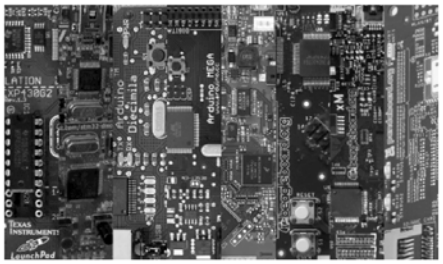
Processing Boards

Andy Gray

Objectives

- Robot communication models
- Microprocessors
- High level Development boards
- Comparison chart



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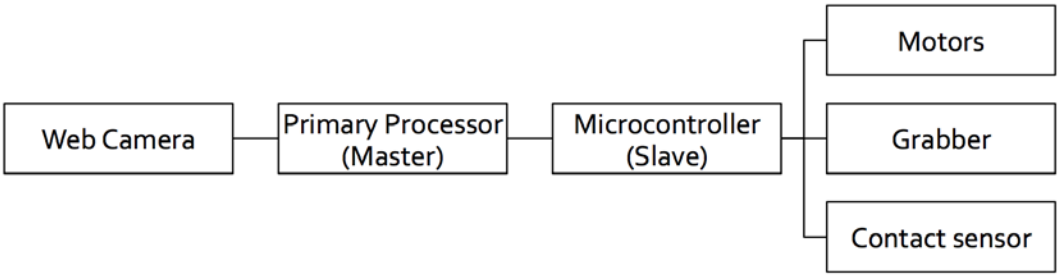
Robot Communication Model



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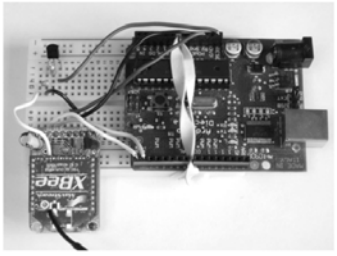
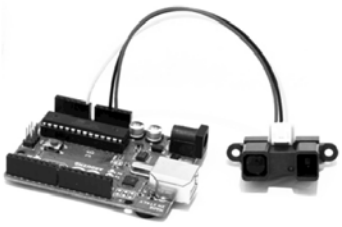
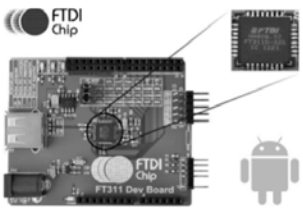
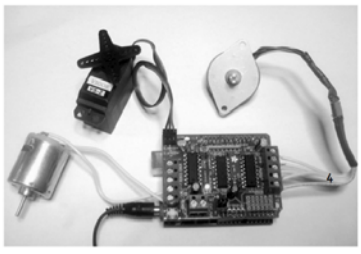
Lower level processing

- Simple processor
- "Medium"
- Basic sensor monitoring
- Control motors
- Slave

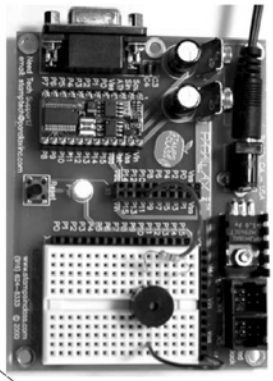


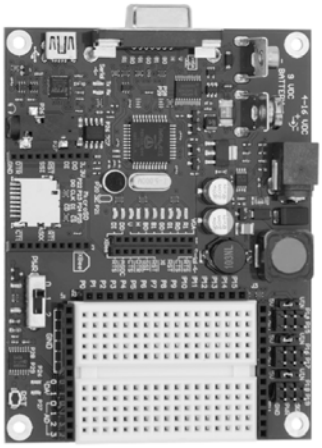






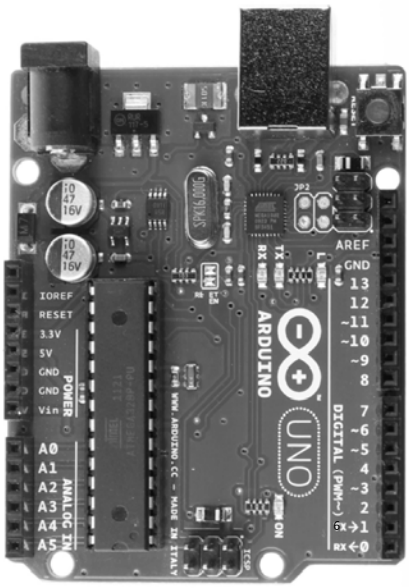
Microprocessors





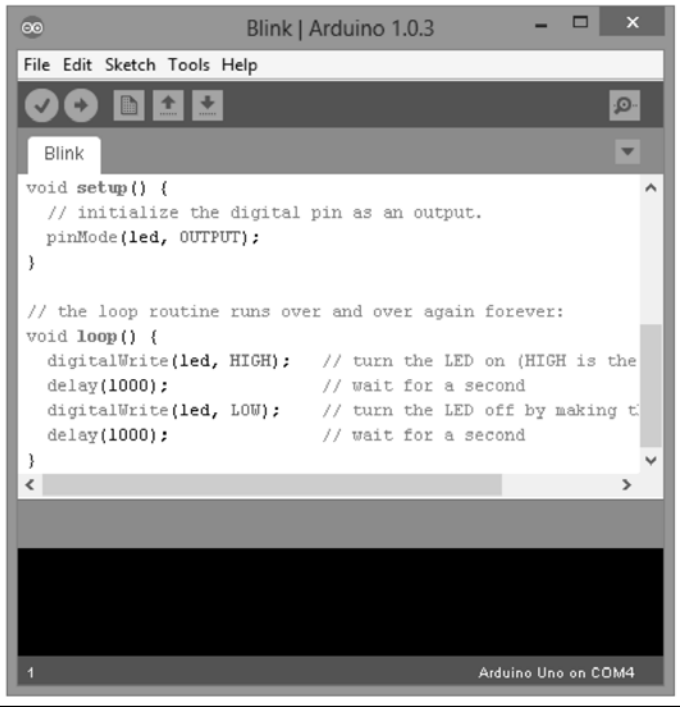
Arduino UNO

- 8 bit processor at 16 MHz
- 14 I/O pins
- 6 PWM
- 6 ADC
- 32KB of memory
- 5V logic
- $24.95 at Sparkfun



Arduino Due

- 32 bit processor at 84 MHz
- 54 I/O pins
- 12 PWM
- 12 ADC
- 2 DAC
- 512 KB of memory
- 3.3V logic
- $49.95 from Sparkfun



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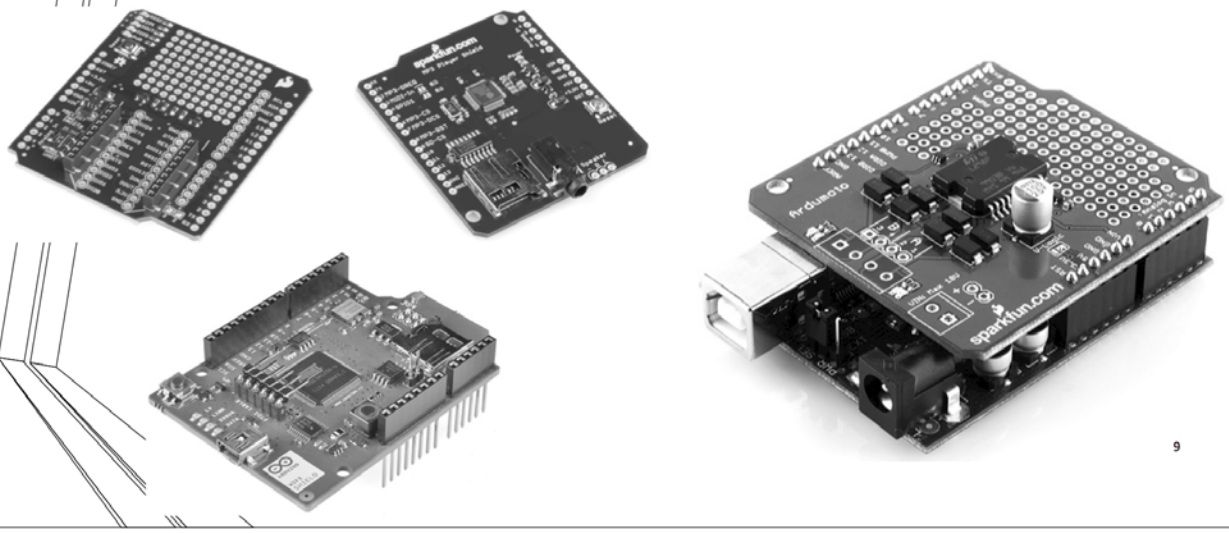
Arduino Shields



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F5529LP TI Launch Pad

- 8 bit processor at 25 MHz
- 40 I/O pins
- 5 PWM
- 16 ADC
- 128KB of memory
- 3.3V logic
- $12.99 from TI

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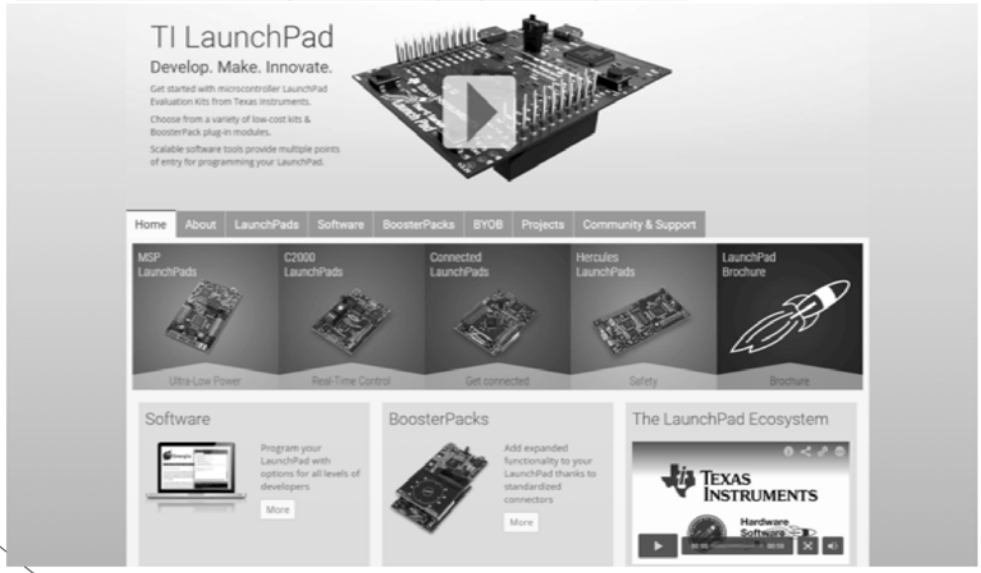
CC3200 TI Launch Pad

- 32 bit processor at 80 MHz
- 40 I/O pins
- 27 PWM
- 27 ADC
- 256 KB of memory
- 3.3V logic
- $29.99 from TI

- http://www.ti.com/ww/en/launchpad/launchpad.html?DCMP=rtos&HQS=ep-sdo-rtos-pr-lp-launchpad-en



Blink | Energia 0101E0009

File Edit Sketch Tools Help

Blink

```
void setup() {
  // initialize the digital pin as an output.
  // Pin 14 has an LED connected on most Arduino boards:
  pinMode(RED_LED, OUTPUT);
}

void loop() {
  digitalWrite(RED_LED, HIGH);   // set the LED on
  delay(1000);                   // wait for a second
  digitalWrite(RED_LED, LOW);    // set the LED off
  delay(1000);                   // wait for a second
}
```

1 LaunchPad w/ msp430g2553 (16MHz) on COM15

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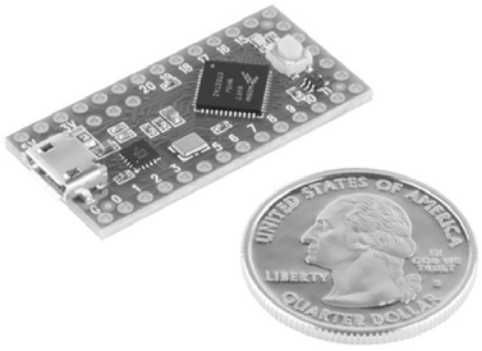
Teensy LC

- 32 bit processor at 48 MHz
- 27 I/O pins
- 10 PWM
- 13 ADC
- 62 KB of memory
- 3.3 V logic
- $12.95 from Sparkfun



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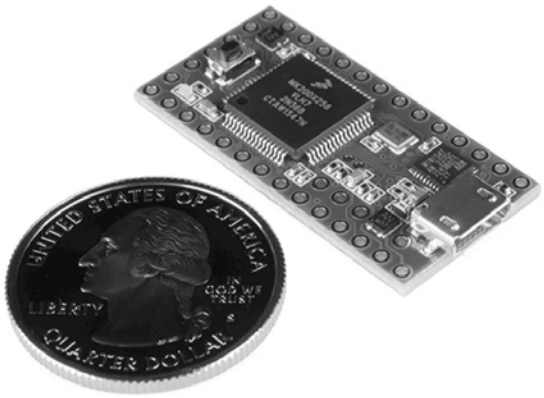
Teensy 3.2

- 32 bit processor at 72 MHz
- 34 I/O pins
- 12 PWM
- 21 ADC
- 256 KB of memory
- 3.3 V logic
- $19.95 from Sparkfun



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- https://www.pjrc.com/teensy/td_libs.html

PJRC Electronic Projects Components Available Worldwide

Shopping Cart • Checkout • Shopping Cost • Download Website

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You are here: Teensy > Teensyduino > Libraries > Main List

PJRC Store

- Teensy 3.1, $19.80
- Teensy LC, $11.65
- Teensy 2.0, $16.00
- Teensy++ 2.0, $24.00

Teensy

- Main Page
- Teensy 3.1
- Teensy LC
- Getting Started
- How To Tips
- Code Library
- Projects
- Teensyduino
  - Main
  - Tutorial
  - Download+Install
  - Basic Usage
  - Digital I/O
  - PWM & Tone
  - Timing
  - USB Serial
  - USB Keyboard
  - USB Mouse
  - USB Joystick
  - USB MIDI
  - USB Flight Sim
  - UART Serial
  - Libraries
    - Main List
    - GLCD
    - LiquidCrystal
    - Ouch32k2811
    - FastSPI_LED
    - Matrix+Sprite
    - LedDisplay
    - LedControl
    - DogLcd
    - ST7565
    - AltSoftSerial
    - NewSoftSerial
    - SoftwareSerial
    - MIDI
    - PS2Keyboard
    - OneSimple
    - Firmata
    - Wire
    - SPI
    - OneWire
    - XBee
    - VirtualWire
    - X10

Libraries

Most code libraries designed for Arduino boards work on Teensy and Teensy++ with little or no modification. This page aims to collect all libraries with any modifications and special instructions specific to Teensy. Clearly, many libraries have yet to be tested....

Display Libraries

Library	Version	Description	Web	Teensy 2.0	Teensy++ 2.0	Teensy LC	Teensy 3.x
GLCD (ks0108)	2	Graphics LCD library - Use a 128x64 graphical LCD. Displays fonts, bitmaps, pixels, lines, circles.		Yes	Yes		
LiquidCrystal	1.0.3	Character type LCD library. Displays text and limited custom characters.		Yes	Yes		Yes
SSD1306		Adafruit small OLED displays		Yes	Yes		Yes
ST7735		Adafruit 1.8 inch (128x160) color TFT LCD display		?	?		Yes
Ouch8WS2811	1.0	Control thousands of WS2811-based LEDs.		No	No		Yes
FastSPI_LED		Efficiently control many types of LED strips.		Yes	Yes		Partial
Matrix & Sprite	1.0	Control many LEDs.		Yes	Yes		Yes
LedDisplay	0.4	Very bright 4 or 8 character display		Yes	Yes		Yes
LedControl	-	Control 7-segment display or LEDs.		Yes	Yes		Yes
DogLcd	1.0.0	Use DOG-M Displays with only 4 pins		Yes	Yes		Yes
ST7565	-	Graphical LCD, 128x64		Yes	Yes		Yes

Communication Libraries

Library	Version	Description	Web	Teensy 2.0	Teensy++ 2.0	Teensy LC	Teensy 3.x
Ethernet	1.0.4	Connect to the Internet or a local Ethernet network. Ethernet allows you to create Internet applications like web servers.		Yes	Yes		Yes
AltSoftSerial	1.2	Serial port emulated by software		Yes	Yes		Yes
NewSoftSerial	10c	Serial port emulated by software		Yes	Yes		No
SoftwareSerial	0018	Known bugs - use NewSoftSerial		Yes	Yes		Partial

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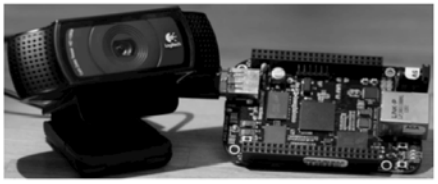
Higher level processing

- "Brains"
- Vision
- State Machine
- Master
- Greater processing power
- Operating System



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Laptop

- Already available
- Powerful
- Windows

- More hardware required to connect to robot
  - Xbee, wifi, bluetooth, IP camera
  - I/O board (microcontroller)
- Mounting laptop requires a bigger platform

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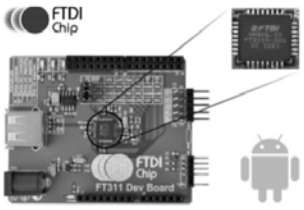
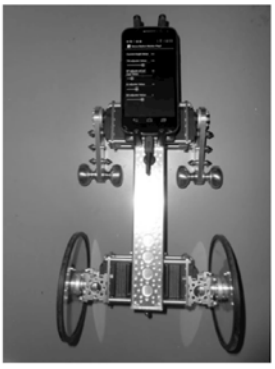
Smart Phone



- Available
- Small footprint with fast camera
- Sensors (GPS, IMU, Camera)
- Wireless communications
- Most economical

- Requires hardware to interface with actuators
- Android / IOS developer



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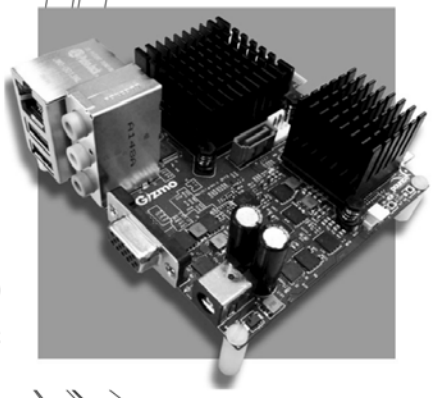
High Level Development Boards



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Raspberry Pi B+

- http://www.raspberrypi.org/
- 700 MHz arm processor
- 512 MB of RAM
- 27 GPIO pins
- 4 USB ports
- Micro SD card only
- Audio Jack
- $35.00 + Micro SD card + power supply + shipping
- Sounds great but…

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Raspberry Pi Zero

- https://www.raspberrypi.org/
- 1 GHz arm processor
- 40 GPIO pins
- 1 USB port
- Micro SD card
- $5.00 + power supply + USB adapter + shipping
- VERY well supported

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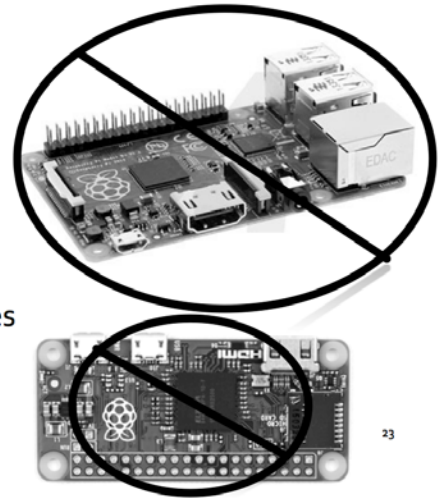
Avoid the Raspberry Pi B+ and Zero unless…

- You are a super programmer
  - Vision is terribly slow even with Raspi camera
  - Voice recognition is slow
- Not intended to be used for intensive processes



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Raspberry Pi 2

- https://www.raspberrypi.org/
- 900 MHz quad-core processor
- 40 GPIO pins
- 4 USB port
- Micro SD card
- $35.00 + power supply + shipping
- VERY well supported
- Windows 10

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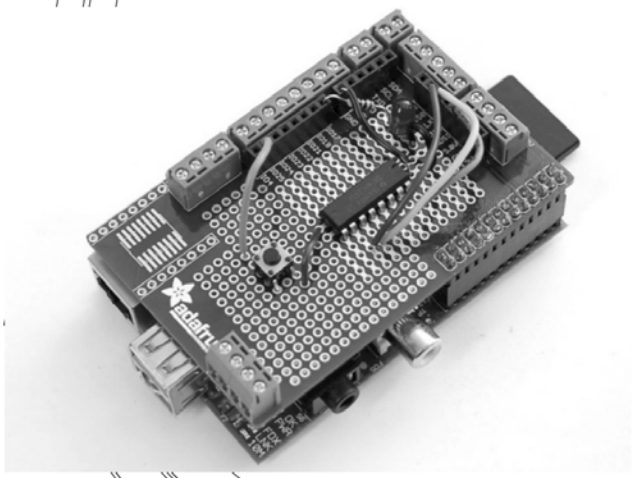
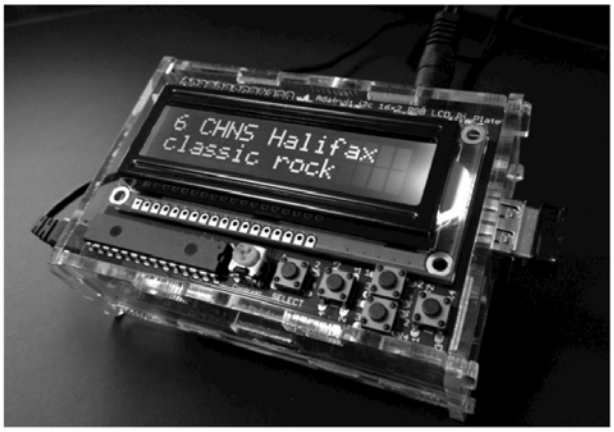
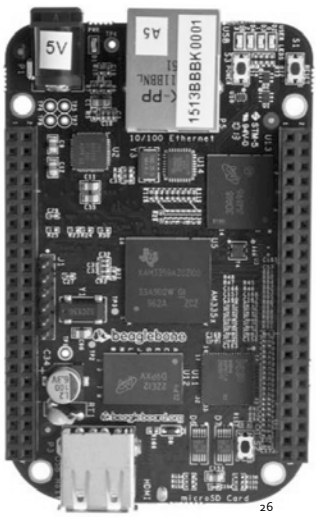
PI Plates





BeagleBone Black

- http://beagleboard.org/black
- 1 GHz arm processor
- 512 MB of RAM
- 65 GPIO pins
- 1 USB port
- Onboard 4GB eMMC + SD card
- $55.00 + power supply + USB hub + shipping
- Well supported



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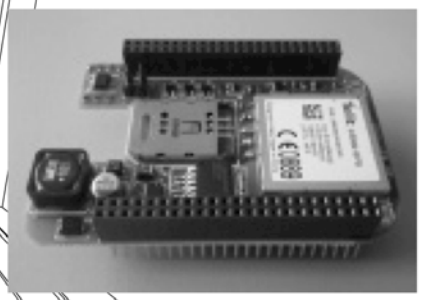
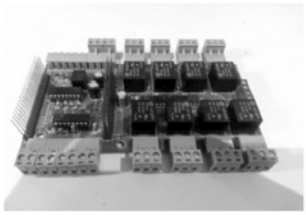
BeagleBone Capes

- http://elinux.org/Beagleboard:BeagleBone_Capes





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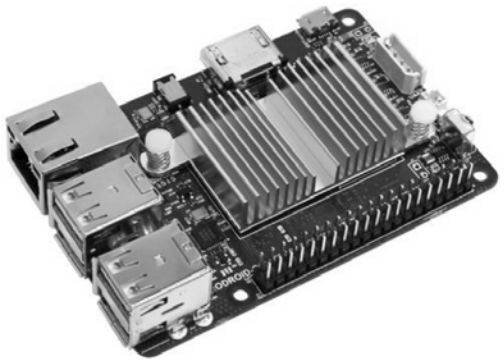
ODROID-C1+

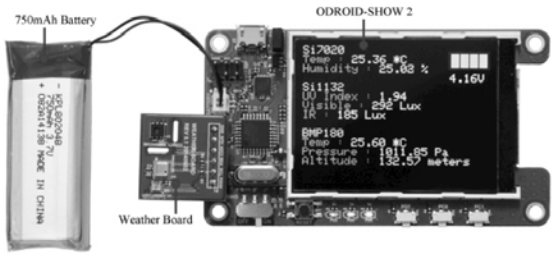
- http://www.hardkernel.com/
- 1.5 GHz quad core CPUs
- 1 GB RAM
- 40 GPIO pins
- 4 USB ports
- eMMC and Micro SD card
- Infrared receiver
- $37.95 + SD Card + power supply + $7.00 (shipping)
- Supported



ODROID-XU4

- http://www.hardkernel.com/main/products/prdt_info.php
- 2 GHz quad-core processor
- 2 GB of Ram
- 42 GPIO pins
- 3 USB ports
- eMMC and Micro SD card
- $74.95 + power supply + $7.00 (shipping)
- Supported

Odroid Shield Accessories



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Cost and features Comparison

	Raspberry Pi B +	Raspberry Pi 2	BeagleBone Black	ODROID U3	ODROID C1+
Processor Speed	700 MHz single core	900 MHz quad core	1 GHz single core	2 GHz quad core	1.5 GHz quad core
RAM	512 MB	1 GB	512 MB	2 GB	1 GB
GPIO Pins	40	40	65	42	40
USB Ports	4	4	1	3	4
Flash Memory	Micro SD	Micro SD	4GB eMMC or micro SD	eMMC or micro SD	eMMC or micro SD
Cost (minimum to use)	~$65	~$65	~$85	~$82	~$50

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Robot Communication Model

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Questions

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