SHITIJ P. KUMAR

Ph.D. Candidate in Engineering

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EXPERIENCE

Lead Researcher & Manager

CM Collaborative Robotics Laboratory (CMCR)

Jan 2016–Present | Rochester Institute of Technology

- Lead the development of first Human-Robot Collaboration lab at RIT.
- Working with a team of graduate students on research addressing challenges of human safety, trust in automation, level of human-robot interaction and productivity in the field of HRC in industry.
- Developed a distributed system to monitor the human actions and psychophysiological responses, control and monitor multiple robots in the lab during HRC experiments.
- Managed & lead sponsored projects in automation using collaborative robots in industry.

Adjunct Instructor

Bio-Robotics/Cybernetics, EEEE 536/636, EE Dept.

Jan 2017–May 2017 | Rochester Institute of Technology

- Taught methodologies for analysing and classifying bio-signals (EEG,EMG & EOG) for interfacing with robots or computer.
- Covered concepts of experiment design, data acquisition, pre-processing, feature extraction, feature selection & reduction and machine learning approaches for classification - supervised, unsupervised and semi-supervised.
- Discussed procedures and ethics of collecting bio-signals during human-subject experiments .

Lab Manager & Graduate Research Assistant

Multi-Agent Biorobotics Laboratory (MABL) & EE Dept. at RIT

May 2012–Jan 2018 | Rochester Institute of Technology

- Responsible for maintaining the lab, course repositories, equipment and resources.
- GRA for Robotic Systems, Principle of Robotics, Advanced Robotics and Bio-Robotics/Cybernetics - gave lectures and tutorials.
- Teaching, providing guidance and help to students and fellow junior researchers for their robotic projects.
- Developed a ROS (Robot Operating System) based course work and practicum labs as part of the Robotics Option Major at EE Dept.

Publication Chair & Registration Chair

12th & 14th Annual System of Systems Engineering Conference (SOSE 2017, SOSE 2019), IEEE

Dec 2016/2018–May 2017/2019 | Rochester Institute of Technology

- Responsible for setting up the conference management system for authors to submit their publications & assisting the reviewers and other program committee members.

Synaptic Inc.

R&D System Architecture Intern

May2014–Aug 2014 | Rochester, NY

- Developed software based testing tools for automating, logging and analysing display and touch performance of touch based LCD screens.

EDUCATION

Ph.D. Candidate, Engineering

Rochester Institute of Technology

Aug 2014 – Dec 2019 | GPA 3.63

Thesis Title:
Enabling Safe Human Robot Collaboration with Industrial Robots using Time-of-Flight Laser-ranging Sensor Arrays

M.Sc. Electrical Engineering

Rochester Institute of Technology

Aug 2011 – Aug 2014 | GPA 3.63

Thesis Title:
A framework for a real time intelligent and interactive Brain Computer Interface

B.Tech. Information & Communication Technology

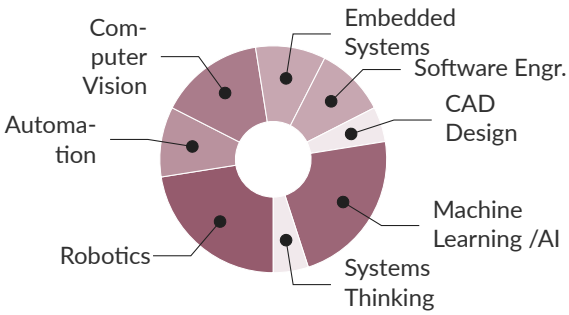
Dhirubhai Ambani Institute of Information and Communication Technology

Sept 2006 – Nov 2010

Main Areas of Study:

- Embedded Hardware Design
- Sensor Networks
- Digital Image Processing

SKILLS SUMMARY



Human Robot Collaboration | HRI | Computer Vision | Robotics | Machine Learning/AI | ROS | Embedded Systems | Cybernetics | Brain Computer Interface | Python | C++ | MATLAB | 3D Simulation

RESEARCH PROJECTS

Monitoring Human Physiological Response during HRC Tasks

CM Collaborative Robotics Research Laboratory, RIT

Jan 2019–Present — Research Co-Lead

- Developed a system for synchronous data acquisition of human physiological state during human-robot collaboration task to record human stress levels.
- Aim of the project is to use this data as a feedback to modify the behavior of robot to enhance human-robot interaction and build trust.
- Featured in News by TechXplore

Developing a Digital Twin Setup for HRC Experiments

CM Collaborative Robotics Research Laboratory, RIT

April 2018–May 2019 — Research Lead

- Virtually representing human, robot and objects in the HRC workspace in a 3D simulation environment in real time using cameras and sensors in the physical world.
- This system plays a crucial role in analysing the human and robot state and interaction during an HRC task.
- This distributed system interfaces with motion capture systems for human pose tracking, cameras, multiple robots and safety devices. A communication layer using ZeroMQ & ROS was implemented for robust and real-time communication.

A Time-of-Flight On-Robot Proximity Sensing System

CM Collaborative Robotics Research Laboratory, RIT

Jan 2017–Present — Research Lead

- Designed a prototype of a time-of-flight single unit lidar sensor array that can be mounted on an industrial robot and used as an electronic safety device (ESD) / proximity sensing system.
- Implemented Speed and Separation Monitoring in accordance with the industrial standards for human safety in HRC.
- Evaluated the human-robot interaction using these sensor arrays in terms of HRC task's safety, fluency & efficiency and compared the results with a 2D Scanning Lidar currently used in industry.
- Developed a second prototype (≈ Minimum Viable Product) of the ToF sensor array that can be used as an alternative or an ancillary to other ESD like 2D Scanning Lidars with a cobot such as UR10.
- Performed sensor characteristic analysis in terms of distance accuracy, sensing volume coverage and ranging under motion.
- Related publications and videos (part of my Ph.D. research).

3D merged pointcloud representation using multiple Kinect2

CM Collaborative Robotics Research Laboratory, RIT

Jan 2017–Dec 2017 — Research Lead

- Interfaced multiple RGB-D (Kinect2) sensors to generate an occupancy grid-map of human-robot shared workspace.
- The aim was to monitor human-robot separation distance, human actions, track objects of interest, and implement an adaptive robot behavior for enhancing human-robot interaction.
- Registered point-clouds and time-synced raw data received from multiple sensors connected to multiple computers.

SKILLS

*fundamental awareness ● to expert ●●●●●

Python, MATLAB	●●●●○
C, C++	●●●○○
Java, JavaScript (Node.js)	●●○○○
C#, Verilog/VHDL	●●○○○
MySQL, MongoDB	●●○○○
Keras, Tensorflow	●●●○○
Robot Operating System (ROS)	●●●●○
V-REP Robotic Simulator	●●●●●
Gazebo, Move-It, PyBullet	●●●○○
zeroMQ, mqtt, LSL, websockets	●●●○○
Solidworks, OnShape	●●●○○
Micro-controllers	●●●○○
Single Board Computers	●●○○○
Digital Comm. Protocols	●●●○○
PCB Layout & Schematic Design	●●○○○
Operating Systems	●●●●●
Microsoft Office	●●●●●
LaTeX git	●●●○○
VS Code, Qt Framework	●●●○○

CERTIFICATES

"No More Than Minimal Risk" human subjects research
CITI Program, A Division of BRANY
Credential Id: 18640373

COURSES

Matrix Methods | Random Signals & Noise | Engineering Analysis (Mathematics & Statistics) | Digital Signal,Image & Video Processing | Pattern Recognition | Principles of Robotics | Adv. Robotics | Bio-Robotics & Cybernetics | Adv. Programming | Sensor Networks | Digital Systems | Modern Control Theory

OUTREACH

Administrator & Coordinator

Robocamp@RIT (Team of 5-7 Volunteers)

Summer, June 2012–Aug 2018

- Organized, managed and instructed summer robotic weekly camps for students from K-10th grade.
- Communicating with parents, organizing the daily activities & coursework during the camps and making sure the students have a fun learning experience.

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SPONSORED PROJECTS

Assisting manufacturing with injection molding machines

$ Century Mold Inc.

Jan 2019–June 2019 **Project Lead (Team of 5)**

- Automated loading and unloading parts during an injection molding process using a UR5e collaborative robot.
- This involved identifying the requirements and constraints of the process, working with the customer for a design and implementation of tooling, optimizing robot movement for efficiency and accuracy and designing the robot workspace.
- Simulation analysis of cycle time of the manufacturing process was done to measure the cost and time benefit of automating the loading and unloading procedure.
- This setup was developed in the CMCR Lab and has been successfully deployed on-site, where it is currently undergoing testing on the factory floor.

Automating for Optical Scaterrometry

$ RPC Photonics Inc.

Jan 2016–Sep 2016 **Project Lead (Team of 3)**

- Developed a solution for precise and careful handling of fragile optical material in a clean room environment using an arm robot, during the process of optical scaterrometry tests.
- Resulted in testing of 65-68 parts/day (by Robot), improvement from 8-10 parts/day (by Human). Also decreased human exposure to laser used during testing.

PUBLICATIONS

* Wrote 13 published papers including

Conference Proceedings

- **Kumar, Shitij**, Sarthak Arora, and Ferat Sahin (Aug. 2019). "**Speed and Separation Monitoring using on-robot Time–of–Flight laser–ranging sensor arrays**". In: *arXiv preprint arXiv:1904.07379, Accepted in IEEE CASE 2019*.
- O.Adamides A. Modur, **S. Kumar** and F.Sahin (Aug. 2019). "**A Time-of-Flight On-Robot Proximity Sensing System to Achieve Human Detection for Collaborative Robots**". In: *Accepted in IEEE CASE 2019*.
- **S. Kumar** and F. Sahin (Oct. 2019). "**Sensing Volume Coverage of Robot Workspace using On-Robot Time-of-Flight Sensor Arrays for Safe Human Robot Interaction**". In: *2019 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*.
- C. Savur and **S. Kumar** et al. (2019). "**HRC-SoS: Human Robot Collaboration Experimentation Platform as System of Systems**". In: *2019 14th Annual Conference System of Systems Engineering (SoSE)*.
- **Shitij Kumar** and Ferat Sahin (June 2017). "**A Framework for an Adaptive Human-Robot Collaboration approach through Perception-based Real-Time adjustments of robot behavior in industry**". In: *12th International Conference on System of Systems Engineering (SoSE)*.

OTHER PROJECTS

- A Laser Tag first person shooter live gaming system using teleoperated Mobile Robots.
- A stress ball like control(squeeze) and haptic feedback device(vibration) for human subjects during HRC tasks.
- American Sign Language (ASL) gesture classification based on EMG signals using CNNs; over 85% accuracy for 27 classes.
- An EEG based classification of a human focusing (also know as fixation) and not focusing; achieved over 95% accuracy for 2 classes.
- A 6-DOF robot end effector pose correction during picking of objects with 2D Data Matrix code.
- Droplet tracking and counting in videos taken during emulsion experiments (plasma in whole blood).

ADDITIONAL SKILLS

Documentation & Presentation

- Have worked on grant proposals and provided research reports.

Verbal & Communication Skills

- Presentations for Graduate seminars and won 3 Minute Thesis Competition in the Engineering Ph.D. department at RIT.

Voracious Reader & Quick Learner

Problem Solving & Troubleshooting.

Leadership & Teamwork.

Ability to work under pressure.

REFERENCES

Dr. Ferat Sahin,
Professor, Director MABL & CMCR Lab
Rochester Institute of Technology
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Dr. Ryan Bowen,
Ph.D., Chief Technology Officer
NRGXP LLC
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Dr. Eyup Cinar,
Ph.D., Sr. Design Engineer
ASML Inc.
exc8020@gmail.com