AD41700 Robots, Art and Culture
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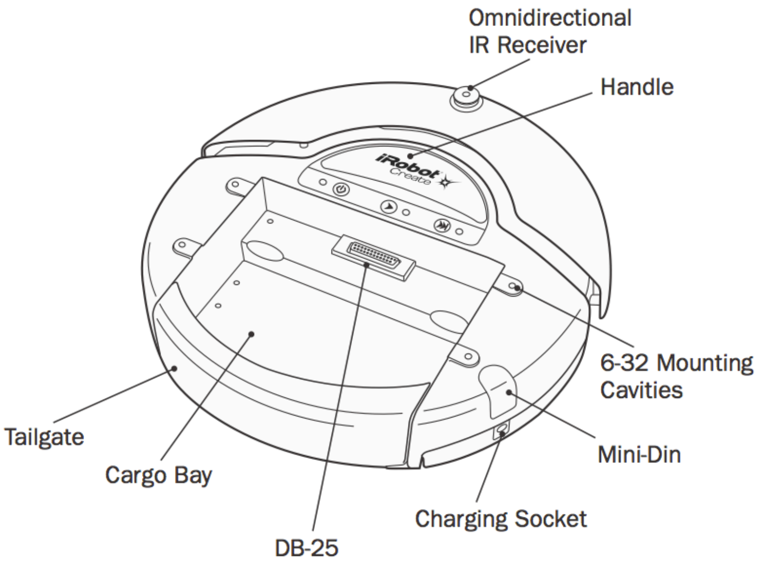
Controlling an iRobot Create Robot Platform with Arduino

This workshop introduces the iRobot Create as a relatively inexpensive and robust robot platform that can be relatively easily controlled with the Arduino board. Even though we are using iRobot Create, the following strategies work with any type of Roomba robot (you may get lucky and find an older model for cheap on ebay or at your local thrift store as well as the iRobot Create 2 robot platform. It is organized in the following sections:

1) Introduction to the iRobot Create

The original iRobot Create (http://store.irobot.com/education-research-robots/shop.jsp?categoryId=3311368) is based on the Roomba 400 series vacuum cleaning robot. It is an inexpensive educational robot platform that can be controlled with an Arduino board using serial commands. These commands are based on the iRobot Create's Open Interface (OI) protocol, a documentation of which can be found here:
http://www.irobot.com/filelibrary/pdfs/hrd/create/Create%20Open%20Interface_v2.pdf
The documentation for the newer Create 2 robot platform (based on the Roomba 600 series) can be found here:
http://www.irobotweb.com/~/media/MainSite/PDFs/About/STEM/Create/iRobot_Roomba_600_Open_Interface_Spec_0908.pdf?la=en

Let's start by first taking a look at the anatomy of the original iRobot Create:



More information about the iRobot Create can be found in the robot's manual: http://www.irobot.com/filelibrary/pdfs/hrd/create/Create%20Manual_Final.pdf

Sensors

The iRobot Create comes with some basic sensors mounted on its platform, they are:

- 2x bump sensors (left, right)
- 4x cliff sensors (left, front left, right, front right)
- 3x wheel drop sensors (left, right, caster (center))
- 2x buttons (labeled advance and play)
- 1x infrared sensor (receiving bytes sent from Roomba remote, home base or user created devices)
- 1x wall sensor (used with the virtual wall accessory: wall detection/signal strength)

Furthermore the iRobot Create allows access to sensor monitoring some of its internal functions:

- distance the robot has traveled since the distance was last requested (in millimeters)
- angle the robot has turned since the last time the angle was requested (in degrees)
- charging state
- battery voltage (in mV)
- current (flowing into the robot's battery, in mA)
- battery temperature (in degrees Celsius)
- battery charge (in mAh)
- battery capacity (in mAh)
- velocity information (left, right, in mm/s)

Actuators

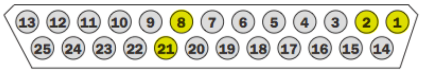
The iRobot Create Open interface allows access to the following on-board actuators

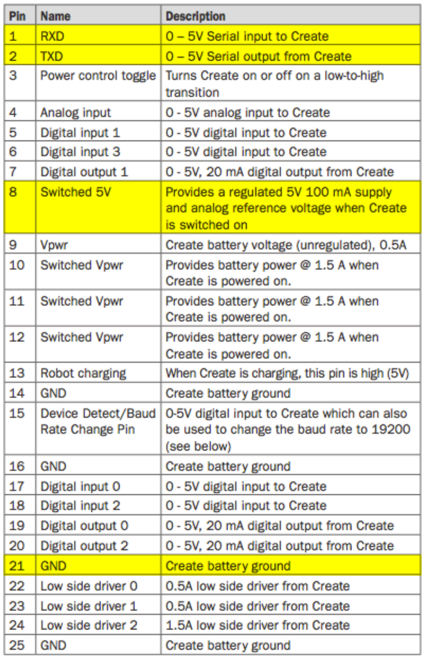
- wheel motors (speed left, speed right)
- LEDs (play, advance, bi-color power LED)
- speaker (define musical notes)

Using the Arduino board as a controller, other sensors and actuators can be added easily to the Arduino board's I/O pins (e.g. photocells, IR proximity sensors, ultrasonic range finders, servo motors, etc.)

2) Connecting the Arduino board

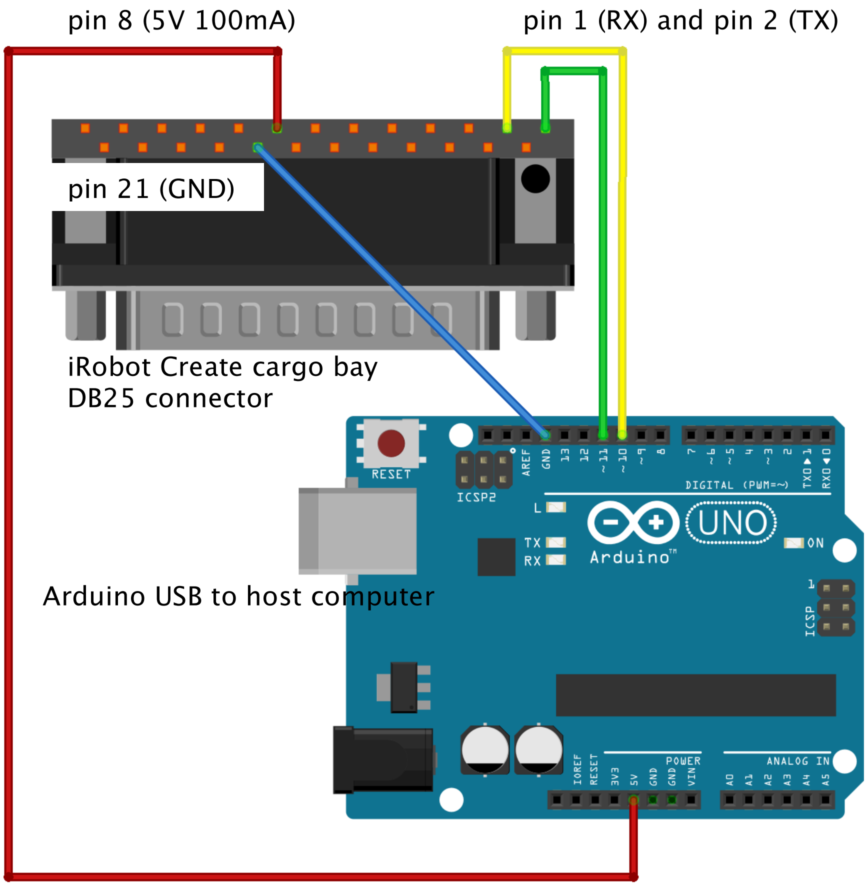
Connecting the Arduino board is easy through the cargo bay DB25 connector, in the diagram below we see the necessary pins:





Pin	Name	Description
1	RXD	0 – 5V Serial input to Create
2	TXD	0 – 5V Serial output from Create
3	Power control toggle	Turns Create on or off on a low-to-high transition
4	Analog input	0 - 5V analog input to Create
5	Digital input 1	0 - 5V digital input to Create
6	Digital input 3	0 - 5V digital input to Create
7	Digital output 1	0 - 5V, 20 mA digital output from Create
8	Switched 5V	Provides a regulated 5V 100 mA supply and analog reference voltage when Create is switched on
9	Vpwr	Create battery voltage (unregulated), 0.5A
10	Switched Vpwr	Provides battery power @ 1.5 A when Create is powered on.
11	Switched Vpwr	Provides battery power @ 1.5 A when Create is powered on.
12	Switched Vpwr	Provides battery power @ 1.5 A when Create is powered on.
13	Robot charging	When Create is charging, this pin is high (5V)
14	GND	Create battery ground
15	Device Detect/Baud Rate Change Pin	0-5V digital input to Create which can also be used to change the baud rate to 19200 (see below)
16	GND	Create battery ground
17	Digital input 0	0 - 5V digital input to Create
18	Digital input 2	0 - 5V digital input to Create
19	Digital output 0	0 - 5V, 20 mA digital output from Create
20	Digital output 2	0 - 5V, 20 mA digital output from Create
21	GND	Create battery ground
22	Low side driver 0	0.5A low side driver from Create
23	Low side driver 1	0.5A low side driver from Create
24	Low side driver 2	1.5A low side driver from Create
25	GND	Create battery ground

Connecting an Arduino UNO board to the iRobot Create:



3) Reading basic sensor values

We are making use of Arduino's softSerial library, so we can work with two independent serial ports on one Arduino board. The reason for this is simple: in order to see if the Arduino can read OI sensor values we need to be able to send requests to OI that return values (serial call and response) and at the same time communicate these readings back to the Arduino serial monitor so we can see what values we get. In a later step we can then trigger driving commands based on the sensor readings. For now however we are just interested in reading sensor values.

Why do we need two serial ports for this?
It's simple – we do not want to get our serial values/commands mixed up – OI commands that we send to the iRobot Create should not show up in the serial monitor and values we send back to the serial monitor should not be interpreted as OI commands.

Why don't we connect the Arduino UNO's hardware serial port (RX/TX)?

> "The serial port output TXD from the Roomba/Create is too weak to drive the RX serial port (hardware serial port) input of an Arduino properly. This is because of the USB-Serial converter on the Arduino: it also tries to drive the RX serial port input via a pullup resistor, but the Roomba does not have enough drive to pull the RX down below about 2.5 volts, which is insufficient to be reliably detected as a TTL serial input of 0."

(from: http://projectsfromtech.blogspot.com/2013/11/irobot-create-arduino-control.html).

Notes on the Arduino Mega: the Arduino Mega has 4 serial ports, use **Serial1**(TX1/RX1), **Serial2**(TX2/RX2) or **Serial13**(TX3/RX3) instead of **Serial0**. You can still use Serial0 to communicate back to a serial monitor via USB or XBee for debugging if needed.

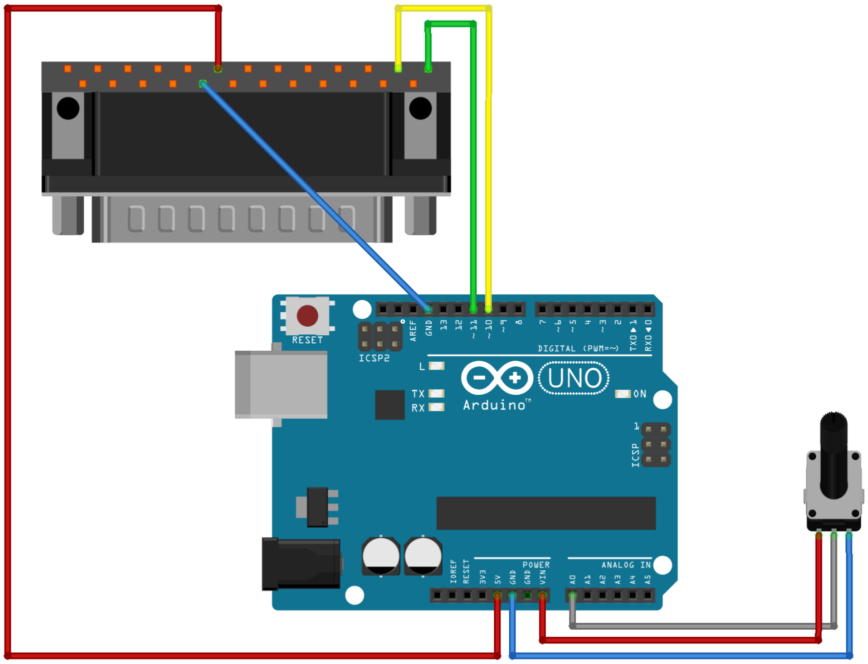
Here is the Arduino code to read the Create's bump Sensors:
http://web.ics.purdue.edu/~fwinkler/AD32600_F14/bump.zip

4) Making the robot move

In this section we develop Arduino code that makes the robot move, it is based on the drive serial sequence documented in the Open Interface manual on page 9:

```
[137] [Velocity high byte] [Velocity low byte] [Radius high byte] [Radius low byte]
```

We would like to connect a potentiometer to Arduino's analog pin A0 for speed control and map the potentiometer's reading like this: the robot should be at speed 0 when the potentiometer is in the middle position, it should be at the maximum speed backwards when we turn the potentiometer all the way to the left and it should be at its maximum forward speed when the potentiometer is turned all the way to the right. The following drawing shows the hardware setup for this example and the full Arduino code example can be downloaded here:
http://web.ics.purdue.edu/~fwinkler/AD32600_F14/create_go.zip.



5) Putting it all together: simple robot navigation with bump and go

Based on the function for moving the robot forward and backward and the documentation from the Create's Open Interface manual we can think of further helpful functions that can become part of almost all code examples that make the robot move:

(1) driveStraight (speed)
(2) drive(speed, radius)

(3) stop()
(4) spinLeft(speed)
(5) spinRight(speed)

The final code example has all of these functions implemented and makes use of them in the bump and go behavior:
http://web.ics.purdue.edu/~fwinkler/AD32600_F14/bump_and_go.zip

Outlook & Further Reading

This is just the beginning of what you can do with Arduino and the iRobot Create platform. See the following resources for more project ideas with the iRobot Create/Roomba platform:

- Kurt, Tod E. *Hacking Roomba*. Indianapolis, IN: Wiley,2007.
- Create 2 Project Instructables: http://www.irobot.com/About-iRobot/STEM/Create-2/Projects.aspx
- Create 2 Arduino Tutorial from iRobot: http://www.irobot.com/~/media/MainSite/PDFs/About/STEM/Create/Arduino_Tutorial.pdf