

## Santhakumar Mohan, Ph. D. (IIT Madras)

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Associate Professor, Mechanical Engineering  
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### Research Interests

Broadly, I work in the field of Robotics and Control. Specifically, I have research interests as follows:

- Parallel Robotic Platforms (Mechanical Design, Dynamics and Control)
- Assistive and Rehabilitation Robots (Lower Limb Rehabilitation Robots)
- Field Robotics, Mobile Manipulators and Underwater Robotic Systems (Dynamics and Control)

### Academic Preparation

Ph. D. in Engineering Design (Specialisation in Robotics and Control)

Indian Institute of Technology Madras, Chennai, India 2007-2010

Advisor: Prof. T. Asokan

Dissertation: Investigations on trajectory tracking and dynamic station keeping control of an underactuated flatfish type autonomous underwater robotic vehicle.

M. E. in Mechanical Engineering (Specialisation in Manufacturing Engineering)

Government College of Technology, Coimbatore, India 2003-2005

Advisor: Prof. P.K. Jayadev

Thesis: Kinematic calibration and optimum path planning of a SCORA ER 14 (SCARA) robotic manipulator using vision system.

B. E. in Mechanical Engineering

Government of College of Engineering, Salem, India 1999-2003

Advisor: Prof. R. Marappan

Project: Design and development of a vehicle manipulator system and implementation of an ultrasonic sensor for an exploration.

### Professional Experience

#### Regular positions

Associate Professor, Indian Institute of Technology Palakkad, INDIA Dec. 2018 – present

Associate Professor, Indian Institute of Technology Indore, INDIA May 2017 – Dec. 2018

Alexander Von Humboldt Research Fellowship, RWTH Aachen, GERMANY May 2016 – May 2017

Assistant Professor, Indian Institute of Technology Indore, INDIA Mar. 2012 - May 2017

Postdoctoral Research Fellow, KAIST, Daejeon, ROK Mar. 2011 - Mar. 2012

Assistant Professor, National Institute of Technology Calicut, INDIA Jul. 2010 - Mar. 2011

Teaching Assistant, Indian Institute of Technology Madras, INDIA Jan. 2007 - Jul. 2010

Lecturer, Bannari Amman Institute of Technology, Sathy, INDIA Jul. 2005 - Dec. 2006

Research Assistant, Government College of Tech. Coimbatore, INDIA Aug. 2003 - Jun. 2005

#### Visiting positions

Visiting Professor, Ecole Centrale de Nantes, FRANCE April 2017 and May 2019

Visiting Faculty, ME, Indian Institute of Science, Bangalore, INDIA May - Jun. 2015

Visiting Assistant Professor, C-FRIEND, KAIST, Daejeon, ROK Dec., 2014, July - Aug. 2015

Visiting Assistant Professor, ORIN, OSE, KAIST, Daejeon, ROK May - Jun. 2013

Visiting Professor, PSG College of Technology, Coimbatore, INDIA Dec. 2013 - present

## Honours and Awards

- Received the Alexander von Humboldt research fellowship from Alexander von Humboldt Foundation, GERMANY 2016-2017
- Received the European Master on Advanced Robotics Plus (EMARO+) fellowship from Erasmus Mundus, FRANCE 2018-19
- Satellite Across Virtual Institute (SAVI) research fellowship from National Research Foundation, ROK 2013-2015
- Outstanding Young Scientist Award from Korea Robotics Society (KROS), ROK 2014
- Best Teacher (Academic Excellence) Award from IIT Indore, India 2013
- Received the World Class University (WCU) and the Brain Korea (BK21) fellowships to conduct research at KAIST, Daejeon, ROK 2011-2012
- Awarded National Doctoral Fellowship (NDF) from AICTE, New Delhi, 2007
- Gold Medal (Memorial Award) from Government of College of Engineering, Salem, India 2003

## Sponsored Research Projects

### Ongoing

1. Principal Investigator, Bio-inspired Hybrid Underwater Vehicle for Ocean Observations, Science and Engineering Research Board (SERB), India, Rs.30.91 Lacs (Three years from April 2019)
2. Principal Investigator, Development of a hybrid robotic system based on a passive orthosis and an active parallel manipulator for the lower limb rehabilitation, Russian Science Foundation (RSF), Russia Rs.190 Lacs (Three years from May 2019)  
Other Principal Investigator: Prof. Larisa Rybak, Belgorod University, RUSSIA
3. Principal Investigator, Robust motion control design for an underwater robot with tilting thrusters, Department of Science and Technology, India, and National Research Foundation (NRF), Republic of Korea (ROK), Rs.125 Lacs (Three years from January 2018)  
Fund for IIT Indore: 25.14 Lacs  
Other Principal Investigator: Prof. Tae Won Seo, Hanyang University (Seoul), ROK
4. Principal Investigator, Teaching Learning Centre on "Internet of Things", Department of Higher Education, MHRD, India, Rs.758 Lacs (Three years from August 2016)  
Fund for IIT Indore: 143 Lacs  
Other Principal Investigators: Prof.L.Behera, IIT Kanpur, Prof. S.K.Parida, IIT Patna, Prof.S.K.Vishwakarama, IIT Indore and Prof.Pawan Goyal, IIT Khargpur.
5. Principal Investigator, Development and Control of a Kinematically Redundant Teleoperated Mobile Manipulator for Mining / Rescue Operations, TSDP Department of Science and Technology (DST), India, Rs. 165 Lacs (Approved)  
Other Principal Investigator: Prof.L.Behera, IIT Kanpur.

### Completed

1. Principal Investigator, Design and development of an economical, lightweight and multi-purpose four degrees of freedom hybrid robotic motion platform, Council of Scientific and Industrial Research (CSIR), Rs. 18.96 Lacs (2016-2019)
2. Principal Investigator, Design, development and control of a new three degrees of freedom (3-dof) parallel robot for x-y theta (xyθz) motion, Department of Science and Technology (DST), India (approx. Rs. 13.32 Lacs) (2013-2016)
3. Principal Investigator, Development of an underwater robotic research platform for the autonomous control and manipulation tasks, National Research Foundation (NRF) of Korea, Republic of Korea, KRW 30 million (approx. Rs. 16 Lacs) (2013-2015)  
Other Principal Investigator: Prof.Jinwhan Kim, KAIST, ROK.
4. Co- Principal Investigator, Design of a popup antenna system for intermittent communication of an observed underwater noise and which remains submerged otherwise, Naval Research Board (NRB), India, Rs.14.86 Lacs (2012-2014)  
Other Principal Investigator: Prof.T.Asokan, IIT Madras.

## Summary of Publications

1. Journal Papers/articles: 50 (Published)
2. Patents: 4 (Indian Patents, Published)
3. Book Chapters: 12
4. International Conferences: 70

## Patents

1. **Santhakumar Mohan** and Yogesh Singh, A MECHANISM OF 2PRP-PPR PLANAR PARALLEL MANIPULATOR AND A METHOD THEREOF, India, 4678/MUM/2015, 2015 (Published, The Patent Office Journal No. 24/2017 Dated 16/06/2017 page 20581)
2. **Santhakumar Mohan** and Jayant Kumar Mohanta, A REHABILITATION ROBOT FOR LOWER LIMB GAIT THERAPY, India, 4757/MUM/2015, 2015 (Published, The Patent Office Journal No. 25/2017 Dated 23/06/2017 page 21372)
3. **Santhakumar Mohan** and Jayant Kumar Mohanta, SIX DEGREE OF FREEDOM PARALLEL MANIPULATOR IN RPRS CONFIGURATION, India, 201621019170, 2016 (Published, The Patent Office Journal No. 49/2017 Dated 08/12/2017 page 47906)
4. Jagadeesh Kadiyam and **Santhakumar Mohan**, HYBRID UNDERWATER VEHICLE FOR OCEAN OBSERVATIONS, India, 201821009575, 2018 (Published, The Patent Office Journal No. 14/2018 Dated 06/04/2018 page 12088)

## Selected Refereed Journal Publications

(SCOPUS Author ID: 26434501600)

### *Published/in press (Science Citation Indexed (SCI) journals)*

1. Ravi Prakash, Laxmidhar Behera, **Santhakumar Mohan**, Jagannathan Sarangapani, Dynamic Trajectory Generation and a Robust Controller to Intercept a Moving Ball in a Game Setting, IEEE Transactions on Control Systems Technology , in press (available online) 2019 (IF:4.883)
2. Jagadeesh Kadiyam, **Santhakumar Mohan**, Conceptual design of a hybrid propulsion underwater robotic vehicle with different propulsion systems for ocean observations, Ocean Engineering 182 (June) 112-125, 2019 (IF: 2.214)
3. Vasanthakumar M, Vinod B, JK Mohanta and Santhakumar Mohan, Design and Robust Motion Control of a Planar 1P-2PRP Hybrid Manipulator for Lower Limb Rehabilitation Applications, Journal of Intelligent & Robotic Systems, in press (available online) 2019 (IF:1.583)
4. Jayant Kumar Mohanta, Yogesh Singh and **Santhakumar Mohan**, Kinematic and Dynamic Performance Investigations of Asymmetric (U-shaped fixed-based) Planar Parallel Manipulators, Robotica, 36, 1111-1143, 2018 (IF: 1.554)
5. Swati Mishra, Pandurang Londhe, **Santhakumar Mohan**, SK Vishwakarama and Balasaheb Patre, Robust task-space motion control of a mobile manipulator using a nonlinear control with an uncertainty estimator, Computers and Electrical Engineering, 67, 729-740, 2018 (IF: 1.747)
6. Jayant Kumar Mohanta, **Santhakumar Mohan**, Deepasunder and Kirubashankar, Development and Control of a new Sitting Type Lower Limb Rehabilitation Robot, Computers and Electrical Engineering, 67, 330-347, 2018 (IF: 1.747)
7. Balasaheb Patre, Pandurang Londhe, Laxman Waghmare and **Santhakumar Mohan**, Disturbance estimator based non-singular fast fuzzy terminal sliding mode control of an autonomous underwater vehicle, Ocean Engineering, 159, 372-387, 2018 (IF: 2.214)
8. **Santhakumar Mohan**, Error analysis and control scheme for the error correction in trajectory-tracking of a planar 2PRP-PPR parallel manipulator, Mechatronics, 46, 70-83, 2017 (IF: 2.423)
9. **Santhakumar Mohan** and Burkhard Corves, Inverse dynamics and trajectory tracking control of a new six degrees of freedom spatial 3-RPRS parallel manipulator, Mechanical Sciences, 8, 235-248, 2017 (IF: 1.211)
10. Anirban Nag, **Santhakumar Mohan** and Sandipan Bandyopadhyay, Forward Kinematic Analysis of the 3-RPRS Parallel Manipulator, Mechanism and Machine Theory, 116, 262-272, 2017 (IF: 2.796)

11. **Santhakumar Mohan** and J.K. Mohanta, Dual integral sliding mode control loop for mechanical error correction in trajectory tracking of a planar 3-PRP parallel manipulator, *Journal of Intelligent & Robotic Systems*, 89 (3), 371-385, 2018 (IF:1.512)
12. Pandurang Londhe, **Santhakumar Mohan**, Balasaheb Patre, and Laxman Waghmare, Robust Task-Space Control of an Autonomous Underwater Vehicle-Manipulator System by PID-like Fuzzy Control Scheme with Disturbance Estimator, *Ocean Engineering*, 139, 1-13, 2017 (IF: 2.214)
13. **Santhakumar Mohan**, J.K. Mohanta, S.Kurtenbach, J. Paris, B.Corves and M. Huesing, Design, development and control of a 2PRP-2PPR planar parallel manipulator for lower limb rehabilitation therapies, *Mechanism and Machine Theory*, 112, 272-294, 2017 (IF:2.796)
14. Pandurang Londhe, **Santhakumar Mohan**, Balasaheb Patre, and Laxman Waghmare, Task Space Control of an Autonomous Underwater Vehicle-Manipulator System by Robust Single-Input Fuzzy Logic Control Scheme, *IEEE Journal of Oceanic Engineering*, 42, 13-28, 2017 (IF: 2.297)
15. Pandurang S Londhe, Yogesh Singh, **Santhakumar Mohan**, Balasaheb Patre and Laxman M Waghmare, Robust Nonlinear PID-like Fuzzy Logic Control of a Planar Parallel (2PRP-PPR) Manipulator, *ISA Transactions*, 63, 218-232, 2016 (IF: 3.370)
16. Yogesh Singh and **Santhakumar Mohan**, Performance investigations on optimum mechanical design aspects of planar parallel manipulators, *Advanced Robotics*,30, 652-675, 2016 (IF: 0.961)
17. **Santhakumar Mohan** and Jinwhan Kim, Coordinated motion control in task space of an autonomous underwater vehicle - manipulator system, *Ocean Engineering* 104, 155-167, 2015 (IF: 2.214)
18. Yogesh Singh and **Santhakumar Mohan**, Inverse dynamics and robust sliding mode control of a planar parallel (2-PRP and 1-PPR) robot augmented with a nonlinear disturbance observer, *Mechanism and Machine Theory* 92, 29-50, 2015 (IF: 2.796)
19. Yogesh Singh, V. Vinoth, Y.Ravi Kiran, Jayant Kumar Mohanta and **Santhakumar Mohan**, Inverse dynamics and control of a 3-DOF planar parallel robotic (U-Shaped 3-PPR) manipulator, *Robotics and Computer Integrated Manufacturing*, 34, 164-179, 2015. (IF: 3.464)
20. **Santhakumar Mohan** and Jinwhan Kim, Robust adaptive tracking control of autonomous underwater vehicle-manipulator systems, *ASME Journal of Dynamic Systems, Measurement and Control*, 136(5), 054502, 1-10, 2014 (IF: 1.388)
21. V.Vinoth, Yogesh Singh and **Santhakumar Mohan**, Indirect disturbance compensation control of a planar parallel (2-PRP and 1-PPR) robotic manipulator, *Robotics and Computer Integrated Manufacturing*, 30(5), 556–564, 2014 (IF: 3.464)
22. **Santhakumar Mohan**, A non-regressor nonlinear disturbance observer based adaptive control scheme for an underwater manipulator, *Advanced Robotics* 27 (16), 1273-1283, 2013 (IF: 0.961)
23. **Santhakumar Mohan** and T.Asokan, Power efficient dynamic station keeping control of an underactuated flat-fish type autonomous underwater vehicle through design modifications of thruster configuration. *Ocean Engineering* 58, 11-21, 2013 (IF: 2.214)
24. **Santhakumar Mohan** and Jinwhan Kim, Indirect adaptive control of an autonomous underwater vehicle-manipulator system for underwater manipulation tasks, *Ocean Engineering* 54, 233-243, 2012 (IF:2.214)
25. **Santhakumar Mohan** and T.Asokan, Investigations on the dynamic station keeping of an underactuated autonomous underwater robot, *International Journal of Simulation Modelling* 10 (3), 145-157, 2011 (IF: 2.23)
26. **Santhakumar Mohan** and T.Asokan, Investigations on the hybrid tracking control of an underactuated autonomous underwater robot, *Advanced Robotics* 24, 1529-1556, 2010 (IF:0.961)

### **Selected Refereed Book Chapters**

1. **Santhakumar Mohan**, J. K. Mohanta, B. Corves, M. Hüsing (2018) Dual-Loop Motion Control for Geometric Errors and Joint Clearances Compensation of a Planar 2-PRP+1-PPR Manipulator, *Mechanical Transmissions and Robotics, Mechanisms and Machine Science*, 52, pp 171-180.

2. **Santhakumar Mohan**, B. Corves, P. Wenger (2018) Design Optimization and Accuracy Analysis of a Planar 2PRP-PRR Parallel Manipulator, *Computational Kinematics, Mechanisms and Machine Science* 50, pp 432-440.
3. J. K. Mohanta, **Santhakumar Mohan**, S. Kurtenbach, B. Corves, M. Hüsing (2017) Augmented PID Control of a 2PPR-2PRP Planar Parallel Manipulator for Lower Limb Rehabilitation Applications, *New Advances in Mechanisms, Mechanical Transmissions and Robotics, Mechanisms and Machine Science*, 46, pp 391-399
4. Gopi Krishnan Regulan, Ganesan Kaliappan, **Santhakumar Mohan**, (2016) Development of an Amphibian Legged Robot Based on Jansen Mechanism for Exploration Tasks, *Advancements in Automation, Robotics and Sensing, Communications in Computer and Information Science*, 627, pp 74-91

### **Selected Refereed Conference Publications**

1. Muralidharan M, **Santhakumar Mohan**, Task-space pose decomposition motion control of a mobile manipulator, *International Conference on Signals, Machines and Automation (SIGMA'18)*, NSIT Delhi, India, pp. 1-8, 2018 (**Best paper (session) award winner**)
2. **Santhakumar Mohan**, J. K. Mohanta, B. Corves, M. Hüsing, Dual-loop motion control for geometric errors and joint clearances compensation of a planar 2prp-ppr manipulator, *The 4th Conference on Mechanisms, Transmissions and Applications (MeTrApp 2017)*, Trabzon, Turkey, pp. 1-10, 2017
3. **Santhakumar Mohan**, Burkhard Corves, Philippe Wenger, Design Optimization and Accuracy Analysis of a Planar 2PRP-PRR Parallel Manipulator, *7th IFToMM International Workshop on Computational Kinematics (CK2017)*, Futuroscope-Poitiers, France, pp. 1-8, 2017
4. J. K. Mohanta, **Santhakumar Mohan**, Error Modelling and Sensitivity Analysis of a Planar 3-PRP Parallel Manipulator, *7th IFToMM International Workshop on Computational Kinematics (CK2017)*, Futuroscope-Poitiers, France, pp. 1-8, 2017
5. J. K. Mohanta, **Santhakumar Mohan**, S. Kurtenbach, B. Corves, M. Hüsing, Augmented PID Control of a 2PPR-2PRP Planar Parallel Manipulator for Lower Limb Rehabilitation Applications, *The Joint International Conference of the XII International Conference on Mechanisms and Mechanical Transmissions (MTM) and the XXIII International Conference on Robotics (Robotics'16)* Aachen, Germany, pp. 1-9, 2016
6. Anirban Nag, **Santhakumar Mohan** and Sandipan Bandyopadhyay, Forward Kinematic Analysis of the 3 -RPRS Parallel Manipulator, *6th European Conference on Mechanism Science (Eucomes 2016)*, Nantes, France, pp. 1-8, 2016 (**Finalist, Best theoretical paper award**)
7. Jayant Kumar Mohanta, **Santhakumar Mohan**, Burkhard Corves, A 2PRP-2PPR Planar Parallel Manipulator for the Purpose of Lower Limb Rehabilitation, *6th European Conference on Mechanism Science (Eucomes 2016)*, Nantes, France, pp. 1-8, 2016 (**Finalist, Best application paper award**)
8. Yogesh Singh and **Santhakumar Mohan**, Kinematic Performance Analysis of a New 2PRP-PRR Planar Parallel Robotic Manipulator, *The Fourth Joint International Conference on Multibody System Dynamics*, Montreal, Canada, May-June, 2016
9. **Santhakumar Mohan** and Yogesh Singh, Task Space Position Tracking Control of an Autonomous Underwater Vehicle with Four Tilting Thrusters, *EEE/MTS OCEANS 2016*, Shanghai, China, pp. 1-3, 2016
10. **Santhakumar Mohan** and Jinwhan Kim, Robust Nonlinear Proportional Integral Derivative Control for Position Tracking of an Underwater Manipulator, *IEEE/ASME International Conference of Advances in Mechatronics (AIM 2015)*, Busan, ROK, July 2015.
11. V. Vinoth, Yogesh Singh, Jayant Kumar Mohanta, **Santhakumar Mohan**, Robust Disturbance Observer based Sliding Mode Control of a Planar Parallel (3-PPR) Manipulator, *Students' Conference on Engineering and Systems (SCES 2014)*, Allahabad, India, May, 2014. (**Best paper (session) award winner**)

12. V. Vinoth, Yogesh Singh, **Santhakumar Mohan**, Inverse Kinematic Modelling of a 6-DOF (3-RPRS) Parallel Spatial Manipulator, The 3rd Joint International Conference on Multibody System Dynamics, Busan, South Korea, June-July, 2014.
13. **Santhakumar Mohan** and Jinwhan Kim, Indirect Adaptive Control for Autonomous Underwater Vehicle-Manipulator Systems, the 22nd International Offshore (Ocean) and Polar Engineering (ISOPE 2012) Conference Rhodes, Greece, June 17 to 22, 2012.
14. **Santhakumar Mohan**, Yonghyun Kim and Jinwhan Kim, Power efficient trajectory tracking control of underactuated autonomous underwater vehicle-manipulator systems, IEEE / MTS OCEANS 2012, Yeosu, ROK, May 2012 .
15. **Santhakumar Mohan** and Jinwhan Kim, Modelling, simulation and model reference adaptive control of autonomous underwater vehicle-manipulator systems, IEEE International Conference on Control, Automation and Systems (ICCAS 2011), KINTEX, ROK, Oct. 26-29, 2011.

## Research Supervision

### Regular (Full-time) PhD Students at IIT Indore

1. **Yogesh Singh**, Performance investigations on mechanical design and motion control of planar parallel manipulators (Joined July 2012, **Thesis defended** in December 2016)
2. **Jayant Kumar Mohanta**, Development and performance investigations of a sitting/lying type lower limb rehabilitation robot (Joined July 2014, **Thesis defended** in July 2018)
3. **Swati Mishra**, Motion control studies and performance investigations of a mobile manipulator (Joined July 2015, **Synopsis submitted** in June 2019) (Co-Supervisor: Dr. SK Vishvakarma, IIT Indore)
4. **Jagadeesh Kadiyam**, Design, development and performance investigations of a hybrid underwater vehicle for ocean observations (Joined January 2017, **Ongoing**)

### Visiting (Other institution) Student

5. **Pandurang Londhe**, SGGs IE & T, Nanded (**Thesis defended** in May 2018)  
Supervisors: Prof. Balasaheb Patre and Prof. Laxman Waghmare

### M.S. (Completed)

1. Yonghyun Kim, (Co-supervisor: Prof. Jinwhan Kim)  
Institute: Korean Advanced Institute of Science and Technology, Daejeon, ROK
2. Francesco Alberto Orsini, Politecnico di Torino, Turin, Italy  
Institute: RWTH Aachen University, Germany

## Other Professional Activities

1. **Course Coordinator**, Five days GIAN course on "Multibody Dynamics", October 2017, held in Indore, Madhya Pradesh, India.
2. **Course Coordinator**, Five days GIAN course on "Humanoid Robotics: Modelling and Control", December 2017, held in Indore, Madhya Pradesh, India.
3. **Course Coordinator**, Five days GIAN course on "Kinematics and Design of Parallel Manipulators", December 2017, held in Indore, Madhya Pradesh, India.
4. **Course Coordinator**, Five days short term course on "Autonomous Mobile Robots", March 2018, held in Indore, Madhya Pradesh, India.
5. **Conference co-chair**, International Conference on Intelligent Robotics, Automation and Manufacturing (IRAM 2013), December 2013, held in Indore, Madhya Pradesh, India.
6. **Publication co-chair**, Asian Conference on Mechanism and Machine Science, December 2018, to be held in Bangalore, Karnataka, India.
7. **Publication co-chair**, International Conference on Advances in Robotics, June - July 2019, to be held in Chennai, Tamil Nadu, India.
8. **Organising Secretary**, Five days short term course on "Mechatronics and Robotics", 2013, held in Indore, Madhya Pradesh, India.