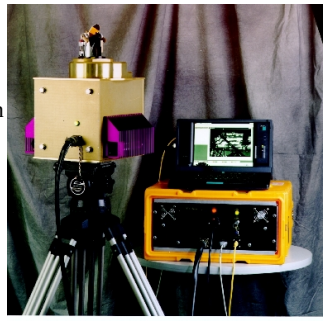


Beyond Range Sensing: XYZ-RGB Digitizing and Modeling
Marc Rioux
National Research Council Canada

- The 3D digitizing and modeling research activities at the NRC laboratories
- From B&W to Color (The use of multi-wavelengths laser sources for color digitizing in 3D)
- From 3D Data Points to Geometry (The use of modeling techniques to recover geometry from 3D data points)
- From Geometry to Reflectance Modeling (Color modeling using both the 3D data points and the registered color data)

Imaging Laser Scanners for 3-D Modeling and Surveying Applications
D. Langer[1], M. Mettenleiter[2], F. Haertl[2] and C. Froehlich[2]
[1]Z+F USA, Inc. and [2]Z+F Wangen, Germany

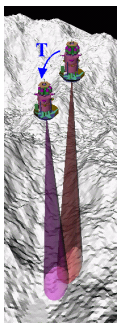
- Introduction to Laser Radar Measurement System
- Profiling Laser Radar Deflection System
- Imaging Laser Radar Deflection System
- Application Results in Reverse Engineering and Inspection



Passive Night Vision Sensor Comparison for Unmanned Ground Vehicle Stereo Vision Navigation
Ken Owens and Larry Matthies
California Institute of Technology

Motion estimation from laser ranging for autonomous comet landing
Andrew E. Johnson and A. Miguel San Martin
California Institute of Technology

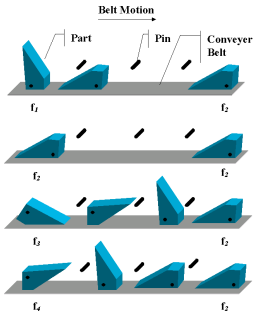
- To estimate spacecraft motion during comet landing using scanning laser rangefinder data.
- Terrain map generation followed by terrain map alignment using SSD and gradient descent.
- Two tests were conducted with data collected using a long range scanning LIDAR. These tests resulted in a 4.4 Hz frame rate and a motion accuracy of 0.5m over 70m of descent.
- Motion estimation for comet landing can be done quickly and accurately using a scanning laser rangefinder.



Part Feeding and Fixturing
Organizers & Chairs: Ken Goldberg, Jeff Trinkle

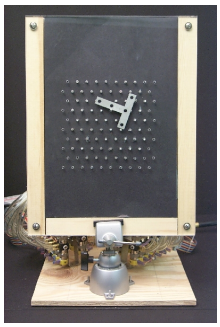
The Toppling Graph: Designing Pin Sequences for Part Feeding
T. Zhang[1], G. Smith[1], R. Berretty[2], M. Overmars[2] and K. Goldberg[1]
[1]University of California, Berkeley and [2]Utrecht University

- This paper extends Lynch's approach to feeding parts on a conveyor belt using pins.
- We introduced the toppling graph, which identifies critical pin heights that permit toppling, and give an $O(n^2)$ algorithm to compute it.
- We develope an $O(n^{3n})$ algorithm for designing pin sequences.



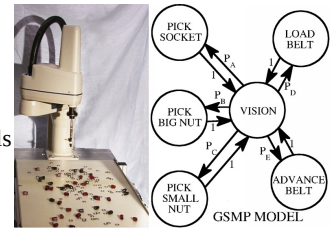
A Reconfigurable Parts Feeder with an Array of Pins
S. Blind, C. McCullough, S. Akella and J. Ponce
University of Illinois

- We present a
- We compute part equilibrium configurations, their capture regions, and a transition graph for planning.
- A planner and a prototype device with 68 pins have been implemented.
- The



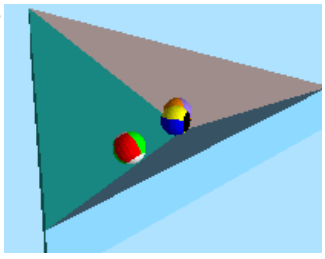
Modeling and Throughput Prediction for Flexible Parts Feeders
M. S. Branicky, G. C. Causey and R. D. Quinn
Case Western Reserve University

- Flex Feeders: key technology; not well understood
- GSMP simulation & analysis for modeling/prediction
- Physical tests to derive models & validate results
- Throughput prediction for novel feeding scenarios



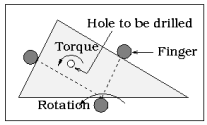
An Implicit Time-Stepping Scheme for Rigid Body Dynamics with Inelastic Collisions and Coulomb Friction
D. Stewart[1] and J. C. Trinkle[2]
[1]University of Iowa and [2]Sandia National Labs

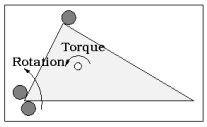
- Previous complementarity methods can lack solutions
- New impulsive method always has solutions
- Method is convergent as step-size reduces
- Method needs no explicit collision checking



On Well-Defined Kinematic Metric Functions
Q. Lin and J. W. Burdick
California Institute of Technology

- Metric functions: scalar functions of rigid configs., velocities & wrenches.
- Utility: to assess robotic metric attributes (e.g. distance, length & angle).
- Approach: intrinsic characterization of objectivity of metric functions.
- Results: objectivity as related to frame-invariance and left, right & bi-invariances.

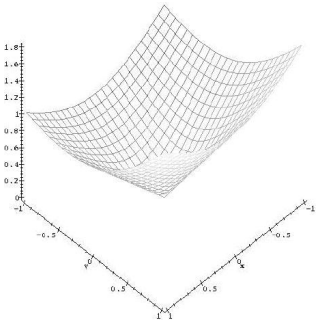




Which fixture has smaller disp.?

Positioning and Orienting a Class of Symmetric Parts Using a Combination of a Unit-Radial and a Constant Force Fields
F. Lamiraux and L. Kavraki
Rice University

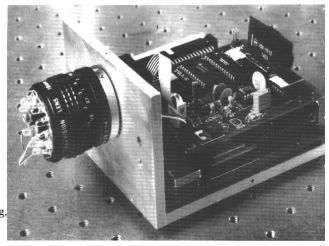
- Uniquely orient parts using force fields in a plane
- Combination of radial and constant force fields
- None
- Some parts uniquely posed up to symmetry



Prototyping Design and Automation
Organizers & Chairs: Kok-Meng Lee, Tarek Sobh

New Trends in Prototyping Design and Automation
Kok-Meng Lee[1] and Tarek Sobh[2]
[1]Georgia Institute of Technology and [2]University of Bridgeport

- This paper is written to provide an overview on Symposium on New Trends on Prototyping Design and Automation with an emphasis on the following two subtopics: (1) a review on prototyping discrete event and hybrid systems, and (2) the trends on prototyping real-time machine vision system design.
- This symposium contains five papers, covering the topics of information extraction for engineering design, predictive models of discrete-event and hybrid systems, process planning automation, and prototyping design of vision sensing systems, micro/nano systems, and automated DNA sequencing.
- The overview paper presents the following two subtopics. The first is an overview for the development of a theory for prototyping discrete event and hybrid systems. The second subtopic is an overview of machine vision prototyping design for real-time automation applications.
- A simple software environment system was developed for simulating, analyzing, synthesizing, monitoring, and controlling discrete event and hybrid systems. In addition, we present an alternative vision system to overcome those problems associated with a traditional video-based vision system.

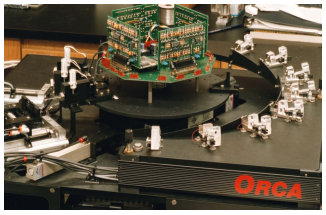


Prototyping Design and Automation of Micro/nano Manipulation System
T. Fukuda and F. Arai
Nagoya University

- There is a great demand to manipulate microobjects. Here we classified the micro/nano manipulation and introduced the basic research topics and fundamental technologies.
- We present two examples of prototyping of the micro/nano manipulation system especially for biological applications.

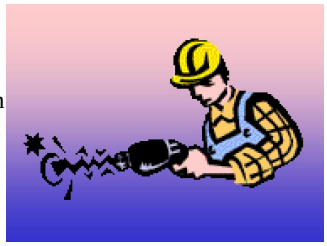
Automating High-Throughput Fluid Sample Handling for Biotechnology and Chemistry
Deirdre Meldrum
University of Washington

- Automated, high-throughput (5000 samples/8 hours), reduced costs, improved quality, reliable, and reproducible system for genome analysis.
- Use glass capillaries and piezoelectric dispensers to prepare submicroliter reactions.
- First generation system complete; 2nd generation system in testing; biology produced is of high quality and reproducible.
- Automated fluid handling system has been successfully developed. It will be tested soon in large-scale genome centers to prepare samples for DNA sequencing.



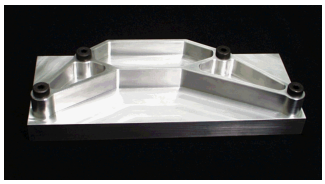
Data Mining in Engineering Design: A Case Study
A. Kusiak and T. L. Tseng
University of Iowa

- New computational paradigm
- Data and parameter prediction
- Novel data mining algorithms
- Accurate results



An Approach to Rapid Manufacturing with Custom Fixturing
Mark Bloomenthal, Richard Riesenfeld, Elaine Cohen, Russell Fish and Samuel Drake
University of Utah

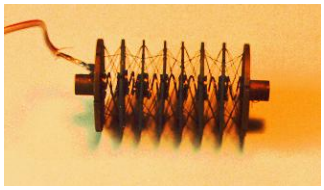
- Automatic generation of process plans with fixturing.
- Quick turn-arounds for functional machined parts.
- Prismatic parts with 4 and 5 axis indexed features.
- Approach: process plan templates.



Actuators 1
Chairs: Michael J. McCarthy, Ken Waldron

Constrained Force Control of Shape Memory Alloy Actuators
D. Grant and V. Hayward
McGill University

- Experimental results are presented to show that SMA actuators can control forces rapidly and precisely.
- A force transduction model for SMA actuators is developed and a two stage switching controller is designed using this model.
- An antagonistic pair that weights 6g (most of it is superfluous) has a peak force of 7 N. It can apply force under control with a 0.5
- Continuous operation was also verified.

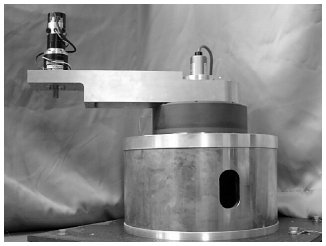


Force Controllable Hydro-Elastic Actuator
David Robinson and Gill Pratt
Massachusetts Institute of Technology

- Develop a force controllable hydraulic actuator.
- Control the strain of a series elastic element.
- Low impedance, shock tolerance, good bandwidth and high power density.
- Excellent force control with large dynamic range.

Development and Analysis of Actuator With ER Damper
N. Takesue[1], G. Zhang[1], M. Sakaguchi[1], J. Furusho[1] and Y. Kiyosawa[2]
[1]Osaka University and [2]Harmonic Drive Systems, Inc.

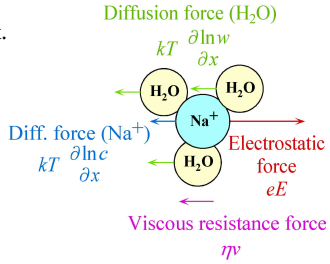
- Motivation
- Development
- Analysis
- Experiments



Velocity Dependence of the Characteristics of Harmonic Drive Built-in Torque Sensing
M. Hashimoto[1], T. Ishizuka[2], I. Godler[3] and M. Horiuchi[4]
[1]Shinshu University, [2]Kagoshima University, [3]Kyushu University and [4]Harmonic Drive Systems, Nagano Japan

An Actuator Model of ICPF for Robotic Applications on the Basis of Physicochemical Hypotheses
S. Tadokoro[1], S. Yamagami[1], T. Takamori[1] and Keisuke Oguro[2]
[1]Kobe University and [2]Osaka National Research Institute

- Accurate ICPF modeling for robotic application development.
- Stress generation model by ionic motion in the membrane.
- High accuracy on transient response and nonlinearities.
- CAD of soft gel actuators for future robotic design.



Modeling and Motion Control of an Actuator Unit using ER Clutches
M. Sakaguchi, G. Zhang and J. Furusho
Osaka University

- Development of an Actuator Unit Using ER Fluid
- Good Response, Low Inertia and Safety Characteristics
- Force and Velocity Response Models of the ER Actuator Unit
- Experimental Results of the Motion Control

Rehabilitation Robotics
Chairs: Atsuo Takanishi, Machiel Van der Loos

A Smart Walker for the Frail Visually Impaired
S. MacNamara and G. Lacey
Trinity College Dublin

- Increased mobility for people with a visual and mobility impairment
- Highly maneuverable with context sensitive user interface
- Robust local navigation with probabilistic feature detector
- Extensively field tested in many residential facilities for the elderly

Step climbing using power assist wheel chair robot with inverse pendulum control
Y. Takahashi[1], S. Ogawa[2] and S. Machida[1]
[1]Kanagawa Institute of Technology and [2]Kanagawa Technical High School, Yokohama, Japan

Autonomous/Semi-autonomous Navigation System of a Wheelchair by Active Ultrasonic Beacons
H. Seki, S. Kobayashi, Y. Kamiya, M. Hikizu and H. Nomura
Kanazawa University

- Navigation Assistance for Wheelchair Users
- Positioning System by Ultrasonic Beacons
- Three Navigation Modes Utilizing Detected Position
- Navigation Experiments

Control Strategies for a Split-Wheel Car-Steering Simulator for Upper Limb Stroke Therapy
M. J. Johnson, H. F. M. Van der Loos, C. G. Burgar, P. Shor and L. J. Leifer
Stanford University

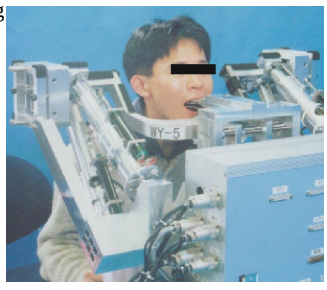
- Our goal is to create effective and low-cost ways of facilitating upper limb stroke therapy. Our challenge was to devise control strategies to increase the level of impaired limb participation in exercise tasks.
- We interfaced a novel split-steering wheel with a driving simulator to create Driver's SEAT. We designed three therapy modes based on force-reflective control strategies. Normal and stroke subjects performed bimanual steering in each mode.
- We detected significant differences between limb forces exerted on the wheel in each therapy mode. We can also quantify tracking performance on our simulated roads.
- Our car-steering simulator (Driver's SEAT) has the potential to be an effective device for upper limb stroke therapy.

DSP-Based Controller for a Multi Degree Prosthetic Hand
H. P. Huang and C. Y. Chiang
National Taiwan University

- Discriminate the EMG features
- Develop a DSP-based controller
- Provide 87.5

Mouth Opening and Closing Training with 6-DOF Parallel Robot
Hideaki Takanobu[1], Takeo Maruyama[1], Atsuo Takanishi[1], Kayoko Ohtsuki[2] and Masatoshi Ohnishi[2]
[1]Waseda University and [2]Yamanashi Medical University

- Motivation: Conventional training by human was 1-DOF
- Approach: 6-DOF Universal Dental Robot (UDR)
- Results: Increase of two patients' mouth opening distances from 21 to 32 and 15 to 26 [mm]
- Conclusions: 6-DOF training robot was developed



Robotics: The 20th Century and Beyond

Chair/Moderator: Georges Giralt, LAAS-CNRS, France

Speakers:

T. Kanade, Carnegie Mellon University
J.C. Latombe, Stanford University
N. Nilsson, Stanford University
B. Roth, Stanford University

During the 20th century, Robotics has progressively emerged as a scientific body of concepts, methods, and algorithmic tools, in fact the most challenging field in machine intelligence.

Currently, it is confronted with paramount challenges both in theoretical aspects with seminal scientific and technical achievements, and practical aspects where Information Technologies and Micro and Nano Technologies appear to be decisive supporting factors.

The current stream of developments paves the way for a very large domain of novel applications ranging from outer space intervention to Assistive Robotics, Personal Robotics and Human Augmentation. These advances are cornerstone aspects for the domain of Human Centered Robotics where machines are among people and might be operated by non specialized users.

The speakers will address four key broad domains presenting their own views on past and current achievements, current trends, and future development they see for the next decade. They will entertain an ample debate with the audience at the end of the four presentations.

- *Computer Vision: Progress in the Last Three Decades*
  T. Kanade, Carnegie Mellon University
- *Robotics and Real-World Computing*
  J.C. Latombe, Stanford University
- *The Programming, Teaching, and Learning (PTL) Model of Robot Control*
  N. Nilsson, Stanford University
- *Kinematics, Dynamics and Control in Robotic Systems*
  B. Roth, Stanford University