ENGI 128

INTRODUCTION TO ENGINEERING SYSTEMS

Lecture 9:
Digital Signals, Computer Systems, Programming Languages, and Python (And Robots!)

"Understand Your Technical World"

The secret world of

Digital Signals

Remember this lab?

2.2 Battery and System Voltage

Use the multimeter to see the change in voltage on the main power supply when the robot is powered on. Look on the lower right of the robot and find a via near the label for resistor 42 ("R42". The actual resistor is a small black ship with the number '0' written on it). Turn the robot off, place the red probe on the via, and record the multimeter reading:

Battery voltage **TP3** (off) = _____

System voltage **TP2** (off) = _____

Turn on the robot and take another multimeter reading. What voltage does it read now?

Battery voltage **TP3** (on) = _____

System voltage **TP2** (on) = _____

Does this reading make sense?

2.3 Switches

Setup the GUI and connect your robot. Verify that you can control motors and read light sensors. Near each of the four buttons is a resistor. Put the red probe on **TP5**, which is the signal for the red button. Record the voltage when you push the button and when you are not pushing the button:

Button voltage **TP5** (released) = _____

Button voltage **TP5** (pressed) = _____

Why do you think you get these particular voltages? Can you get any other voltages?

2.4 Light Sensor

The robot has three light sensors. We will measure the front right sensor. Near the FR light sensor, put your probe on **TP12**. Record the voltage reading from this sensor and the reading from the GUI with the robot just sitting on the desk. Record these same two measurements with the sensor covered, and then with a flashlight pointed at it.

Light sensor voltage **TP12**, GUI value (initial) = _____ , _____

Light sensor voltage **TP12**, GUI value (covered) = _____ , _____

Light sensor voltage **TP12**, GUI value (flashlight) = _____ , _____

How does this data differ from the readings of the button? Can you get any voltage you want by moving the flashlight and covering the sensor?

eading from the two pulse width modulation (PWM) channels for the right
o set the PWM for the right motor to the specified values:

P14, **TP15** (PWM setting = 0) = _____ , _____

P14, **TP15** (PWM = 50%) = _____ , _____

P14, **TP15** (PWM = 75%) = _____ , _____

TP14, **TP15** (PWM = 100%) = _____ , _____

TP14, **TP15** (PWM = -50%) = _____ , _____

B channels different? What is the range of the measured voltage? How does
ge compare to the PWM value and the system voltage?

reading from the right encoder channels. Use the GUI to set the PWM for the
pecified values:

B **TP16**, **TP17** (PWM = 0) = _____ , _____

B **TP16**, **TP17** (PWM = 50%) = _____ , _____

B **TP16**, **TP17** (PWM = 75%) = _____ , _____

B **TP16**, **TP17** (PWM = 100%) = _____ , _____

, B **TP16**, **TP17** (PWM = -75%) = _____ , _____

d B channels different? What is the range of the measured voltage? How does
ge compare to the PWM value and the system voltage? Do these measurements
, what were you expecting?

[Oscilloscope Demo]

Voltage Signals

Analog

Digital

The Bit

Frequency

PWM

DAC

ADC

omg

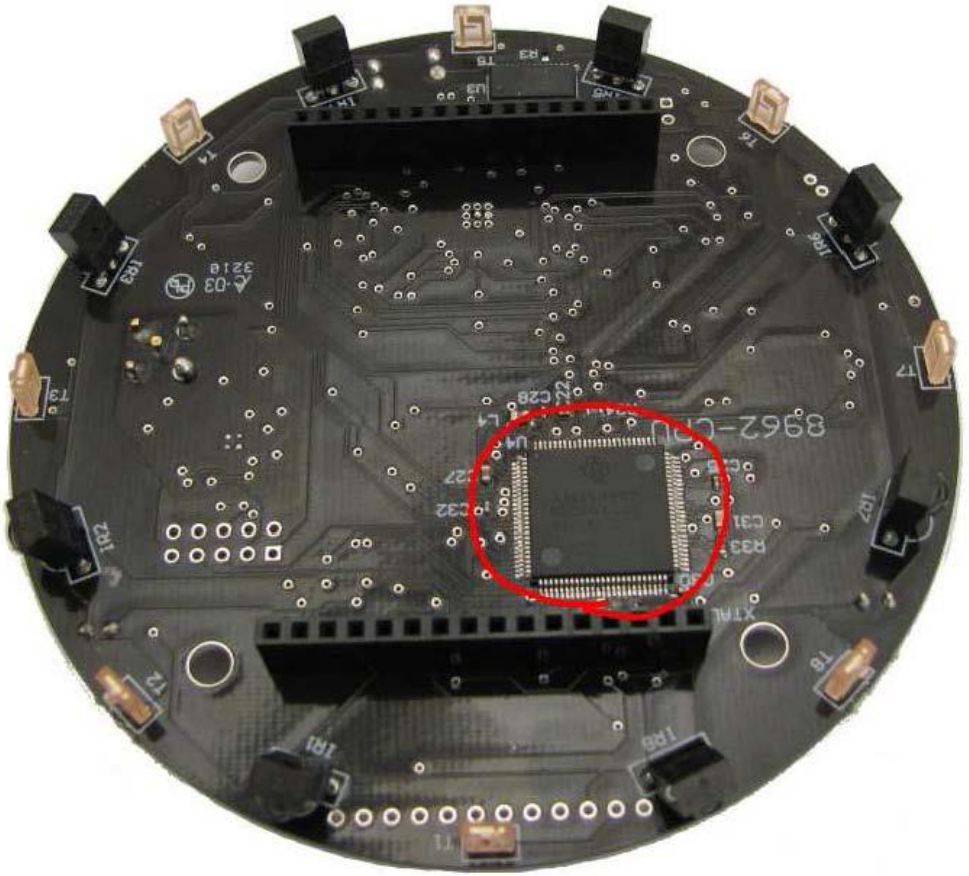
Computer Systems

What is a computer?

The r-one has a computer…

It is a Texas Instruments LM3S8962 Microcontroller

- It gets warm (you can feel for it)



- Wait a minute, what's a "microcontroller"

CPU vs. Microcontroller

A microcontroller is integrated:

- Memory
- Lots and lots of *Input/Output* (I/O)
- Pictures approximately to scale

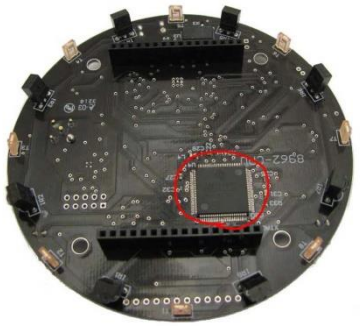
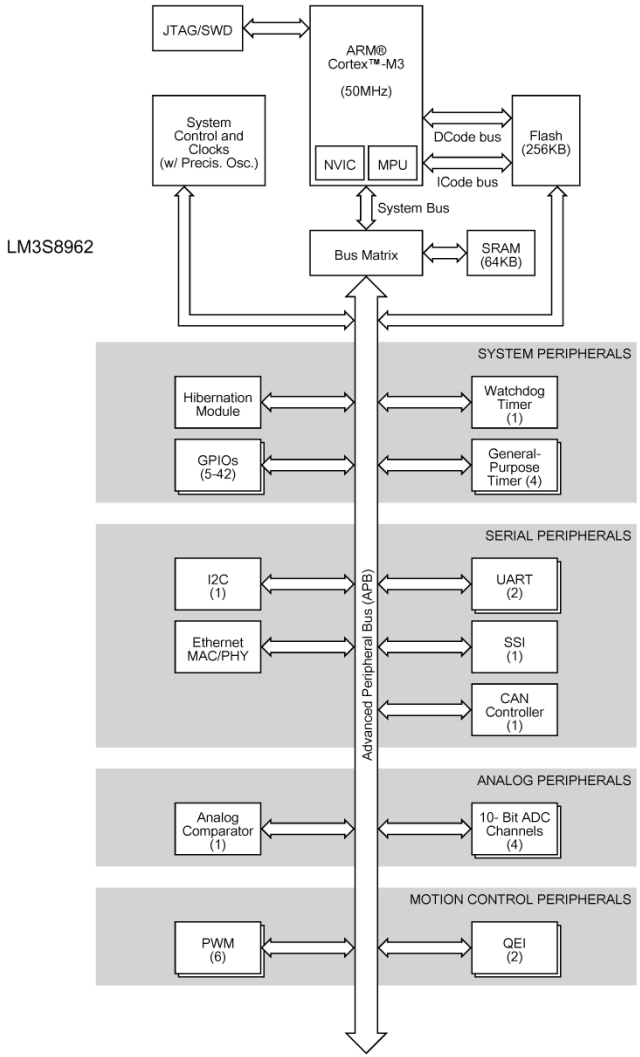
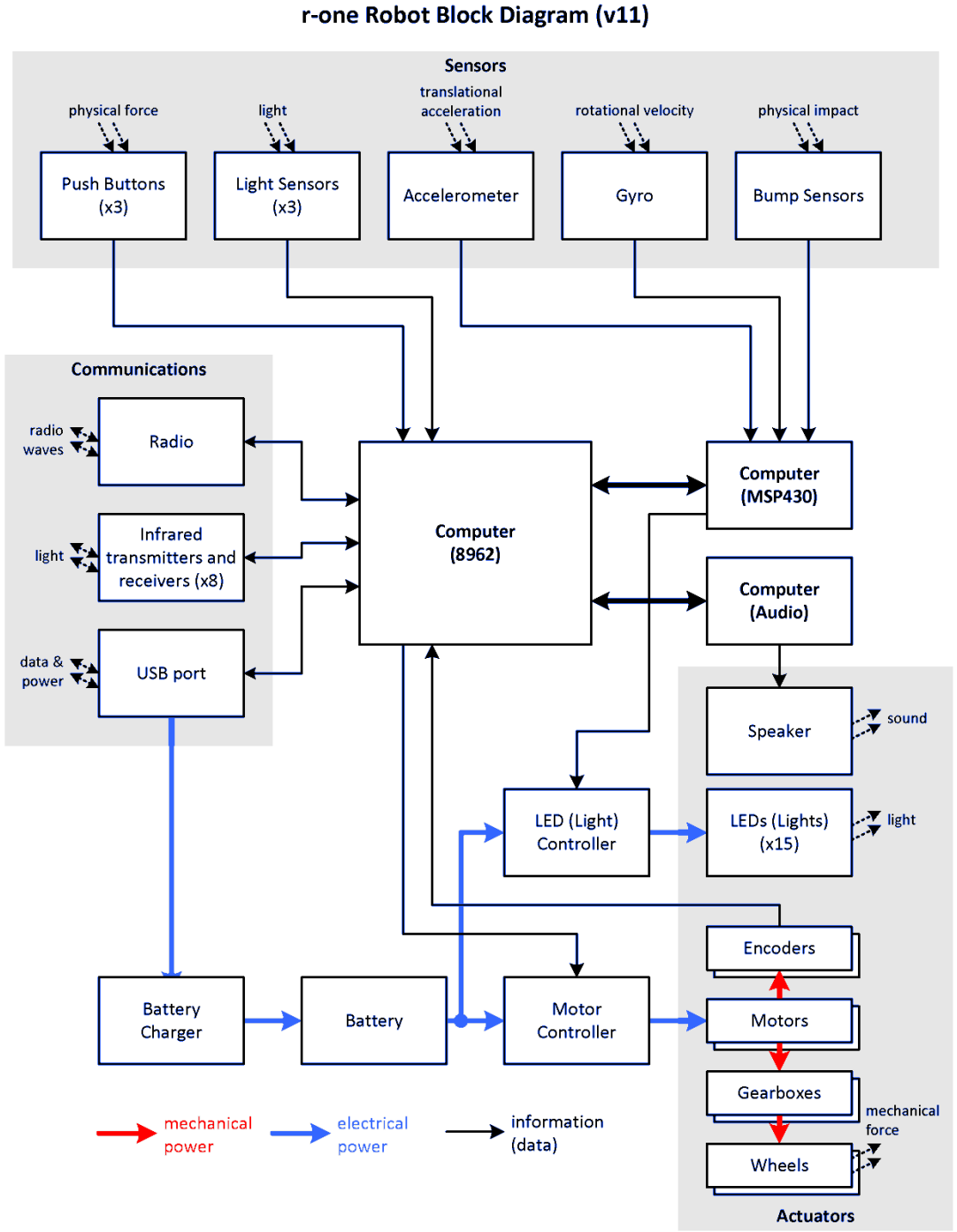


Figure 1-1. Stellaris LM3S8962 Microcontroller High-Level Block Diagram



r-one Architecture



All Computers have three main things

CPU

- Add, multiply, do logical operations
- Read and write *memory*
- That's about it

Memory

- A list of numbers
- Each number has an *address*
- Your robot can remember 65,536 numbers

Input/Output (I/O)

- Connection to the outside world
- Sensors, actuators, USB…

1015	D
1016	T
1017	H
1018	I
1019	S
1020	I
1021	S
1022	E
1023	N
1024	G
1025	I
1026	1
1027	2
1028	8
1029	M
1030	Y
1031	F
1032	A
1033	V
1034	C

Programming Languages

Programming Languages

What are some popular programming languages?

[whiteboard rush]

Why are there so many?

We will use Python for ENGI 128

Why?

- It’s easy to learn
- The robots run it
- It’s fun

The Robot’s Computer runs Python?

No, the Robot doesn't run Python all by itself

Machine code

- Lowest-level language
+ It's all computers can actually run
- Just 1's and 0's: Too tedious for humans to write

Assembly language

- Low-level language
+ Just like machine code, except with letters
- Not fun to write, but possible

C/C++

+ Medium-level languages, very popular
  (90% of your robot's code is in C)
- The programmer has to keep track of every byte of memory

Java

+ High-level language
+ Interpreted, garbage collected
- Complex syntax

Python

+ High-level language
+ Interpreted , garbage collected
+ Simple syntax

The r-one Robot!

Care and feeding of your r-one robot

Floor

- Floor is good. Robot not fall on floor if already on floor.

Desk

- Desk is high. Robot want floor!

Block

- Block is good. When robot on block on desk, no want floor.

Cable

- Cable is good. Connect robot to laptop.
- Cable let student pull robot to floor. Robot want floor!

Water

- Water is bad. Robot not thirsty.

Python I

[switch to IDLE]

The Partnering