LEGO EV3 PROGRAMMING

16级计科基地班

刘安

pacer97@qq.com

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Intro to EV3

- LEGO MINDSTORMS EV3 is based on a brick
- includes an ARM®9-based processor, micro SD card reader, and USB port for Wi-Fi connectivity.
- It connects to a variety of sensors, such as ultrasound, color/light, gyroscope, and touch.
- It also connects to up to four servo motors, so you can use it to build mobile robots.

Brick

	EV3	NXT	RCX
Release Date	September 2013	July 2006	1998
Display	178×128 pixel Monochrome LCD	100×64 pixel Monochrome LCD	segmented Monochrome LCD
Main Processor	TI Sitara AM1808 (ARM926EJ-S core) @300 MHz	Atmel AT91SAM7S256 (ARM7TDMI core) @48 MHz	Hitachi H8/300 @16 MHz
Main Memory	64 MB RAM 16 MB Flash microSDHC Slot	64 KB RAM 256 KB Flash	32 KB RAM 16 KB ROM
USB Host Port	Yes	No	No
WiFi	Optional dongle via USB port	No	No
Bluetooth	Yes	Yes	No
Connects to Apple devices	Yes	No	No

Sensors

触动传感器

颜色传感器

远程红外信标

红外/超声波传感器

Program with Matlab

```
% LEGOEV3 - The class to represent the LEGO EV3 brick
% You can use LEGOEV3 to interact with EV3 brick.
%
% myev3 = legoev3('usb')
% set up USB connection between host and EV3 brick.
%
% myev3 = legoev3('wifi', ip_address, hardware_id)
% set up WiFi connection between host and EV3 brick
% For example:
% myev3 = legoev3('wifi', '192.168.1.7', '00165340e49b')
%
% myev3 = legoev3('bluetooth', com_port)
% set up Bluetooth connection between host and EV3 brick
% For example:
% myev3 = legoev3('bluetooth', 'COM19')
%
```

```
>> mylego = legoev3('usb')

mylego =

  legoev3 - 属性:

      FirmwareVersion: 'V1.09H'
         HardwareID: []
          IPAddress: []
    CommunicationType: 'USB'
         BatteryLevel: 100
     ConnectedSensors: {''  'gyro'  'color'  'sonic'}
```

Demo1-Control Sensors

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Create a connection to the gyroscopic sensor called mygyrosensor.
% Measure the rotation, in degrees,
% since the creation of the connection to the sensor.
% Reset the measurement to zero.
% Measure the current rate of rotation, in degrees per second.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
myev3 = legoev3;
mygyrosensor = gyroSensor(myev3);
angle = readRotationAngle(mygyrosensor);
resetRotationAngle(mygyrosensor);
rate = readRotationRate(mygyrosensor);
```

Demo2-Collision Alarm Template

```
%------- Change ME -------------------------
mylego = legoev3; % Set up MATLAB and EV3 communication
RANGE = 0.3; % Detection range in meters
%---------------------------------------
mysensor = sonicSensor(mylego); % Set up ultrasonic sensor

%% Operations %%%%%%%%%%%%%%%%%%%%%%%%%%%%
while ~readButton(mylego, 'up') % Exit if UP button is pressed
dis = readDistance(mysensor); % Read ultrasonic sensor value
freq = 5000*(RANGE-dis)/RANGE; % Increase frequency as getting closer
volume = 100*(RANGE-dis)/RANGE; % Increase volume as getting closer
playTone(mylego, freq, 1, volume); % Play tone
end
```

Demo3-How to Go Straight

```
mylego = legoev3; % Set up MATLAB and EV3 communication
mymotor1 = motor(mylego, 'B'); % Set up motor
mymotor2 = motor(mylego, 'C');

% Application parameters
EXE_TIME = 10; % Application running time in seconds
SPEED = 30; % Motor speed

mymotor1.Speed = SPEED; % Set motor speed
mymotor2.Speed = SPEED;
start(mymotor1); % Start motor
start(mymotor2);
pause(EXE_TIME); % Wait
stop(mymotor1); % Stop motor
stop(mymotor2);
```

Demo3-How to Go Straight (closeloop)

```
%%% setup %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
mylego = legoev3; % Set up MATLAB and EV3 communication
% Change based on your motor port numbers
mymotor1 = motor(mylego, 'B'); % Set up motor
mymotor2 = motor(mylego, 'C');
% Application parameters
EXE_TIME = 10; % Application running time in seconds
PERIOD = 0.1; % Sampling period
SPEED = 20; % Motor speed
P = 0.01; % P controller parameter
%-------------------------------------------
mymotor1.Speed = SPEED; % Set motor speed
mymotor2.Speed = SPEED;
resetRotation(mymotor1); % Reset motor rotation counter
resetRotation(mymotor2);
start(mymotor1); % Start motor
start(mymotor2);
t = timer('TimerFcn', 'stat=false;', 'StartDelay',EXE_TIME);
start(t);
```

```
%% Operations %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
stat = true;
lastR1 = 0;
lastR2 = 0;
while stat == true % Quit when times up
r1 = readRotation(mymotor1); % Read rotation counter in degrees
r2 = readRotation(mymotor2);
speed1 = (r1 - lastR1)/PERIOD; % Calculate the real speed in d/s
speed2 = (r2 - lastR2)/PERIOD;
diff = speed1 - speed2; % P controller
mymotor1.Speed = mymotor1.Speed - int8(diff * P);
lastR1 = r1;
lastR2 = r2;
pause(PERIOD); % Wait for next sampling period
end
%% Clean up %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
stop(mymotor1); % Stop motor
stop(mymotor2);
```

ev3dev is your EV3 *re-imagined*

ev3dev is a Debian Linux-based operating system that runs on several LEGO® MINDSTORMS compatible platforms including the LEGO® MINDSTORMS EV3 and Raspberry Pi-powered BrickPi.

Just like you can take apart your LEGO® models and build something completely different, we have reverse-engineered the EV3 and created a new software platform for programming your robots.

EV3 programming unlocked

ev3dev gives you the power to program how *you* want to. We have created a low-level driver framework for controlling sensors, motors and pretty much everything else. It's as easy as reading from and writing to a file.

ev3dev supports many popular scripting languages out-of-the-box, so you can get started right away with your favorite language and libraries.

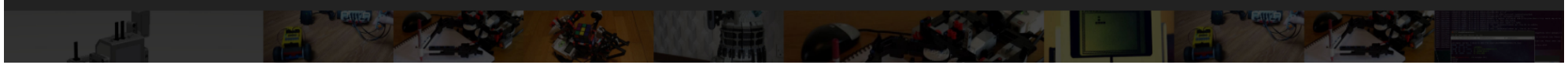
Backed by the full power of Linux

Since ev3dev is built on Debian Linux, there are over 43,000 free software packages available for you to install.

And with the Linux kernel at its core, many USB and Bluetooth devices, like Wi-Fi dongles, keyboards, keypads, joysticks and cameras work too.

It's not firmware

It's more like dual-boot. ev3dev runs from a microSD card and doesn't ever touch the firmware installed on the EV3. To switch back, you just shut down and remove the microSD card - no flashing required.



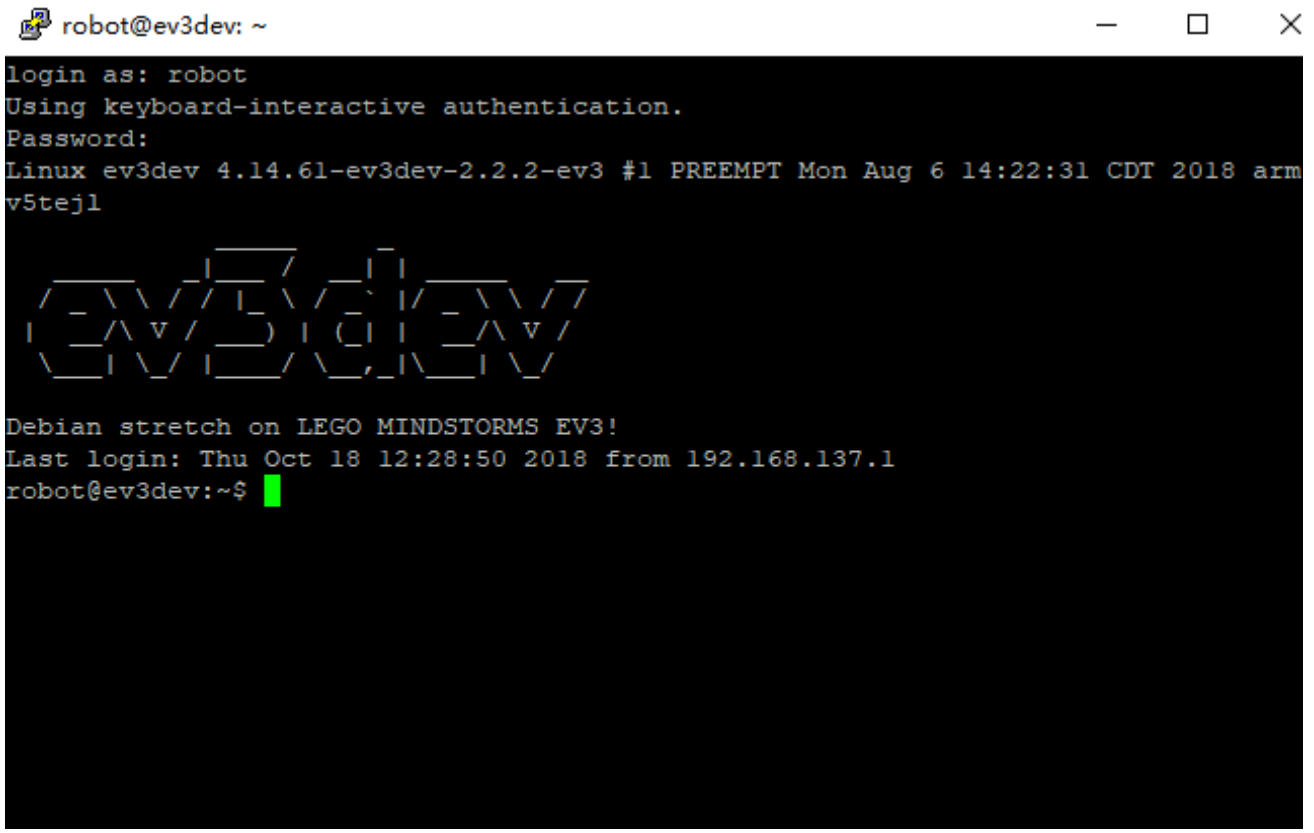
Program in other Languages

- Python
- JavaScript
- C/C++
- Go
- Ruby
- Java
- ……

Need to Prepare

- A LEGO MINDSTORMS EV3 Intelligent Brick or Raspberry Pi (any model).
- A microSD or microSDHC card (2GB or larger). microSDXC is not supported on the EV3. **All cards larger than 32GB will not work with the EV3!**
- A computer with an adapter for the SD card. You will need administrator user permissions on this computer.
- USB Wi-Fi dongle

Demo- Connecting to Ev3dev Using SSH



Program in Python

```
#!/usr/bin/env python3
from ev3dev2.motor import LargeMotor, OUTPUT_A, OUTPUT_B, SpeedPercent, MoveTank
from ev3dev2.sensor import INPUT_1
from ev3dev2.sensor.lego import TouchSensor
from ev3dev2.led import Leds
# TODO: Add code here

sound = Sound()
sound.speak('Welcome to the E V 3 dev project!')

tank_drive = MoveTank(OUTPUT_A, OUTPUT_B)
# drive in a turn for 5 rotations of the outer motor
# the first two parameters can be unit classes or percentages.
tank_drive.on_for_rotations(SpeedPercent(50), SpeedPercent(75), 10)
# drive in a different turn for 3 seconds
tank_drive.on_for_seconds(SpeedPercent(60), SpeedPercent(30), 3)
```

Demo-Color

```
#!/usr/bin/env python3
"""Make robot say whatever color it observes with the color sensor."""
from ev3dev2.sensor.lego import ColorSensor
from time import sleep
from ev3dev2.sound import Sound
color_sensor = ColorSensor()
sound = Sound()
while True:
color = color_sensor.color
text = ColorSensor.COLORS[color]
sound.speak(text)
sleep(2)
```

Demo-Touch

```
#!/usr/bin/env python3
"""
Reverse robot if bumps into wall.
This script is a simple demonstration of the touch sensor.
"""
from ev3dev2.motor import MoveSteering, OUTPUT_B, OUTPUT_C
from ev3dev2.sensor.lego import TouchSensor
motor_pair = MoveSteering(OUTPUT_B, OUTPUT_C)
touch_sensor = TouchSensor()
# Start robot moving forward
motor_pair.on(steering=0, speed=10)
# Wait until robot touches wall
touch_sensor.wait_for_pressed()
# Stop moving forward
motor_pair.off()
# Reverse away from wall
motor_pair.on_for_seconds(steering=0, speed=-10, seconds=2)
```

Demo - Ultrasonic

```
#!/usr/bin/env python3
"""
Use robot to reposition cuboid.
This script is a simple demonstration of the ultrasonic sensor and medium
motor.
"""
from ev3dev2.motor import (
MoveSteering, MediumMotor, OUTPUT_A, OUTPUT_B, OUTPUT_C)
from ev3dev2.sensor.lego import UltrasonicSensor
from time import sleep
motor_pair = MoveSteering(OUTPUT_B, OUTPUT_C)
medium_motor = MediumMotor(OUTPUT_A)
ultrasonic_sensor = UltrasonicSensor()
# Start robot moving forward

motor_pair.on(steering=0, speed=10)
# Wait until robot less than 3.5cm from cuboid
while ultrasonic_sensor.distance_centimeters > 3.5:
sleep(0.01)
# Stop moving forward
motor_pair.off()
# Lower robot arm over cuboid
medium_motor.on_for_degrees(speed=-10, degrees=90)
# Drag cuboid backwards for 2 seconds
motor_pair.on_for_seconds(steering=0, speed=-20, seconds=2)
# Raise robot arm
medium_motor.on_for_degrees(speed=10, degrees=90)
# Move robot away from cuboid
motor_pair.on_for_seconds(steering=0, speed=-20, seconds=2)
```

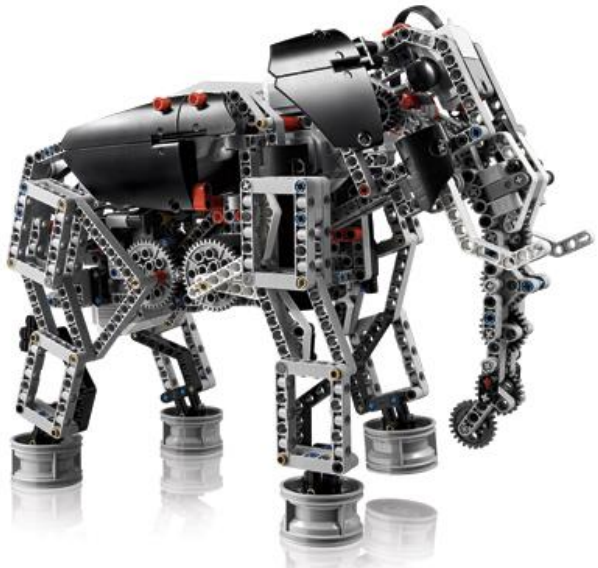
Demo-Square

```
#!/usr/bin/env python3
"""
Move robot in a square path without using the Gyro sensor.
This script is a simple demonstration of moving forward and turning.
"""
from ev3dev2.motor import MoveSteering, OUTPUT_B, OUTPUT_C
motor_pair = MoveSteering(OUTPUT_B, OUTPUT_C)
for i in range(4):
# Move robot forward for 3 seconds
motor_pair.on_for_seconds(steering=0, speed=50, seconds=3)
# Turn robot left 90 degrees (adjust rotations for your particular robot)
motor_pair.on_for_rotations(steering=-100, speed=5, rotations=0.5)
```

Demo-Square-gyro

```
#!/usr/bin/env python3
"""
Move robot in a square path using the Gyro sensor.
This script is a simple demonstration of turning using the Gyro sensor.
"""
from ev3dev2.motor import MoveSteering, OUTPUT_B, OUTPUT_C
from ev3dev2.sensor.lego import GyroSensor
motor_pair = MoveSteering(OUTPUT_B, OUTPUT_C)
gyro = GyroSensor()
gyro.mode = GyroSensor.MODE_GYRO_ANG
for i in range(4):
# Move robot forward for 3 seconds
motor_pair.on_for_seconds(steering=0, speed=50, seconds=3)
# Spin robot to the left
motor_pair.on(steering=-100, speed=5)
# Wait until angle changed by 90 degrees
gyro.wait_until_angle_changed_by(90)
# Stop motors
motor_pair.off()
```

Usage



Vedios

- https://www.youtube.com/watch?v=Z4Lz2rYRipQ
- https://www.bilibili.com/video/av5740892/

Reference

- https://sites.google.com/site/ev3python/learn_ev3_python/going-further/auto-drive
- https://www.ev3dev.org/docs/getting-started/
- https://github.com/ev3dev/ev3dev-lang-python
- https://python-ev3dev.readthedocs.io/en/ev3dev-stretch/motors.html#units
- https://github.com/ev3dev/ev3dev-lang-python-demo
- https://github.com/sshopov/pyconau2017/blob/master/final.ipynb

THANKS

Q&A