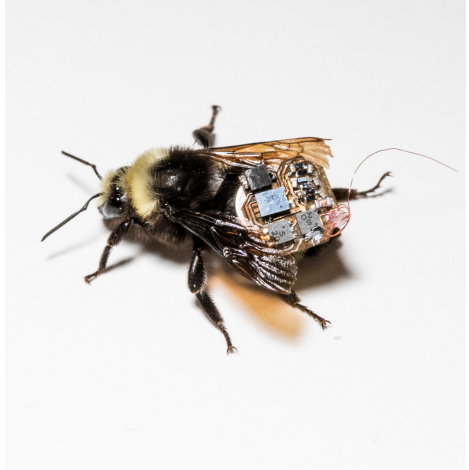
CSE/ECE 474: Intro to Embedded Systems

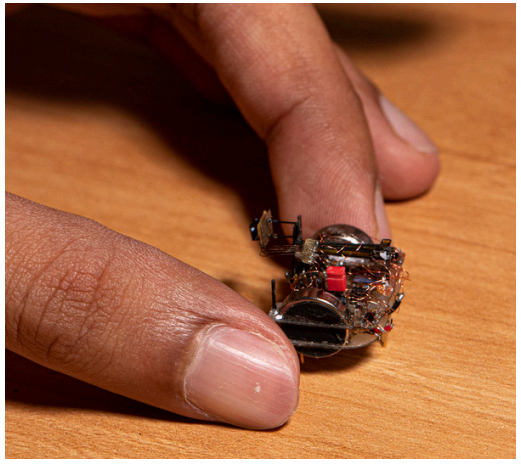
Lecture 1

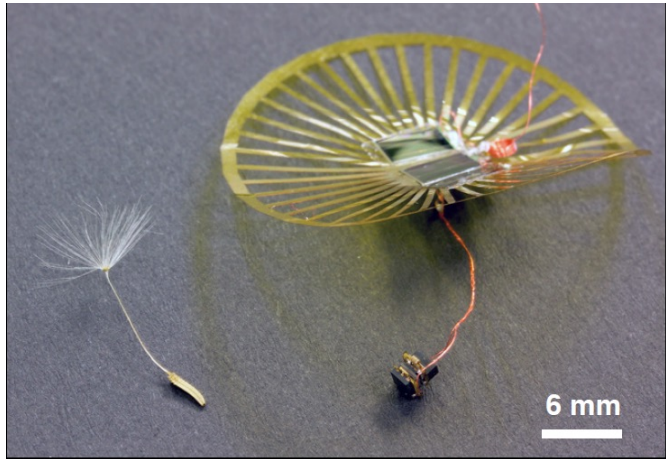
Vikram Iyer

Plan for today

- Logistics
  - Intro to course staff
  - What are embedded systems?
  - Canvas and resources
  - Class format
  - Labs
  - Grading
- Examples of embedded systems





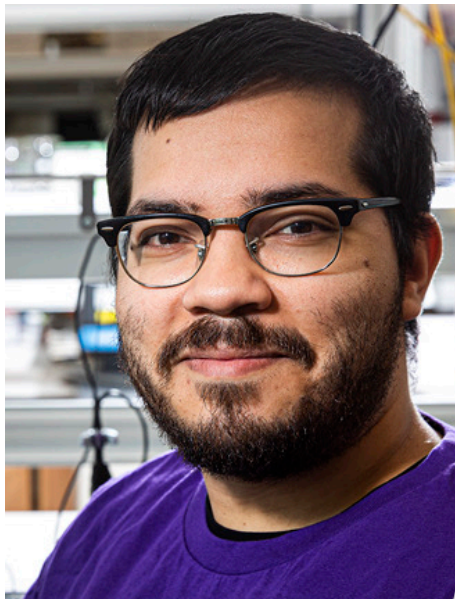


Course staff

Instructor: Vikram Iyer, vsiyer@uw.edu

TAs:

Kyle Johnson



Vicente Arroyos

Joe Breda

What are embedded systems?

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Tiny computers that are *embedded* or hidden inside something else.

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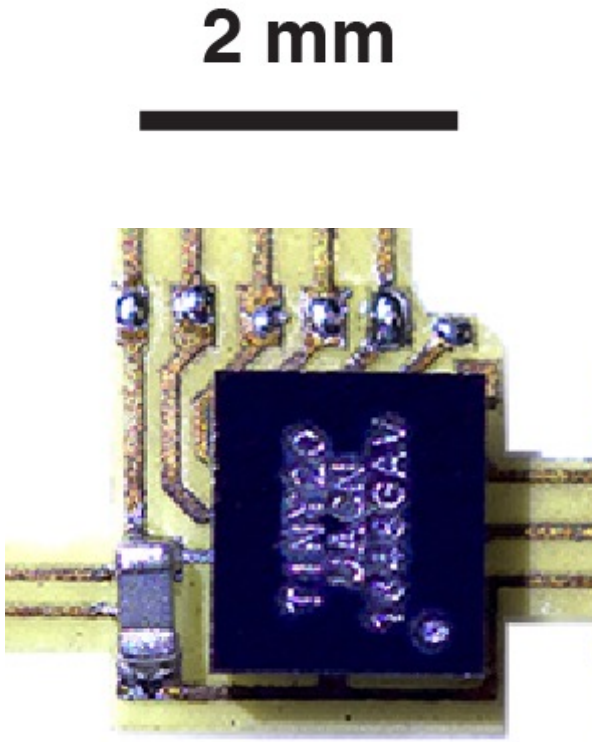

Microcontroller

What are embedded systems?

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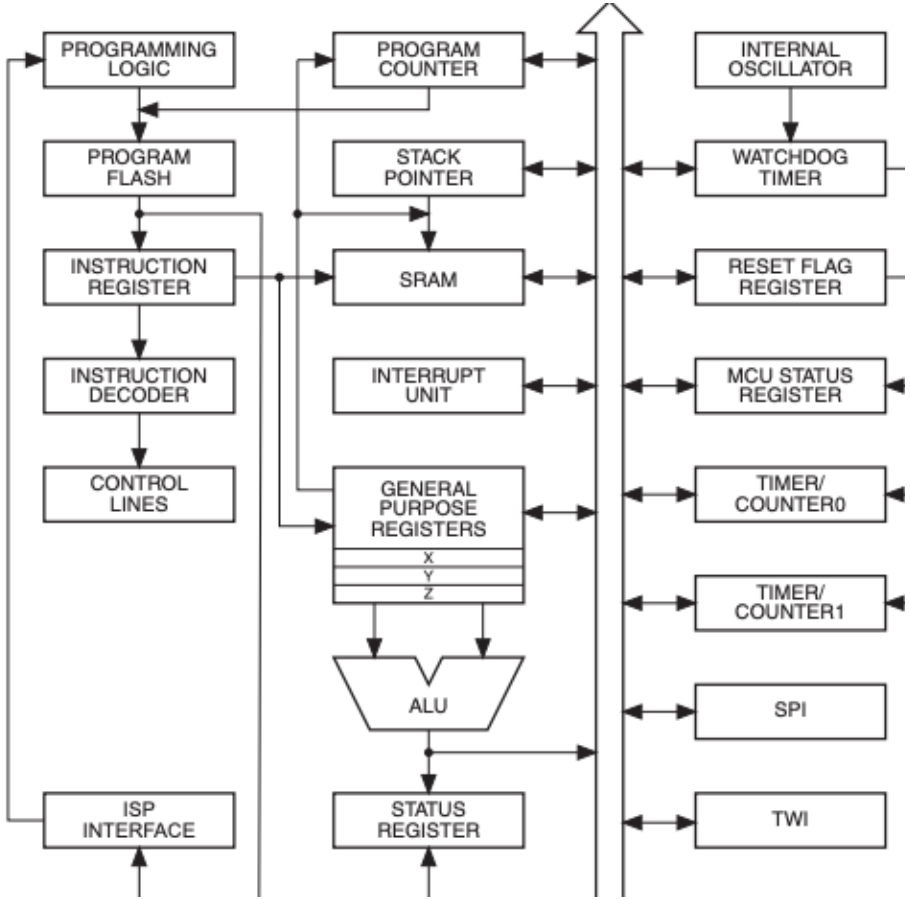

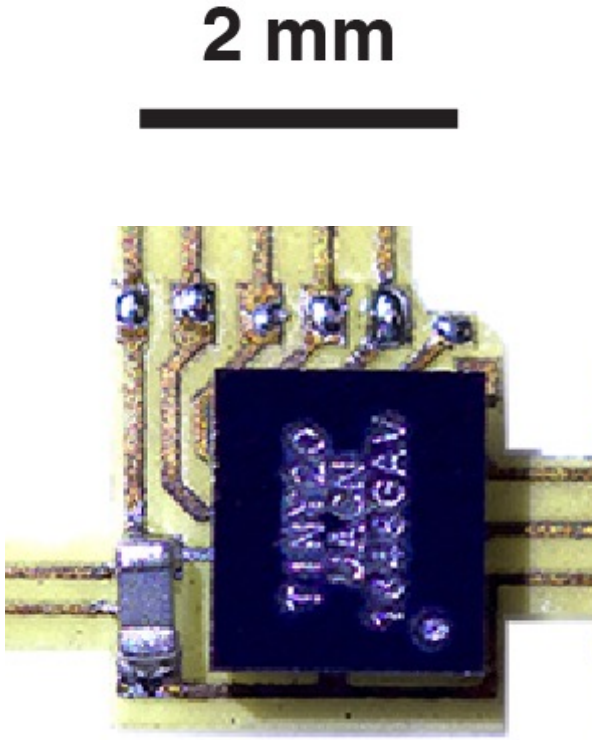

Microcontroller

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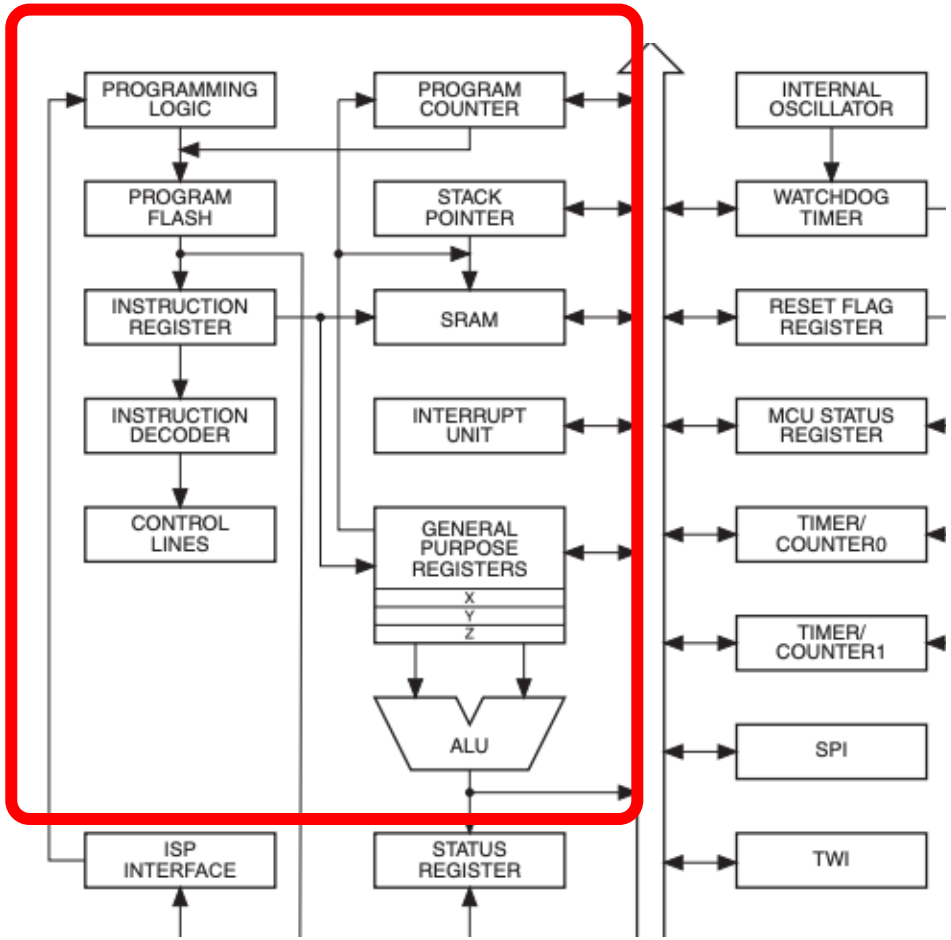
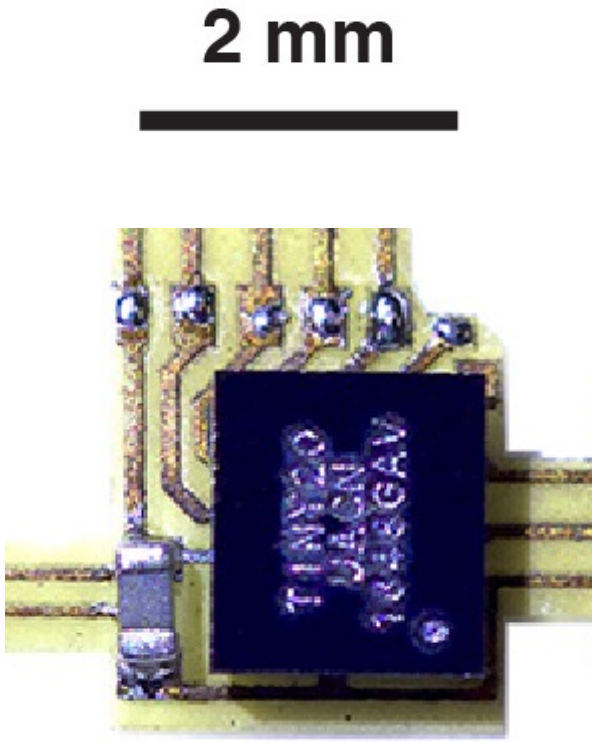
CPU





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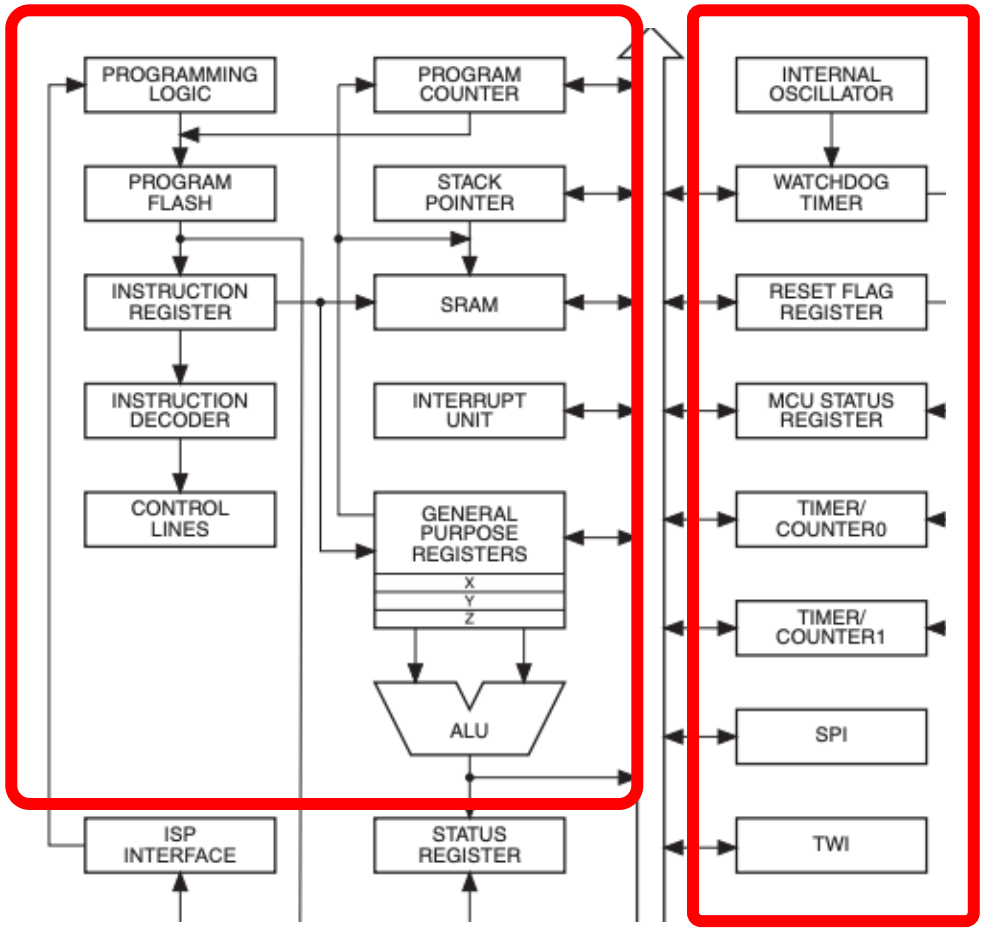
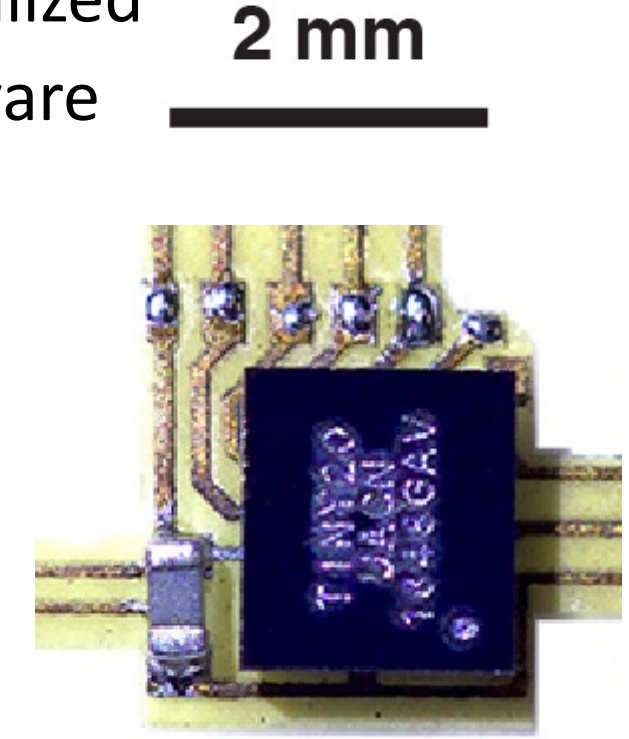


Specialized hardware blocks



Microcontroller

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CSE/ECE 474 Key Ideas:

- C programming intro for Java programmers
- Advanced C programming (void pointers etc.)
- Process Context, Multi-tasking, Basic schedulers
- Meeting real-time performance constraints, scheduling algorithms.
- Coordination of resources shared between multiple tasks.
- Interrupt service routines
- Bit-level I/O to hardware devices.
- Use of a minimalist real-time kernel.

Prerequisites

- You must have completed two quarters programming in Java or C

- Basic understanding of computer organization and architecture
- Helpful: Understanding and use of electronic laboratory instrumentation

Spring 2023

Home
Announcements
Assignments
Quizzes
Grades
Panopto Recordings
Zoom
People
UW Resources

CSE 474 A Sp 23: Introduction To Embedded Systems

Welcome to CSE/ECE 474!

The detailed weekly schedule and syllabus is HERE.

The primary usage of Canvas this quarter will be

- Central place with links
- Turning in assignments
- Posting of grades

Lecture time: 12:30-2:20, Wed & Fri in MOR 230

Lab room: EEB 345

Course Staff & Office hours(will be in EEB 345)

Vikram Iyer (instructor) : (TBD)

email: vsiyer@uw.edu

Kyle Johnson (TA) : Tues/Thurs 9-11am

Vicente Arroyos (TA) : Mon/Wed 9-11am

Joe Breda (TA) : Monday - Mon/Thurs 1:30-3:30

View Course Stream
View Course Calendar
View Course Notifications

To Do

C Programming 1
CSE 474 A Sp 23: Introduction To Embedded Systems
20 points |
Apr 12 at 11:59pm

Lab 1
CSE 474 A Sp 23: Introduction To Embedded Systems
70 points |
Apr 19 at 11:59pm

C Programming 2
CSE 474 A Sp 23: Introduction To Embedded Systems
20 points |
May 5 at 11:59pm

New Thread

CATEGORIES

- General
- Lectures
- Labs
- Assignments
- Social

0 others online

Search

Filter

This Week

Welcome to CSE/ECE474

General Vikram Iyer STAFF now

Welcome to CSE/ECE474 #1

Vikram Iyer STAFF

Now in General

PIN STAR WATCHING 1 VIEW

Hi everyone,

We're using Ed Discussion for class Q&A.

This is the best place to ask questions about the course, whether curricular or administrative. You will get faster answers here from staff and peers than through email.

Here are some tips:

- Search before you post
- Heart questions and answers you find useful
- Answer questions you feel confident answering
- Share interesting course related content with staff and peers

For more information on Ed Discussion, you can refer to the Quick Start Guide.

All the best this semester!

Vikram

Comment Edit Delete Endorse •••

Add comment

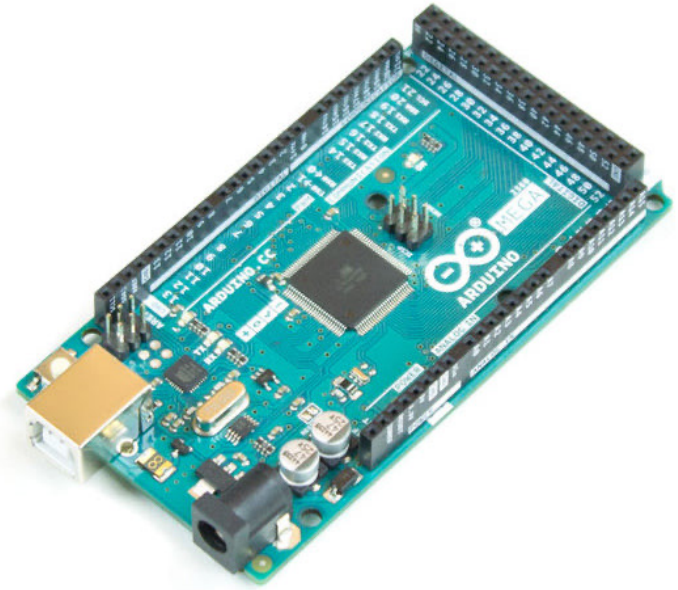
Weekly Schedule

Regular schedule	Lab/Office Hours Room: EEB 345					
	Mon	**Tue**	**Wed**	**Thu**	**Fri**	Lecture
9:00	Vicente OH	Kyle OH	Vicente OH	Kyle OH		VI OH
9:30	Vicente OH	Kyle OH	Vicente OH	Kyle OH		Kyle OH
10:00	Vicente OH	Kyle OH	Vicente OH	Kyle OH		Vicente OH
10:30	Vicente OH	Kyle OH	Vicente OH	Kyle OH		Joe OH
11:00						
11:30						
12:00						
12:30			Lecture		Lecture	
1:00			Lecture		Lecture	
1:30	Joe OH		Lecture	Joe OH	Lecture	
2:00	Joe OH			Joe OH	VI OH	
2:30	Joe OH			Joe OH	VI OH	
3:00	Joe OH			Joe OH		
3:30						
4:00						
4:30						
5:00						
5:30						

ECE/CSE 474 Syllabus- Spring 2023

				Homework		Lab					
Wk	W/F Dates		Theme	Assignment	Due Date	Assignment	Due Date (Report and Demo)	Topics/Lab	Quizzes & Exams	Past offering slides	Past Lecture Videos (Sp21)
1	3/29	O	474 Intro							Intro to 474 / Arduino Project Example	
	3/31	O	C Programming Intro					Arduino IDE Install/Setup		Cprog.s.pdf	C-programming intro (3/29/21) First half of lecture was not recorded
2	4/5	O	Pointers in C	C Programming Asgmt 1	4/12/2022			pointers, strings, malloc().		Pointers.s.pdf	Pointers (4/5/21)
	4/7	O	Number representation and Bitwise operators							interactive demos - no slides	Pointers, Strings, Chars in C. Intro to Arduino. (4/7/21)
3	4/12	O	Hardware & Machine Organization							Const_Def.s.pdf Hardware_IO.s.pdf	Bitwise Operations in C (missed first hour), Hardware I/IO, Open the Pod Bay Doors.
	4/14	O	Working with registers MPU5060 Demo			Lab 1	4/19/2022	Build your own mini lab bench.		Open the Pod Bay Doors	
4	4/19	O	ATMega 2650 Datasheet and 16 bit timer					Lab 1 Folder		Details of the 16-bit counter/timer	More bit manipulation and Intro to the ATMega2560 (4/15/21) 16 Bit Timer/Counter (4/21/21)

Labs



- Four lab exercises using the Arduino Mega Board (ATMEGA 2560ARM-based CPU).
- Lab kits will be signed out from ECE store.
- **Lab kits to be returned at the end of the quarter**
- Lab are in a two-person team.

Grading

- Each lab exercise will require a report to be turned in and also an in-person, in-lab demo with TA or instructor.
- Both team members must be able to answer questions about the entire lab project.

Lab kit pickup times

- MONDAY: 12:00 - 2:00
- TUESDAY: 11:30 - 5:30
- WEDNESDAY: 12:00 - 2:00
- THURSDAY: 10:00 - 2:00
- FRIDAY: 10:00 - 12:00

Lab location: EEB 345

Labs build on each other

- All ECE474 labs build on each other to create a software prototype.
- We will implement more and more tasks, building the complexity and efficiency of the real-time code.
- Lab 1 Getting Started with the Arduino Mega
- Lab 2 Digital I/O and timing of outputs
- Lab 3 Round Robin Scheduling and multitasking
- Lab 4 FreeRTOS and Project

Advice: When you get stuck, try hard to fix the problem, but then come to us. We will get you going again even if we don’t know all answers right away.

Labs Teams

- 2-person Lab team
- Team work is critical to success. “Friction,” “tension,” “miscommunication,” happen to some groups. (5% — 10% of teams).
- When these occur, take individual initiative to come to TA or Prof. immediately.
- Example problems:
  - Partner not showing up for meetings
  - One person is doing all the work

- You are responsible for bringing these problems to attention of TAs or Prof.

Labs Grading

- In-person sessions in which you demonstrate correct operation of your system and answer questions from a member of the staff

- Both team members must be present for the demo
  - Both team members must be able to answer a question about any part the project.

  - We will expect in-depth answers from the person who coded/debugged specific parts, and specific though less detailed answers from the other team member.

Lab Reports

- You must follow the Detailed Report Format for Spring 2023.
- Reports must be turned in (PDF only) according to the Canvas due date. Late work will be subject to a penalty of 25% per day.
- Assignment-specific requirements for the reports may be given in the Lab Assignment.

Grading system

- “Flat” point system.
- 400 total points
- Grade will be obtained by dividing your total by 100
- Final adjustment at the end

		Points
C prog 1		20
C prog 2		20
Lab 0 Scope Demo		0
Quiz		15
Lab 1		70
Lab 2		70
Lab 3		70
Lab 4 / Project		90
Midterm		45
No Final		
	TOTAL	400

Grade Multiplier		**0.01**

Example:	Student Total	400	
	times 0.01	4	
	class adjustment*	-0.1	(all students get the same adjustment)
	Final Grade	3.900	
	Offical Grade	3.9	(with rounding)

* a uniform adjustment will be applied to all students so that the class mean grade correctly reflects overall learning effort and performance, extenuating circumstances, etc.

In cell C24 above, -0.1 is an example only. It can be positive or negative.

Grading system

- Team members receive same Lab grade
- Each lab's grade is computed based on Demo and Report.
- In exceptional cases a student's lab grade may be adjusted up or down relative to their teammates.
- Individual final grades still vary because of performance on individual performance on C-coding assignments, quizzes, and exams

Academic Integrity and Cheating

We expect students to follow the relevant UW policies on Cheating (working collaboratively on quizzes/exams and homework submissions, sharing answers and previewing quizzes/exams).

Plagiarism (representing the work of others as your own without giving appropriate credit to the original author(s))

Other Important Policies and Inclusion

- Our goal is to create a comfortable, welcoming and safe environment for all enrolled students

- Disability and religious accommodations
  - Have already gotten notifications from DRS
  - Reach out early (first two weeks)

- Illness (COVID, etc)
  - For things affecting the whole class we'll announce updated policies (e.g. zoom lectures, remote lab check offs, etc)
  - If you get sick, have to quarantine, etc let us know (sooner the better)

Examples of embedded systems

Example: Wireless headphones

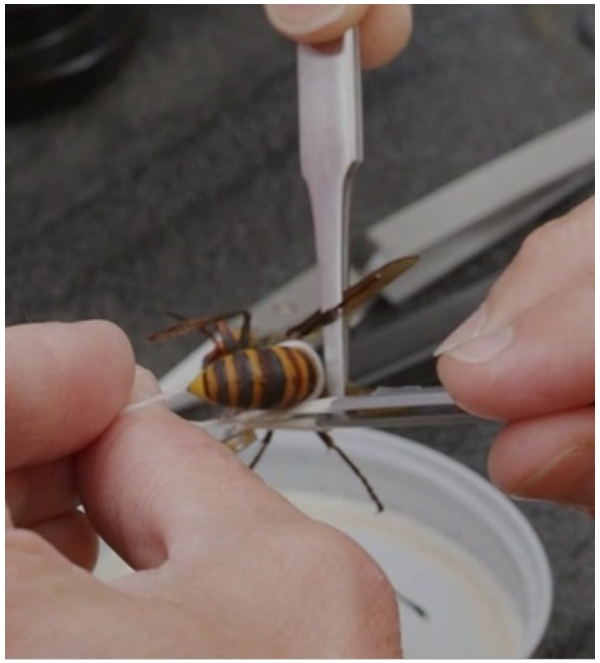
Example: Wireless headphones

Embedded systems research

Bumblebees + wireless temperature

Beetle + wireless steerable camera

Tracking murder hornets with Dept of Agriculture

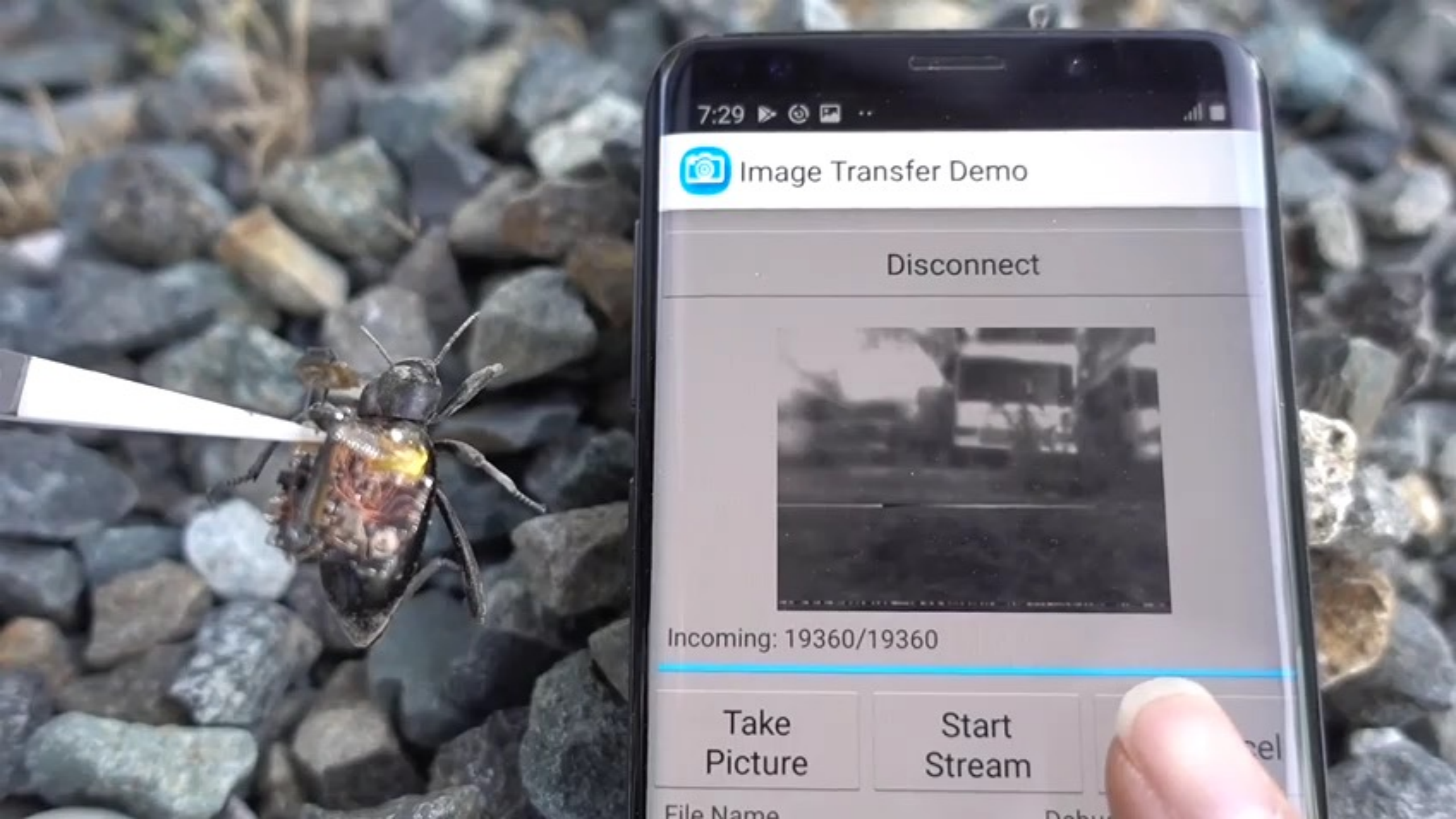


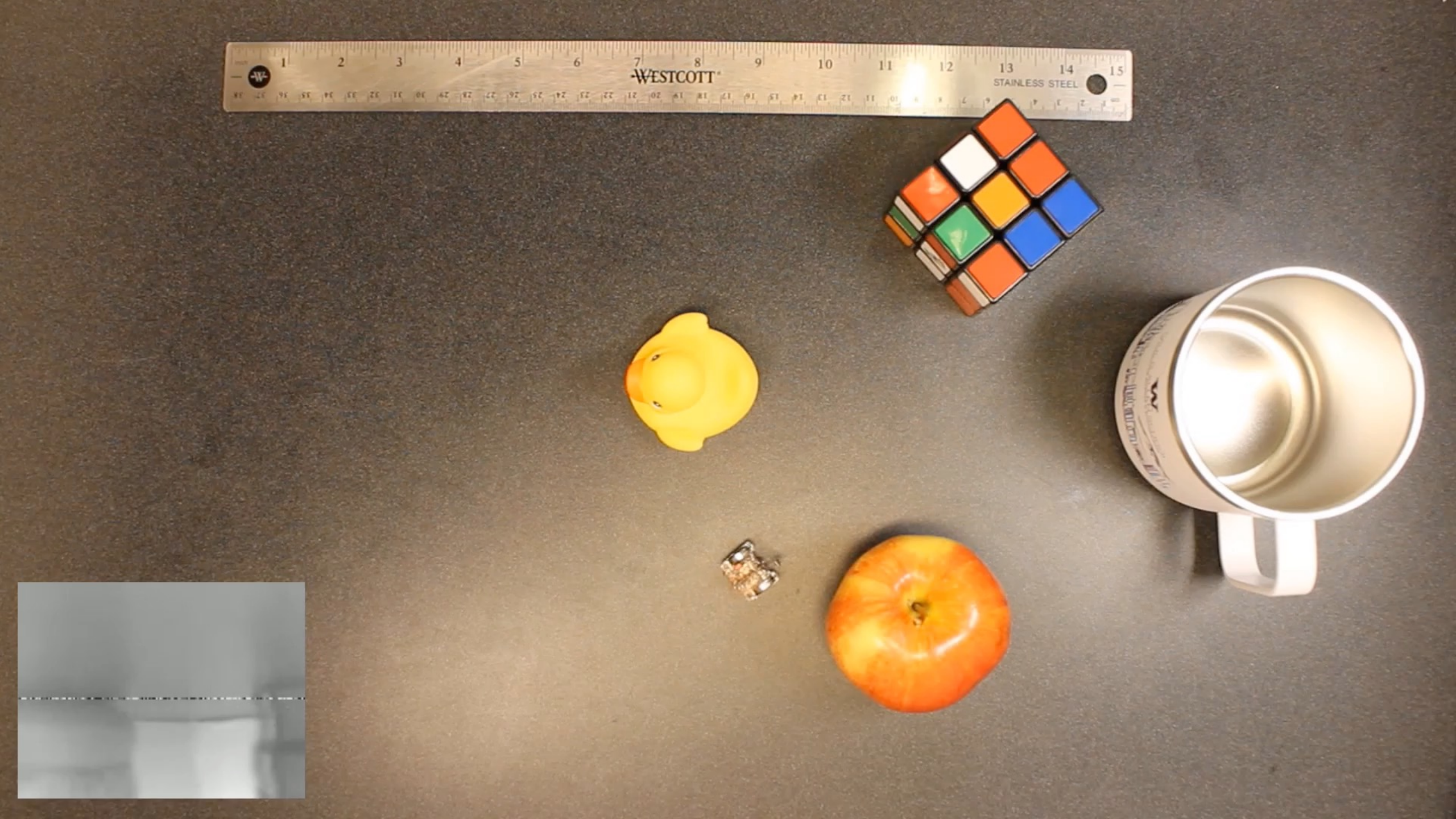
Useful for understanding wildlife behavior of insects and small animals in the wild

Live bumblebee carrying our sensors and electronics

Tagging “Murder” Hornets with WA DoA

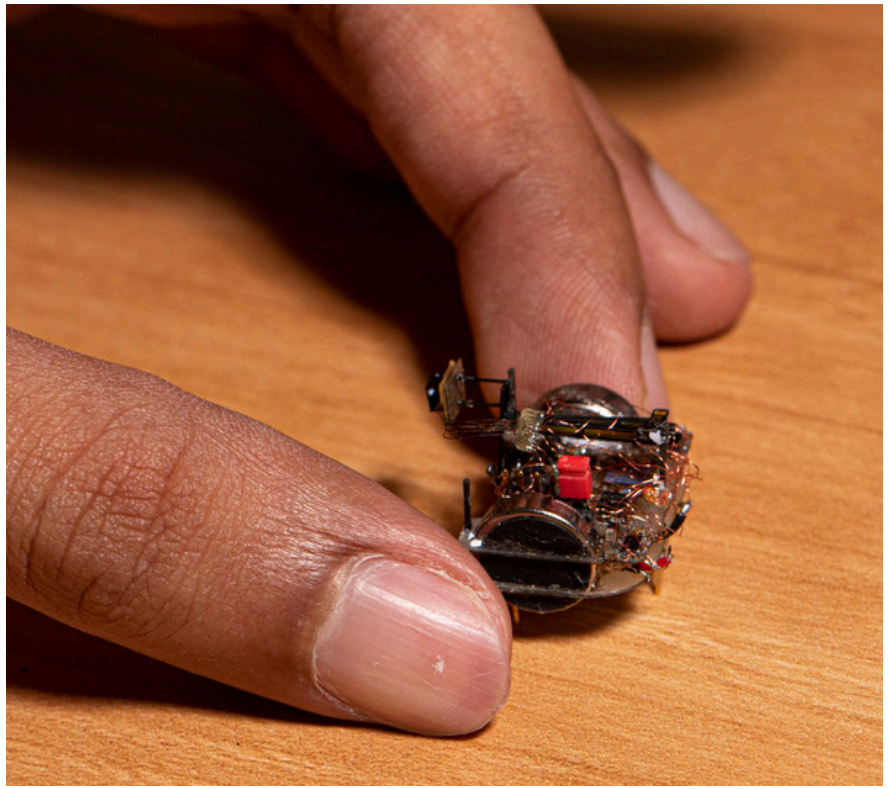
Video credit: WSDA/Karla Salp

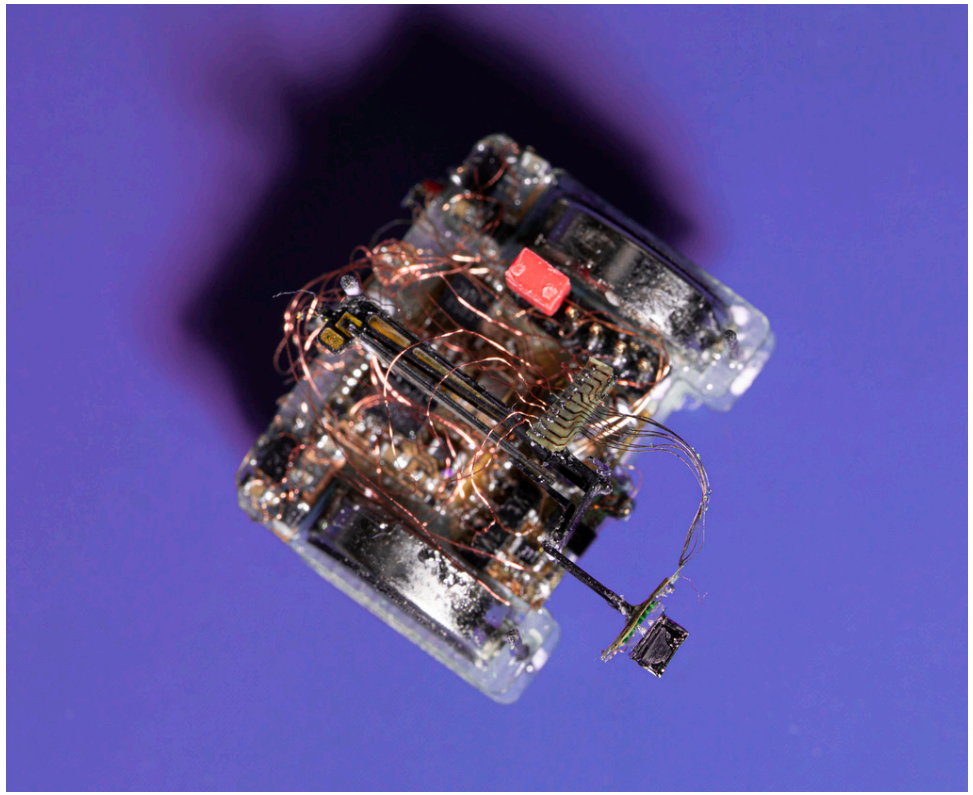

7:29
Image Transfer Demo
Disconnect
Incoming: 19360/19360
Take Picture
Start Stream


WESTCOTT
STAINLESS STEEL

Creating insect-scale wireless robots

Power autonomous, wirelessly controlled robot with a steerable camera

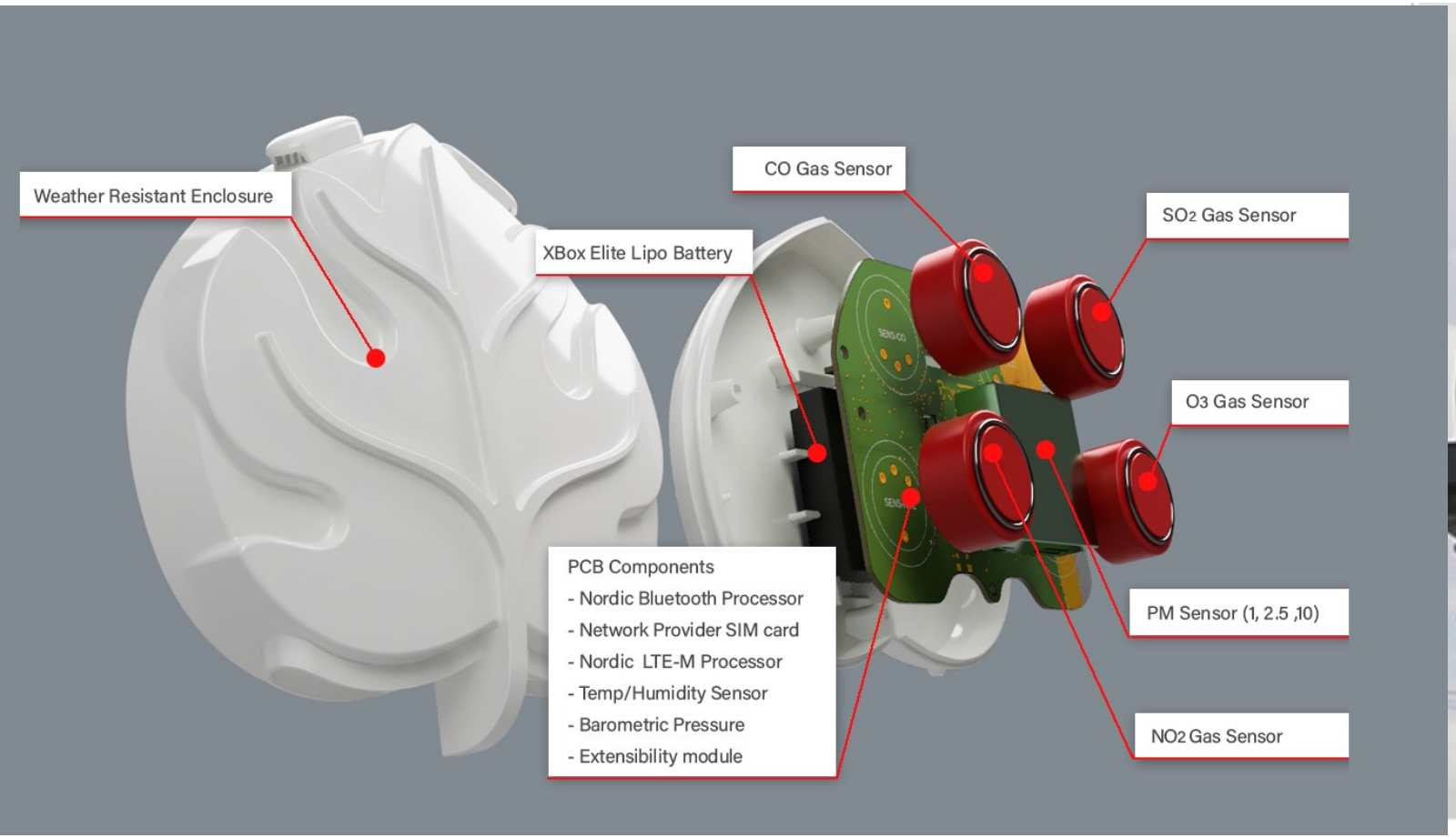




Useful for exploring confined spaces like pipes or under industrial equipment

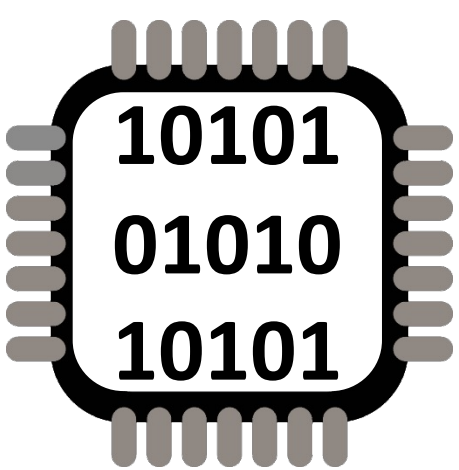
Microsoft Research: Project Eclipse

Low cost, cloud connected air quality sensors



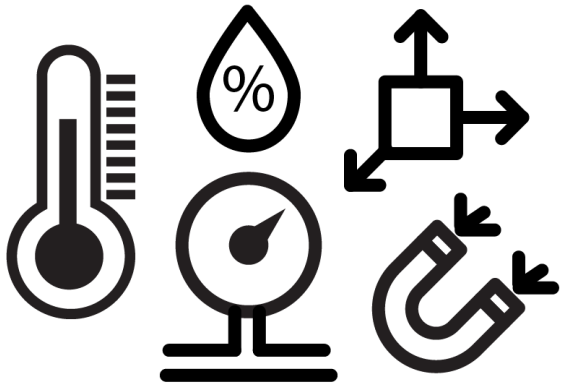
More info: urban.microsoft.com

What are the major parts of these systems?



Computing

+



Sensors and actuators

+

Wireless Link

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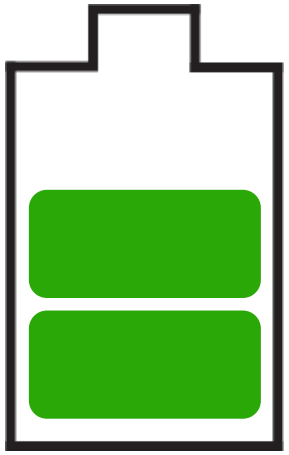
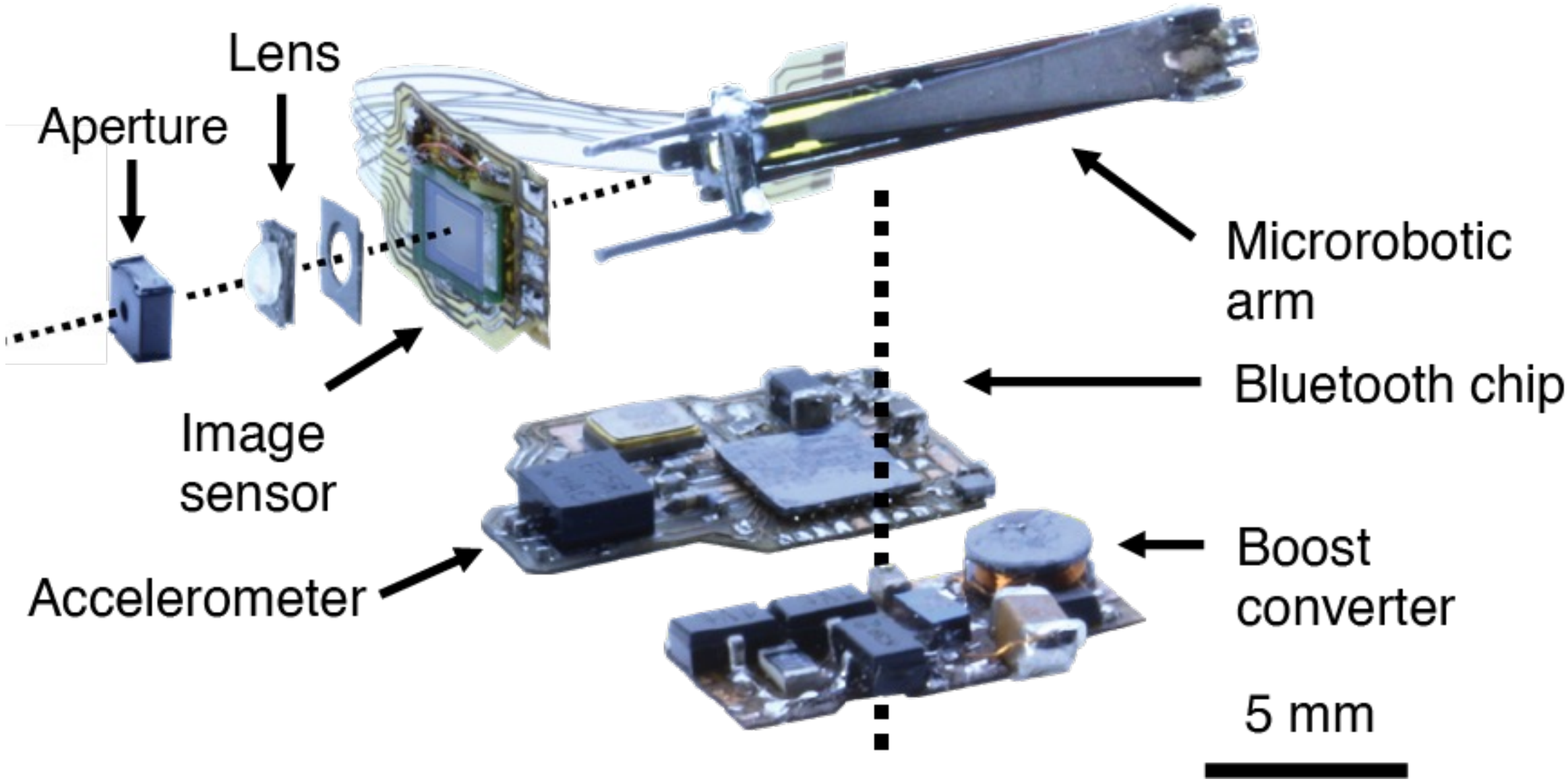
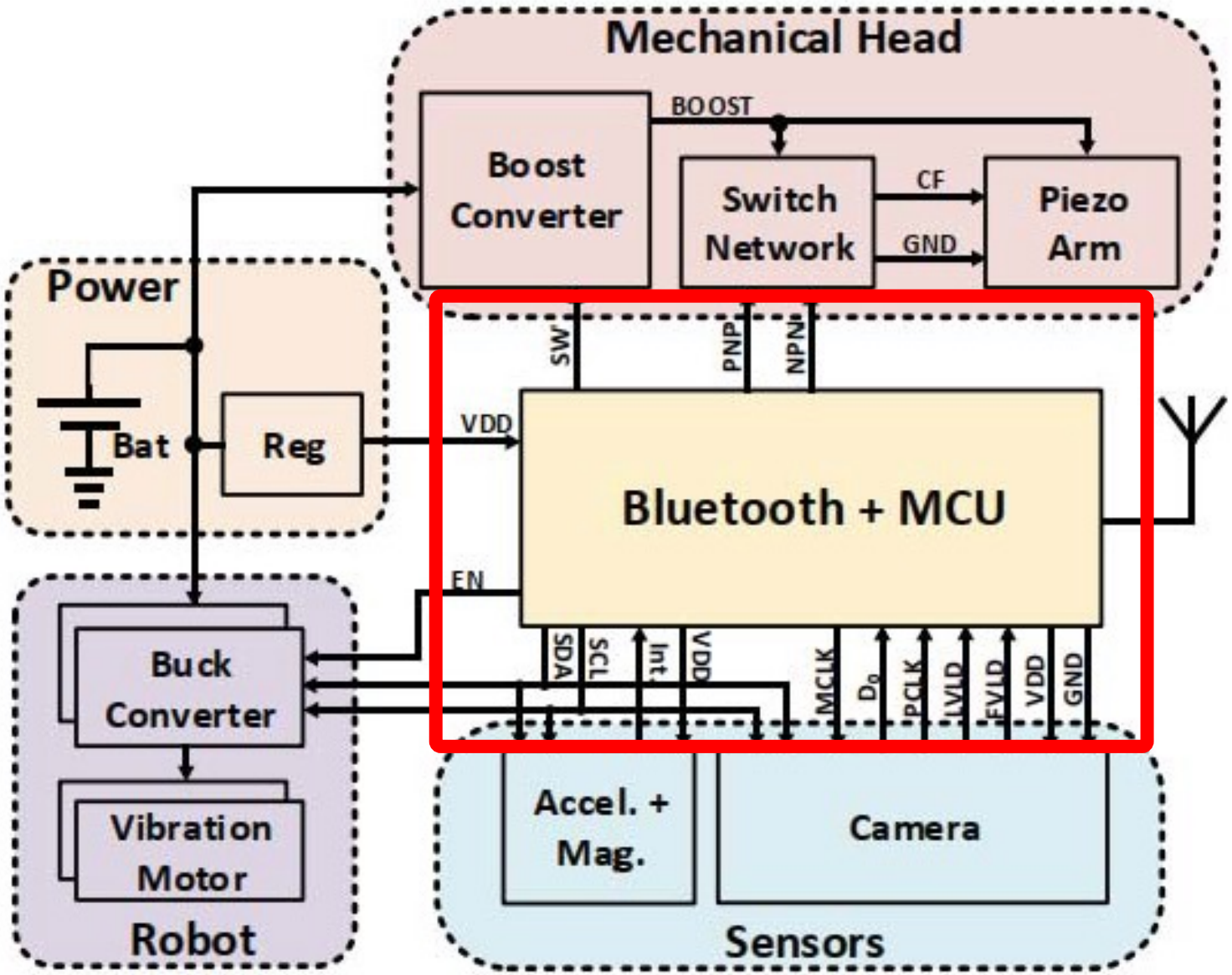
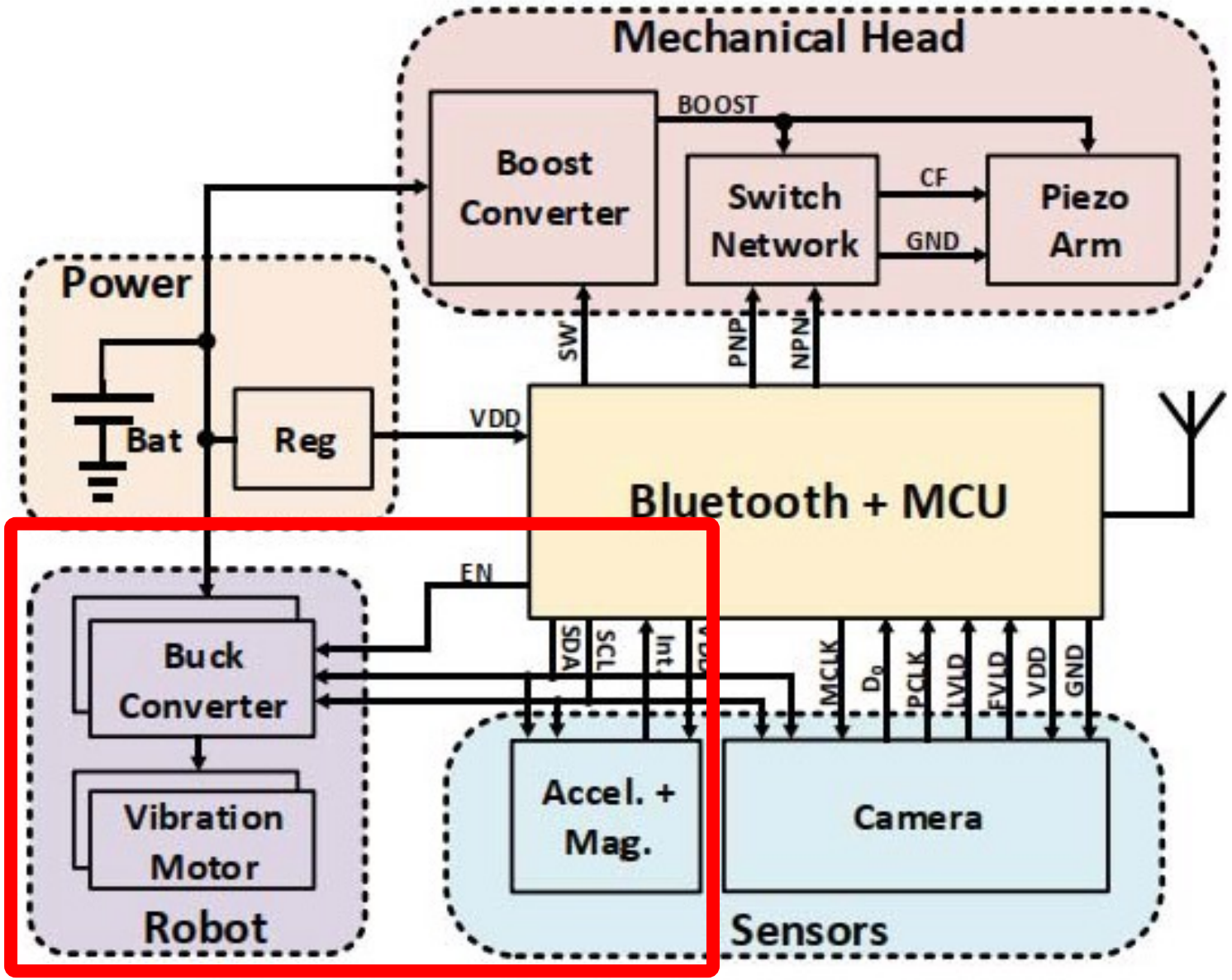


Power Source


Lens
Aperture
Image sensor
Accelerometer
Microrobotic arm
Bluetooth chip
Boost converter
5 mm


Mechanical Head
Boost Converter
BOOST
Switch Network
CF
GND
Piezo Arm
Power
Bat
Reg
SW
PNP
NPN
VDD
Bluetooth + MCU
EN
SDA
SCL
Int
VDD
MCLK
D0
PCLK
LVLD
FVLD
VDD
GND
Buck Converter
Vibration Motor
Robot
Accel. + Mag.
Camera
Sensors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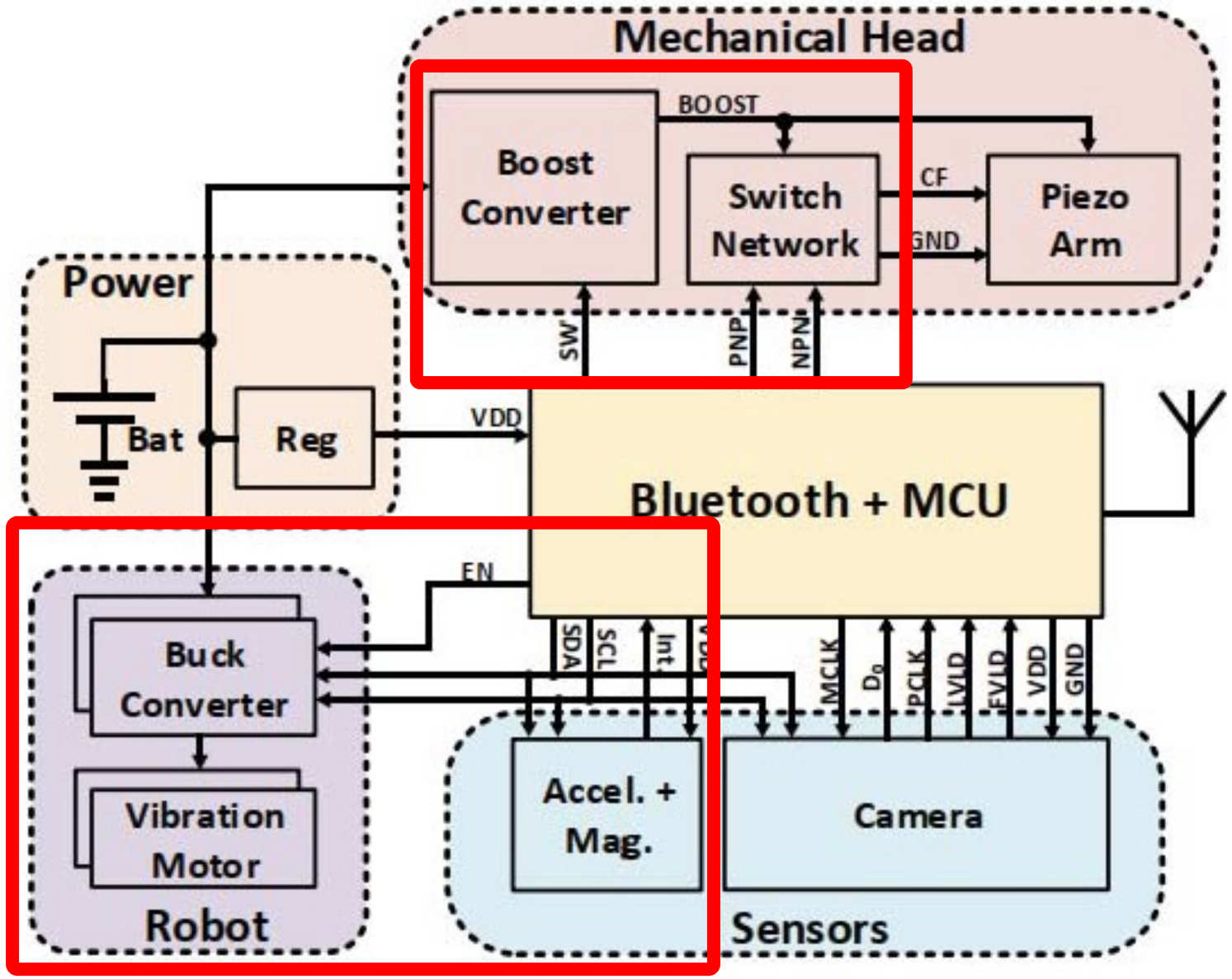
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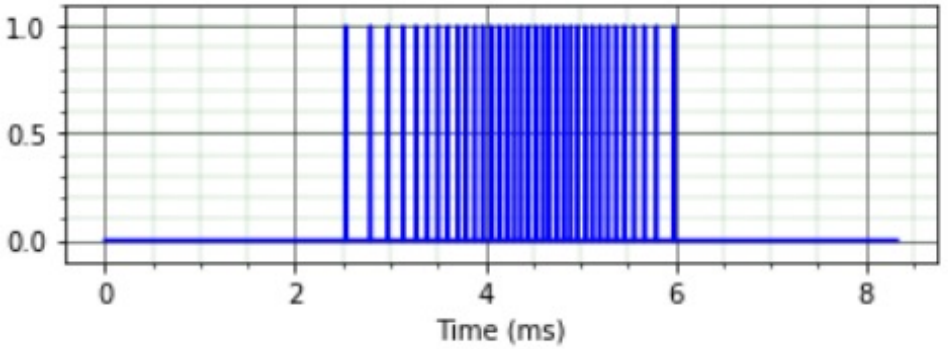
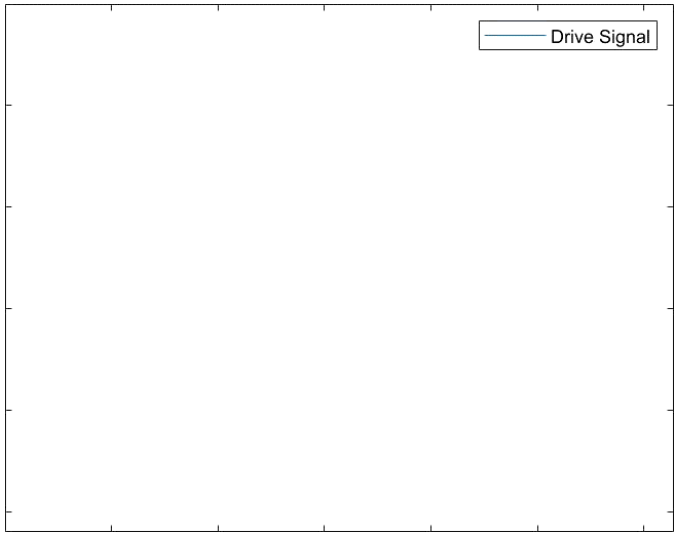

1.0
0.5
0.0
0
2
4
6
8
Time (ms)


Drive Signal