BeagleBone Cookbook Webinar Series
Recipe #4
Controlling the Speed and Direction of a DC Motor

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Jason Kridner
Co-author of BeagleBone Cookbook
Board member at BeagleBoard.org Foundation
Sitara Applications Engineering at Texas Instruments
BeagleBone Black
Ready to explore and use in minutes

Truly flexible open hardware and software development platform

All you need is in the box

Proven ecosystem from prototype to product

BeagleBone Black – the most flexible solution in open-source computing

- Ready to use
  - USB client network
  - Built-in tutorials
  - Browser based IDE
  - Flashed with Debian
- Fast and flexible
  - 1-GHz Sitara ARM
  - 2x200-MHz PRUs
  - 512-MB DDR3
  - On-board HDMI
  - 65 digital I/O
  - 7 analog inputs
- Support for numerous Cape plug-in boards
  [http://beaglebonecapes.com](http://beaglebonecapes.com)

~$50
BeagleBone Black board features

10/100 Ethernet
USB Host
Easily connects to almost any everyday device such as mouse or keyboard
microHDMI
Connect directly to monitors and TVs
microSD
Expansion slot for additional storage
512MB DDR3
Faster, lower power RAM for enhanced user-friendly experience

1-GHz Sitara AM335x ARM® Cortex™-A8 processor

Expansion headers
Enable cape hardware and include:
- 65 digital I/O
- 7 analog
- 4 serial
- 2 SPI
- 2 I2C
- 8 PWMs
- 4 timers
- And much much more!

Money saving extras:
- Power over USB
- Included USB cable
- 4-GB on-board storage
- 4-GB on-board storage using eMMC
  - Pre-loaded with Debian Linux Distribution
  - 8-bit bus accelerates performance
  - Frees the microSD slot to be used for additional storage for a less expensive solution than SD cards

Power Button
LEDS
Reset Button
USB Client
Development interface and directly powers board from PC

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Simple browser-based interactions

http://beagleboard.github.io/bone101
Cloud9 IDE hosted locally
Zero install and exposes command-line
10,000s of developers building connected devices today

- Medical analysis, assistance and information management
- Home information, automation and security systems
- Home and mobile entertainment and educational systems
- New types of communications systems
- Personal robotic devices for cleaning, upkeep and manufacturing
- Remote presence and monitoring
- Automotive information management and control systems
- Personal environmental exploration and monitoring
BeagleBone Cookbook
http://beagleboard.org/cookbook

• 99 recipes covering
  – Basics
  – Sensors
  – Displays and outputs
  – Motors
  – Internet of things
  – Kernel
  – Real-time I/O
  – Capes
Prerequisites

• Connect to the board per recipe 1.2
  – http://beagleboard.org/getting-started

• Verify the software image per recipe 1.3 and potentially updating per recipe 1.9
  – http://beagleboard.org/latest-images

• Components
  – BeagleBone Black
  – L293D H-Bridge IC
  – 5V DC motor
    • For other voltages, verify H-bridge compatibility
  – Breadboard and jumper wire
    • Alternatively, I’ve had a PCB fabricated
Direct Current (DC) Motor

https://en.wikipedia.org/wiki/DC_motor

- DC voltage causes motor to turn
- Brush contact resets drive after partial revolution
- Drive strength is proportional to input voltage
- There’s a maximum input voltage
- Reversing voltage reverses direction
- BeagleBone Black doesn’t supply enough current on its I/O pins
Pulse-Width Modulation (PWM)

https://en.wikipedia.org/wiki/Pulse-width_modulation

- Enables approximating a voltage by turning on and off quickly
- BeagleBone Black has 8 hardware PWMs
- PRU can produce another 25 more with appropriate firmware
H-Bridge
https://en.wikipedia.org/wiki/H_bridge

- Enables reversing direction of the motor
- Integrates driver as well
L293D Block Diagram

- Pin 1 is the speed control
- Pin 2 is the forward drive
- Pin 7 is the backward drive
Connect your L293D H-bridge

http://beagleboard.org/Support/bone101/#headers

- Pin 1 to P9_14 “EN”
- Pin 2 to P8_9 “FWD”
- Pin 3 to “Motor +”
- Pin 4 and 5 to DGND
- Pin 6 to “Motor -”
- Pin 7 to P8_11 “BWD”
- Pin 8 to VDD_5V
- Pin 9 to VDD_3V3
Recipe 4.3: Controlling the motor

var b = require('bonescript');
var motor = { SPEED: 'P9_14', FORWARD: 'P8_9', BACKWARD: 'P8_11' };
var FREQ = 50;
var STEP = 0.1;
var count = 0;
var stop = false;

b.pinMode(motor.FORWARD, b.OUTPUT);
b.pinMode(motor.BACKWARD, b.OUTPUT);
b.analogWrite(motor.SPEED, 0, FREQ, 0, 0);

var timer = setInterval(updateMotors, 100);

function updateMotors() {
  var speed = Math.sin(count*STEP);
  count++;
  Mset(motor, speed);
}

• Define the pins
• Keep track of state
• Setup pins initially
• Use a 100ms timer to update the motors
• Use a sine wave to increment/decrement the speed for test
• Call ‘Mset’ to update the PWM and direction
function Mset(motor, speed) {
    speed = (speed > 1) ? 1 : speed;
    speed = (speed < -1) ? -1 : speed;
    //console.log("Setting speed = " + speed);
    b.digitalWrite(motor.FORWARD, b.LOW);
    b.digitalWrite(motor.BACKWARD, b.LOW);
    if(speed > 0) {
        b.digitalWrite(motor.FORWARD, b.HIGH);
    } else if(speed < 0) {
        b.digitalWrite(motor.BACKWARD, b.HIGH);
    }
    b.analogWrite(motor.SPEED,
                  Math.abs(speed), FREQ);
}
Recipe 4.3: Controlling the motor


```javascript
function doStop() {
    clearInterval(timer);
    Mset(motor, 0);
}

process.on('SIGINT', doStop);
```

- Detect when program is being stopped by a `^C`
- Stop the timer and disable the motor
My quick-hack PCB
See recipe 9.7
More

• Learn more about H-Bridges and motors

• My simple PCB
  – https://oshpark.com/shared_projects/Mz40o0aN

• Shortcuts to updates and examples from the book
  – http://beagleboard.org/cookbook