Mobiles for Development: Using upcycled electronics for transformative impact in low-income communities

Course Number: EC.751, EC.793 (G)
Unite: 3-0-6
Class Size: 18
Location: N51-350
Time: 2:00-5:00 PM Wed
Instructors: Heewon Lee (heewon1@mit.edu), Aditya Mehrotra (adim@mit.edu)

Course Overview:

Students explore possible uses of upcycled electronic devices in several sectors of development, including agriculture, education, health, and energy, to have a positive impact on people living in low-income communities. Guest lecturers provide insight into current trends in information and communication technology for development (ICT4D). Students work in teams to apply participatory design principles to specific projects that has been develop by community innovators in urban/rural areas of Tanzania. Optional travel to Tanzania will occur over summer 2024 with D-Lab partners in the field.

Course Objectives

Technical:

- Understanding the basics of an "Internet of Things," sharing data between devices over WiFi and cellular connections, and using smart devices to control mechatronics systems.
- Understand how to interface with analog and digital sensors to read environmental and machine data. Understand basic communication systems, data filtration, and sampling.
- Understand how to interface with and control DC motors, servos, relays, and similar ouput devices.
- Understand how to design for robustness in the field including connectivity loss, flash and EEPROM memory.
- Write and apply technical system functional requirements using basic mathematics and physics.

Non-Technical:

- Learning and practicing the participatory design process
- Gaining exposure to co-creating solutions with local innovators in the development context
- Developing skills for planning, designing, and implementing innovative projects
- Working collaboratively with local innovators to affect change

Prerequisites
None, just an open attitude toward learning and sharing.

Syllabus:
Each class will be divided into three parts. The initial segment will focus on D-Lab/Design-related lectures, the second part will cover technical lectures, and the final segment will be dedicated to lab time.

Week	Lecture	Content	Readings	Homework
Week 1 Feb 7	Part 1: D-Lab Lecture	-Welcome -Activity: Introduce yourself -Overview of the Class -Introductions to the "Design for Second Life Innovations Project" -Syllabus Overview + Grading -Photo & Video Release -Travel Survey		-Students will meet their partners, and discuss potential project directions. -Lab 0: Introduction to Arduino Programming
	Part 2: Technical Lecture	-Understanding IoT in the Context of Development -General IoT / Use / Applications -IoT System Architecture and Technical Overview	-Intro to Electronics: How to not explode everything	
	Part 3: Lab	-Intro to projects -Intro to local innovators -Project selection -Team building (working style) -Scheduling meetings -Build timeline -Identify team leader		
Week 2 Feb 14	Part 1: D-Lab Lecture	-Participatory Design: Creative Capacity Building (CCB) Methodology		-Meet the Partners: Gathering Information &

		Design Process 1: -Information gathering -Information synthesizing -Problem framing -Problem statement -Needs Assessment		Synthesizing Information & Needs Assessment
	Part 2: Technical Lecture	-Hardware Lab 1 (Use your phone to control your Arduino and receive data back)	-Example, developing system-level functional requirements	
	Part 3: Lab	-Hardware Lab 1		
Week 3 Feb 21	Part 1: D-Lab Lecture	Design Process 2: -Ideation -Idea selection -Sketch modeling		-Meet the Partners: Ideation + Select a Project
	Part 2: Technical Lecture	-Functional Requirements + System-Level Architecture Design (sensors, output devices, processors, connectivity)	-Introduction to sensors, measurement, and filtration	
	Part 3: Lab	-Ideation Lab -Sketch modeling		
Week 4 Feb 28	Part 1: D-Lab Lecture	Design Process 3: -Prototyping -Design requirements		-Prototyping: Create a user scenario -Meet the Partners: Share the lo-fi prototype / Draw a System Diagram / Feasibility Assessment for Each
	Part 2: Technical Lecture	-Hardware Lab 2 (Sensors and Input Devices)	-Introduction to motors, actuators, and mechatronics systems	
	Part 3: Lab	Hardware Lab 2		
Week 5	Part 1:	Design Process 4:		

March 6	D-Lab Lecture	-User feedback & User testing		-Begin your functional prototypes
	Part 2: Technical Lecture	-Hardware Lab 3 (Actuators, Output Devices)		
	Part 3: Lab	-Hardware Lab 3		
Week 6 March 13	Part 1: D-Lab Lecture	-Hardware Lab 4 (Considering Connectivity in the Field)		-Collect user feedback on your projects
	Part 2: Technical Lecture	-Hardware Lab 4		
	Part 3: Lab	-Team Work Time		
Week 7 March 20	-In-Class Design Review			Project Work
Week 8 March 27	Spring Break			
Week 9 April 3	Part 1: D-Lab Lecture	-Measurement and Documentation in the Field		-Project Work / Documentation
	Part 2: Technical Lecture	-Technical Documentation for Hardware and Software		
	Part 3: Lab	-Documentation Work Time		
Week 10 April 10	Part 1: D-Lab Lecture	-Field Trip Lecture		-Project Work / Conduct a user testing
	Part 2: Technical Lecture	-Project Work		
	Part 3: Lab	-Project Work		
Week 11	Part 1:	-Guest Lecture:		-Project Work

April 17	D-Lab Lecture			
	Part 2: Technical Lecture	-Project Work		
	Part 3: Lab	-Project Work		
Week 12 April 24	Part 1: D-Lab Lecture	-Guest Lecture		-Project Work
	Part 2: Technical Lecture	-Project Work		
	Part 3: Lab	-Project Work		
Week 13 May 1	Part 1: D-Lab Lecture	-Project Work		-Project Work
	Part 2: Technical Lecture	-Project Work		
	Part 3: Lab	-Project Work		
Week 14 May 8	Final Presentations			

Final Project:
Throughout the semester, students will engage in project work centered around the theme of "Utilizing Upcycled Electronics for Transformative Impact in Low-Income Communities."

Students will collaborate in teams and partner with local innovators in Tanzania for the duration of the semester. These teams will organize weekly video meetings through digital portals to co-create innovative ways of incorporating upcycled electronics with the existing technologies developed by our local innovators, aiming to amplify their impact.

As students will have a diverse set of skills and backgrounds represented, groups will develop challenges or mechanisms based on their interests and prerogative. In areas where teams may

have limited knowledge and experience, they can consult with the instructors, faculty, staff, and other local experts. As this is a project-based course, the instructors will provide guidance and direction with appropriate goals for a team of students to make a significant contribution to the local partners. Projects will be presented to the class and guests during the final session.

Seminars and Guest Speakers:
The instructors and guest speakers will periodically offer lectures and case studies related to humanitarian innovation design. Students should reflect on the material presented in class and investigate parallels to their own design projects.

Course Materials

Course materials are found on a shared Google Drive folder. Please do not share the materials outside the class. All technical course content will be hosted at mit-d-lab.github.io including labs, readings, and documentation.

Attendance and Participation
Each student's presence and involvement in class is important, as most sessions involve discussions, hands-on activities, prototyping, and user testing. Much of this work is also done in teams and would be affected by students' absence. For team projects, the level of a student's commitment and engagement might matter not only to the team but to the entire community.

Grade Distribution
- In-Class Participation: 10%
- Lab Participation: 10%
- Assignments: 30%
- Final Project: 30%
- Attendance: 20%

Grading Criteria
- F – Multiple unexcused absences. Does not complete assignments. Inappropriate behavior in class. Failure to complete the final project.
- D – Consistent lateness and disengagement with course material. Shows minimal interest and applies minimal effort. Failure to complete assignments. Completes final project.
- C – Occasional lateness, inconsistent effort/engagement with course material. Failure to complete assignments. Completes final project.
- B – Always present. Clearly applies effort to assignments and is engaged during class time. Difficulty with some concepts but consistently tries to learn. Completes assignments and final projects.
- A – Always present. Consistently engages with course material and effectively utilizes out-of-class time to develop skills. Completes assignments and final projects.