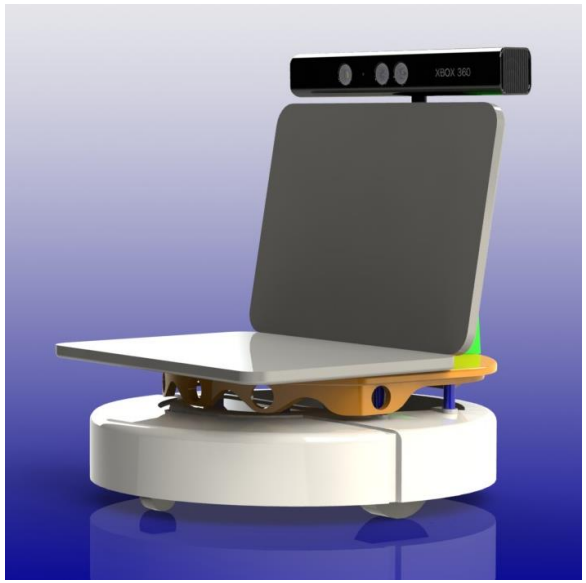
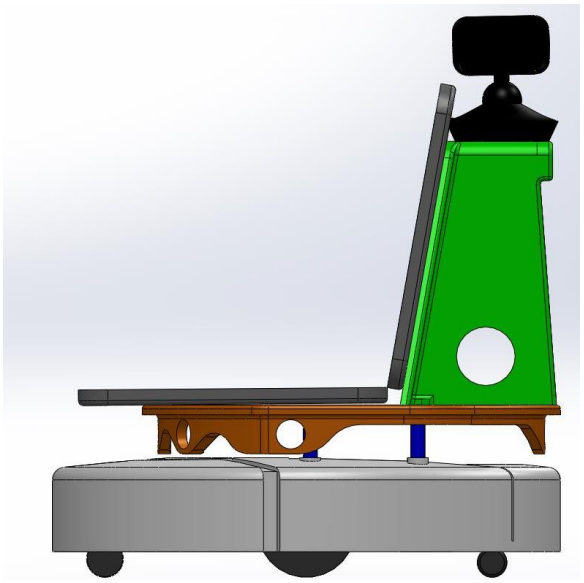
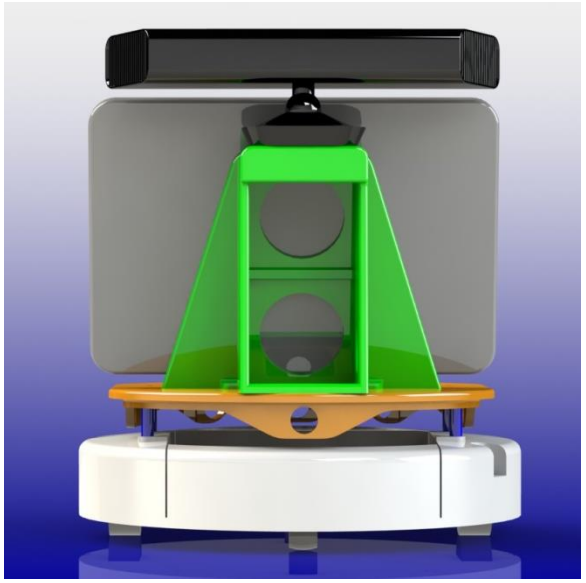
MAE 493G, CpE 493M, Mobile Robotics

2. Mobile Robot Design



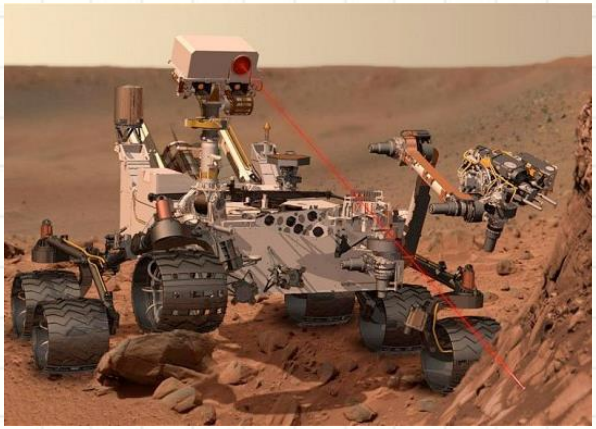




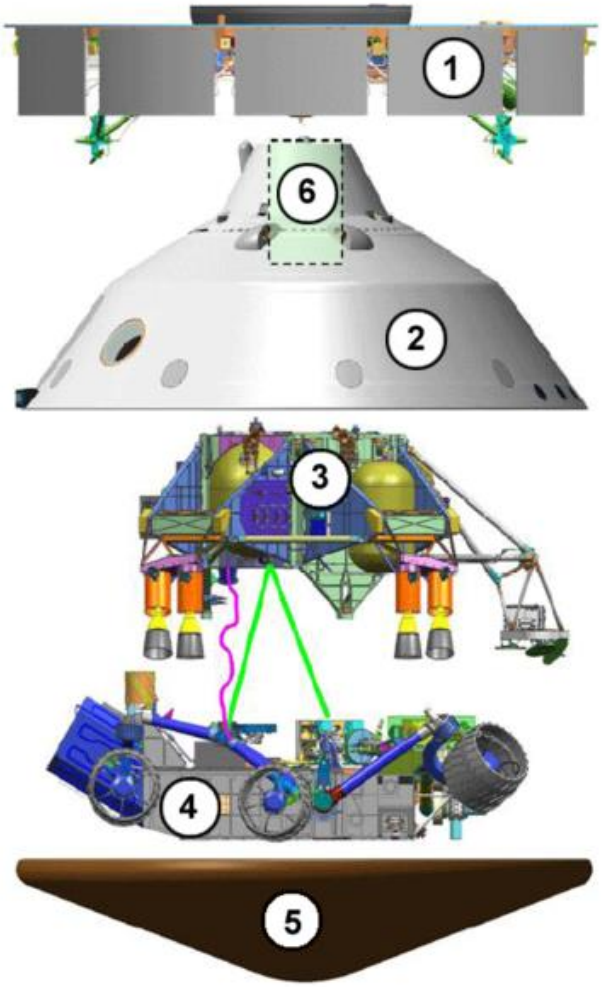
Three Different Mobile Robots

The design of a robot is greatly determined by its intended function:

- NASA Mars Rover Curiosity: finding evidence of a past environment well suited to supporting microbial life;
- iRobot Roomba: clean the floor (while keeping at a low cost);
- WVU Phastball: perform various aviation safety research.

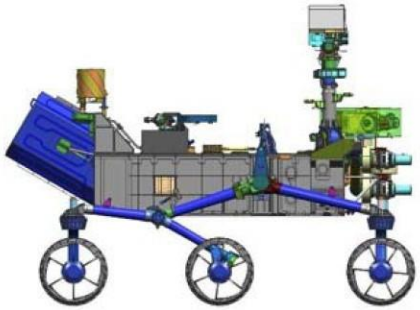


Mars Science Laboratory



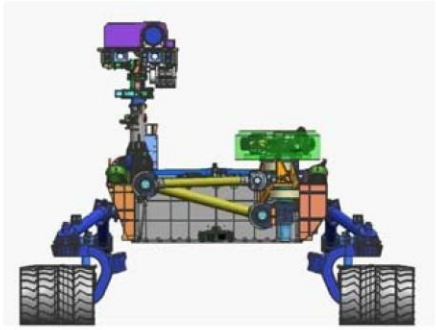
1- Cruise stage;
2- Backshell;
3- Descent stage;
4- Curiosity rover;
5- Heat shield;
6- Parachute

The Curiosity Rover



JPL 2009 MSL Rover

2005 MINI Cooper S

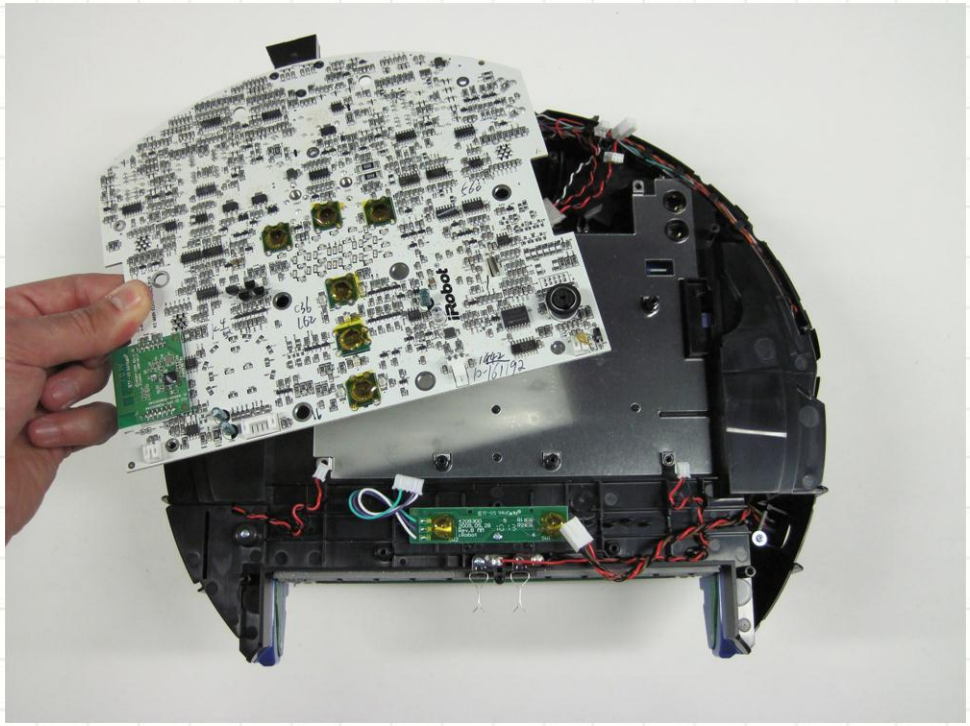


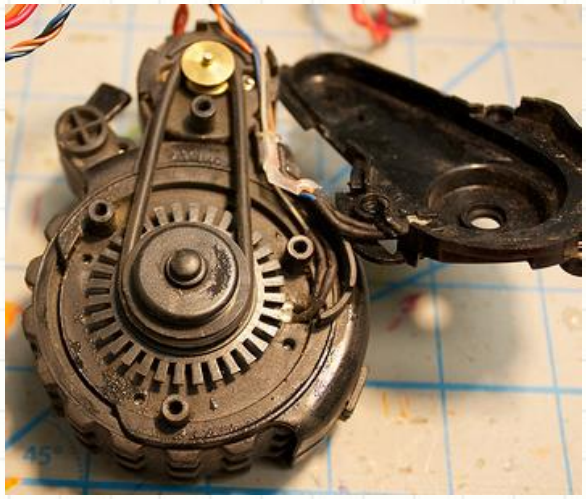
Mass: 899kg
Dimension: 2.9×2.7×2.2m
Power: 125W nuclear battery

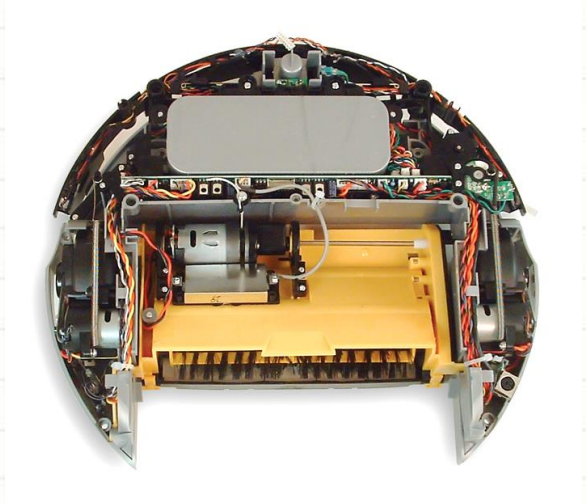
Images Taken From Here

More information from the JPL website

Inside Roomba



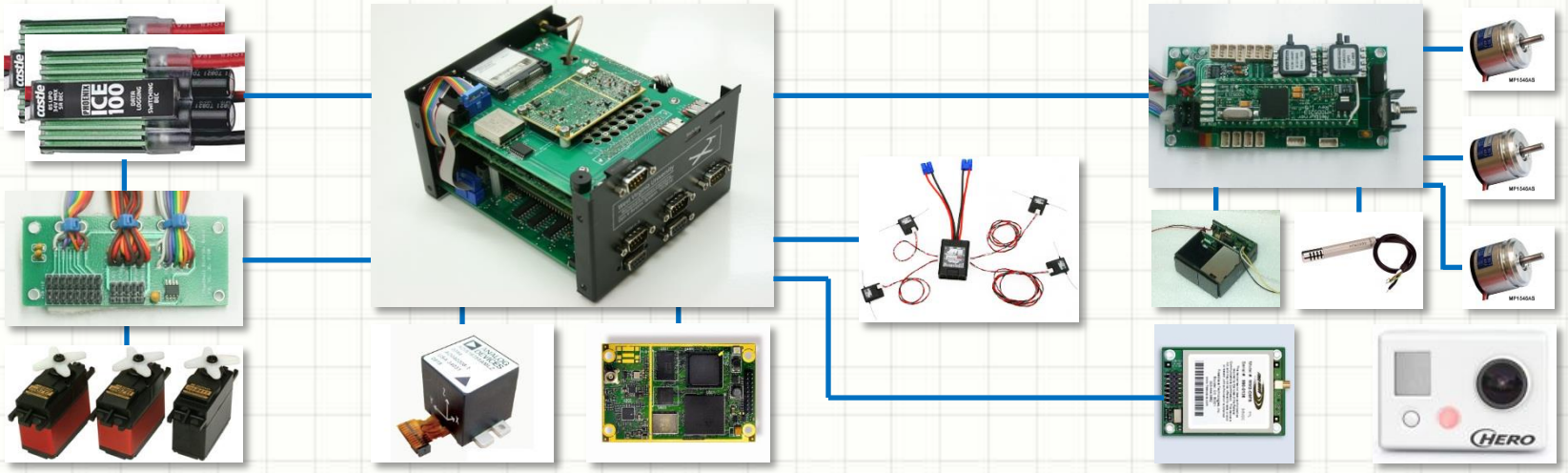




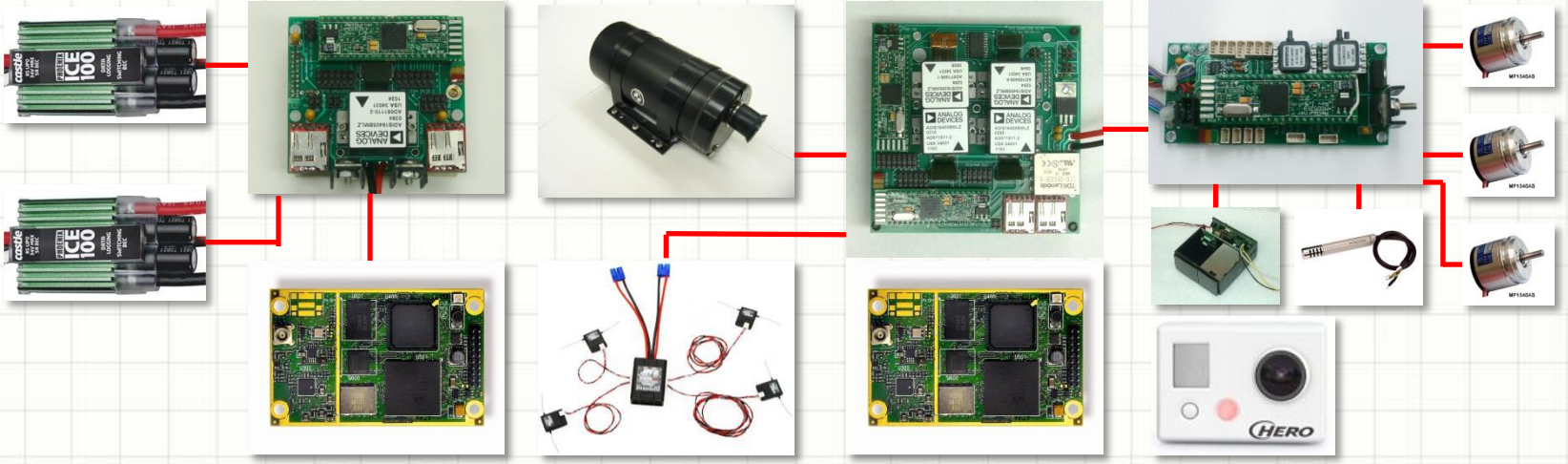
Roomba Actuators and Sensors

How Roomba Work

Phastball - Flight Control

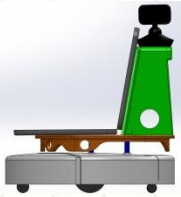


Phastball - Sensor Fusion



SMART

- SMART stands for Shared Mobile Autonomous Robot for Teaching.
- SMART was designed specifically for this class;
- SMART is also a open-source platform with all design information and software to be shared on the Internet.



Design Requirements

An ideal teaching robot should meet the following criteria:

- Have a simple, low-cost, and rugged design yet sophisticated enough to accommodate for state-of-the-art algorithms;
- Easy to understand and program by entry-level students;
- Allow reconfiguration and expansion with modular components;
- Well supported by the community.

You Don't Want This!

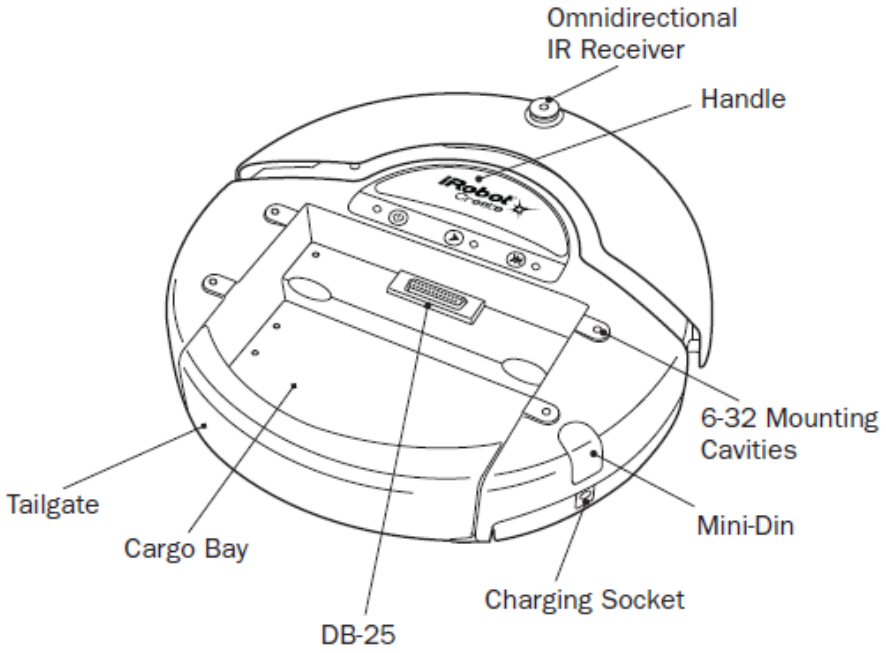
Lego

TurtleBot

SMART

iRobot Create

An iRobot Create is a Roomba without the Vacuum Cleaner.



Create Open Interface

Available Online Resources

Matlab Toolbox for the iRobot Create (MTIC)

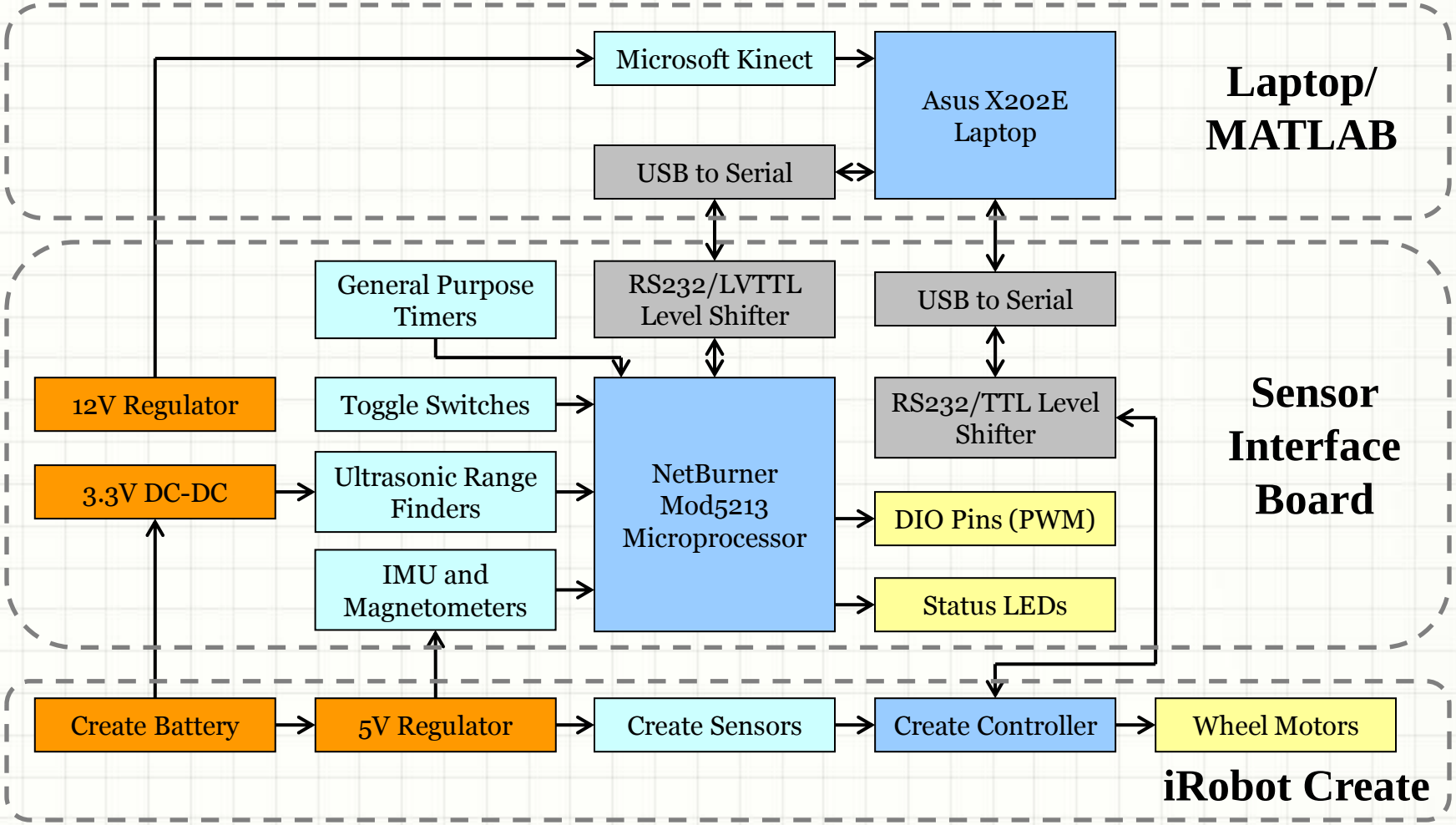
Matlab iRobot Create Simulator

MATLAB Robotics Toolbox

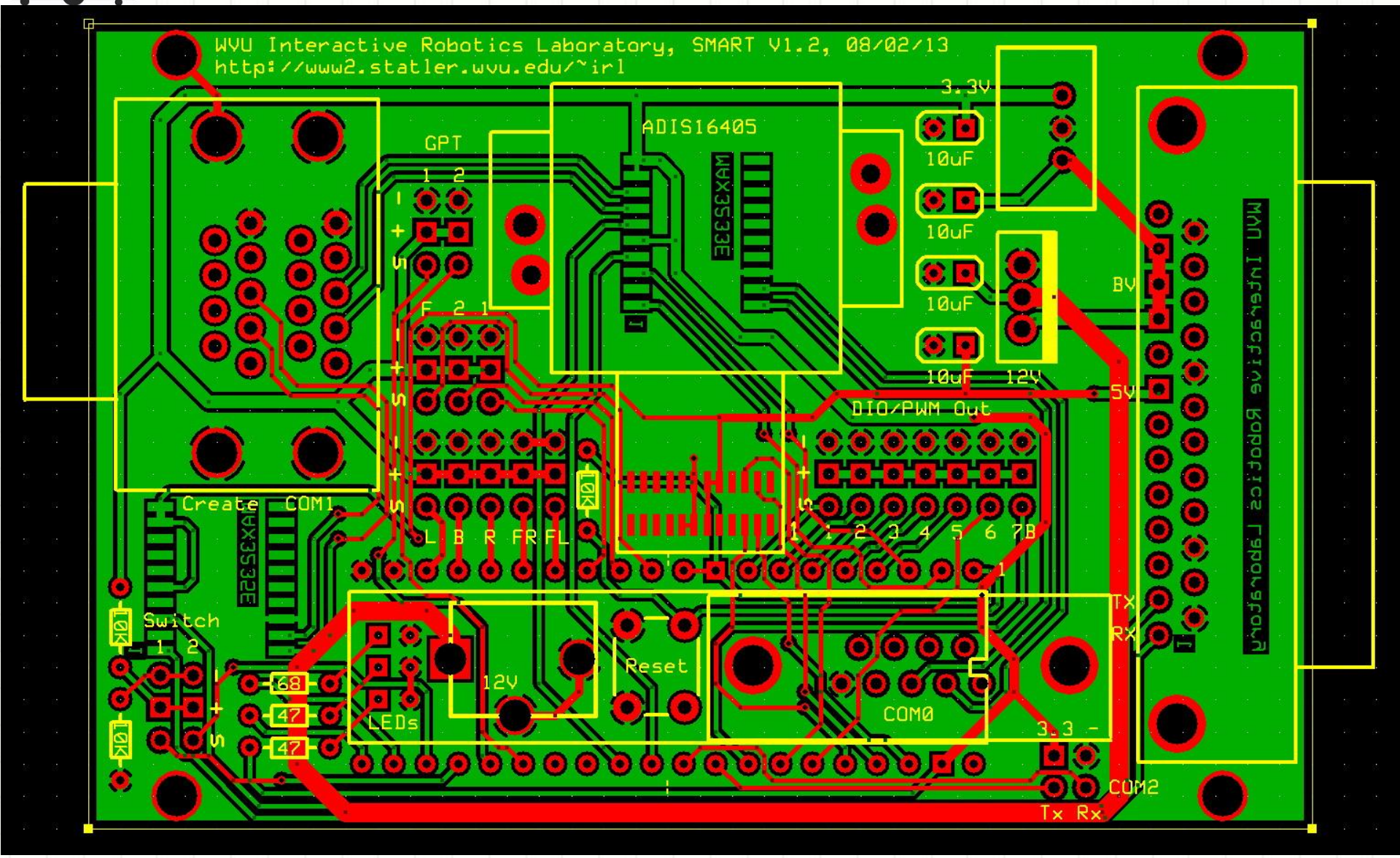
Machine Vision Toolbox

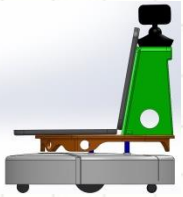
A lot more! You just have to find them!

SMART System Architecture



SMART PCB Design





Sensor Interface Board (Front)

IMU and Magnetometer

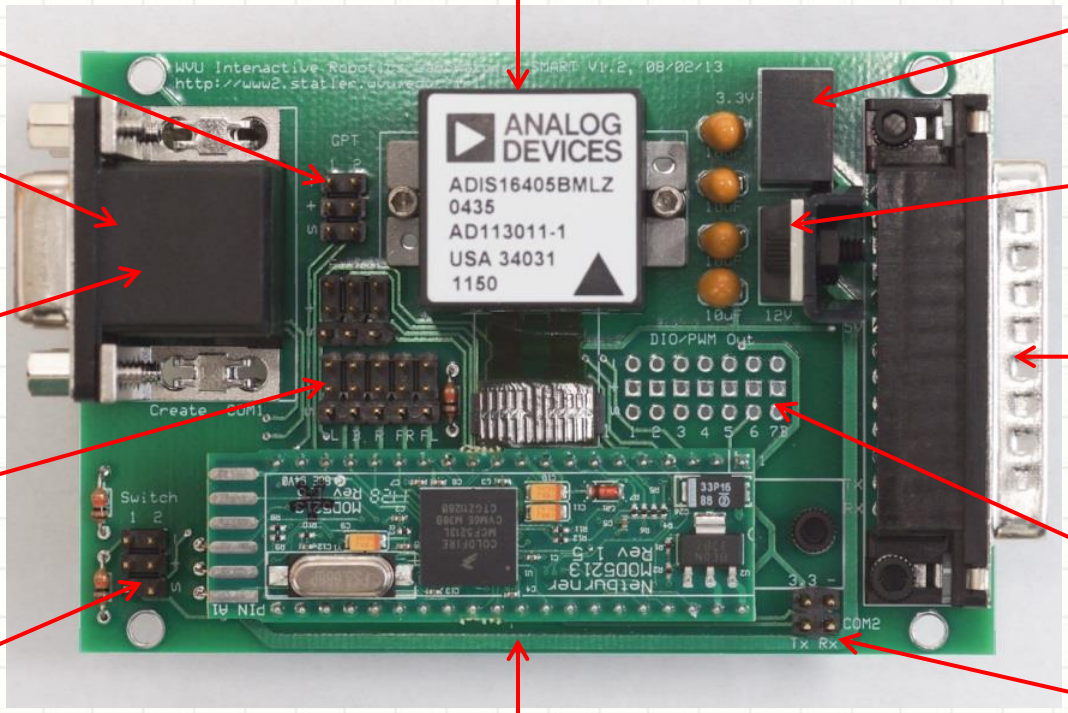
General Purpose Timer

DB9 Connector for Create Data

DB9 Connector for NetBurner COM1

A/D Pins

Connect to Two Toggle Switches



3.3V DC-DC Power Supply

12V Voltage Regulator

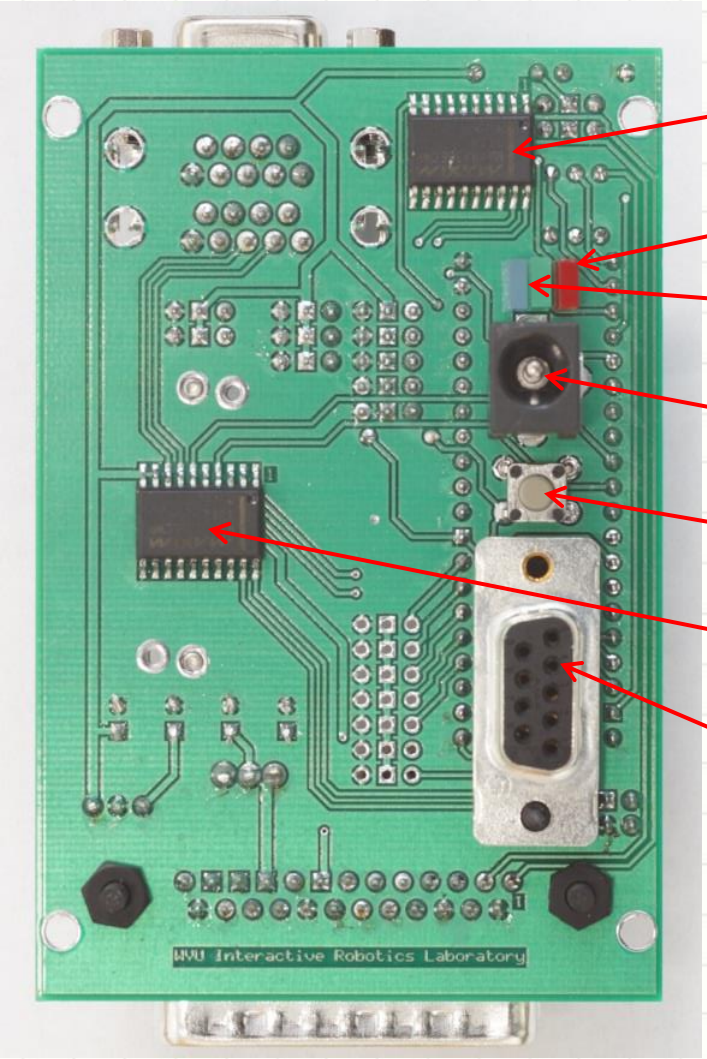
DB25 Connector to Create

Digital I/O Pins

NetBurner COM 2 Port

NetBurner Mod5213 Processor

Sensor Interface Board (Back)



RS232/TTL Level Shifter

Red LED, Power Indicator

Blue/Green LED, NetBurner Signal

12 V Power for Kinect

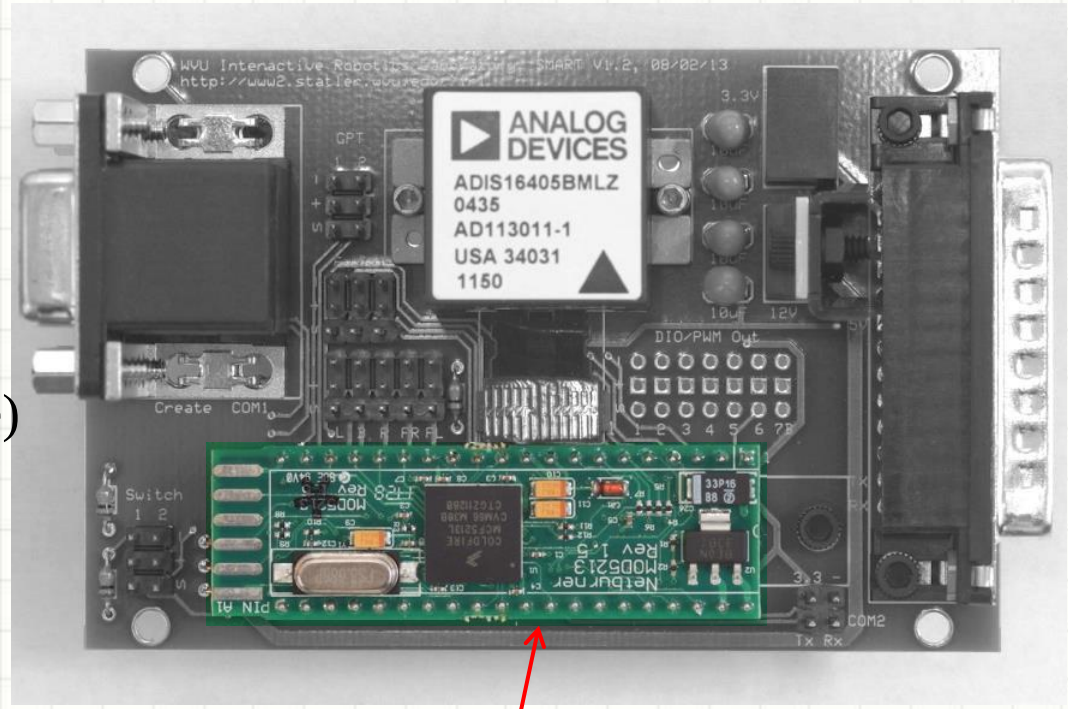
NetBurner Reset

RS232/LVTTL Level Shifter

NetBurner COM 0 for Firmware Update

NetBurner Mod5213

- 40 Configurable Pins
- 66 MHz processor (63MIPS)
- 256Kb Flash, 32Kb SRAM
- 3 UART (serial ports)
- 8 channel 12-bit A/D
- SPI (Serial Peripheral Interface)
- Lots of digital IOs
- Lots of timers
- Small Size
- Real-time Operating System (RTOS)
- Programs in C



This Guy

NASA Curiosity Vs. WVU SMART

Locomotion:	6-wheel “rocker-bogie”	2-wheel differential drive
Max Speed:	0.04 m/s	0.5 m/s
Power:	125W Nuclear Battery	14.4V 3300 mAH NiMH
Computation:	2x RAD750 CPUs (400MIPS) 256 MB of memory	Intel Core i3-3217U (~40k MIPS) 4 GB of memory
Navigation Sensors:	wheel encoders Inertial Measurement Unit 17 cameras	wheel encoders Inertial Measurement Unit 1 camera and 6 range finders Magnetometer Kinect
Science:	Many	Not much
Education:	You can learn about it	You can work on it

Summary

- Robot design is greatly determined by its intended function;
- The design is also limited by practical constraints;
- SMART was designed as an open-source teaching robot;
- We will learn more about SMART and robotics as we go...

Further Reading

- Robotic Design Process
- How Robotic Vacuum Work
- Matlab Toolbox for the iRobot Create (MTIC)
- Matlab iRobot Create Simulator
- MATLAB Robotics Toolbox
- Machine Vision Toolbox