Sudershan Boovaraghavan

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Research Interests

My research interests lie at the intersection of **systems, applied artificial intelligence and machine learning (AI/ML), the Internet of Things (IoT), and health** domains. Specifically, I specialize in **building large-scale, deployable sensing systems** for smart environments and **developing foundation machine learning models** for human activity recognition and various health and well-being applications.

Education

Carnegie Mellon University — Pittsburgh, US
Ph.D. in Computer Science - Societal Computing — *Aug 2018 – Aug 2024 (expected)*
Advisor: Yuvraj Agarwal
Thesis: "Towards Enabling General-Purpose Sensing Systems"
Committee: Yuvraj Agarwal (Chair), Chris Harrison, Mayank Goel, and Anind K. Dey

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

Research Experience

Carnegie Mellon University — Pittsburgh, US
Graduate Research Assistant — *Aug 2018 – Present*
Advisor: Yuvraj Agarwal || Collaborator(s): Chris Harrison and Mayank Goel

Building a General-Purpose Sensing Infrastructure || Paper(s) : P.1, P.4, P.6 || www.mites.io

- Developed Mites.io, a full-stack multimodal sensing platform to provide high-fidelity sensing of various ambient environmental facets. Built the hardware and firmware, achieving accurate sub-second event capture with real-time edge processing. Implemented a fault-tolerant distributed backend using Node.js and Python with dynamic load balancing, low latency data streaming, storage, and seamless over-the-air firmware updates.
- Developed edge ML approaches for speech filtering in audio-based activity recognition to preserve privacy.
- Deployed 300+ Mites devices in the CMU TCS building, serving over 400 occupants and enabling 10+ real-world applications, establishing it as the largest IoT infrastructure of its kind.

Production-scale Machine Learning Platform for the Internet of Things || Paper(s) : P.2

- Developed MLIoT, a scalable ML platform automating model training, optimization, and serving for IoT applications using user- and application-driven policies. Engineered the system to adapt to IoT environments, diverse data sources, and compute resources, outperforming Google TFX by 50%-75% in accuracy with reduced latency.
- Explored foundational models using unlabeled multimodal sensor data to capture temporal relationships.

Understanding Activity Contexts for Wellness Applications || Paper(s) : P.5 || Github

- Implemented TAO, a framework that leverages OWL-based ontology and temporal clustering for detecting the context of an activity. Achieved near-ground-truth accuracy in wellness metrics for productivity and stress assessment.

Carnegie Mellon University — Pittsburgh, US
Research Associate — *Jan 2016 – Aug 2018*
Advisor(s): Yuvraj Agarwal, Anind K. Dey and Raj Reddy

Safe and Secure Building Operating System || Paper(s) : D.1, D.2, D.3 || buildingdepot.org

- Implemented BuildingDepot, a distributed building OS with features for sensor data storage, access control, and actuation with a robust RabbitMQ-based stream processing. Managed the deployment of IoT test beds at CMU and Google, using the OS as middleware, and created IoT apps for the GIoTTO project (iotexpedition.org).

National Internet Exchange of India (NIXI) and SRM — Chennai, IN
Researcher — *Dec 2013 – Dec 2015*
Advisor(s): D. Narayana Rao

- Created a cluster-based search engine tailored for Indian websites, enhancing search functions for local users ( ).

Selected Awards and Honors

CMU CyLab Presidential Fellowship 2023

Best Demo Award, Systems for Energy-Efficient Buildings, Cities, and Transportation Conference 2020

Publications

[P.6] **Sudershan Boovaraghavan**, Haozhe Zhou, Mayank Goel, and Yuvraj Agarwal. 2024. Kirigami: Lightweight Speech Filtering for Privacy-Preserving Activity Recognition using Audio. Proc. ACM Interact. Mob. Wearable Ubiquitous Technol. 8, 1, Article 36 (**Ubicomp '24**).

[P.5] **Sudershan Boovaraghavan**, Prasoon Patidar, and Yuvraj Agarwal. 2023. TAO: Context Detection from Daily Activity Patterns Using Temporal Analysis and Ontology. Proc. ACM Interact. Mob. Wearable Ubiquitous Technol. 7, 3, Article 87 (**Ubicomp '23**).

[P.4] **Sudershan Boovaraghavan**, Chen Chen, Anurag Maravi, Mike Czapik, Yang Zhang, Chris Harrison, and Yuvraj Agarwal. 2023. Mites: Design and Deployment of a General-Purpose Sensing Infrastructure for Buildings. Proc. ACM Interact. Mob. Wearable Ubiquitous Technol. 7, 1, Article 2 (**Ubicomp '23**).

[P.3] Abdelkareem Bedri, Yuchen Liang, **Sudershan Boovaraghavan**, Geoff Kaufman, and Mayank Goel. 2022. FitNibble: A Field Study to Evaluate the Utility and Usability of Automatic Diet Monitoring in Food Journaling Using an Eyeglasses-based Wearable. In 27th International Conference on Intelligent User Interfaces (**IUI '22**). ACM, New York, NY, USA.

[P.2] **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**). ACM, New York, NY, USA.

[P.1] 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**). ACM, New York, NY, USA.

Preprints

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

Posters & Demos

[D.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, 342–343. [**Best Demo Award**]

[D.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.

[D.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**). ACM, New York, NY, USA, Article 25, 1–2.

Patents

[T.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**)

Teaching Experience

Teaching Assistant, Carnegie Mellon University — Pittsburgh, US
17-334/734,05-436/836,19-534/734 Usable Privacy and Security (Undergraduate & Graduate) — *Spring 2024*

Teaching Assistant, Carnegie Mellon University — Pittsburgh, US
17-422/722,05-499/899: Building User-Focused Sensing Systems (Undergraduate & Graduate) — *Spring 2020*

Teaching Assistant, SRM University — Chennai, India
CS 238: Introductions to Computer Networks — *Spring 2015*

Technical Skills

- **Programming Languages**: C, C++, Java, Python, HTML, CSS, PHP, Javascript, Node.js, Vue.js
- **Machine Learning Tools**: TensorFlow, PyTorch, Keras, Scikit-learn
- **WebFrameworks/Databases**: Flask, Nginx, Xen, MySQL, MongoDB, InfluxDB, Bigtable

Selected Invited Talks and Presentations

Ubicomp, *Context detection from daily activity patterns* — 2023
Ubicomp, *Mites: General-Purpose Sensing Infrastructure for Buildings* — 2023
CyLab Partners Conference, *Mites: General-Purpose Sensing Infrastructure for Buildings* — 2022,2023
IoTDI Conference, *Building Machine Learning Systems for the Internet-Of-Things* — 2021
CyLab Partners Conference, *Towards Safe and Secure Internet-Of-Things infrastructure* — 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

Academic Service

External Reviewer:
ACM IMWUT — 2021, 2022, 2023
ACM CHI, CHI LBW, CHI Play — 2022, 2023
IEEE ISMAR — 2023

Selected Press

CMU SCS, *CMU's Synergy Lab Presents Ubiquitous Sensing Research at UbiComp* — 2023
ACM Communications, *Privacy Battle Erupts Over Smart Building Sensors* — 2023
MIT Tech Review, *Computer scientists designing the future can't agree on what privacy means* — 2023
The Link, *Super Sensors for a Smart Internet of Things"* — 2018
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
Carnegie Mellon, *CMU Leads Google Expedition To Create Technology for "Internet of Things"* — 2016

Academic Mentees

Anurag Maravi, *Undergraduate, Computer Science, (Currently pursuing Masters at USC)* — 2017 - 2023
Mike Czapik, *Research Scientist, (Currently at TikTok)* — 2017 - 2023
Suryaa Selvaraj, *CMU Masters, ECE* — 2022 - 2023
Bingchen Li, *CMU Undergraduate, Computer Science* — 2022 - 2023
Lucas Blanchard, *REU Student,(Joining Masters at CMU)* — 2022
Shreyas Nagare, *Undergraduate, CMU Masters, Computer Science, (Currently at Apple)* — 2017 - 2020
Matilda Fergurson, *REU Student, (Currently at Bloomberg)* — 2019