CS756: Mobile Computing and Sensor Networks

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Course website: https://canvas.njit.edu/

Class meets every Thursday, 11.30 AM to 2.20 PM at GITC 4402.

Office hours by Appointment, or Thursday 2.30 to 3.30 PM.

Course Overview:

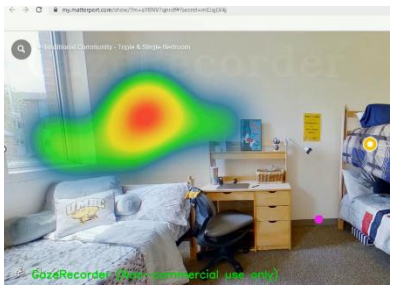
This course presents a comprehensive view of mobile and pervasive computing, from design choices for various mobile platforms, their applicability in smart cities, smart homes and digital health, and pertinent performance trade-offs in the context of mobile sensing. Topics will introduce fundamentals of sensing and analytics as applicable to smartphones, personal wearables, edge processors, AR/VR systems and mobile robots, and will cover a range of techniques relevant to indoor/outdoor localization, activity and physiological sensing, deep learning under resource constraints, and collaborative machine learning. The course will also introduce students to emerging paradigms such as intermittent computing and human-robot teaming. Students will participate in instructor-led weekly discussions, acquire practical programming skills for various mobile platforms through in-class labs, critique mobile systems research papers through in-class presentations, and work on a semester-long project.

Grading Policy: The course is designed such that there'll be opportunities for evaluation and feedback throughout the semester. The course grade is allocated as follows:

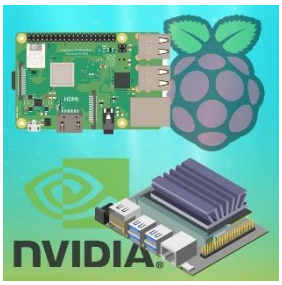
- **Group Labs (45%)** – Three lab assignments each worth 15% consisting of (a) instructed, hands-on programming of different mobile platforms (e.g., **smartphone using Android Studio, Raspberry Pi/Jetson Nano, and educational mobile robots**) and (b) answering design questions related to the platforms. Students will work in teams of 3-4.
- **Project (35%)** – Students will work on a semester-long individual project related to mobile computing. Interim updates (i.e., abstract, 1-page update) will also contribute towards the component grade. Final write-up in a workshop-style format will be due a week after the final presentations. The Fall 2024 offering will involve students using the **RealEye.io** platform for gaze-based sensing applications.
- **Paper critique (20%)** – Each student will pick one paper from a list of papers provided by the instructor to critique and present in class (worth 10%). 10% of the total grade will be allocated for submitting summaries for at least three other papers presented by the peers.

Platforms/Software used in Class:

Android



Eye Tracking



Edge Processors

Mobile Robots

Tentative Course Schedule:

	Topic	Group Labs	Due from you
Week 1	**Course Introduction**		
	Wireless Communication	Group Lab 1 logisitics	
Week 2	Wifi-based Localization	Lab 1A: Accessing sensors (location/inertial)	
Week 3	Context Awareness	Lab 1B: Activity detection with phone sensors	Individual project abstract due (1 para)
Week 4	Context Awareness (Optimizations)		
Week 5	Energy Awareness (Networking, Displays)	Group Lab 2 logistics	Lab Assignment 1 Due
Week 6	Sensing with light and sound	Lab 2A: Profiling DNNs on edge platforms	
Week 7	Edge Computing	Lab 2B: Image processing at the edge	
Week 8	Continuous/Collaborative Vision Processing	Lab 2C: Collaborative edge example	Individual project - Git commits
Week 9	**Paper Presentations I (10 mins each)**		Lab Assignment 2 Due
Week 10	**Paper Presentations II (10 mins each)**	Group Lab 3 logistics	
Week 11	Mobile Robotic systems	Lab 3A: Intro to ROS/Gazebo	
Week 12	AR/VR Systems	Lab 3B: Publishing/Subscribing to topics	
Week 13	Human-Robot Teaming/Intermittent Computing	Lab 3C: Image processing for navigation	
Week 14	**Final Project Presentations + Wrap Up**		3-Min Contest (Individual Projs)
Week 15			Lab Assignment 3 Due

Sample Paper List:

Weeks 1 through 4

Acharya, A., Misra, A., & Bansal, S. (2003, March). MACA-P: a MAC for concurrent transmissions in multi-hop wireless networks. In Proceedings of the First IEEE International Conference on Pervasive Computing and Communications, 2003.(PerCom 2003). (pp. 505-508). IEEE.

Abbas, M., Elhamshary, M., Rizk, H., Torki, M., & Youssef, M. (2019, March). WiDeep: WiFi-based accurate and robust indoor localization system using deep learning. In *2019 IEEE International Conference on Pervasive Computing and Communications (PerCom* (pp. 1-10). IEEE.

Taiwoo Park, Jinwon Lee, Inseok Hwang, Chungkuk Yoo, Lama Nachman, Junehwa Song, "E-Gesture: A Collaborative Architecture for Energy-efficient Gesture Recognition with Hand-worn Sensor and Mobile Devices", *ACM SenSys 2011.*

Kumar, M., Veeraraghavan, A., & Sabharwal, A. (2015). DistancePPG: Robust non-contact vital signs monitoring using a camera. Biomedical optics express, 6(5), 1565-1588.

Wang, E. J., Zhu, J., Jain, M., Lee, T. J., Saba, E., Nachman, L., & Patel, S. N. (2018, April). Seismo: Blood pressure monitoring using built-in smartphone accelerometer and camera. In Proceedings of the 2018 CHI conference on human factors in computing Systems (pp. 1-9).

Weeks 5 through 7

Huynh, L. N., Lee, Y., & Balan, R. K. (2017, June). Deepmon: Mobile gpu-based deep learning framework for continuous vision applications. In Proceedings of the 15th Annual International Conference on Mobile Systems, Applications, and Services (pp. 82-95).

Cao, Q., Balasubramanian, N., & Balasubramanian, A. (2017, June). MobiRNN: Efficient recurrent neural network execution on mobile GPU. In Proceedings of the 1st International Workshop on Deep Learning for Mobile Systems and Applications (pp. 1-6).

Guo, H., Yao, S., Yang, Z., Zhou, Q., & Nahrstedt, K. (2021, July). CrossRoI: Cross-camera region of interest optimization for efficient real time video analytics at scale. In Proceedings of the 12th ACM Multimedia Systems Conference (pp. 186-199).

Jayarajah, K., Wanniarachchige, D., Abdelzaher, T., & Misra, A. (2022, May). Comai: Enabling lightweight, collaborative intelligence by retrofitting vision dnns. In IEEE INFOCOM 2022-IEEE Conference on Computer Communications (pp. 41-50). IEEE.

Liu, S., Yao, S., Fu, X., Tabish, R., Yu, S., Bansal, A., ... & Abdelzaher, T. (2020, December). On removing algorithmic priority inversion from mission-critical machine inference pipelines. In *2020 IEEE Real-Time Systems Symposium (RTSS)* (pp. 319-332). IEEE.

Chen, Q., Ma, X., Tang, S., Guo, J., Yang, Q., & Fu, S. (2019, November). F-cooper: Feature based cooperative perception for autonomous vehicle edge computing system using 3D point clouds. In Proceedings of the 4th ACM/IEEE Symposium on Edge Computing (pp. 88-100).

Weeks 10 through 13

Liu, Z., Lan, G., Stojkovic, J., Zhang, Y., Joe-Wong, C., & Gorlatova, M. (2020, April). Collabar: Edge-assisted collaborative image recognition for mobile augmented reality. In *2020 19th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN)* (pp. 301-312). IEEE.

Guan, Y., Hou, X., Wu, N., Han, B., & Han, T. (2022, June). DeepMix: mobility-aware, lightweight, and hybrid 3D object detection for headsets. In *Proceedings of the 20th Annual International Conference on Mobile Systems, Applications and Services* (pp. 28-41).

Dulanga Weerakoon, Vigneshwaran Subbaraju, Nipuni Karumpulli, Tuan Tran, Qianli Xu, U-Xuan Tan, Joo Hwee Lim, and Archan Misra. 2020. Gesture Enhanced Comprehension of Ambiguous Human-to-Robot Instructions. In Proceedings of the 2020 International Conference on Multimodal Interaction (ICMI '20)

Weerakoon, D., Subbaraju, V., Tran, T., & Misra, A. (2022). Cosm2ic: Optimizing real-time multi-modal instruction comprehension. *IEEE Robotics and Automation Letters*, *7*(4), 10697-10704.

Knox, W. B., Setapen, A. B., & Stone, P. (2011, March). Reinforcement learning with human feedback in mountain car. In *2011 AAAI Spring Symposium Series*.

Sathyamoorthy, A. J., Weerakoon, K., Guan, T., Liang, J., & Manocha, D. (2022, October). Terrapn: Unstructured terrain navigation using online self-supervised learning. In *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* (pp. 7197-7204). IEEE.

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