Rekha Raja, Ph.D.

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Curriculum Vitae

Research Interests

- Robotics, AI, Machine Learning, Computer Vision,
- Decision-making and control, Industry Automation, AgroFood Robotics

Education

Doctor of Philosophy in Mechanical Engineering – Indian Institute of Technology Kanpur, India 2016

Master of Technology in Mechatronics and Robotics – IIEST Shibpur, Howrah, WB, India 2009

Bachelor of Technology in Information Technology – Jalpaiguri Govt. Engg. College, WB, India 2007

Professional Experience

Postdoctoral Researcher - Wageningen University & Research, NL Nov 2019 - Present

Postdoctoral Researcher - University of California Davis, CA, USA Mar 2018 - Oct 2019

Research Scientist - Tata Consultancy Services (TCS), Noida, India Nov 2015 - Mar 2018

Project Engineer - Indian Institute of Technology Kanpur, India July 2015 - Dec 2015

Junior Research Fellow - Central Mech. Engg. Res. Inst., Durgapur, India Jan 2009 - Dec 2009

Postgraduate research summary

- **Postdoctoral Work:** *Cognitive Robots for Flexible Agro Food Technology (Flexcraft)*
- **Postdoctoral Work:** *Robotic Weed Control*
- **Research Scientist:** *Automatic bin picking of objects in a warehouse scenario*
- **Project Engineer:** *detect deviation in alignment of the weldsim during the pipe expansion process*
- **Doctoral Thesis Title:** *Rough Terrain Motion Planning and Redundancy Resolution of an Articulated Rover Manipulator System.*
- **Master's Thesis Title:** *Obstacle Avoidance & Navigation of Autonomous Mobile Robot*

Awards/Fellowship

- **EurAgEng Outstanding Paper Award with a cash prize of 300 EURO, 2022**: The paper 'Real-time weed-crop classification and localisation technique for robotic weed control in lettuce' [Biosystems Engineering, Volume 192, April 2020, Pages 257-274].This award is given by EurAgEng once every two years to 2-3 research papers only.
- **Best Paper Award Robocom 2022,** for the paper, "Concurrent Transmission for Multi-Robot Coordination", Robocom 2022 in conjunction with IEEE CCNC 2022.
- **EurAgEng Outstanding Paper Award with a cash prize of 300 EURO, 2020**: The paper 'Crop

signalling: A novel crop recognition technique for robotic weed control' [Biosystems Engineering, Volume 187, November 2019, Pages 278-291]. This award is given by EurAgEng once every two years to 2-3 research papers only.

- **(S)miles Award (An inspiring role model to your colleagues), August 2016:** in appreciation of my outstanding contribution to the organization (Tata Consultancy Services).
- **Special initiative innovation award by TCS. Aug, 2016:** in appreciation of my outstanding contribution to the Amazon picking challenge competition in Germany.
- **Young Researcher Award, Dec, 2015:** in the Area of Computational Intelligence from IEEE UP Section Computational Intelligence Society Chapter, Kanpur, India.
- **Best paper award in IEEE-WIE Conference, Dec 2015:** for the paper 'Motion planning and redundancy resolution of a rover manipulator', Rekha Raja, Bhaskar Dasgupta, Ashish Dutta, 2015 IEEE International WIE Conference on Electrical and Computer Engineering (WIECON-ECE), Dhaka, Bangladesh.
- **Journal Cash Awards, IIT Kanpur, 2015:** Received Journal Cash Awards of Rs. 10000 (July 2015) from Resource and Alumni Office, Indian Institute of Technology, Kanpur (Appl_Id 1201, No.DORA/IITK.2015/Cash Award/01) for SCI Indexed Journal papers during Phd programs.
- **Institute Scholarship, MHRD, 2009-2015:** Recipient of Institute Scholarship (Ministry of Human Resource Development, India) for Post-graduate Studies (Ph.D).
- **Travel grant, IIT Kanpur, 2014:** for attending IEEE International Conference on Control, Automation, Robotics and Vision, ICARCV, Singapore, Dec, 2014.
- **GATE scholarship, 2009:** for qualifying General Aptitude Test in Engineering (GATE) and pursuing M.Tech at IIEST, shibpur, WB, India.

Teaching Experience

Lecturer for Robotics: Mobile Platform - WUR, Wageningen, Netherlands	Fall 2022
Lecturer for Sensing & Perception - WUR, Wageningen, Netherlands	Spring 2020, 21, 22
Teaching Assistant for Advanced Topics in Robotics - IIT Kanpur, India	Spring 2015
Teaching Assistant for Robot Motion Planning - IIT Kanpur, India	Fall 2014
Teaching Assistant for Introduction to Robotics - IIT Kanpur, India	Spring 2013
Teaching Assistant for Robot Dynamics and Control - IIT Kanpur, India	Fall 2013
Teaching Assistant for Engineering Graphics - IIT Kanpur, India	Fall 2012

Research Publications

Journal Articles

1. **R. Raja*,** A. K. Burusa, G. Kootstra, E. V. Henten "A novel method to evaluate an autonomous robot for pick-and-place of natural deformable food products from a cluttered bin", *The International Journal of Robotics Research*, 2023. [submitted]

2. **R. Raja***, DC Slaughter, S Fennimore, MC Siemens, "Real-time control of high-resolution micro-jet sprayer integrated with machine vision for precision weed control", Biosystems engineering, 2022. **(Impact factor: 5.0)**

3. S. Bharadwaj, K. Gonabattula, S. Saha, C. Sarkar, & **R. Raja**, "Concurrent Transmission for Multi-Robot Coordination", *arXiv preprint arXiv:2112.00273, 2021*.

4. **R. Raja*,** T. Nguyen, VV Young, DC Slaughter, S Fennimore**, "**RTD-SEPs: Real-time detection of stem emerging points and classification of crop-weed for robotic weed control in producing tomato **",** *Biosystems Engineering*, 195, 152-171, August 2020, https://doi.org/10.1016/j.biosystemseng.2020.05.004. **(Impact factor: 5.0)**

5. **R. Raja*,** T. Nguyen, DC Slaughter, S Fennimore, "Real-time weed-crop classification and localization technique for robotic weed control in lettuce field", *Biosystems Engineering*, 192, 257-274, February 2020, https://doi.org/10.1016/j.biosystemseng.2020.02.002 **(Impact factor: 5.0)** [**Winner of a EurAgEng Outstanding Paper Award 2022**]

6. **R. Raja*,** T. Nguyen, DC Slaughter, S Fennimore, "Real-time robotic weed knife control system for tomato and lettuce based on geometric appearance of plant labels", *Biosystems Engineering*, 194, 152-164, February 2020, https://doi.org/10.1016/j.biosystemseng.2020.03.022 **(Impact factor: 5.0)**

7. H. Jangid, S. Jain, B. Teka, **R. Raja**, A. Dutta, "Kinematics based end-effector path control of a mobile manipulator system on an uneven terrain using Support Vector Machine", *Robotica*, 1-19, (2019), https://doi.org/10.1017/S0263574719001541. **(Impact factor: 1.20)**

8. H. Kennedy, SA. Fennimore, DC. Slaughter, T. Nguyen, V. Vuong, **R. Raja**, "Detection of Marked Lettuce and Tomato by an Intelligent Cultivator and Effect on Weed Removal and Hand Weeding Requirements", *Weed Technology*, 1-32, November 2019, https://doi.org/10.1017/wet.2019.120. **(Impact factor: 1.384)**

9. **R. Raja***, DC Slaughter, SA Fennimore, T. Nguyen, V Vuong, N Sinha, L Tourte, and R. F. Smith, and M. C. Siemens, "Crop Signaling: A Novel Crop Recognition Technique for Robotic Weed Control", *Biosystems Engineering*, 187, 278-291, (2019), https://doi.org/10.1016/j.biosystemseng.2019.09.011. **(Impact factor: 5.0)** [**Winner of a EurAgEng Outstanding Paper Award 2020**]

10. **R. Raja***, A. Dutta, B. Dasgupta, "Learning Framework for Inverse Kinematics of a Highly Redundant Mobile Manipulator", *Robotics and Autonomous Systems*, 120, 1032-45, (2019), https://doi.org/10.1016/j.robot.2019.07.015. **(Impact factor: 3.7)**

11. T. Beteley, **R. Raja**, and A. Dutta. "Learning based end effector tracking control of a mobile manipulator for performing tasks on an uneven terrain." *International Journal of Intelligent Robotics and Applications,* 3(2), 102-114, February 2019, 10.1007/s41315-019-00081-8 **(Impact factor: 1.1)**

12. S. Kumar, A. Majumder, S. Dutta, **R. Raja**, S. Jotawar, A. Kumar, M. Soni, V. Raju, O. Kundu, E. Hassan, L. Behera, K. S. Venkatesh and R. Sinha, "Design and Development of an automated Robotic Pick & Stow System for an e-Commerce Warehouse." *arXiv preprint arXiv*:1703.02340, March 2017, arXiv:1703.02340v1.

13. **R. Raja***, A. Dutta, and K. S. Venkatesh. "New potential field method for rough terrain path planning using genetic algorithm for a 6-wheel rover" *Robotics and Autonomous Systems,* 72, 295-306, (2015), doi:10.1016/j.robot.2015.06.002. **(Impact factor: 3.7)**

14. **R. Raja***, S N. Shome, S. Nandy, R. Ray, ''Obstacle Avoidance and Navigation of Autonomous Mobile Robot", *Advanced Materials Research*, Vol 403, 4633-4642, November 2011, https://doi.org/10.4028/www.scientific.net/AMR.403-408.4633. **(Impact factor: 0.87)**

Conference/Workshop Articles

1. **R. Raja**, D. R. Rincón, F. Kemp, G. Kootstra and E. V. Henten, "PosePP: 6D Pose Estimation of Poultry Pieces in a Cluttered Bin," 2022 IEEE 10th Jubilee International Conference on Computational

Cybernetics and Cyber-Medical Systems (ICCC), 2022, pp. 000239-000244, doi: 10.1109/ICCC202255925.2022.9922692..

2. S. Bharadwaj, K. Gonabattula, S. Saha, C. Sarkar, & R. Raja, "Concurrent Transmission for Multi-Robot Coordination", Robocom 2022 in conjunction with IEEE CCNC 2022.
3. F. Kemp, D. R. Rincon, **R. Raja**, G. Kootstra, "Instance segmentation and pose estimation of chicken legs in a cluttered environment", *EurAgEng 2021*, Portugal, 5th July 2021.
4. **R. Raja*,** DC. Slaughter, S. Fennimore, "A novel weed and crop recognition technique for robotic weed control in a lettuce field with high weed densities", *American Society of Agricultural Engineering*, Boston, July 2019, DOI: 10.13031/aim.201900029.
5. **R. Raja*,** DC. Slaughter, S. Fennimore, "Automatic crop recognition based on geometric appearance for a non-chemical robotic weed control system in a tomato field", *American Society of Agricultural Engineering*, Boston, July 2019, DOI: 10.13031/aim.201900028.
6. **R. Raja*,** DC. Slaughter, S. Fennimore, M Siemens, "Precision weed control robot for vegetable fields with high crop and weed densities", *American Society of Agricultural Engineering*, Boston, July 2019, DOI: 10.13031/aim.201900030.
7. **R. Raja***, A. Dutta, "Path planning in Dynamic Environment for a Rover using A* and Potential Field Method", *International Conference on Advanced Robotics (ICAR)*, Hong Kong, 10-12 July 2017.
8. **R. Raja***, B. Dasgupta, A. Dutta, "Cooperative motion planning of redundant rover manipulators on uneven terrains", *International Conference on Advanced Robotics (ICAR),* Hong Kong, 10-12th July 2017.
9. **R. Raja***, S. Kumar, "Advances in motion planning for industrial robot manipulators", *ICRA workshop on dynamic motion planning*, Singapore, 29th May 2017.
10. B. Hailu, **R. Raja**, A. Dutta, "Advanced KSOM based Redundancy Resolution of a Mobile Manipulator System for Motion on an Uneven Terrain", *International Conference on Advances in Robotics*, Delhi, 28-2 July 2017.
11. **R. Raja***, S. Kumar, "A hybrid image based visual servoing for 6-D manipulator using kinect", *International Conference on Advances in Robotics*, Delhi, 28-2 July 2017.
12. **R. Raja***, B. Dasgupta, A. Dutta, "Motion planning and redundancy resolution of a rover manipulator", *IEEE-WIE Conference*, Dhaka, Bangladesh, Dec 2015.
13. A. Bhasin, **R. Raja***, A. Dutta, "Non-holonomic mobile manipulator kinematic control using hybrid simulated annealing", *IEEE-WIE Conference*, Bangladesh, Dec 2015.
14. **R. Raja***, A. Dutta, "Motion planning of a mobile manipulator using fuzzy controller to dexterity measures", *IEEE-WCI Conference*, IIT Kanpur, India, Dec 2015.
15. **R. Raja***, A. Dutta, B. Dasgupta, "KSOM based learning for cooperative motion of a redundant rover-manipulator system on uneven terrain", *International Conference on Control, Automation, Robotics and Vision*, ICARCV 2014, Singapore, Dec 10-12, 2014.
16. **R. Raja***, A. Dutta, B. Dasgupta, "Redundancy resolution of a redundant mobile manipulator", Research Scholars' Day, *Department of Mechanical Engineering, IITK* on 21st March 2014.
17. **R. Raja***, A. Dutta, "Path planning algorithm for a Planetary Rover with Fuzzy Logic Adaptation and a Combination of A* and Potential Field Method*", IEEE Workshop on Computational Intelligence: Theories, Applications and Future Directions,* IIT Kanpur, 14th July 2013.
18. **R. Raja***, A. Dutta, "Path Planning and obstacle avoidance of a mobile robot", *International workshop on Advances in Robotics*, 5-7th July 2012, IIT Delhi.

Articles In Preparation

1. **R. Raja**, G. Kootstra, E. V. Henten, "Software Robot Architecture for agriculture" [**Under**

preparation].

2. **R. Raja**, DC Slaughter, S Fennimore, M Siemens, "Real-time Celery Detection for Weed Control in Lettuce Field" [**Under preparation**].
3. **R. Raja,** J. Scholten, D. Rapado Rincon, G. Kootstra**,** "Object detection in poultry processing" **[Under preparation].**
4. **R. Raja,** A. K. Burusa, "Key point detection of poultry in a cluttered bin" **[Under preparation].**
5. A. Huiesjes, A. K. Burusa, R. Raja, "Autonomous pick-and-place of fruits from cluttered bin using three fingers gripper integrated with machine vision" [**under preparation**]

Student Supervised

- Bsc : 3 (completed)
  - Joost Scholten, "Object detection in poultry processing using deep learning" Wageningen University and Research, Netherlands, 2020.
  - Frans Kamp, "Soft-flexible object detection in bin picking situations using deep learning" Wageningen University and Research, Netherlands, 2021.
  - Martijn Veldhuizen, "Key point detection of chicken legs in bin using deep learning", Wageningen University and Research, Netherlands, 2022.

- Msc: 7 (completed) 2 (ongoing)
  - Gregory Bandy, "Learning Pushing and Grasping for Agro-Food Clutter Clearance", Wageningen University and Research, Netherlands, 2021.
  - Kadir Demirag, "Ensure object grasp safety by evaluating haptic feedback", Wageningen University and Research, Netherlands, 2021.
  - Douwe Schotanus, "Ripeness, position and weight estimation of tomatoes using deep learning and multi-view vision for harvesting robots", Wageningen University and Research, Netherlands, 2020.
  - Xingyu Alfieris, "Keypoints-based pose estimation of whole chicken using multi-view perception ", Wageningen University and Research, Netherlands, 2022.
  - Chit Ho Cheng, "6-DoF grasp pose estimation in cluttered bin", Wageningen University and Research, Netherlands, 2021.
  - Luis Ponce Pacheco "6-DoF grasp pose estimation using Key-point based pose detection of objects in cluttered bin", Wageningen University and Research, Netherlands, 2022.
  - Guus, "motion planning to cut rose stem and plant in a pot in industry setting", 2022.
  - Yiping Xie, "Finding best grasping point on the Object in manipulation task", Wageningen University and Research, Netherlands, 2020. (ongoing)
  - Nikolaos Alfieris, "Design of robot architecture for bin picking of chicken pieces", Wageningen University and Research, Netherlands, 2021. (ongoing)

Invited talk

- Talk entitled "AI in agriculture and Food", TU Delft and DSM - invitation for AI4b.io symposium, 2022,
- Talk entitled, "Learning Pushing and grasping of AgroFood Product", 2022, ISHRIA-22, INDO-JAPAN symposium.
- Invited talk entitled "Computational intelligence: Concepts and Applications", QIP program, IIT Kanpur, 8th December 2017.
- Talk entitled "Robotics in agriculture and Food", Women power webinar series, BRCM Group of institutes, Bahal, Bhiwani, Haryana. 8th June 2020.
- Talk entitled "Advances in Robotics in Agriculture and Food Science". Invited as a speaker in the international web conference on recent advances in science, organized by Department of Physics and IQAC, Don Bosco College, Tura, Meghalaya, India, 2020.

Technical Skills

Software

Programming Languages:	C, C++, MATLAB, Labview, Labview real-time, Labview FPGA, Python, ROS.
Tool/Library:	OpenCV, CMake, PCL, Gazebo, *MoveIt!*, RVIz, VISP, Mathematica, ImageJ.
Operating System:	Linux, Dos, Windows XP/7/8/10.
Query Language:	SQL.
Mechanical design:	Inventor.

Hardware

- UR10, UR5, PUMA, Barrett Arm, SCARA manipulator.
- All Terrain Rover, Turtlebot, Pioneer 3-DX mobile robot, XWAM.
- Arduino hardware and software environment, Simple/smart servo motor control, Xbee.
- Microsoft Kinect, Sonar, IR and Laser sensors.
- Basler camera, QSI camera, Fastec IL Series camera.
- Weeding robot, Micro-jet spray, Robotic-knife.

Professional Activities

- Technical committee member, Robotics research for practicality, 2019-Till.
- Member, program committee, Conference of ComNet-Iot-2020.
- Steward member of Postdoctoral Association of University of California Davis, 2018-2019.
- IEEE member, IEEE-RAS member 2015-Till.
- American Society of Agricultural and Biological Engineers (ASABE) members, 2018-Till.
- Specialty Crop Engineering Committee member, 2019-Till.
- Head Student Section, State Uttar Pradesh, IEEE Computational Intelligence Society, India, 2013 – 2015.
- Served as a reviewer of IEEE Transaction of Mechatronics, RAS, Robotica, AIR, WIE, CIS.
- Senator for PhD, in the student senate, IIT Kanpur, 2011-2013.
- President, Hall VI, IIT Kanpur, 2011-2012.
- Captain of Institute Girls Football team, IIT Kanpur, 2012.

Personal Details

Date of Birth:	25th June 1984
Sex:	Female
Nationality:	Indian
Marital Status:	Married
Language Proficiency:	English, Bengali, Hindi

Declaration

I hereby declare that the above mentioned information is true to the best of my knowledge.

Date: 05/10/2022

Place: Wageningen, Netherlands (Rekha Raja)