ROBOTICS AND CONTROL: THEORY AND PRACTICE

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PRE-REQUISITES : Basic Mathematics

INTENDED AUDIENCE : Electrical Engineering, Computer Science Engineering, Mechanical Engineering,Electronics and Communication Engineering, Mathematics students

COURSE OUTLINE :

Robotics has stimulated an growing interest among a wide range of scholars, researchers and students due to its interdisciplinary characteristics. The development of this field of science is boosted by various domains which are not limited to Cybernetics, Controls, Computers, Mechanics, Bio-Engineering, and Electronics. Among these areas, modelling, control, planning play a fundamental role not only in the growth of industrial robotics, but also towards the advanced fields including healthcare and field robotics.

Through this course the participants will acquire the ability to conduct research, develop innovative designs in the field of systems engineering and control of robots and to direct the development of engineering solutions in new or unfamiliar environments by linking creativity, innovation and transfer of technology.

ABOUT INSTRUCTOR :

Prof. N. Sukavanam received his Ph. D from the Indian Institute of Science, Bangalore in 1985. He served as a Scientist-B at Naval Science and Technological Laboratory, DRDO for two years (1984-86). Then joined as a Research Scientist in the Department of Mathematics, IIT Bombay (1987-90). Worked as a Lecturer at BITS Pilani from 1990 to 1996. In May 1996 he Joined the Department of Mathematics at IIT Roorkee (University of Roorkee at that time) as an Assistant Professor. Currently he is a Professor in the Department of Mathematics IIT Roorkee and Head of the Mathematics from Feb. 2018. His areas of research includes Nonlinear Analysis, Control Theory and Robotics. Professor Sukavanam has published about 80 papers in refereed journals, 30 papers in International Conference Proceedings. He has guided 19 Ph. Ds, 60 M. Sc./M. Phil/MCA Dissertations. Organized International Workshop on Industrial Problems. Developed Pedagogy online course on Mathematics I, offered NPTEL online video course on Dynamical Systems and Control and conducted more than six QIP/Continuing Education courses on Robotics and Control.

Dr. M. Felix Orlando received his Ph.D. from Electrical Engineering Department at Indian Institute of Technology Kanpur (IITK) in 2013, where his advisors were Prof. Laxmidhar Behera, Prof. Ashish Dutta, Prof. Anupam Saxena. In 2015, he completed his post doctoral fellowship at Case Western Reserve University, USA, working with Prof. Tarun Podder, Prof. Yan Yu, Prof. Hutapea focussing on Medical robotics. Dr. Felix Orlando has started as an Assistant Professor in the Department of Electrical Engineering at the Indian Institute of Technology Roorkee (IITR) from November 2015 onwards. He is also the member of IEEE, IEEE-Robotics and Automatin Society (IEEE-RAS), ASME. His current research focuses on medical robotics, rehabilitation robotics, visual servoing and Biomechanics. He is currently the board member of the Student Technical Committee (STC) of robotics, IITR. He has also received the Faculty Initiation Grant (FIG) from IITR for the duration 2016 to 2018. He has received the Early Career Research Award in 2017. He has also coordinated a GIAN course on robotics with Prof. Doik Kim of South Korea in 2017. He has chaired several technical sessions of IEEE international conferences which include, IEEE-AIM 2018, Auckland, IEEE-INDICON 2017, IIT Roorkee, IEEE IECON 2017, Beijing and IEEE ICCSCE 2016, Malaysia. He has presented research papers at various international conferences and has several international robotics journal papers.

COURSE PLAN :

Week 1: Simple manipulators: Two /three arm manipulators and their kinematics equations, Work space Homogeneous Transformation: Rotation, Translation, Composition of homogeneous transformations

Week 2: Danavit-Hartimber Algorithm: D-H procedure for fixing joint coordinate frames, Robot parameters, Arm matrix, Inverse Kinematics for PUMA, SCARA manipulators.

Week 3: Introduction to Robotic Exoskeletons,Optimal Design of a Three Finger Exoskeleton for Rehabilitation Purpose

Week 4: Differential transformation and velocity of a frame: Derivative of a frame, Velocity, Jacobian, Inverse Jacobian, Trajectory Planning: Polynomial trajectory, Biped trajectory

Week 5: Dynamics: Lagrangian method, Robot dynamics equation,Control: Robot dynamics equation as a control system, Trajectory tracking control, PD controller, Neural network control design

Week 6: Redundancy Resolution of Human Fingers using Robotic Principles,Manipulability Analysis of Human Fingers during Coordinated Object Rotation,Kinematics of Flexible Link Robots,

Week 7: Robot Assisted Needling System for Percutaneous Intervention-An Introduction,Smart Robotic Needles for Percutaneous Cancerous Interventions

Week 8: Robust Force Control of a Two Finger Exoskeleton during Grasping ,Neural Control of an Index Finger Exoskeleton – Lecture 1,Neural Control of an Index Finger Exoskeleton – Lecture 2