ECE 2195: Biomedical Computing (15402)

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Fall 2007

Course Information - Fall 2007

Instructor

Professor Allen Cheng
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Course Description & Objectives

In this 3-credit graduate-level course, we will explore the principles of designing computing devices and systems that can be implanted inside or attached to the human body for the purpose of sensing, collecting, and processing various physiological and neurophysiological signals to facilitate proactive health monitoring and disease treating. In addition to improve the state of health cares, these bio-computing devices will also have tremendous impact in our daily lives by fundamentally changing the way we implement authentication, surveillance, position tracking, and many other applications that make use of our biological traits or interact with our biological systems. The goals of this course are to help increase the awareness and understanding of both state-of-the-art designs and futuristic research and to stimulate the interest and develop the basis of being a world-class researcher and a professional engineer in this exciting field where the next-generation computing is heading.

Prerequisite

All-levels of graduate and advanced undergraduate (juniors and seniors) students are welcome.

Class Time & Location

Time: Tuesdays & Thursdays 2:30PM - 3:45PM
Location: 423 Benedum Hall

Requirements

This course is developed to train you to become a world-class researcher and professional. The goal is to help you develop critical and independent thinking

required for a successful career. Therefore, besides intensive literature reading, you will have the opportunity to improve your skills in presentations and literature critiques. You will have the opportunity to participate in scholarly discussion in a conference-like setting. To increase your hands-on experience, you will also have the opportunity to work on a term project that you will be proud of at your job interview. There is one open-book, open-note, open-ended exam towards the end of the semester to help you gauge your level of understanding.

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Course Schedule

The following course schedule is tentative and may be changed by the instructor to adapt to the needs of students and the instructor.

Class	Topic / Lecture	Reading Paper # / Presentator	Assignment / Project	Supplemental Reading
1 (08/28)	Syllabus and Overview		Pick Your Papers	
2 (08/30)	Introduction to Bio-Computing		Finalize Your Papers	
3 (09/04)	Bio-Computer Architecture	1: Nicholas Alexiades	Brainstorm Project Idea	
4 (09/06)	Bio-Computer Architecture	2: Alan Degenhart	Brainstorm Project Idea	
5 (09/11) *333 BENDM	Individual Meeting		Pick Your Topic	
6 (0913) *333 BENDM	Individual Meeting		Pick Your Topic	
7 (09/18)	Bio-Computer Architecture	3: Yuan Sun		
8 (09/20)	Bio-Computer Architecture	4: Yuan Sun		
9 (09/25)	Wireless Sensor Network	5: Michael Smithula		
10 (09/27)	Wireless Sensor Network	6: Michael Smithula		
11 (10/02)	Biomonitoring System	7: Zhanpeng Jin	Project Proposal Due	
12	Biomonitoring	8: Kyle		

(10/04)	System	Treleaven		
13 (10/09)	Brain-Computer Interface	9: Amy McCarty		
14 (10/11)	Brain-Computer Interface	10: Sara Hanrahan, Alan Degenhart		
15 (10/16)	Biocompatibility	11: Dr. Tracy Cui (Guest Speaker)		
16 (10/18)	Biocompatibility	12: Zhanpeng Jin		
17 (10/23)	Neural Implant and Prosthetics	13: Nicholas Alexiades		
18 (10/25)	Neural Implant and Prosthetics	14: Amy McCarty		
19 (10/30)	Mobility and Rehabilitation	15: Sara Hanrahan	Progress Report Due	
20 (11/01)	Mobility and Rehabilitation	16: Benjamin Schmidt		
21 (11/06)	Nano and Molecular Computing	17: Kyle Treleaven		
22 (11/08)	Nano and Molecular Computing	18: Samuel Dickerson		
23 (11/13)	Nanomedicine and Nanorobotics	19: Benjamin Schmidt		
24 (11/15)	Nanomedicine and Nanorobotics	20: Dr. Mingui Sun (Guest Speaker)		
25 (11/20)	Exam			
26 (11/22)	No class - Thanksgiving Recess			
27	Capsule	Dr. Robert Sclabassi		

(11/27)	Endoscopy and Robotics	(Guest Speaker)		
28 (11/29)	Capsule Endoscopy and Robotics	21: Ning Yao 22: Ning Yao, Samuel Dickerson		
29 (12/04)	Project Presentation			
30 (12/06)	Project Presentation		Final Report Due	

* - changed time and/or location

Reading List

Note: Numbering of these paper (i.e., #1 to #22) corresponds to the "Reading Paper #" of the above presentation schedule. Please use them to find your presentation assignment.

1. Jens-Peter Kaps; Kaps, J.-P.; Sunar, B., "Cryptography on a Speck of Dust," IEEE Computer Volume 40, Issue 2, Feb. 2007 Page(s):38 - 44.
2. Henry Markram, "The Blue Brain Project," Nature Reviews Neuroscience 7, 153-160, February 2006.
3. Iyad Al Khatib, Francesco Poletti, Davide Bertozzi, Luca Benini, Mohamed Bechara, Hasan Khalifeh, Axel Jantsch, Rustam Nabiev, "A multiprocessor system-on-chip for real-time biomedical monitoring and analysis: architectural design space exploration," Proceedings of the 43rd annual conference on Design automation DAC '06, July 2006.
4. Oliver, T.F.; Schmidt, B.; Maskell, D.L., "Reconfigurable architectures for bio-sequence database scanning on FPGAs," IEEE Transactions on Circuits and Systems II: Express Briefs, Volume 52, Issue 12, Dec. 2005 Page(s):851 - 855.
5. Leyla Nazhandali, Bo Zhai, Javin Olson, Anna Reeves, Michael Minuth, Ryan Helfand, Sanjay Pant, Todd Austin, David Blaauw, "Energy Optimization of Subthreshold-Voltage Sensor Network Processors," Proceedings of the 32nd annual international symposium on Computer Architecture ISCA '05, Volume 33 Issue 2, May 2005.
6. Philip Levis, David Culler, "Maté: a tiny virtual machine for sensor networks," Proceedings of the 10th international conference on Architectural support for programming languages and operating systems ASPLOS-X, Volume 37 , 30 , 36 Issue 10 , 5 , 5, October 2002.
7. Kramp, Gunnar; Kristensen, Margit; Pedersen, Jacob Frolund, "Physical and digital design of the BlueBio biomonitoring system prototype, to be used in emergency medical response," IEEE Pervasive Health Conference and Workshops, Page(s):1 - 11, 2007.
8. BP Lo, JL Wang, GZ Yang, "From imaging networks to behavior profiling: Ubiquitous sensing for managed homecare of the elderly," Proceedings of the

3rd ACM International Conference on Pervasive Computing, 2005.
9. Miguel A. L. Nicolelis, "Actions from thoughts," Nature 409, 403-407, 18 January 2001.
10. Hochberg, L.R. Donoghue, J.P., "Sensors for brain-computer interfaces," IEEE Engineering in Medicine and Biology Magazine, Sept.-Oct. 2006, Volume: 25, Issue: 5, page(s): 32- 38.
11. Robert Langer, David A. Tirrell, "Designing materials for biology and medicine," Nature 428, 487-492 Review, 2004.
12. M P Lutolf1, 2 & J A Hubbell, "Synthetic biomaterials as instructive extracellular microenvironments for morphogenesis in tissue engineering" Nature Biotechnology 23, 47 - 55, 2005.
13. Mingui Sun; Justin, G.A.; Roche, P.A.; Jun Zhao; Wessel, B.L.; Yingze Zhang; Sclabassi, R.J., "Passing data and supplying power to neural implants," IEEE Engineering in Medicine and Biology Magazine, Volume 25, Issue 5, Sept.-Oct. 2006 Page(s):39 - 46.
14. S. Musallam, B. D. Corneil, B. Greger, H. Scherberger, and R. A. Andersen, "Cognitive Control Signals for Neural Prosthetics," Science 9 July 2004 305: 258-262.
15. William Craelius, "The Bionic Man: Restoring Mobility," Science 8 February 2002 295: 1018-1021.
16. E Jovanov, A Milenkovic, C Otto, PC de Groen, "A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation," Journal of NeuroEngineering and Rehabilitation, 2005.
17. A. Prasanna de Silva, Seiichi Uchiyama, "Molecular logic and computing," Nature Nanotechnology 2, 399-410 Review, 2007.
18. Mauro Ferrari, "Cancer nanotechnology: opportunities and challenges," Nature Reviews Cancer 5, 161-171 Review, 2005.
19. Cavalcanti, A.; Rosen, L.; Kretly, L.C.; Rosenfeld, M.; Einav, S., "Nanorobotic challenges in biomedical applications, design and control," Proceedings of the 2004 11th IEEE International Conference on Electronics, Circuits and Systems, 2004. ICECS 2004. 13-15 Dec. 2004 Page(s):447 - 450.
20. Cavalcanti, A.; Hogg, T.; Shirinzadeh, B., "Nanorobotics System Simulation in 3D Workspaces with Low Reynolds Number," 2006 International Symposium on Micro-NanoMechatronics and Human Science, 5-8 Nov. 2006 Page(s):1 - 6.
21. Matsui, T.; Hirukawa, H.; Ishikawa, Y.; Yamasaki, N.; Kagami, S.; Kanehiro, F.; Saito, H.; Inamura, T., "Distributed real-time processing for humanoid robots," Proceedings. 11th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications, 2005. 17-19 Aug. 2005 Page(s):205 - 210.
22. David R Cave, "Current status of video capsule endoscopy," Nature Clinical Practice Gastroenterology & Hepatology 3, 158-164 (01 Mar 2006) Review.