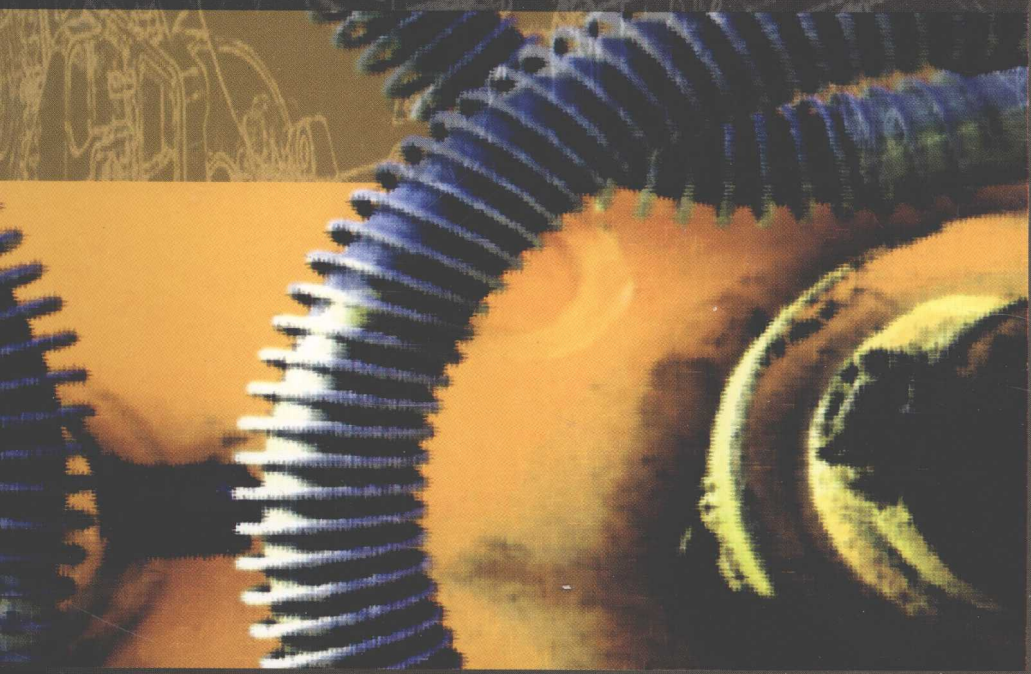
MACHINES AND MECHANISMS



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MACHINE AND MECHANISMS

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Preface

Machines and mechanisms form the backbone of industries, implements in agriculture, space exploration, and various appliances used in our daily lives. The science of machines and mechanisms is fairly old. However, its methods and applications are ever-evolving. Sophisticated modern applications demand complex designs, and new formulations and methods are continuously developed to meet the challenges. Therefore, it is extremely important that researchers in the related fields keep themselves up to date through regular academic interactions among themselves. It is equally important that the practising engineers in various industries, who perceive the needs of newer technologies first hand, get to discuss the same with the researchers, who, on the other hand, are perhaps better equipped to deliver the improvements. It is with this motivation that National Conference on Machines and Mechanisms (NaCoMM 2011) is being organised under the aegis of the Association for Machines and Mechanisms (AMM) and the International Federation for the Promotion of Mechanism and Machine Science (IFToMM), of which AMM is a member. NaCoMM 2011 is the fifteenth in the series of conferences held over the past three decades with the aim of providing a platform to bring together people who use, develop, analyse, and, design machines and mechanisms, as well as teach these subjects at various levels.

NaCoMM 2011 has been successful in attracting about 170 abstracts, of which 123 made it to the final round of reviews. Thanks to the 100 reviewers in India as well as 8 other countries, 281 reviews were conducted in the double-blind mode. Finally 63 papers were selected for oral presentations and 20 others for the interactive poster session. The papers cover a variety of topics, such as, analysis and synthesis of mechanisms, design of machines and machine elements, health monitoring of machine components, dynamics and controls, robotics, parallel manipulators, compliant mechanisms, applications of mechanisms in rural implements, space technologies, biomedical devices etc. Such a rich variety of topics as well as the quality of the contents, ensured by rigorous reviews, should make this collection of contributions significantly interesting to beginners and experts alike. The conference included a workshop on kinematics conducted by Univ.-Prof. Dr. Manfred L. Husty, Professor of Geometry and CAD, University of Innsbruck, Austria. There were three keynote lectures delivered by eminent academicians, Prof. Ashitava Ghosal, (Department of Mechanical Engineering, Indian Institute of Science, India), Prof. Dr.-Ing. Andrés Kecskeméthy, (Chair of Mechanics and Robotics, University of Duisburg-Essen, Germany) and Prof. Marco Ceccarelli, (President, IFToMM, Laboratory of Robotics and Mechatronics, University of Cassino, Italy).

A large number of people contributed towards the success of the conference. Firstly, we would like to thank all the authors for their contributions to NaCoMM 2011. They are solely responsible for the quality of the contents of this title. The Programme Committee

members did a tremendous job by completing the reviews timely enough for the proceedings to be prepared well in time. Members of AMM and several friends abroad contributed to the review process. The Advisory Committee also played an enthusiastic role in helping the conference organisation at different levels, through out the past year.

We would like to thank various Government of India agencies as well as private organisations for supporting the event through participation and sponsorships, and the IIT Madras administration for providing the facilities towards the organisation of the event. We would like to thank the colleagues in the Organising Committee, the faculty and staff of Department of Engineering Design for their efforts towards organising the conference. A large number of colleagues and student volunteers from different departments of IIT Madras helped the conference via academic contributions, as well in its organisation. We also acknowledge the contribution of Narosa Publishing House in bring out the proceedings on time.

Sandipan Bandyopadhyay
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Workspace Evaluation for Analysis and Synthesis of Manipulators

Marco Ceccarelli

Abstract

In this keynote lecture, manipulator workspace is illustrated by discussing its basic characteristics as fundamental for design and operation of mechanical systems in manipulation applications. Algorithms are explained for numerical evaluation of the workspace of serial and parallel manipulators. Formulations are discussed also for design purposes. Design problem for manipulators is formulated by using workspace characteristics. Experimental procedures for workspace determination are outlined both for model validations and performance evaluation.

Keywords: Manipulators, Workspace, Analysis, Design, Characterization

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From Equations to Embodiment - 3 Case Studies

Ashitava Ghosal

Abstract

Mechanisms and machines enter our lives in multiple ways and our dependence on them for several aspects of our day-to-day existence continue to grow in an ever increasing manner. Analysis and design of mechanisms and machines are an integral part of all engineering curriculum, more so in branches such as mechanical, aerospace and bio-medical engineering. There is a lot of stress on analysis aspects and a large amount of time and effort goes into acquiring mastery of analysis tools either in the form of mathematical equations and techniques or, more recently, software packages. However, engineering education should (and in many places does) emphasize creation of innovative products. There is a need to go through the complete cycle -- conceptual design, analysis, detailed design, prototyping, testing and refinement -- of product development. In this talk, I will present three case studies of analysis, design, prototyping and testing. It is shown how one can go from equations to embodiment in the three following examples:

1) Gough-Stewart platform based force-torque sensor,
2) Improved laparoscopic tool, and
3) Hyper-redundant manipulator.

A six degree-of-freedom Gough-Stewart platform is widely used as a motion platform or, with actuators replaced by force sensing elements, used as a six component force-torque sensor. In the first case study, a Gough-Stewart platform is chosen to be in singular configuration and then used as force-torque sensor. This novel concept allows mechanical amplification of chosen components of force and moment and hence measurement sensitivity to desired components of force and moment can be enhanced. In this study, the entire process from determining singular directions, estimating amplification, detailed design using finite element analysis, prototyping using sophisticated CNC machining and testing is demonstrated. The second case deals with the analysis, design and prototyping of a surgical tool used in minimally invasive surgery. With existing laparoscopic tools, a surgeon loses dexterity and the sense of touch and feel. The main engineering challenge in the design of improved laparoscopic tool is the severe space and geometry constraints and maintaining independence of motion. In this example, the concept of a robot wrist is adapted to add an extra degree of freedom to the end-effectors in a laparoscopic tool. All the stages of analysis, design, prototyping and refinement are illustrated. The last case study involves development of a novel strategy to obtain unique values of joint variables given the task space variables of the end-effectors, also known as resolution of redundancy. The strategy, based on a classical tractrix curve, is developed and implemented on an eight degree-of-freedom planar hyper-redundant manipulator. The simulation and experimental results show that strategy leads to more 'natural' motions.

Keywords: Product development, Manipulator design, Simulation, Prototyping

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