Sudershan Boovaraghavan

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EDUCATION

Carnegie Mellon University　　　　　　　　　　　　　　　　　　　　　Pittsburgh, PA
Ph.D. in Computer Science - Societal Computing　　　　　　　　　　　　　*Aug 2018 – Present*
Advisor: Yuvraj Agarwal

SRM University　　　　　　　　　　　　　　　　　　　　　　　　　　　Chennai, India
B.Tech in Computer Science and Engineering　　　　　　　　　　　　　　*Jun 2012 – Jun. 2016*

RESEARCH EXPERIENCE

EdgeSense: Collaborative Learning edge machine learning at scale　　　　Pittsburgh, PA
Lead Researcher || Mentors: **Prof.Yuvraj Agarwal**　　　　　　　　　　　*Jan 2019 - Present*

- Proposed a collaborative edge learning framework that uses data from different edge multi-modal sensors to build a customized model specific to each device, improving the learning performance beyond that achieved by any single device, without any cloud support.

MLIoT: An End-to-End Machine Learning System for the Internet-of-Things　　Pittsburgh, PA
Lead Researcher || Mentors: **Prof.Yuvraj Agarwal**　　　　　　　　　　　*May 2019 - Present*

- Developed a large-scale platform tailored towards supporting the ML lifecycle of IoT applications by adapting to different IoT applications tasks, IoT data sources, and different compute resources by automatically training, optimizing, and serving models based on expressive application-specific policies.

- Designed the system to adapt to changes in IoT environments by enabling re-training, and updating models served on the fly while maintaining accuracy and performance.

- Evaluated the system with state-of-the-art ML systems such as Google's TensorFlow Extended (TFX) and Ubicoustics and showed that MLIoT improves accuracy from 50% - 75% while reducing or maintaining similar latency and performance.

Mites: A Ubiquitous Sensing System and Stack [www.mites.io]　　　　　　Pittsburgh, PA
Lead Researcher || Mentors: **Prof.Yuvraj Agarwal** *&* **Prof.Chris Harrison**　　*Nov 2016 - Present*

- Designed and developed the hardware, firmware, and backend for a ubiquitous sensing device called Mites (previously called SuperSensor), which integrates 12 hardware sensors for Activity Detection in the environment. Customized the firmware to sample the hardware sensors at a maximum of 500Hz and sending data over WiFi at 10Hz.

- Architected and Implemented an end-to-end system with a fault-tolerant distributed backend based on Node.js with smart load balancing and RESTful APIs for real-time data streaming.

- Deployed a custom SSL protocol with AES-128 based encryption between the Mites and the Backend as well as symmetric key-based encryption between the Backend and End-User applications for secure streaming.

- Developed a web-based machine learning pipeline with custom visualization to label the raw data stream from the Mites and build custom ML classifiers for activity recognition.

- Individually deployed ∼400 Mites devices and the system-stack in the new CMU TCS building as a part of campus-wide sensor deployment, which supports several real-world applications.

- This project is currently in the process of being commercialized, after being evaluated by several industrial companies in IoT, healthcare, and financial sectors.

Activity Recognition using Transfer Learning　　　　　　　　　　　　　Pittsburgh, PA
Researcher || Mentors: **Prof.Yuvraj Agarwal** *&* **Prof.Anind Dey**　　　　*Feb 2017 - Jan 2018*

- Proposed a machine learning pipeline to perform transfer learning for activity recognition in IoT deployments which reduces the variance in accuracy of activity recognition during maintenance (replacement of sensor nodes) and expansion (addition of sensor nodes) operations in a longer term sensor deployments.

- Developed a time synchronized data collection pipeline for obtaining raw data streams for five different sensors (Mites, Bosch XDK, Matrix.one etc.) which can be customized to varying sampling rates.

BuildingDepot [www.buildingdepot.org] Pittsburgh, PA
Technical Lead || Mentor: **Prof.Yuvraj Agarwal** *Jan 2016 - Present*

- Designed and implemented a distributed middleware OS called BuildingDepot to support the smart building applications built around GIoTTO, a Google funded smart IoT project, for sensor data storage, management and actuation.

- Developed a robust security layer with access control mechanism and resilient pub-sub system using RabbitMQ and scaled up performance to handle more than 10000 requests per second.

- Developed various device drivers for commercially available sensors and actuators (Eg. Philips Hue bulb, Ti sensor tag,.etc) to interact with BuildingDepot. (Github)

- Integrated BRICK, a unified metadata schema for buildings, with the existing tagging system to represent attributes and relationships in buildings and sensors.

PUBLICATIONS

[6] **Sudershan Boovaraghavan**, Xingchen Wang, Sungho Chen, Yuvraj Agarwal,"EdgeSense: Collaborative sensing at Scale"[**in progress**]

[5] **Sudershan Boovaraghavan**, Chen Chen, Yang Zhang, Gierad Laput, Yuvraj Agarwal, Chris Harrison, "Mites: A Ubiquitous Sensing System and Stack" [**in progress**]

[4] Abdelkareem Bedri, Yuchen Liang, **Sudershan Boovaraghavan**, Geoff Kaufman, and Mayank Goel. 2021. FitNibble: A Field Study to Evaluate the Utility and Usability of Automatic Diet Monitoring in Food Journaling using an Eyeglasses-based Wearable. [**submitted to IUI 2022**]

[3] **Sudershan Boovaraghavan**, Anurag Maravi, Prahaladha Mallela and Yuvraj Agarwal. 2021. MLIoT: An End-to-End Machine Learning System for the Internet-of-Things. In Proceedings of the International Conference on Internet of Things Design and Implementation (**IoTDI '21**)

[2] Jason Koh, Dezhi Hong, Shreyas Nagare, **Sudershan Boovaraghavan**, Yuvraj Agarwal, and Rajesh Gupta. 2019. Who can Access What, and When? Understanding Minimal Access Requirements of Building Applications. In Proceedings of the 6th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation (**BuildSys '19**). Association for Computing Machinery, New York, NY, USA, 121124. [DOI]

[1] Matùš Tomlein, **Sudershan Boovaraghavan**, Yuvraj Agarwal, and Anind K. Dey. Supporting Maintenance Operations for IoT-Based Activity Recognition Using Transfer Learning. arXiv preprint (2018). [DOI]

PATENTS

[1] Yuvraj Agarwal, Christopher Harrison, Gierad Laput, **Sudershan Boovaraghavan**, Chen Chen, Abhijit Hota, Bo Robert Xiao, and Yang Zhang. "Virtual sensor system." U.S. Patent Application 16/591,987, filed January 30, 2020. (**Accepted**)

POSTERS & DEMOS

[3] Matilda Kathryn Ferguson, **Sudershan Boovaraghavan**, and Yuvraj Agarwal. 2020. Vista: Spatial Data Representation for Smart Buildings. In Proceedings of the 7th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation (**BuildSys '20**). Association for Computing Machinery, New York, NY, USA, 342343. [DOI] [**Best Demo Award**]

[2] **Sudershan Boovaraghavan**, Chen Chen, Dohyun Kim, Yuvraj Agarwal, GioTTO: A Safe, Secure and Easy to Use IoT Stack for Buildings, CMU Energy Week, March 2018, Pittsburgh, PA, USA. [PDF]

[1] Matùš Tomlein, **Sudershan Boovaraghavan**, Yuvraj Agarwal, and Anind K. Dey. 2017. CharIoT: an end-user programming environment for the IoT. In Proceedings of the Seventh International Conference on the Internet of Things (**IoT '17**). Association for Computing Machinery, New York, NY, USA, Article 25, 12. [DOI]

Work Experience

Institute of Software Research, Carnegie Mellon University　　　　　　　Pittsburgh, PA
Research Associate, Synergy Labs || Advisor: ***Prof. Yuvraj Agarwal***　　　　*Jan 2016 – Present*
- Led and engaged with significant IoT projects which includes BuildingDepot, Mites, and GIoTTO. Investigated on different research topics broadly in IoT, distributed systems, sensing, ubiquitous computing, privacy, and security.

Zesper Labs Digital Media　　　　　　　　　　　　　　　　　　　　New Delhi, India
Developer　　　　　　　　　　　　　　　　　　　　　　　　　*Dec 2014 – Feb 2015*
- Independently developed a website for local distributors in companies like Adidas and Lee to manage their outlets.

Technical Skills

- **Programming Languages**: C, C++, Java, Python, HTML, CSS, PHP, Javascript, Node.js

- **Machine Learning Methods**: Decision trees, Naive Bayes, KNN, K-Mean, Random Forest, Bayesian network, Support Vector Machines, Hidden Markov Models, and Deep Learning.

- **Machine Learning Tools**: TensorFlow, Keras, PyTorch, TFX, Scikit-learn

- **WebFrameworks /Databases**: Flask, Nginx, Xen, MySQL, MongoDB, Influxdb, Bigtable

- **Others**: Git, Linux

Selected Invited Talks and Presentations

IoTDI Conference, Building Machine Learning Systems for the Internet-Of-Things	2021
CyLab Partners Conference, Machine Learning Systems for the Internet-Of-Things	2020
BuildSys Conference, Spatial Data Representation for Smart Buildings	2020
CMU Scott Institute for Energy Innovation, Sensors in IoT	2018
CMU Energy Week, Safe, Secure and Easy to Use Building Infrastructure for IoT	2018
CMU 50th Anniversary Expo, Towards Building a Safe and Secure IoT Infrastructure	2017

Teaching Experience

Teaching Assistant, Carnegie Mellon University	Pittsburgh, PA
Building User-Focused Sensing Systems (Undergraduate & Graduate)	*Spring 2020*

Selected Press

ISR Carnegie Mellon, *Sensors to detect that a dementia patient is having symptoms they can't remember*	2018
New Atlas, *Single Synthetic Sensor keeps watch over entire room*	2017
Digital Trends, *Synthetic Sensors create a connected home without adding smart devices*	2017
Engadget, *A smart home mega sensor can track what goes on in a room*	2017
TechCrunch, *Google-funded super sensor project brings IoT powers to dumb appliances*	2017