

Ali Shtarbanov

INVENTOR · ENGINEER · DEVELOPER · DESIGNER

100 Memorial Drive, Apt. 8-4C, Cambridge, MA 02142

☎ (484) 809-4230 | ✉ alims@media.mit.edu | 🏠 www.shtarbanov.com | 📺 alishtarbanov

Education

Massachusetts Institute of Technology, MIT Media Lab

Cambridge, MA

CANDIDATE FOR MASTER OF SCIENCE IN MEDIA ARTS AND SCIENCES, GPA: 5.00/5.00, ADVISER: DR. V. MICHAEL BOVE, JR.

Sept. 2015 - PRESENT

- Thesis Project: Taking Mid-Air Haptics to the Next Level and Liberating the Interactive Multimodal Experience.
- Areas of Focus: Interactive System Design, Context-Aware System Design.

Lehigh University, College of Engineering and Applied Sciences (RCEAS)

Bethlehem, PA

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING (SUMMA CUM LAUDE), GPA: 3.88/4.00

Aug. 2010 - May 2015

- Senior Design Project: Ultrasonic Tactile Display + Acoustic Field Characterization Machine.
- Areas of Concentration: Signals and Systems, Digital Design.

Lehigh University, College of Arts and Sciences (CAS)

Bethlehem, PA

BACHELOR OF ARTS IN PHYSICS (SUMMA CUM LAUDE), GPA: 3.90/4.00

Aug. 2010 - May 2015

- Areas of Concentration: Mathematical Physics, Electromagnetism.

Research and Engineering Experience

MIT Media Lab, Object-Based Media Group

Cambridge, MA

GRADUATE RESEARCH ASSISTANT, SUPERVISOR: DR. V. MICHAEL BOVE, JR.

Sept. 2015 - PRESENT

- Developed QuietSense - A distributed, context-awareness system that autonomously puts a user's phone in the appropriate ring mode. The system is agnostic to personal information and requires no GPS, Internet, WiFi, Bluetooth, nor other connection to the smartphone.
- Developed a complete IoT platform including a PHP-based dashboard and a custom C++ firmware, which allows WiFi modules to seamlessly connect to any WiFi network and be controlled remotely and securely from the dashboard over the internet. The system even allows remote firmware updates, which enables modules to be deployed nearly anywhere and maintained without requiring physical access.
- Developed an interactive system in Unity3D that allows a user to touch a virtual object and feel its presence through haptic feedback delivered via toroidal air-vortices. The system was first demonstrated during spring 2016 and became one of the most popular demos in our lab.
- Built and presented demos of in-progress and finished projects.

Lehigh University, Sherman Fairchild Center

Bethlehem, PA

SUMMER RESEARCH PROGRAM FOR UNDERGRADUATES (SHERMAN FAIRCHILD FELLOWSHIP), SUPERVISOR: DR. MILTIADIS HATALIS.

May 2014 - Aug. 2014

- Designed a tactile display that uses a phased array of 40 KHz ultrasonic transducers to deliver mid-air cutaneous stimulus up to a range of 30 cm, within an area of 11 cm X 9 cm. Different texture perceptions could be achieved through different modulation schemes.
- Derived a generalized mathematical model for focal point formation from N arbitrarily-positioned sources of acoustic waves.
- Developed software in Java that computes the phase offset of each transducer so that the focal point can be moved in 3D space.
- Developed software in Verilog for a Spartan 3 FPGA that controls the driving signal for each transducer of the ultrasonic tactile display.
- Built a high-resolution, autonomous, field-mapping robot that was used to characterize the acoustic field in the 3D region above the display.

Lehigh University, Display Research Laboratory

Bethlehem, PA

UNDERGRADUATE RESEARCH ASSISTANT, SUPERVISOR: DR. MILTIADIS HATALIS.

Jan. 2014 - May 2014

- Performed an extensive literature review of present and emerging tactile and kinesthetic haptic interfaces.
- Studied the physiology and neurology of human tactile perception and explored methods for artificially stimulating the mechanoreceptors.

Universiti Teknologi PETRONAS, Advanced Communication Engineering Cluster

Ipoh, Malaysia

INTERNATIONAL RESEARCH EXPERIENCE FOR UNDERGRADUATES (LEE IACocca FELLOWSHIP), SUPERVISOR: DR. VARUN JEOTI

June 2013 - Aug. 2013

- Worked with a team of five on the WiDuct research project, aiming to establish long range, over the horizon, ultrawideband wireless communication between oil rigs at sea, by exploiting the waveguide characteristics of an evaporation duct.
- Designed and carried out experiments for performing path-loss characterization of a wireless channel at 3.5 GHz and 10.5 GHz.
- Developed MATLAB software for remote instrumentation control, and for analysis and computation involving thousands of data points.
- Performed theoretical computations in MATLAB and compared the computed against the measured results.
- Utilized Vector Signal Generator and Vector Signal Analyser for data acquisition and analysis.
- Delivered oral presentation and technical report upon program completion.

Freelance Computer Technician and Consultant

Wind Gap, PA

SELF EMPLOYED DURING HIGH SCHOOL

Aug 2007 - Aug. 2010

- Fixed hundreds of computers with problems related to hardware, software, data recovery, and networking
- Gained advanced experience with a variety of Linux Distributions and developed skills in penetration testing, password cracking, terminal programming, and more.
- Published a website with advanced tutorials for Linux and Windows related to data recovery from deleted partitions, GRUB hacking, gaining administrator access, and more.

Leadership and Teaching Experience

Massachusetts Institute of Technology

Cambridge, MA

TEACHING ASSISTANT FOR MAS.863, "HOW TO MAKE (ALMOST) ANYTHING"

Sept. 2016 - PRESENT

- Taught circuit design and electronics production for a graduate digital fabrication course.
- Designed FabOptimus - the most space-optimized FabISP to date.
- Wrote several electronics design and PCB design tutorials, which are available on the public class website.
- Provided feedback and technical assistance for final projects.

Massachusetts Institute of Technology

Cambridge, MA

UROP SUPERVISOR

Mar. 2016 - PRESENT

- Supervised undergraduate research assistants for projects related to Android development and hardware design.
- Wrote job descriptions, evaluated applications, and conducted interviews to recruit talented and motivated candidates.
- Provided mentorship, tutoring, and guidance with Android programming and product development.

Lehigh University

Bethlehem, PA

VOLUNTEER TUTOR

Sept. 2011 - May 2015

- Offered help with homework and exams for several Mathematics, Physics, and Engineering subjects.
- Provided comprehensive derivations to promote a first-principles approach to learning.

Lehigh University Association for Computing Machinery

Bethlehem, PA

PRESIDENT, TREASURER

Aug. 2011 - May 2013

- Increased ACM's annual student senate funds by 150%.
- Ran recruiting campaigns that resulted in tripling the number of members.

Cahit Nakiboğlu Middle School

Gaziantep, Turkey

INTERNATIONAL TEACH & TRAVEL PROGRAM FULLY SPONSORED BY THE FEDERATION OF BALKAN-AMERICAN ASSOCIATION (FEBA)

May 2011 - July 2011

- Taught English language at a private school for an accelerated summer language program.
- Prepared and delivered lessons, and had full responsibility for a group of nine students ages 10 to 13.

Freelance Mathematics Tutor

Wind Gap, PA

SELF EMPLOYED DURING HIGH SCHOOL

Nov. 2009 - July 2010

- Taught fundamental mathematical thinking skills and alternative approaches to reasoning.
- Emphasized conceptual understanding and intuitive approaches for solving problems.

Skills

PROGRAMMING LANGUAGES, ENVIRONMENTS, AND FRAMEWORKS

- **Advanced:** C, C++, Java, PHP, Verilog, HTML/CSS, Bootstrap, Unix Terminal
- **Intermediate:** Android, JavaScript, LabVIEW, Assembly, MATLAB, jQuery
- **Basic:** Mathematica, Unity3D, Highcharts, NodeJS, Python, LaTeX

EMBEDDED SYSTEMS

- FPGA, Arduino family, ESP8266, ESP32, AVR Microcontrollers.

DESIGN SOFTWARE

- SolidWorks, EAGLE PCB Design, Photoshop, InkScape, Shopbot, Microsoft Office Publisher, TeXmaker.

FABRICATION

- Laser cutting, 3D printing, Vinyl cutting, CNC Milling, Water jet cutting, Molding and Casting, Woodworking, Metalworking, PCB Fabrication.

HARDWARE AND INSTRUMENTATION

- Vector Signal Generator, Vector Signal Analyzer, Oscilloscope, Antennas, Spectrum Analyzer, Curve Tracer, Sensors, Motors, Output devices.

LANGUAGES

- English, Bulgarian, Russian (basic), Bosnian (basic)

Awards and Distinctions

- Jan. 2017 **MIT Sandbox Innovation Fund Recipient**, Awarded seed funding and resources to bring a project to market
- Jan. 2017 **StartMIT Participant and Finalist**, Workshop for Entrepreneurs and Innovators
- July 2015 **Francis du Pont Memorial Prize**, Awarded to the two highest-ranking graduates in Electrical Engineering
- June 2015 **Summa Cum Laude** (both degrees), Lehigh University
- 2014-2015 **Presidential Scholarship**, Full Tuition Scholarship for a Fifth Year of Study at Lehigh. Awarded to 1% of students.
- 2010-2015 **Dean's List (Every Semester)**, Lehigh University
- 2010-2014 **H & F Dornblatt Scholarship**, Full Tuition Scholarship for Four Years
 - 2014 **Sherman Fairchild Fellowship**, Undergraduate Summer Research Fellowship
 - 2013 **Lee Iacocca Fellowship**, International Research Experience for Undergraduates (REU) Program
- 2011-2012 **Donald B. and Dorothy L. Stabler Scholarship**, Lehigh University
 - 2011 **Wilbur Mathematics Prize**, for Demonstrating Outstanding Abilities in Mathematics During Freshman Year
 - 2014 **IEEE - Eta Kappa Nu Electrical Engineering Honor Society**, Lehigh University
 - 2012 **Tau Beta Pi Engineering Honor Society**, Lehigh University
 - 2011 **Phi Eta Sigma Freshman Honor Society**, Lehigh University

Affiliations

PROFESSIONAL MEMBERSHIPS

- IEEE, ACM

OPEN SOURCE COMMUNITY INVOLVEMENT

- Made contributions to Mozilla Firefox, Ubuntu, Fedora, PartedMagic, Gparted, and GNOME.
- Authored and designed the documentation for GNOME Simple Scan.

CITIZENSHIPS

- United States, European Union (Bulgaria)

Projects Portfolio

Taking Mid-Air Haptics to the Next Level & Liberating the Interactive Multimodal Experience

Cambridge, MA

RESEARCH/THESIS PROJECT

Nov. 2016 - PRESENT

- Extending the research on haptic feedback via toroidal air rings and developing a novel device with a large number of individually controlled apertures for generating multiple air-vortex rings with different physical properties at a range of angles. The device and corresponding system would enable users interacting with a stereoscopic display to not only see the 3D content, but also touch, feel, and smell it.
- The complete system would deliver a multimodal immersive experience consisting of visual, auditory, cutaneous, and olfactory stimuli.

Notebook Telepresence

Cambridge, MA

MIDTERM (GROUP) PROJECT FOR "TANGIBLE INTERFACES"

Sept. 2016 - Oct. 2016

- Worked on a team of four to explore the possibility of shared, screen-free, reading and writing experiences over long distance via responsive, shape-changing notebooks. We created two identical notebooks whose covers and pages can serve as inputs (via touch and bending) as well as outputs (via shape change). When a user performs an action on one notebook, that action is reflected on the other through corresponding shape-change.

QuiSense - Distributed, Autonomous, Context-Awareness System for Android Devices

Cambridge, MA

RESEARCH PROJECT

Mar. 2016 - PRESENT

- Designed a system that autonomously changes the ring mode of a phone depending on the local context, and thereby eliminates the need for a user to manually change or even think about changing the ring mode of their phone, such as during a meeting or when in a movie theater.
- Contextual information is embedded into the environment rather than the phone and broadcasted locally. Thus, all phones present could listen to the broadcasted information and change their behavior accordingly. The information is retrieved from room-reservation calendars and dynamically embedded into the SSID strings of local WiFi transmitters. Since no personal or tracking information is used, and no Internet, GPS, WiFi, Bluetooth, or any other network connection is established, there is not even a possibility of a security of privacy exploits for phone users.
- The project was demonstrated during the Fall 2016 Member Event.

Immersive, Multimodal Drawing and Storytelling Interface

Cambridge, MA

FINAL PROJECT FOR "SENSOR TECHNOLOGIES FOR INTERACTIVE ENVIRONMENTS"

Mar. 2016 - May. 2016

- Developed an interactive system that lets users experience 2D content on a standard page of paper through several modalities including audio and self-motion. I embedded capacitive touch sensors, printed in the form of different animals or characters, within a regular blank sheet of paper. When a user moves their finger over the paper and over the hidden capacitive touch image, they hear either a sound made by the animal, or a story told by the character. The user then has to guess what the hidden images is and draw it right above the hidden touch sensor.
- The system enables a new kind of immersive storytelling experience that stimulates thinking and artistic creativity through guided drawing that includes only auditory and kinesthetic guidance but no tactile or visual guidance.

Interactive, Haptic-Feedback System for 3D Displays

Cambridge, MA

DEMO PROJECT

Jan. 2016 - Mar. 2016

- Developed a prototype of a system that delivers mid-air haptic feedback via air-vortex rings when a user touches the surface of a virtual 3D object on a screen. The system consisted of a custom-made, 3D printed vortex-ring generator, a scene designed in Unity 3D, a microcontroller with a custom-made driver board for delivering high current, and a Leap Motion controller for hand tracking.
- The project was demonstrated during the Spring 2016 Member Event.

Autonomous, Energy-Saving Window

Cambridge, MA

FINAL PROJECT FOR "HOW TO MAKE (ALMOST) ANYTHING"

Nov. 2015 - Dec. 2015

- Designed a window that senses the temperature and humidity inside and outside, and then Autonomously opens or closes depending on the heat index difference and on preselected user preferences. If integrated with the heating/cooling system of a house, this project could significantly reduce the power consumed for heating and cooling by relying more on the external environment yet still maintaining a constant internal temperature.

Ultrasonic Tactile Display

Bethlehem, PA

SENIOR DESIGN PROJECT

May. 2014 - May. 2015

- Designed a tactile display that uses modulated focused ultrasound to provide midair tactile stimulus on a user's bare hands. Different texture perceptions could be achieved by changing the low frequency modulation applied to the 40KHz carrier.
- The project consisted of a 2D phased array of ultrasonic transducers arranged in a hexagonal configuration, an FPGA that provides independent driving signals for all transducers on the phased array, a custom-made driver board that amplifies the FPGA signals, and a custom-made Java Swing application that computes the phase offsets for each transducer such that constructive interference can be achieved at any point within a volume.

Autonomous, Acoustic Field Characterization Machine

Bethlehem, PA

TESTING EQUIPMENT FOR THE ULTRASONIC TACTILE DISPLAY

May. 2014 - May. 2015

- Designed an autonomous, field mapping robotic system with three degrees of freedom to characterize the acoustic field profile in the volume above the ultrasonic tactile display. By utilizing high resolution stepper-motor assemblies from recycled flatbed scanners, and by building a control system that enables microstep driving of the motors, I could achieve micrometer resolution (along each axis) with a system I built for less than \$100.

FIFO Buffer System

Bethlehem, PA

PROJECT FOR "DIGITAL SYSTEMS DESIGN"

Oct. 2014 - Nov. 2014

- Designed an 8 byte FIFO buffer with two inputs and one output. The input ports communicated with two external systems via handshake lines using sender originated protocols. The output port communicated with a third external system via handshake lines using a receiver originated protocol.

CPU Design

Bethlehem, PA

PROJECT FOR "DIGITAL SYSTEMS DESIGN"

Sept. 2014 - Oct. 2014

- Designed an 8-bit processor with architecture similar to that of the Intel 8085. The processor could perform over a dozen assembly instructions from the Intel 8085 instruction set, including addition, subtraction, data transfer between registers, data transfer between register and memory, processor halt, operations involving pairs of registers, and more.
- The project was implemented in Verilog and simulated in Cadence.

Dual Microphone Background Noise Reduction System

Bethlehem, PA

TERM PROJECT FOR "GRAPHICAL SIGNAL PROCESSING"

Oct. 2014 - Nov. 2014

- Implemented in LabVIEW a dual-microphone system capable of suppressing background noise that might be present when a user is speaking. The system was based on a 2012 paper titled "Noise Reduction for Dual-Microphone Mobile Phones Exploiting Power Level Differences." In an environment of diffuse and homogeneous noise field, two microphones placed at different distances from a person, would both receive inputs containing noise and speech. While the noise components would be the same for both microphones, the speech components would have different spectral power. I used this power level difference to discern the speech component from the noise component and to then attenuate the only the noise.
- Submitted a 15-page term paper upon completion of the project.

Semi-Automatic Book Scanner

Bethlehem, PA

PERSONAL PROJECT DURING WINTER BREAK

Dec. 2013 - Jan. 2014

- Built a semi-automatic book scanning system capable of scanning a 1000-page book in less than 2 hours. The user only had to flip the pages of the book, without the need of lifting the book. I designed a platform that ensures that the pages always remain flat, as well as a servo-controlled mechanism that attaches to a regular digital camera to augment it into a remote controlled camera capable of shooting autonomously or on trigger.

Antenna Simulation and Design

Bethlehem, PA

FINAL PROJECT FOR "COMMUNICATION THEORY"

Sept. 2013 - Dec. 2013

- Simulated a Yagi-Uda antenna over a wide frequency range to observe the contributions due to the different elements and to understand the undesirable distortions that occur outside of the operating frequency range.
- Studied various smart antennas and how to design phased antenna arrays, that enable the radiation pattern to be directed at any angle simply by changing the phase offset between the different array elements to achieve desired constructive or destructive interference patterns.

Omnidirectional Holonomic Robot

Bethlehem, PA

GROUP PROJECT FOR A FIRST YEAR ENGINEERING COURSE

Jan. 2011 - Mar. 2011

- Designed a holonomic platform out of Lego, capable of following an arbitrary serpentine contour and avoiding obstacles. Several sensors were employed to detect whether the contour was being followed and whether any obstacles were present along the way.