

Sanford T. Freedman

Curriculum Vitae

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Education

- 2006–present **Doctor of Philosophy in Computer Science**
Vanderbilt University, Nashville, TN.
Adviser: Prof. Julie A. Adams
GPA: 4.0
Dissertation title: Human-inspired forgetting for robotic systems
Expected completion date: August 2010
- 2004–2005 **Master of Science in Computer Science Specializing in Intelligent Robotics**
University of Southern California, Los Angeles, CA.
Adviser: Prof. Maja J. Matarić
GPA major: 3.96; GPA overall: 3.95
- 1998–2003 **Bachelor of Science in Electrical Engineering**
Worcester Polytechnic Institute, Worcester, MA.
Graduated with high distinction
- 1998–2003 **Bachelor of Science in Computer Science**
Worcester Polytechnic Institute, Worcester, MA.
Graduated with high distinction

Experience

- 2006–present **Research Assistant**
Human-Machine Teaming Laboratory, Vanderbilt University, Nashville, TN.
Working under the direction of Prof. Julie A. Adams, current responsibilities include researching robotic designs capable of generating and maintaining situational awareness and the development of computer systems aimed to aid human-robot teams in disaster rescue environments.
- 2006–2007 **Teaching Assistant**
Vanderbilt University, Nashville, TN.
Lectured class, held office hours, and graded assignments and exams.
- 2004–2006 **Research Assistant**
The Interaction Laboratory, University of Southern California, Los Angeles, CA.
Researched social and assistive human-robot interaction under the direction of Prof. Maja J. Matarić.
- 2006 **Co-op**
The MITRE Corporation, Bedford, MA.
Maintained and updated a legacy, research-based client server application. Developed in-house development tools operating on custom file formats. *Secret Clearance*

- 2003–2006 **Electrical Engineer**
IISI Corporation, North Billerica, MA.
 Researched software and hardware designs in proof of principal applications for the US government. Areas of research included unconventional communications and remote sensing. *Top Secret Clearance*
- 2002 **Co-op**
Analog Devices, Inc., Wilmington, MA.
 Designed an automation suite to test semiconductor properties with Agilent VEE. Analyzed the effects of a new fabrication process on existing semiconductor designs, verified PCB designs, and developed Windows device drivers.
- 2001 **Intern**
Bose Corporation, Framingham, MA.
 Designed, constructed, and tested a 12-channel audio amplifier durability box and inspected car audio amplifiers for EMI interference.
- 2000 **Design Engineer Co-op**
Texas Instruments, Merrimack, NH.
 Constructed evaluation board for semiconductor testing, performed semiconductor testing, correlation, simulation, and probing
- 1999 **Co-op**
Siemens Business Services, Burlington, MA.
 Provided quality assurance of internet software, performed computer backup and restoration, and inspected software for ease of use and aesthetic issues.

Graduate Projects

- title **Human-Inspired Forgetting for Robotic Systems**
- adviser Prof. Julie A. Adams
- description This project is exploring the potential benefits of incorporating human-inspired forgetting mechanisms into robotic systems. A new model of forgetting, named ActSimple, has been developed to increase the ability for robots to negotiate the waves of data generated by robotic sensors. Unlike some existing models of human forgetting and robotic systems, the proposed forgetting approach does not select items from memory, but filters the data available to existing algorithms. Through this data screening, traditional robotic algorithms may realize improved performance and increased accuracy. Results from completed experiments suggest ActSimple may not only provide the benefits of forgetting to robotics, but also realize increased performance over a number of existing algorithms. ActSimple is a non-domain specific algorithm with a number of parameters and subcomponents that can be adjusted for particular domains and tasks.
- title **Cognitively Compatible and Collaboratively Balanced Human-Robot Teaming in Urban Military Domains**
- adviser Prof. Julie A. Adams
- description This project is creating a system of interfaces for the manipulation and control of robots within large CBRNE and disaster rescue environments. Individual interfaces are being developed that conform to the specific needs and requirements of first responders at various levels within the management hierarchy. A prototype design for the remote operator, the individual who directly tasks and monitors robots, has been created. A usability study is being developed to evaluate the interface's effectiveness. This project is part of a larger effort to develop the underlying principles, methodologies, and technologies necessary to develop autonomous robot teammates that collaborate naturally with humans as peers, and behave compatibly with human cognitive, attentive, and communicative abilities and limitations.

title **Effective Control of Multiple Unmanned Robotic Vehicles**
adviser Prof. Julie A. Adams
description This project created an interface for a single human operator to control larger numbers of robotic vehicles. Two modes are present within the interface, orchestration mode and manipulation mode. Orchestration mode allows the human operator to assign tasks to any robot while maintaining an awareness of the entire scenario. The manipulation mode allows the operator to directly teleoperate robots while still observing the dynamics of the environment. A sidebar provides the operator with both task and robot status information. This project influenced the design of the Human- Machine Teaming Laboratory's interfaces within the Cognitively Compatible and Collaboratively Balanced Human-Robot Teaming in Urban Military Domains project.

title **Usability Study of The Courseware Authoring and Packaging Environment (CAPE)**
adviser Prof. Julie A. Adams
description This project developed and administered a usability study for the software package The Courseware Authoring and Packaging Environment (CAPE). The study explored the software's ease of use while evaluating the potential for current educators to use CAPE to develop courseware for their students.

title **A 'Hands Off' Physical Therapy Assistance Robot**
adviser Prof. Maja J. Matarić
description This project developed a system to empirically study the effects of different types of interaction between robotic assistants and cardiac surgery patients. The system assists patients in reaching their physical therapy goals by providing engaging feedback and encouragement during the completion of painful but necessary breathing exercises. Patients of cardiothoracic surgery are required to use special breathing equipment every hour in order to prevent pneumonia and speed recovery. Nurses are too busy to oversee all the sessions throughout the patient's stay, and patients quickly lose their internal motivation to complete the exercises because of physical discomfort or boredom. The robot employs a 'Hands-Off' approach to providing assistance, allowing for lower cost designs and decreased liability. A proof of concept experiment was conducted at the USC University Hospital and experiments were conducted to evaluate the relative effectiveness of purely verbal communication and interaction that incorporated the use of a small PDA type device. The system provided a popular demonstration for the Interaction Laboratory.

title **The Humanoid Robot - Bandit**
adviser Prof. Maja J. Matarić
description This project created a new servomotor controller for the Interaction Laboratory's Living Creatures Humanoid Robot, commonly referred to as Bandit. The controller board is capable of simultaneously controlling and monitoring the angular position and velocity of up to 6 servomotors with the use of analog to digital converters. Host controllers are able to communicate with the new board through a simple RS-232 interface. The redesigned system provided a popular demonstration for the Interaction Laboratory during tours and throughout the concurrent USC 125th anniversary and Viterbi School of Engineering 100th anniversary celebrations.

title **Enhanced Inertial Motion Capture System**
adviser Prof. Maja J. Matarić
description During this project, the transmitter portion of the Interaction Laboratory's inertial motion capture system was reengineered. Improvements afforded by this redesign consist of amplified transmission range, reduction of interference, enhanced durability, and increased reliability.

Undergraduate Projects

title **Evolving NPC**
type Major Qualifying Project
adviser Prof. Lee A. Becker
description Created a means of expressing complex and intelligent behaviors in a manner that would require minimal computation while being amenable to machine learning. During the course of the project, a behavioral representation, called Behavioral Curve Summation, was produced along with a preliminary evolution algorithm. Results from this project are able to reproduce highly intelligent behavior and reduce artificial intelligence design time.

title **Synchronized Audio Sample Looper**
type Major Qualifying Project
adviser Prof. William R. Michalson
description Developed a device that alleviates playback tempo problems that occur when digital samples are used during live musical performances. Three new algorithms were created, Beat Detection, Time Stretching, and Note Detection. Utilizing these new algorithms, a device was constructed that adjusts playback of digital samples to match the tempo of a monitored drummer.

title **Efficiency and Effectiveness of ThaiWheel Wheelchairs**
type Interactive Qualifying Project
adviser Prof. Chrysanthe Demetry
description Developed a resource packet to help facilitate improvements in the ThaiWheel organization. The packet included consumer input, information for future opportunities, and a program to calculate total wheelchair costs when making or buying parts. Methods included focus groups, obtaining government and manufacturing contacts, and writing a make-buy and total cost program. Recommendations were for future donation strategies, design alterations, and to make a large initial investment on domestic wheelchair brakes.

title **USS Constitution: The Embodiment of American Military Thought**
type Sufficiency
adviser Prof. Jed E. Watters
description While American Military Thought is very complex and multifaceted, the underlying concepts have remained the same throughout the existence of the country. This sufficiency shows that the USS Constitution is an able representative of almost the entirety of American Military Thought, even though the vessel was constructed in the early years of the country.

Publications

Sanford T. Freedman and Julie A. Adams. Human-inspired robotic forgetting: Filtering to improve estimation accuracy. In *Proceedings of the 14th IASTED International Conference on Robotics and Applications*, pages 434–441. 2009.

Sanford T. Freedman. Human inspired forgetting for robotics systems: Ph.D. Proposal. Technical Report HMT-09-02, Human-Machine Laboratory Technical Report, 2009.

Sanford T. Freedman and Julie A. Adams. Improving robot situational awareness through commonsense:side-stepping incompleteness and unsoundness. Technical Report HMT-09-03, Human-Machine Laboratory Technical Report, 2009.

Jesse Gray, Matt Berlin, Cynthia Breazeal, Paula Aguilera, Kenton Williams, Julie A. Adams, Philipp Robbel, Sanford T. Freedman, Jonathan P. How, Aditya Undurti, Stefanie Tellex, Nicholas Roy, Thomas Kollar, Sigurdur Orn Adalgeirsson, Jason B. Alonso, Fardad Faridi, Jun Ki Lee, Mikey Siegel, Sophie Wang, and Jonathan Williams. Robots to the rescue: Mixed-initiative human-robot teaming for disaster response. The 2009 International Joint Conference on Artificial Intelligence, July 2009. (Nominated: Best Video and Best Sound Track).

Sanford T. Freedman and Julie A. Adams. Synthetic cognitive agent situational awareness components. In *AAAI Fall Symposium on Biologically Inspired Cognitive Architectures*, AAAI Technical Report FS-08-04, page 62. 2008.

Sanford T. Freedman and Julie A. Adams. Synthetic cognitive agent situational awareness-components. Technical Report HMT-08-04, Human-Machine Laboratory Technical Report, 2008.

Sanford T. Freedman. Robots that forget: Improving robot situational awareness by purging information - preliminary examination paper. Technical Report HMT-08-03, Human-Machine Laboratory Technical Report, 2008.

Julie A. Adams and Sanford T. Freedman. Unmanned system autonomy, situation awareness, and system safety. In *Proceedings of the 25th International System Safety Conference*, pages 800–810. 2007.

Sanford T. Freedman and Julie A. Adams. The inherent components of unmanned vehicle situation awareness. In *Proceedings of the 2007 IEEE International Conference on Systems, Man and Cybernetics*, pages 973–977. 2007.

Roger Wu, Curtis M. Humphrey, Sanford T. Freedman, and Julie A. Adams. Multi-robot disaster recon: Building software foundations with real and simulated robots to work with a common interface. Technical Report HMT-07-01, Human-Machine Teaming Laboratory Technical Report, 2007.

Kyong Il Kang, Sanford Freedman, Maja J. Matarić, Mark J. Cunningham, and Becky Lopez. Hands-off physical therapy assistance robot for cardiac patients. In *Proceedings of the International Conference on Rehabilitation Robotics*, pages 337–340. Chicago, IL, June 28 - July 1 2005.

Kyong Il Kang, Sanford Freedman, Maja J. Matarić, Mark J. Cunningham, and Becky Lopez. Hands-off physical therapy assistance robot for cardiac patients. Technical Report CRES Technical Report CRES-05-001, University of Southern California, Los Angeles, CA, 2005.

Teaching Experience

course	CS-252 Theory of Automata, Formal Languages, and Computation
semester	Spring 2008
role	Guest lecturer
course	CS-252 Theory of Automata, Formal Languages, and Computation
semester	Spring 2007
role	Teaching assistant
course	CS-258 Introduction to Computer Graphics
semester	Fall 2006
role	Teaching assistant

Fellowships and Awards

- IBM Graduate Fellowship Award, 2006 - present
- Graduated from Worcester Polytechnic Institute with High Distinction, 2003
- Major Qualifying Project Honorable Mention, 2002

Professional Memberships

- Eta Kappa Nu Electrical and Computer Engineering Honor Society
- Tau Beta Pi Engineering Honor Society
- Association for Computing Machinery (ACM)
- Institute of Electrical and Electronics Engineers (IEEE)

Media Coverage

"Absent-minded Robots Remember What Matters", Kristina Grifantini, Technology Review, MIT, Nov. 6th, 2009.

"Making Robots Absent-Minded Boosts Thier Memory", Tudor Vieru, Softpedia, Nov. 7th, 2009.