


Curriculum Vitae

Name	SOUMEN SEN	
Date of Birth	January 02, 1970.	Nationality: INDIAN
Research Interest	Variable-Impedance/Stiffness Actuation and Control; Robot design, Mechanics and Control; Physical Human-Robot Interaction; Multifingered grasp and manipulation; Tendon-driven systems; Biomimetics and Biorobotics; Underwater robots/vehicle	
Qualification	<p>1. Ph.D. The University of Pisa, ITALY April, 2009. Thesis Title: Toward an Articulated Manipulation System with Antagonistic Actuation for Physical Human-Robot Interaction</p> <p>2. Master of Engineering (Production) Jadavpur University, Kolkata, INDIA June, 1994 Specialization Robotics and CAD/CAM Thesis Title: A Study on Kinesthetic Force-feedback Control for a Teleoperator System</p> <p>3. Bachelor of Engineering (Mechanical) Regional Engineering College, Durgapur, INDIA (Presently, National Institute of Technology) July 1992</p>	
Job Experience (more than Fifteen Years)	<p>1. Sept 15, 2011 – Till date Central Mechanical Engineering Research Institute, CSIR, Durgapur, India. Designation: Principal Scientist Robotics and Automation Division</p> <ul style="list-style-type: none"> • Variable Stiffness/Impedance Actuation • Soft/Human Friendly Robots – physical Human Robot Interaction • Robot Design, Mechanics and Control • Biomimetics - underwater swimming and propulsion 	
Period of service: Nov.10, 1994 To July 8, 2005		
Then from June 25, 2010 till date	<p>2. June 25, 2010 – Sept 15, 2011 (FN) Central Mechanical Engineering Research Institute, CSIR, Durgapur, India. Designation: Scientist Fellow Robotics and Automation Division</p> <ul style="list-style-type: none"> • Variable Stiffness/Impedance Actuation • Soft/Human Friendly Robots – physical Human Robot Interaction 	
(in between joined Univ of Pisa from Aug, 2005 to June, 2010)		

<p>Job Experience (contd....)</p>	<p>3. April 01, 2009 to January 2010 Interdepartmental Research Centre "E. Piaggio", University of Pisa (after PhD work) Designation: Post Doctoral Research Fellow</p> <ul style="list-style-type: none"> • Physical Human Robot Interaction • Variable Stiffness / Impedance Actuation • Tendon actuation and Human Friendly Robots <p>4. November 1996 – June 2005 Bhabha Atomic Research Centre, Mumbai Govt. of India, INDIA</p> <p>Designation: Scientific Officer Division : Div of Remote Handling and Robotics</p> <ul style="list-style-type: none"> • Force Feedback control for Master-Slave Telemanipulators. • Automation in Chemical Handling Laboratory System. • Multifingered Robotic Gripper (Grasp, Manipulation and Control). • Development of different types of Force Sensors for Robotic Applications. <p>5. November 1994 – November 1996 Centre for Advanced Technology, Indore Govt. of India, INDIA Designation: Scientific Officer Division : RF and Microwave</p> <ul style="list-style-type: none"> • RF Amplifier Cavity • Wave guides
<p>Research Project Experience (other than Job experience)</p>	<p>1. September, 2005 – May, 2010 Research Collaborator Interdepartmental Research Centre "E.Piaggio" University of Pisa, ITALY</p> <ul style="list-style-type: none"> • Project PHRIDOM – Physical Human Robot Interaction in anthropic Domain EURON-II Prospective Research Project (participating last three months) <p>1. Project PHRIENDS - Physical Human Robot Interaction: Dependability and Safety, funded by European Commission in Sixth framework programme (FP6, STRReP IST-045359) with Six European partners (From Oct., 2006 to Oct. 2009) http://www.phriends.eu/ or http://www.phriends.org/</p> <ul style="list-style-type: none"> • Project VIATORS (Variable Impedance Actuation systems embodying advanced interaction behaviors), a project supported by the European Commission under the 7th Framework Programme, spanning Feb.2009 to Jan 2010) http://www.viactors.org <p>2. August 1994 - October 1994 Research Associate Jadavpur University, Kolkata, INDIA</p> <p>2. Project - Joystick Controlled Teleoperated Robots, funded by Board of Research On Nuclear Science, Department of Atomic Energy, India.</p>

Recent Projects handled as Principal Investigator at CSIR-CMERI, Durgapur	Name of Project	Funding Agency	Role	Project Value	Duration
	<p>1. Toward Developing Biomimetic Underwater Swimming Robot for Autonomous Surveillance</p> <p>Project No.: GAP152812</p>	DST, Govt. of India	Principal Investigator	Rs. 89.10 Lakh	Three years (March 22, 2013 to May 31, 2017 (expected))
	<p>2. Ejection Mechanism for deployment of launcher and Mechanism for opening/closing of payload cavity door in AMCA: feasibility study</p> <p>Project No.: SSP 152712</p>	Aeronautical Development Agency (ADA), Ministry of Defence, Govt. of India	Principal Investigator	Rs. 30.25 Lakh	One Year Three Months (August 01, 2012 to July, 2014)
	<p>3. Capability generation and knowledge development on variable impedance anthropomorphic cybernetic arm for physical human robot interaction</p> <p>Project No.: OLP 152312</p>	CSIR, Institute Project	Principal Investigator	Rs. 42.046 Lakh	Two Years (Dec 01, 2011 to Nov 31, 2013)
	<p>4. Soft Robots – Flexible Robot Joint with Variable Compliance</p> <p>Project No.: OLP 151912</p>	CSIR, Institute Project	Principal Investigator	Rs. 19.30 Lakh	One Year Ten Months August 25, 2010 to June 30, 2012
	<p>5. Autonomous Underwater Robotics (UnWaR)</p> <p>A CSIR Five year plan Large Mission Five-Lab-Consortium Project</p> <p>Project No.: ESC 0113</p>	12 th Five Year Plan Project of CSIR and CMERI as Nodal Lab	Co-investigator	Rs. 4093.50 Lakh (Rs. 40.936 Crore)	Three Years Ten Months May 2013 to March 2017

Invited talks / presented	<ol style="list-style-type: none"> 1. Title: Articulated Manipulation with Antagonistic Actuation with Stiffness Variability Venue: Dipartimento di Informatica Universita' di Verona Ca' Vignal 2 -- Strada Le Grazie, 15 37134 Verona, Italy 2. Title: Articulated Manipulation with Antagonistic Actuation with Stiffness Variability Venue: Mechanical Engineering Department Indian Institute of Technology Kanpur India
International Schools, Conferences and Meetings attended in recent past	<p>International Summer School attended:</p> <ol style="list-style-type: none"> 1. IEEE-RAS/IFRR School of Robotics Science on "Haptic Interaction", held in Paris, France, September 25-29, 2006. <p>International Workshops attended:</p> <ol style="list-style-type: none"> 1. "Nonlinear control of flexible joint robots" a Full-day tutorial, April 14, 2007, held in conjunction with IEEE International Conference on Robotics and Automation, Rome, 2007. 2. IROS'06 Workshop on " physical Human Robot Interaction " October 10, held in conjunction with IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2006), Beijing, China, October 9-15, 2006.

**Membership
of
Professional
Organization**

1. IEEE Member

Membership No.: 90627556. Email: soumen.sen (at) ieee.org

2. Member (Life) AMM – Association for Machines and Mechanisms

Membership No.: A20110021

3. Member RSI – Robotics Society of India

Membership No.: R130116

Summary of Academic attainments	1. Ph.D.						
	University		Department of Electrical Systems and Automation, (Automation, Robotics and Bioengineering) The University of Pisa, ITALY				
	Thesis defended on April 17, 2009.						
	Thesis Title: Toward an Articulated Manipulation System with Antagonistic Actuation for Physical Human-Robot Interaction						
	Best thesis and presentation in Robotics category. The proof can only be obtained from the University of Pisa on demand (since it is not public) with Student No., or, Matricola: 265969, Cycle:XX, Name: Soumen Sen, Supervisor: Prof. Antonio Bicchi, defended on April 17, 2009.						
	2. Master of Engineering (Production)						
	University		Jadavpur University, Calcutta, INDIA				
	Year of Passing		June, 1994				
	Major Subjects taught		ROBOTICS, Control System, Automation, NC & CNC, Computer Languages, Ergonomics.				
	Percentage of Marks						
1st Semester	2nd Semester	3rd Semester	Grand total %				
74.3	71.8	88.3	76.4				
3. Bachelor of Engineering (Mechanical)							
Institute		Regional Engineering College, Durgapur, INDIA (Presently, National Institute of Technology)					
Year of Passing		July, 1992					
Percentage of Marks and Semester Credit Point Average (SCPA) ♦							
1st Sem	2nd Sem	3rd Sem	4th Sem	5th Sem	6th Sem	7th Sem	8th Sem
%age							
74.9	70.3	75.7	79.2	73.3	76.6	76.7	77.0
SCPA (Semester Credit Point Average)							
73.4	73.3	77.6	78.6	71.4	76.4	77.1	78.1
Grand Total %		Total Credit Point Average (TCPA) ♣					
75.6		75.9				Honours	

♦Credit point = (Weekly contact hours of each subject) x (% marks).

SCPA = (Aggregate of credit points) / (Total contact-hours).

♣TCPA = Sum of {(SCPA) x (weightage of each semester)} / (Total weight).

Honours / Awards etc.	<ol style="list-style-type: none"> 1. Honours in B.E. Mechanical Engineering, Regional Engineering College, Durgapur, 1992. 2. MIUR (Ministero dell'Istruzione dell'Università e della Ricerca, ministerial decree 198/2003) fellowship grant of Italy to follow Ph.D. work in the University of Pisa from 2005 to 2007. 3. Best paper Award (with three other authors) KUKA Service Robotics IEEE Best Paper Award in IEEE International Conference on Robotics and Automation, May 19 – 23, 2008, Pasadena, USA. 4. Best Ph.D. thesis and presentation in Robotics Category in the programme of “Automatica, Robotica e Bioingegneria” of the ‘Università di Pisa’ in April 17, 2009. (Please see summary of academic qualifications above) 																									
Languages	<table border="1"> <thead> <tr> <th></th> <th>Mother tongue</th> <th>Speak</th> <th>Read</th> <th>Write</th> </tr> </thead> <tbody> <tr> <td>Bengali</td> <td>X</td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>English</td> <td></td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>Hindi</td> <td></td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>Italian</td> <td></td> <td></td> <td>Basic</td> <td></td> </tr> </tbody> </table>		Mother tongue	Speak	Read	Write	Bengali	X	X	X	X	English		X	X	X	Hindi		X	X	X	Italian			Basic	
	Mother tongue	Speak	Read	Write																						
Bengali	X	X	X	X																						
English		X	X	X																						
Hindi		X	X	X																						
Italian			Basic																							
Hobby and Mindset	<ul style="list-style-type: none"> • Making models (still and working), both scientific and artistic • Making Portraits, Sketching and Cartooning • Writing Poems (in mother tongue) I love to write long letters to friends • Listening to music a lot and watching soccer • Travelling to places of history with my Nikon DSLR (toward making my work and hobby synonymous.) 																									

References

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**Selected
recent
publications**

- [1] Prem Kumar Prasad, **Soumen Sen**, and S.N. Shome: “*Impedance Estimation of a Pneumatic Muscle as a Mechanical Transmission and Actuation device*”, IEEE First International Conference on Control, Measurement and Instrumentation (CMI-2016), Kolkata, January 8 – 10, 2016. DOI: 10.1109/CMI.2016.7413773.
- [2] Kishore Chimmula, **Soumen Sen**, and Siva Ram Krishna Vadali: “*Characterizing the Composite Noise of a Camera used as a Sensor for Position Estimation*”, IEEE First International Conference on Control, Measurement and Instrumentation (CMI-2016), Kolkata, January 8 – 10, 2016. DOI: 10.1109/CMI.2016.7413782.
- [3] N. Srinivasa Reddy, **Soumen Sen**, and S.N. Shome: “*An Investigation on the Performance of an Oscillating Flat Plate Fin with Compliant Joint for Underwater Robotic Actuation*”, IEEE First International Conference on Control, Measurement and Instrumentation (CMI-2016), Kolkata, January 8 – 10, 2016. DOI: 10.1109/CMI.2016.7413739.
- [4] N. Srinivasa Reddy, **Soumen Sen**, Diwakar Kumar and S.N. Shome: “*Caudal fin load characteristics with different motion patterns toward developing biorobotic fish-fin actuator*”, International Conference on Advances In Robotics, 2nd International Conference of Robotics Society of India, Goa, 2nd to 4th July, 2015. DOI: 10.1145/2783449.2783467. (published in ACM, ISBN: 978-1-4503-3356-6).
- [5] Virendra Kumar, **Soumen Sen**, S.S. Roy and S.N. Shome: “*Inverse Kinematics of Redundant Serial Manipulators using Interval Method in handling uncertainties*”, International Conference on Advances In Robotics, 2nd International Conference of Robotics Society of India, Goa, 2nd to 4th July, 2015. DOI: <http://dx.doi.org/10.1145/2783449.2783450>. (published in ACM, ISBN: 978-1-4503-3356-6).
- [6] Sudipta Ray, **Soumen Sen**, Dipankar Chatterjee: “*Numerical analysis of Goldschmied geometry with boundary-layer suction*”, IEEE International Symposium on Underwater Technology (UT15), 23-25 Feb, 2015, NIOT Chennai. DOI: 10.1109/UT.2015.7108305.
- [7] Virendra Kumar, **Soumen Sen**, Sibendu S. Roy, ChandanHar and Sankar Nath Shome: “*Design Optimization of Serial Link Redundant Manipulator: an approach using global performance metric*”, International Conference on Innovations in Automation and Mechatronics Engineering, ICIAME 2014, March 2014, India (Elsevier Procedia Technology, 2014).
- [8] VirendraKumar, **Soumen Sen**, S.S. Roy, S.K.Das, S.N.Shome: “*Inverse Kinematics of Redundant Manipulator using Interval Newton Method*”, International Journal of Engineering and Manufacturing, Aug. 2015, vol.2, pp. 19-29, DOI: 10.5815/ijem.2015.02.03
- [9] Swarn S. Rathour, **Soumen Sen**, Pratik Saha and Sankar N. Shome: “*A Tendon Driven Biorobotic Pectoral Fin: Mechanism and Analysis*”, the 23rd International Offshore (Ocean) and Polar Engineering Conference (ISOPE 2013), Alaska, USA, June 30-July 05,2013.
- [10] **Soumen Sen**, Sananda Chatterjee and Chandan Har: “*Design and Impedance Estimation of a Biologically Inspired Flexible Mechanical Transmission with Exponential Elastic Characteristic*”, IEEE/RSJ International Conference on Intelligent Robots and

**Selected
recent
publications**

contd...

Systems (IROS 2013), Tokyo, Japan, Nov.03-07, 2013.

[11] **Soumen Sen**, Chandan Har and Sananda Chatterjee: “*Variable Impedance Actuator with Exponential Elasticity for Robots with Joint Flexibility and Estimation of Joint Impedance*”, 1st International and 16th National Conference on Machines and Mechanisms (iNaCoMM 2013), December 18-20, 2013.

[12] Sananda Chatterjee, **Soumen Sen** and S. Nandy: “*Estimation of Mechanical Impedance of a Flexible Transmission using Partial Knowledge of Elastic Characteristic and Its Validation*”, Advances in Robotics, International Conference of Robotics Society of India, July 04-06, 2013.

[13] Sananda Chatterjee, **Soumen Sen** and Sambhunath Nandy: “*Estimation of Mechanical Impedance in a Flexible Nonlinear Transmission using a Dual EKF Procedure*”, 2nd International Conference on Electronics, Mechatronics and Automation, ICEMA-2013, August 24-25, 2013, Singapore. [Accepted]

[14] **Soumen Sen**, Antonio Bicchi: “*A Nonlinear Elastic Transmission for Variable-Stiffness-Actuation: Objective and Design*”, 15th National Conference on Machines and Mechanisms, Chennai, November, 2011.

[15] **Soumen Sen**: “*Biologically Inspired Elastic Transmission for Stiffness Variability in Actuation: Design and Implementation*”, IEEE Int. Conf. on Robotics and Biomimetics (IEEE-ROBIO2011), Phuket, December, 2011.

[16] Roberto Filippini, **Soumen Sen**, Antonio Bicchi: “*Toward Soft Robots You Can Depend On: A Study of Antagonistic Actuation*”, IEEE Robotics and Automation Society Magazine, Special issue on “Adaptable Compliance, design, control, and applications of robotic stiffness actuators”, Vol.15, No.3, September, 2008, pp.31-41.

[17] Riccardo Schiavi, Giorgio Grioli, **Soumen Sen**, and Antonio Bicchi. “*VSA-II: A Novel Prototype of Variable Stiffness Actuator for Safe and Performing Robots Interacting with Humans*”. In Proc. **IEEE Int. Conf. on Robotics and Automation**, May 19-23, 2008, Pasadena, USA, pages 2171 - 2176. **IEEE Best paper Kuka Service Robotics Award in the conference.**

[18] A. Bicchi, M. Bavaro, G. Boccadamo, D. De Carli, R. Filippini, G. Grioli, M. Piccigallo, A. Rosi, R. Schiavi, **S. Sen** and G. Tonietti: “*Physical Human-Robot Interaction: Dependability, Safety, and Performance*”, In Proc. 10th Intl. Workshop Advanced Motion Control (AMC08), Trento, Italy, March 26-28, 2008, pages 9-14.

[19] Roberto Filippini, **Soumen Sen**, and Antonio Bicchi: “*Variable Impedance Actuations for Physical Human Co-operating Robots: a Comparative analysis of Performance, Safety and Dependability*”, The Fifth IARP-IEEE/RAS-EURON Joint Workshop on Technical Challenges for Dependable Robots in Human Environments, Rome, Italy, April 14 - 15, 2007.

[20] Roberto Filippini, **Soumen Sen**, G. Tonietti and Antonio Bicchi: “*A Comparative Dependability Analysis of Antagonistic Actuation Arrangements for Enhanced Robotic Safety*”, in Proc. IEEE Int. Conf. on Robotics and Automation, April 10-14, 2007, Rome, Italy.

**Selected
recent
publications**

contd...

[21] R. Alami, A. Albu-Schaeffer, A. Bicchi, R. Bischoff, R. Chatila, A. De Luca, A. De Santis, G. Giralt, J. Guiochet, G. Hirzinger, F. Ingrand, V. Lippiello, R. Mattone, D. Powell, **S. Sen**, B. Siciliano, G. Tonietti, L. Villani, “*Safe and Dependable Physical Human-Robot Interaction in Anthropic Domains: State of the Art and Challenges*”, Workshop on Physical Human Robot Interaction in Anthropic Domain, held in conjunction with IEEE/RSJ Int. Conference on Intelligent Robots and Systems, October 10, 2006, Beijing, China.

[22] G. Boccadamo, R. Schiavi, **S. Sen**, G. Tonietti, and Antonio Bicchi: “*Optimization and Fail-Safety Analysis of Antagonistic Actuation for pHRI*”, in Springer Tracts in Advanced Robotics (star), Vol.22, Ed. Henrik Christensen, European Robotics Symposium 2006, pp 109-118, 2006, ISBN: 3-540-32688-X.