

Sanford T. Freedman

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Areas of Expertise

- mobile robotics
- human-robot interaction
- embedded systems
- device interfacing
- digital design
- system architecture
- situational awareness
- human factors
- GUI Design
- cognitive systems
- computer graphics
- distributed systems
- software design
- system integration
- emulator design
- reverse engineering
- project management
- new technology integration

Technical Competencies

Languages - C, C++, C#, Java, assembly

Computer - Windows, Linux, embedded systems, Qt, .Net, Win32, XML, SQL, microcontrollers, SVN

Electrical - digital systems, circuit design, PCB design & assembly, soldering, USB

Robot - Player-Gazebo, YARP, USARSim, remote interaction, proximate interaction, automation

Education

PhD in Computer Science, 2006-2010

Vanderbilt University, Nashville, TN

GPA: 4.0

Dissertation title: Human-Inspired Forgetting for Robotic Systems

IBM Graduate Fellowship Award

MS in Computer Science, 2004-2005

University of Southern California, Los Angeles, CA

Specializing in Intelligent Robotics

GPA major: 3.96; GPA overall: 3.95

BS in Computer Science & Electrical Engineering, 1998-2003

Worcester Polytechnic Institute, Worcester, MA

Graduated with high distinction

Experience

Robotic Systems Software Engineer, 2011 – Present

Digilab, Inc., Holliston, MA

Research Assistant, 2006--2010

Human-Machine Teaming Laboratory, Vanderbilt University, Nashville, TN

Working under the direction of Dr. Julie A. Adams, researched robotic systems capable of improving both mobile robot and human operator situational awareness. Lead the development of graphical user interfaces providing control of robot teams within CBRNE environments. Conducted user testing experiments and mentored junior researchers. Maintained the laboratory's computers, servers, networks, codebase, and development platforms.

Human-Inspired Forgetting for Robotic Systems

Explored the benefits of incorporating human-inspired forgetting mechanisms into robotic systems. ActSimple, a novel model of forgetting, was 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 forgetting approach does not select items from memory, but filters data available to existing algorithms. The data screening may allow traditional robotic algorithms to realize improved performance while increasing accuracy. Results 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 adjustable parameters and subcomponents that can be tuned for individual domains and tasks.

Cognitively Compatible and Collaboratively Balanced Human-Robot Teaming in Urban Military Domains

Designed a hierarchical system of Qt-based graphical interfaces for the manipulation and control of robot teams in large CBRNE and disaster rescue environments. Led interface development and created multiple backend servers allowing the system to communicate with both simulators and real hardware. Introduced advanced scripting capabilities to support user and reliability testing.

Effective Control of Multiple Unmanned Robotic Vehicles

Designed and developed a multi-modal Qt-based GUI interface for the control of robot teams. High-level task assignment and direct teleoperation capabilities are present, along with a novel overlay mechanism aiding in the generation of situational awareness. Comprehensive system information is presented in the form of side panels. Design decisions from this project heavily inspired future laboratory interface projects.

Usability Study of The Courseware Authoring and Packaging Environment (CAPE)

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 and potential for current educators to use CAPE to develop courseware for their students. Custom online surveys were administered and participant performance was analyzed with the Morae usability testing application.

Teaching Assistant, 2006--2007

Vanderbilt University, Nashville, TN

Lectured class, held office hours, and graded assignments and exams. Courses included Introduction to Computer Graphics and Theory of Automata, Formal Languages, and Computation.

Co-op, 2006

The MITRE Corporation, Bedford, MA

Maintained and updated a legacy, research-based client server application. Developed in-house GUI development tools operating on custom file formats. *Secret Clearance*

Research Assistant, 2004-2006

The Interaction Laboratory, University of Southern California, Los Angeles, CA

Researched social and assistive human-robot interaction under the direction of Dr. Maja J. Mataric. Constructed real-time mobile robotic systems employing voice recognition, vision processing, video presentation, and alternative forms of communication.

A 'Hands Off' Physical Therapy Assistance Robot

Developed an autonomous system to empirically study the effects of different types of interaction between robotic assistants and cardiac surgery patients. The system assisted patients in reaching physical therapy goals by providing engaging feedback and encouragement during the completion of painful but necessary breathing exercises. A 'Hands-Off' approach was employed, 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. Robot capabilities included voice recognition, vision processing, video presentation, and navigation. The system provided a popular demonstration for the Interaction Laboratory.

The Humanoid Robot - Bandit

Created a new servomotor controller for a small humanoid robot. Angular position and velocity control is available for up to 6 servomotors with host control provided through RS-232. The redesigned system provided a popular demonstration during tours and university celebrations.

Enhanced Inertial Motion Capture System

Reengineered the transmitter portion of a custom inertial motion capture system. The transmission range was amplified, interference reduced, durability enhanced, and reliability increased.

Electrical Engineer, 2003-2006

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*

Co-op, 2002

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.

Intern, 2001

Bose Corporation, Framingham, MA

Designed, constructed, and tested a 12-channel audio amplifier durability box and inspected car audio amplifiers for EMI interference.

Design Engineer Co-op, 2000

Texas Instruments, Merrimack, NH

Constructed evaluation boards for semiconductor testing, performed semiconductor testing, correlation, simulation, and probing.

Co-op, 1999

Siemens Business Services, Burlington, MA

Provided internet software quality assurance, performed computer backup and restoration, and inspected software for ease of use and aesthetic issues.

Undergraduate Projects, 1998-2003

Worcester Polytechnic Institute, Worcester, MA

Developed a behavior representation, embedded system, and an information packet for a non-profit organization.

Evolving NPC

Produced a behavioral representation, called Behavioral Curve Summation, capable of reproduction highly intelligent behavior and reducing artificial intelligence design time. Developed an evolution algorithm for system training.

Synchronized Audio Sample Looper

Developed a device alleviating playback tempo problems occurring when digital samples are used during live musical performances. The system adjusts playback of digital samples to match the tempo of a monitored drummer.

Efficiency and Effectiveness of ThaiWheel Wheelchairs

Developed a resource packet facilitating improvements in the ThaiWheel organization. Contents included consumer input, information for future opportunities, and a program to calculate total wheelchair costs.

Methods included focus groups, obtaining government and manufacturing contacts, and writing a make-buy and total cost program.

Publications

Dissertation

Freedman, Sanford T. *Human-Inspired Forgetting for Robotic Systems*. Ph.D. thesis, Vanderbilt University, December 2010.

Journal articles

Freedman, Sanford T. and Adams, Julie A. Filtering data based on human-inspired forgetting. *IEEE Transactions on Systems, Man, and Cybernetics - Part B*, 2010. (In Press).

Freedman, Sanford T. and Adams, Julie A. The performance of human-inspired forgetting throughout a task. *Journal of Intelligent and Robotic Systems*, 2010. (Under Revision).

Conference papers

Freedman, Sanford T. and Adams, Julie A. 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.

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

Freedman, Sanford T. and Adams, Julie A. 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.

Kang, Kyong Il, **Freedman, Sanford**, Mataric, Maja J., Cunningham, Mark J., and Lopez, Becky. 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.

Symposium papers

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

Technical reports

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

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

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

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

Wu, Roger, Humphrey, Curtis M., **Freedman, Sanford T.**, and Adams, Julie A. 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.

Kang, Kyong Il, **Freedman, Sanford**, Mataric, Maja J., Cunningham, Mark J., and Lopez, Becky. 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.

Media

Gray, Jesse, Berlin, Matt, Breazeal, Cynthia, Aguilera, Paula, Williams, Kenton, Adams, Julie A., Robbel, Philipp, **Freedman, Sanford T.**, How, Jonathan P., Undurti, Aditya, Tellex, Stefanie, Roy, Nicholas, Kollar, Thomas, Adalgeirsson, Sigurdur Orn, Alonso, Jason B., Faridi, Fardad, Lee, Jun Ki, Siegel, Mikey, Wang, Sophie, and Williams, Jonathan. 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).

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

- Grifantini, Kristina. Absent-minded robots remember what matters. *Technology Review*, MIT, November, 6th 2009.
- Vieru, Tudor. Making robots absent-minded boosts their memory. *Softpedia*, November, 7th 2009.
- Vivian, Tan Sze Sze. A hands-off physical therapy assistance robot for cardiac patients. *Robot News*, April 2007.