How To Be a Maker!

A free beginner's guide to making cool stuff using Arduino and Raspberry Pi

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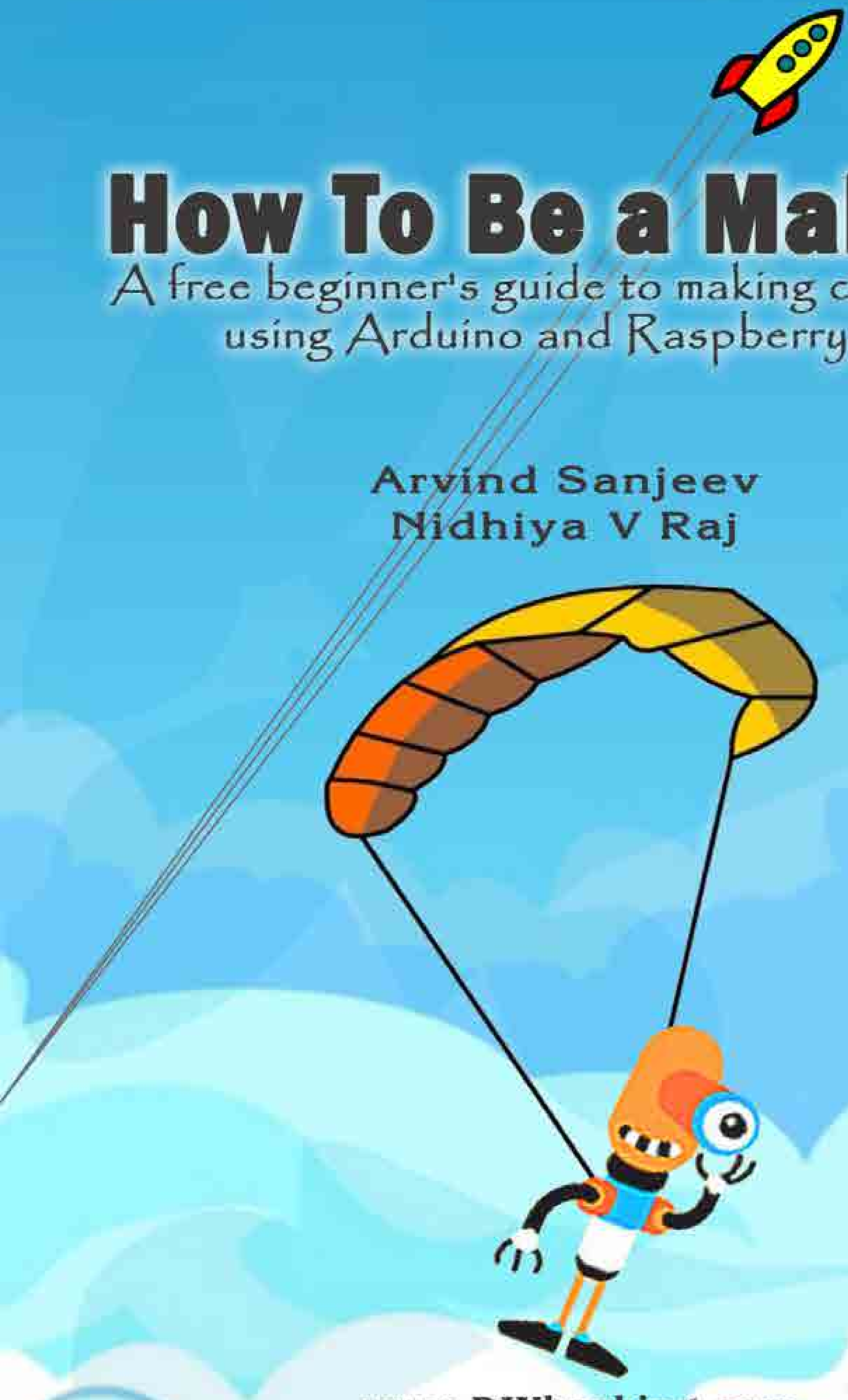


RaspberryPi

ARDUINO

www.DIYhacking.com

Introduction

What this is about and what you gain from it

This ebook is part of an initiative called DIY Hacking (http://diyhacking.com), which has been instigated in the hope of inspiring young minds with technology development. It aims at imparting pragmatic knowledge through various hands on projects and tutorials. It provides tutorials in the realm of the latest technologies, for example: one of the projects published in it – Smart Cap, a DIY Google Glass clone, was even featured on Techcrunch.

Technology prototyping has become so facile and swift today that terms like “Rapid Prototyping” is used instead for it. New and powerful open source development platforms like “Arduino” and “Raspberry Pi” make it easy for even school children to work on robotics and other fascinating technologies. These technologies have become an inevitable step to gaining profound knowledge about microcontrollers and microprocessors and hence should even be made a part of the current academic curriculum.

There are prolific number of communities and forums surrounding these platforms which allow for quick and easy troubleshooting. Furthermore, beginner tutorials in YouTube are also very helpful in gaining a better perspective about it. Today, with the advent of 3D printers, now you can even create a custom casing for your project or print your own PCB.

This ebook will act like a beginner’s guide for you to start prototyping using tools like the Arduino and Raspberry Pi. Moreover, this ebook has been designed in such a way to promote self-learning and ingenuity. So, have fun with this ebook and good luck on being a Maker!

What you will be learning

Who is a MAker?

And some other terms you need to know

A Maker is a person who transforms their project from an idea on paper to reality. Anyone who does this and who uses open source tools for the same can be called a Maker. They even share their project with the world by posting through online blogs or other platforms and thereby contributing back to the same open source community which had aided them initially in their work.

Why you should be a Maker?

Being a Maker is extremely beneficial. Apart from letting you stand in good stead in your community it can also:

- Help you in building a good work-experience profile, thereby increasing your chances of getting a good job.
- Help you earn money while in college, by doing part time work for others.
- Help you gain good credibility and even get covered by the media and newspapers.
- Allow you to work on really cool projects while in college/school.
- Keep you updated with the latest technologies around you and help you develop the skills for building your own.

DIY - Do It Yourself

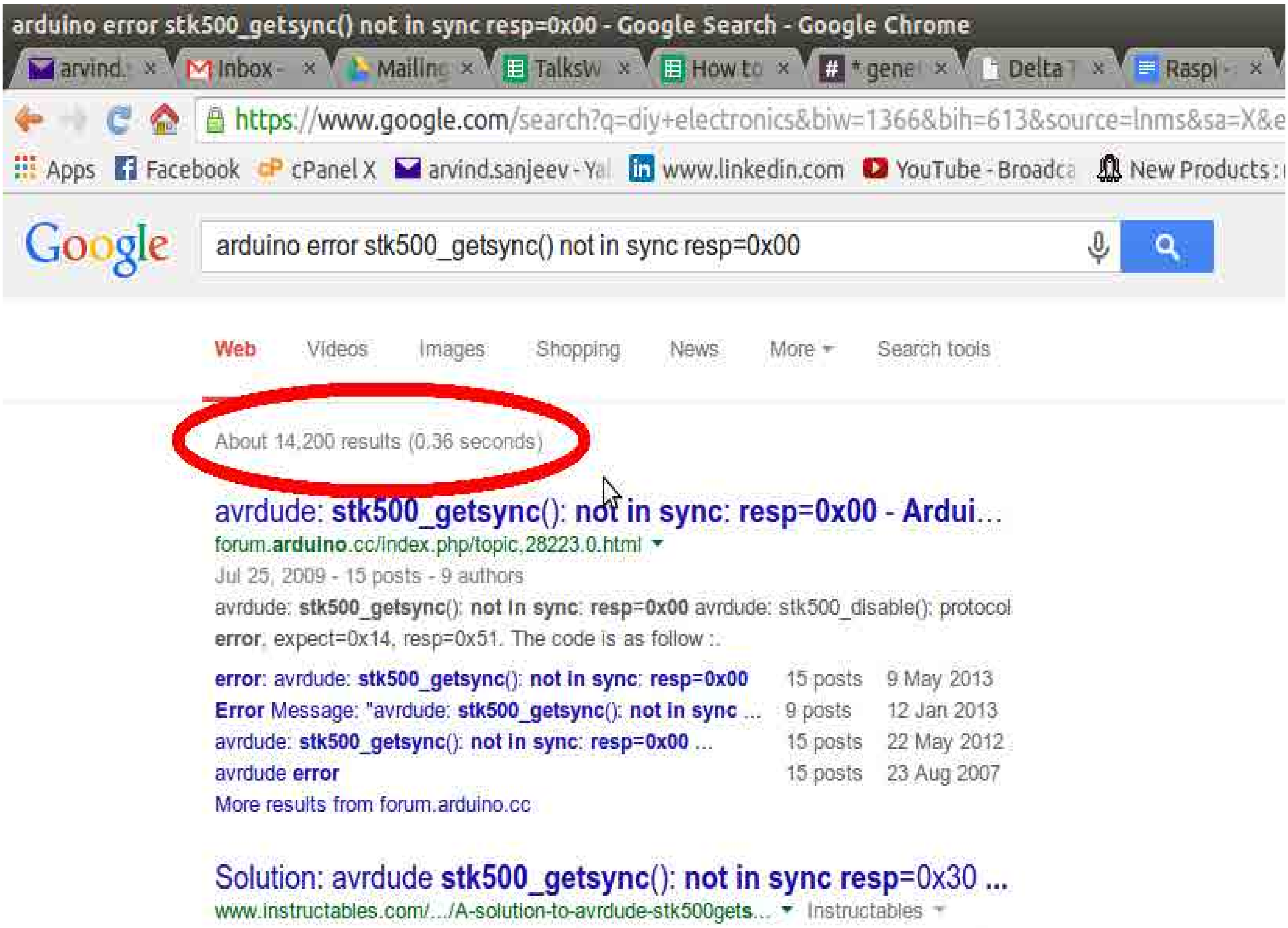
DIY stands for Do It Yourself. DIY is one of the most popular acronyms used by Makers today. It emphasizes on the fact that - everything could be made/achieved with your own effort.

For example: if you want to make an electric car, you can do that yourself today, because of the resources and tons of information relating to that, which is available on the internet right now! Don’t believe me? Check out this article and video in it:

Build an electric car

The DIY phenomenon has created prolific number of communities and projects which allows you to build absolutely anything, using the knowledge from a collective community, instead of just an individual.

The collaborative and altruistic nature of all the members is the sole reason for its success. This means that you can search for queries regarding your project and find innumerable solutions or results pertaining to it, instead of relying on an individual.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forum.arduino.cc/index.php/topic,28223.0.html
Jul 25, 2009 - 15 posts - 9 authors
avrdude: stk500_getsync(): not in sync: resp=0x00 avrdude: stk500_disable(): protocol error, expect=0x14, resp=0x51. The code is as follow :.

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Error Message: "avrdude: stk500_getsync(): not in sync ...	9 posts	12 Jan 2013
avrdude: stk500_getsync(): not in sync: resp=0x00 ...	15 posts	22 May 2012
avrdude error	15 posts	23 Aug 2007

More results from forum.arduino.cc

Solution: avrdude stk500_getsync(): not in sync resp=0x30 ...
www.instructables.com/.../A-solution-to-avrdude-stk500gets... Instructables

What is Open Source?

Open source means that the original project, its design files or even source code is made freely available. You can use this free info for building your projects.

Makers rely on both open source hardware like: arduino and raspberry pi and also on open source software like: python, android OS, etc.

These data are not confined by any patents; instead they are made available for free, so that Makers and DIYers can build upon these free technologies.

Posting to open source

You only become a true Maker when you post your projects online and contribute back to the community. Your efforts will in turn help your friends and others in your community, just like how you were aided in your initial phases.

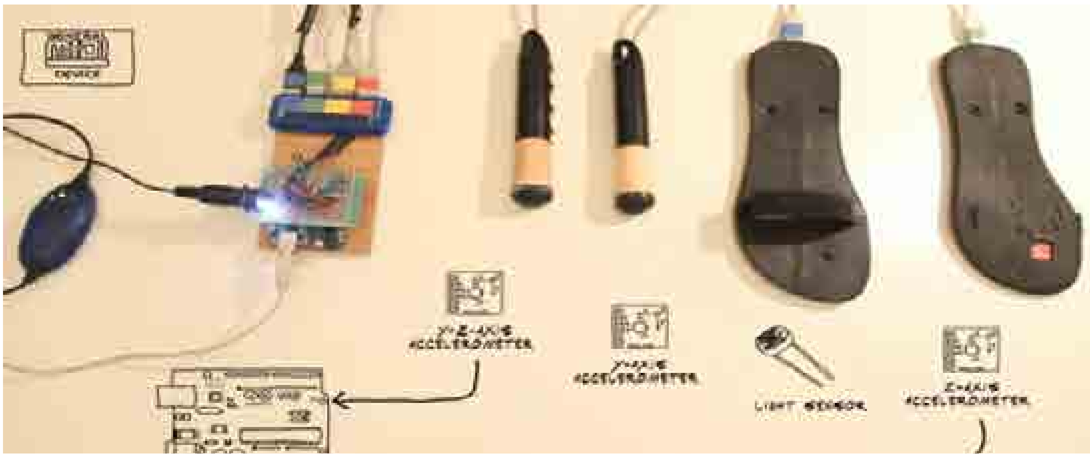
Tools like Github, etc are made available for you to post the source code of your project (https://github.com/). You can view several examples of this at: Instructables and DIY Hacking.

FYI- If you are viewing this Ebook in a web browser, please press the Ctrl button while clicking on the hyperlinks, to open it in a new tab.

DIY Projects

Some cool projects you can do later

Arduino Air Drums Project



In this cool DIY, you can see how you can bring an air drum to life by using an arduino. Check out this cool video to see what I am talking about:
Youtube Video.

Arduino Coke Can Piano

You won't find a better use for used coke cans anywhere else. In this DIY, a Maker has turned a bunch of used coke cans into a really cool and versatile musical instrument.
Youtube Video.

Arduino Passcode Lock for Bikes

The main reason that I did this project was because I always used to keep losing the keys of my scooter and this resulted in getting a lot of duplicate ones made, each time I loose one. So after a lot of frustration, I came up with this idea to use a passcode lock system for my scooter; instead of a keypad lock. Check out this video:
Youtube Video.

Raspberry Pi Based Head Mounted Display

In this DIY project, I was able to create a cool head mounted display which was capable of mimicking the functions of a Google Glass, as it had: a head mounted display, voice recognition and first person video streaming using a webcam. It even got featured on Techcrunch. Check out this video:
Youtube Video.
The guide to making it (check it out after you're finished with this ebook):
Smart Cap Tutorial.

Raspberry Pi Powered Autonomous Boat

Check out this cool project, where a Maker has used a raspberry pi to create an autonomous/remote controlled boat. It even has a camera that streams a live feed from the boat.
Youtube Video.
The tutorial: Autonomous Boat Tutorial.

Raspberry Pi Quadrotor

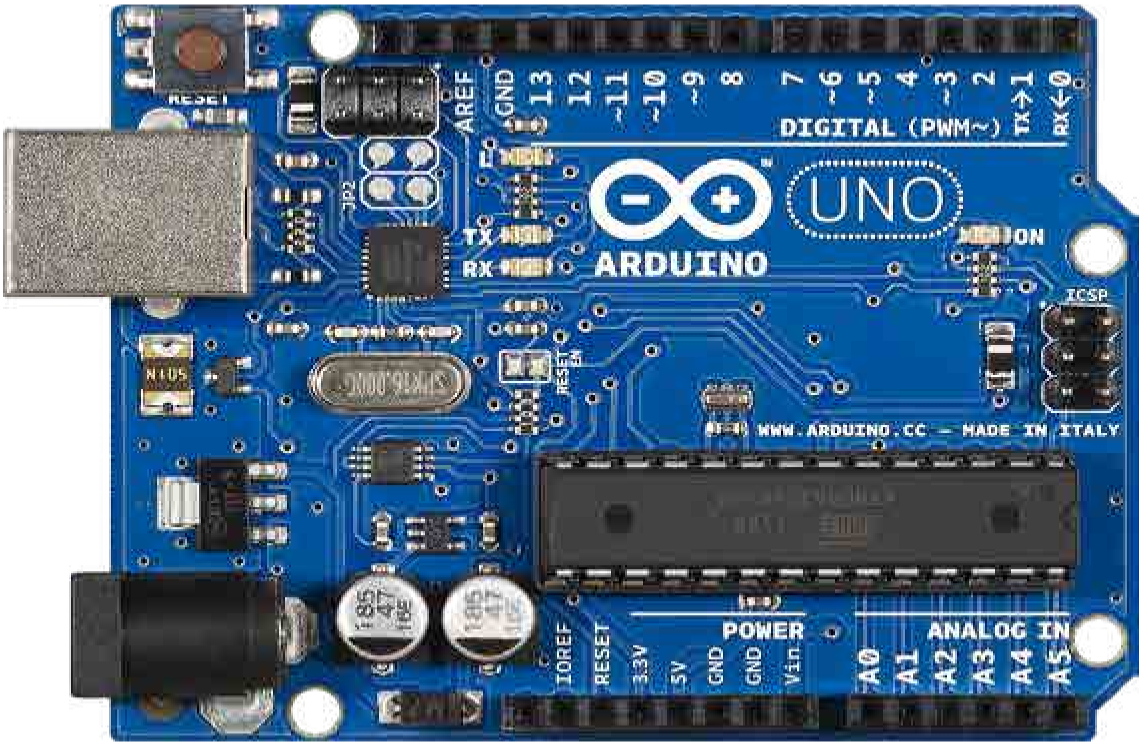
In this project, you can see a quadrotor, which has been built using a raspberry pi. The system uses IMU sensors and brushless motors for stabilizing and powering the copter.
Check out the video:
Youtube Video.
The tutorial: Raspberry Pi Quadrotor Tutorial.

Arduino

The easiest electronics development platform

What is Arduino?

Arduino is an open source microcontroller board designed for quickly prototyping an electronic project. It is an embedded electronics platform, which uses a programming language comprising of simple and easy C/C++ functions. It is a perfect tool that can be used for working on your school/college projects or to quickly prototype a cool product idea.



Arduino is usually interfaced with various sensors like: motion sensors, temperature sensors, etc, either individually or collectively and whose output signals act as an input to arduino, based on which we can program it to do certain tasks. To understand the basic logic flow model for arduino, consider the following example:

Suppose that we have connected a temperature sensor (LM35) to arduino and our objective is to turn ON the air conditioning when the temperature exceeds 27C/80F. For the arduino to do that, we program it using the following logic:

```
if(temperature>27)
{
Turn ON the AC
}
else
{
Turn OFF the AC
}
```

The programming jargon used for “Turn ON the AC” and “Turn OFF the AC” will be explained in detail later.

Now, to get a basic understanding of what arduino is all about and to see some projects that are built using it, watch this video:
Arduino Introduction Video.

The video above initially alludes different sensors such as:

- Photoresistor or LDR (Light Dependent Resistor) - To measure the intensity of light.
- Motion sensor- To detect the presence of a person in a room (using the infra red radiations from our body).
- GPS (Global Positioning System) sensor- To track something in an outdoor environment using latitude and longitude coordinates.

The video also demonstrates the working of a project where: the lights in a living room switch off when you turn ON the TV. This is done using an IR (Infra Red) sensor, which detects the signals coming off from the IR LED of the TV remote. The arduino reads these signals through an IR sensor and commands the lights to be turned OFF/ON depending on these signal values.

You can do all sorts of cool stuff like this, arduino makes it pretty easy. Most of the projects that are built using arduino are even posted as open source with detailed tutorials on platforms like Instructables, DIY Hacking, etc.

Note- Arduino boards come in various forms and types, a few of them are:

- Arduino Uno
- Arduino Due
- Lilypad Arduino- Can be integrated into clothing.
- Arduino Mega- For extra pins and more muscle.

There are also several arduino clone boards like the freeduino, which offer the same functionalities as the arduino, but at a cheaper price (Rs.800 or approx 9$). These boards differ only in appearance; their functions and working are all the same. You can buy these boards and its sensors online from popular sites like Ebay or others. Moreover, you can even make your own arduino boards at home.

Reference link: http://arduino.cc/en/Main/Products?from=Main.Hardware

Getting Technical with Arduino

Some of the chief components that make up the arduino are:

- ATMega328 Microcontroller
  ATMega328 is the brain of Arduino, all the programming and software associated with arduino is loaded inside this. It offers 32 KB of program memory and runs at 5V.

- FTDI (Future Technology Devices International) USB Chip
  This chip is responsible for converting the USB signals (from the PC) into serial UART signals, understandable by arduino.

- Voltage Regulator
  This chip is used to provide a constant 5V power supply to the arduino from the power jack. Arduino can also be powered alternatively through the USB cable.

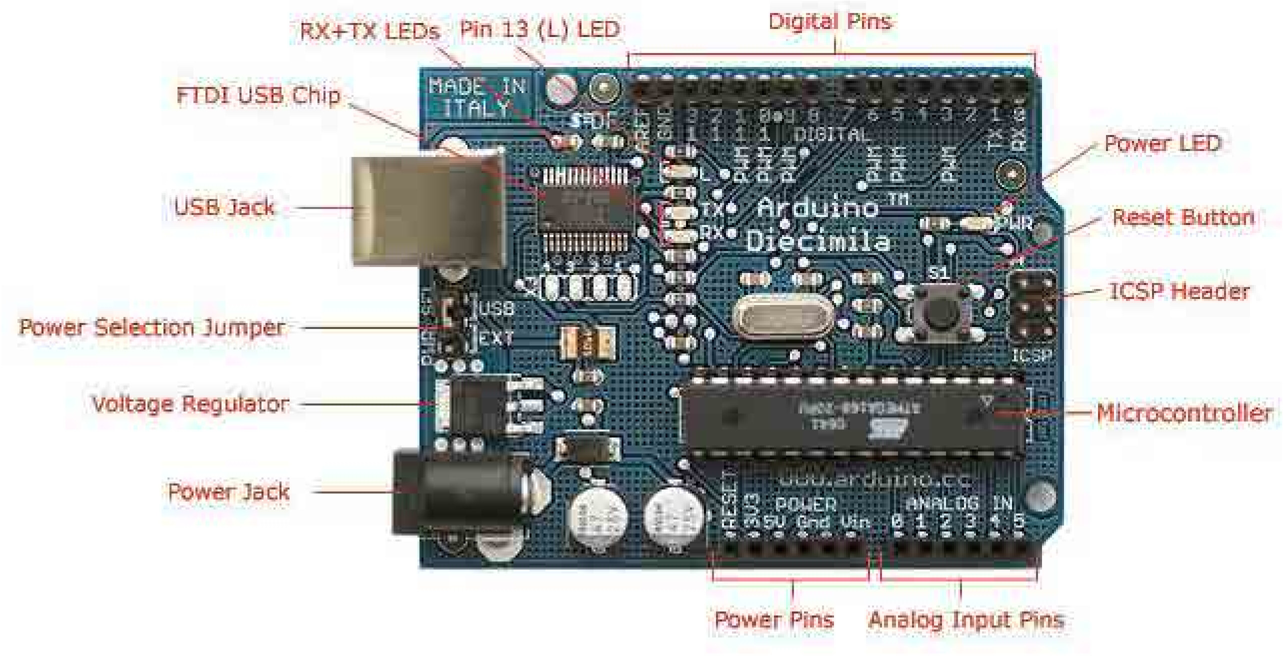
- Clock Crystal
  The 16 MHz crystal is used as the clock to arduino, it is imperative for applications relating to timing, etc.

- Reset Button
  To reset a program running on the arduino, that is to make it run from the beginning.

- Digital Pin headers
  Digital pins are present for digital control applications and to interface with digital sensors respectively.

- Analog Pin headers
  To interface with analog sensors, it can also be used as GPIO (General Purpose Input/Output) pins.

For more information, please check out: http://www.arduino.cc/en/Reference/Board



Pin Assignments

To connect a sensor or a motor to an arduino, you need to connect them to its pins. Hence, you'll be using them for all your projects. The three different types of pins and their uses are:

1. Power Pins

   These are the set of 6 pins on the lower left side of the board as in the figure above. The ones you would use most frequently from these are:

   - 5V

     To provide a 5V output power supply to your sensors, motors, LEDs or other components you connect to arduino. The arduino supplies the power to these external peripherals.

   - GND

     Every component that you connect to the arduino requires a GND (ground) connection along with the power supply. This pin is used to provide the ground connection to those external peripherals.

   - 3V3

     This pin provides 3.3V power supply to external peripherals like sensors, etc, since some of the sensors work at 3.3V instead of 5V.

2. Analog Pins

The six analog pins in the arduino (0-5) are used to connect to analog sensors. These pins have the capability to convert the analog signals or voltages from these sensors into digital (in the range 0-1023) using the ADC (analog to digital converter) on the AT-Mega328. Pins 4, 5 are also used for I2C communication with sensors like IMU (Inertial Measurement Unit), etc.
Reference link: http://arduino.cc/en/Tutorial/AnalogInputPins

For example: if you need to connect a light sensor (LDR), you connect it to one of the analog pins. The variations in light intensity are interpreted in the form of voltage variations from 0-5V, which are converted into the digital range 0-1023, by arduino. 0- being the lowest intensity of light and 1023- the highest intensity.
Reference video: Arduino LDR Tutorial.

3. Digital Pins

The digital pins in the arduino range from 0-13. These pins are used for connecting LEDs, motors, or even digital sensors to arduino. These are called as GPIO (General Purpose Input/Output) pins, since they can be used for either taking inputs from sensors or can be used to control output devices like LEDs. These pins can provide a maximum of 5V to power output devices like LEDs or relays.
These pins (0, 1) also support UART communication, to communicate with sensors like bluetooth, xbee, etc.

Hands - On with your Arduino

The following are the stuff you need to have with you, in order to start working on your arduino project:

1. Arduino or arduino clone board.
2. USB programming cable.
3. Laptop/PC.
4. Arduino IDE (Integrated Development Environment).

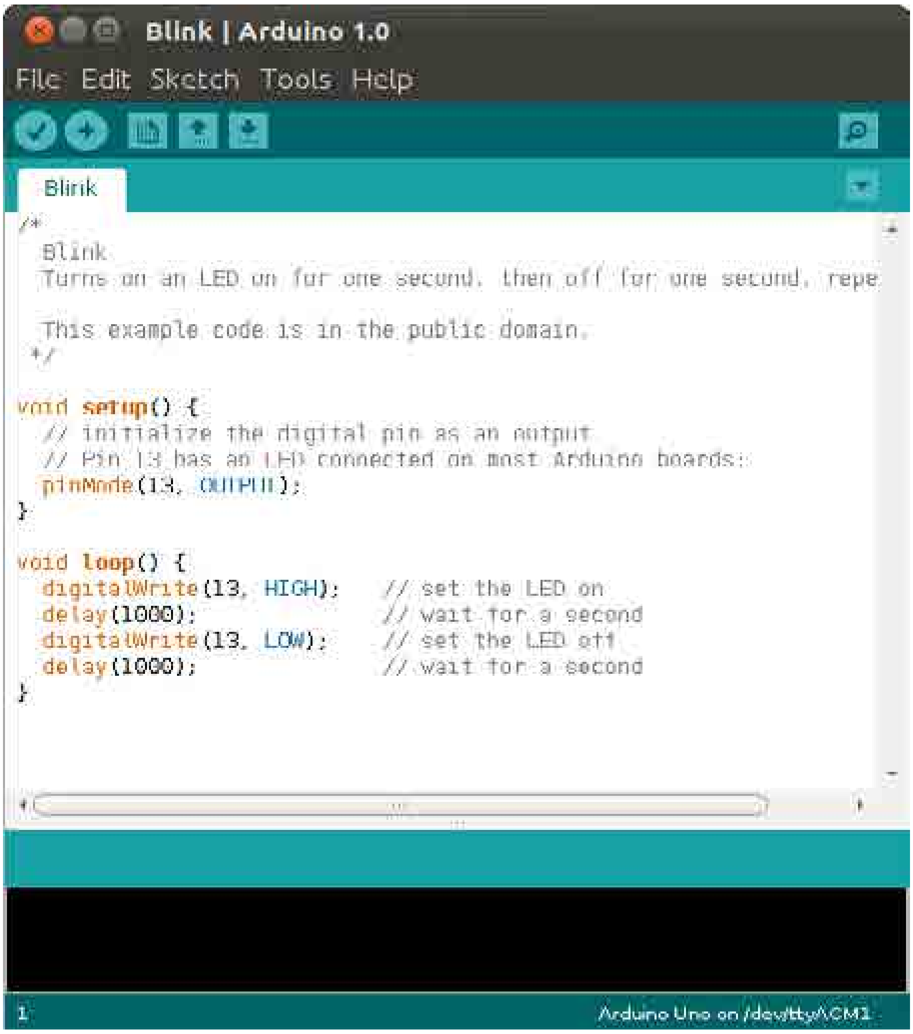
First Step - Downloading the Arduino IDE on your Computer

To download the arduino software, go to: http://arduino.cc/en/main/software and select the latest version of arduino and your respective operating system and download it.

Since the downloaded file is a zip file, you just need to extract it and then click on the arduino application to launch it.

To see this in action, watch this video from 4:40: Arduino Installation Video.

The earlier video is just one of the several arduino tutorial videos which are available on youtube, you can refer them for learning about arduino in detail.



```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repe

  This example code is in the public domain.
 */

void setup() {
  // initialize the digital pin as an output.
  // Pin 13 has an LED connected on most Arduino boards:
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);   // set the LED on
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // set the LED off
  delay(1000);              // wait for a second
}
```

The Arduino IDE

Second Step - Hooking up arduino to your computer

Use the USB cable to connect your arduino to your computer and check to see if the power light on the arduino is ON.
If you find that the driver is not successfully installed, refer to the video given above to view the solution.

Now, we need to find the COM port assigned to your arduino (this is a serial port assigned to each serial device that is connected to your computer).

For doing this:

1. First open the arduino IDE and disconnect your arduino from your computer, then go to: Tools → Serial Port and find out the names of the serial ports listed there and note them down.

2. Next, connect the arduino to your PC and again go to: Tools → Serial Port and check to see if a new COM port has come up this time, by comparing with the list you noted earlier. This new COM port is the one assigned to your arduino.

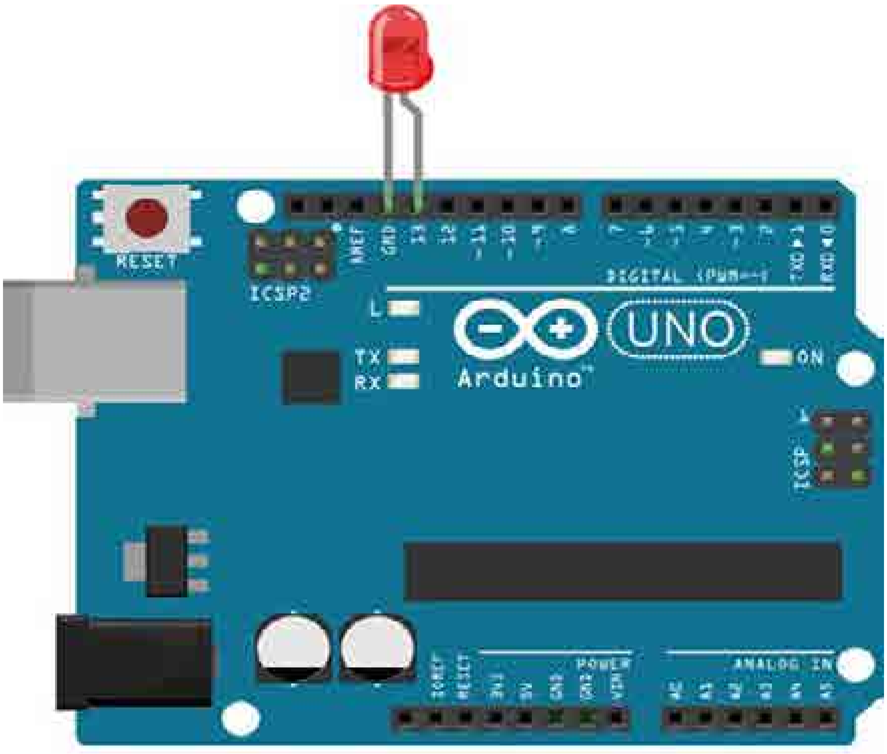
Furthermore, select your arduino board from: Tools → Board, most of the boards out there are Arduino Uno, so select Arduino Uno.

Third Step - Loading your First Arduino Program

Now, we'll try to blink an LED using arduino. There are several example programs available for the arduino, you can access them from: File → Examples. To program the arduino to blink an LED, you can view the example program from: File → Examples → Basics → Blink.

This is a video which shows how the program is uploaded to the arduino board and how the LED is connected to it.

Arduino LED Blink Video.



This is the program code for the above program to blink an LED, “//” represents comments, which are not read during program execution:

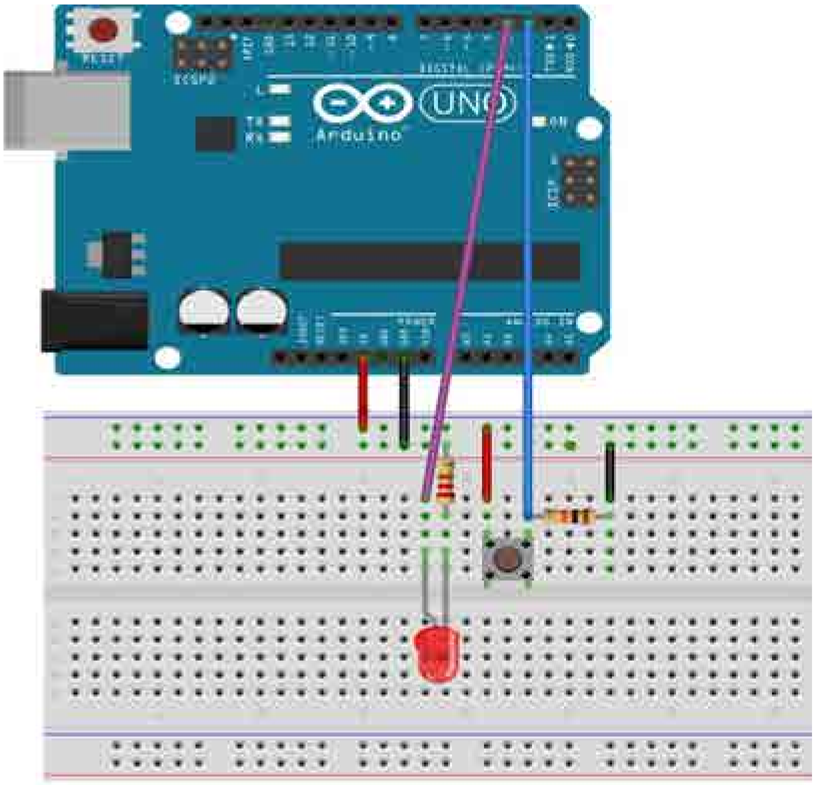
```
void setup()  {
pinMode(13,OUTPUT);    //assigns digital pin 13 as the output pin
}

void loop()  {
digitalWrite(13, HIGH);     //sets pin 13 to 5V
delay(1000);                //maintains pin 13 at 5V for 1000ms or 1 second.
digitalWrite(13, LOW);      //sets pin 13 to 0V
delay(1000);                //maintains pin 13 at 0V for 1000ms or 1 second.
}
```

After uploading this code, by pressing the upload button on the arduino IDE, you will notice an LED blinking on the arduino.
Note - In arduino, by default there is an LED connected to pin 13 on the board, so it’s not necessary to connect an external LED to it.

Congrats! You have now successfully run your first arduino program.

Programming in Arduino

Here, let us consider an example of switching an LED ON using a button switch. The connections are made as per the following image.



Based on the above example I will be explaining the programming structure in arduino. Here, we need to find the state of the button press and switch ON the LED accordingly. Furthermore, if the button is pressed, a HIGH (5V) voltage is passed to the digital pin; else a LOW (0V) voltage is passed.

The two basic functions that are used in every arduino program are:

- void setup()
  This function is used to set up the pins, baud rate, etc of the arduino for a particular program. It is run only once initially, unlike the void loop(). It is used to define pins as input/output, set the baud rate for communication, etc.

An example of its use:

```
void setup()
{
pinMode(2,  INPUT);          //sets digital pin 2 as INPUT pin for a button switch
Serial.begin(9600);          //sets baud rate for communicating with your computer
                                                                    at 9600bps.
}
```

- void loop()
  This function is the main program loop of arduino. Everything that the arduino is supposed to do is written inside here. The code written inside this function keeps repeating again and again until it is programmed over the next time.

  Here, digital value 0 indicates no or LOW voltage and digital value 1 indicates HIGH voltage.

  An example of its use:

```
    void loop()  {
    int button=digitalRead(2);   //reads the state of the button switch on pin 2.

    if (button == 0)             //if the button is not pressed
    {
      digitalWrite(3, LOW);      //turn the LED on pin 3 OFF
    }

    else if (button == 1)        //if the button is pressed
    {
     digitalWrite(3, HIGH);      //turn the LED on pin 3  ON
    }
```

Here, the if-else statements determine whether the LED should be turned ON/OFF. Thus, when the arduino detects a button press, it turns ON the LED, else switches it OFF.

Some popular functions in arduino:

- digitalRead()
  Used to read digital signals from a switch or sensor.
  Syntax: digitalRead(1);

- digitalWrite()
  Used to output voltages: HIGH (5V) and LOW (0V).
  Syntax: digitalWrite(1, HIGH);

- analogRead()
  Used to read analog voltage signals from a sensor.
  Syntax: analogRead(0);

- analogWrite()
  Used to output voltages in the mapped range of 0-1023 (0-5V).
  Syntax: analogWrite(1, 700);

- Serial.print()
  Used to print or view data from the sensors via the arduino serial monitor.
  Syntax:Serial.print("hello");

- delay()
  To delay the next command for a particular period.
  Syntax: delay(1000);

Interfacing Sensors with Arduino

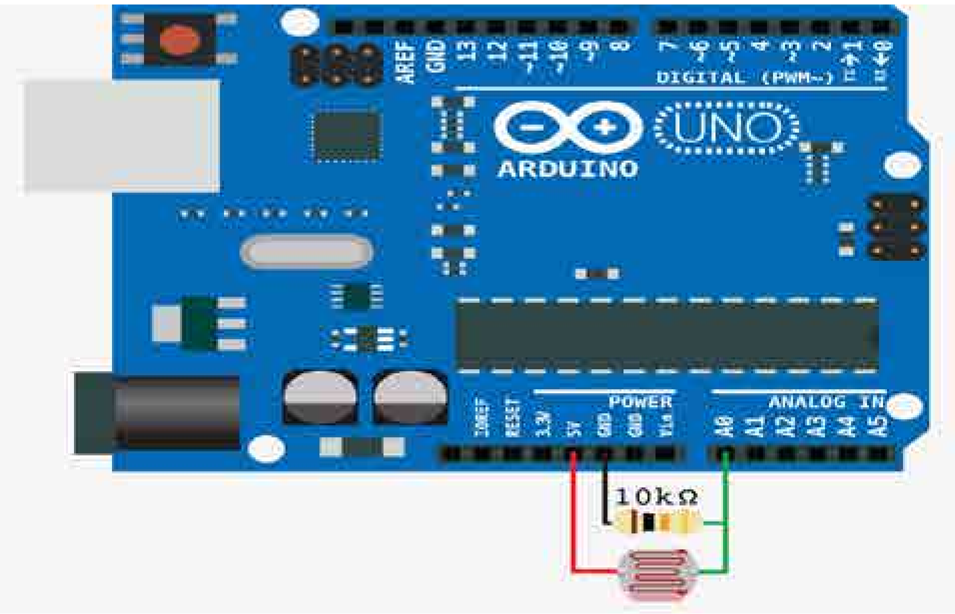
LDR (Light Dependent Resistor)

Purpose - To detect intensity of light.

Connection - To arduino analog pins.

Example - It can be used to create an automatic emergency light, which turns itself ON using an arduino when the lights in a room turn OFF due to power supply failure.

Reference - [Youtube Video.]



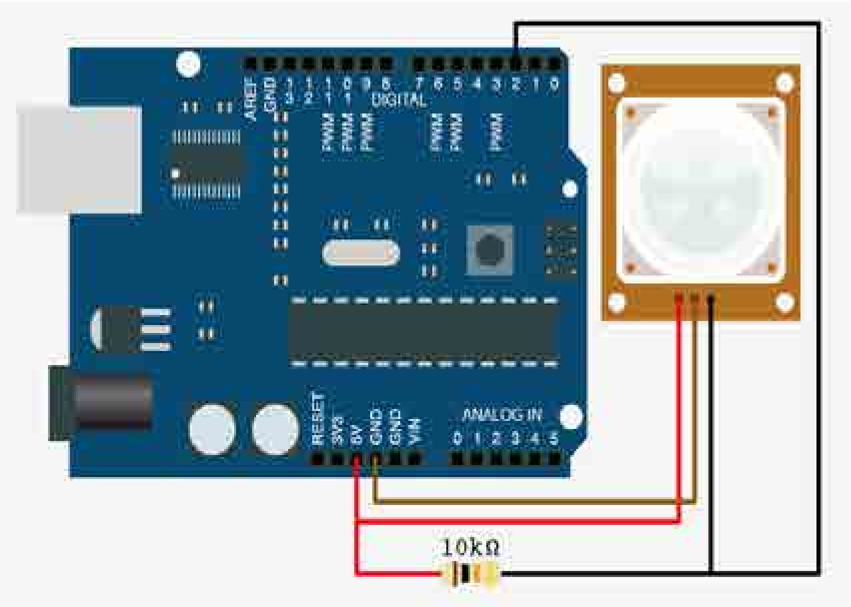
PIR (Passive InfraRed) Motion sensor

Purpose - To detect the presence of a person in a room.

Connection - To arduino digital pins.

Example - It can be used to automatically turn ON the lights in a room, when a person or a group of people walks inside.

Reference - [Youtube Video.]



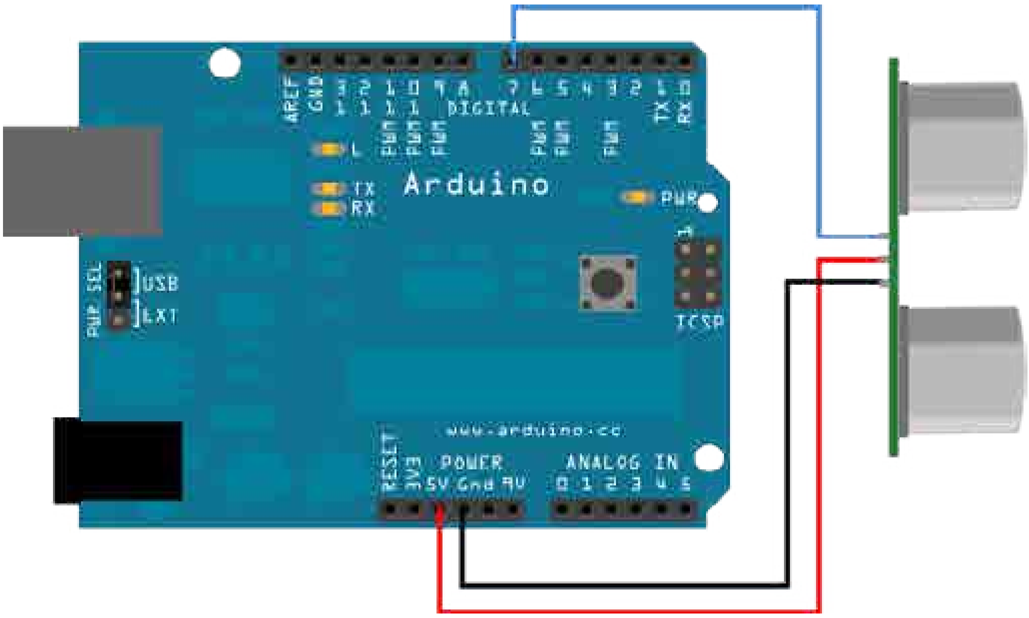
Ultrasonic Distance Sensor

Purpose - To detect the distance from nearest object.

Connection - To arduino digital pins.

Example - To build an obstacle avoiding robotic car.

Reference - Arduino Ultrasonic Sensor Tutorial.



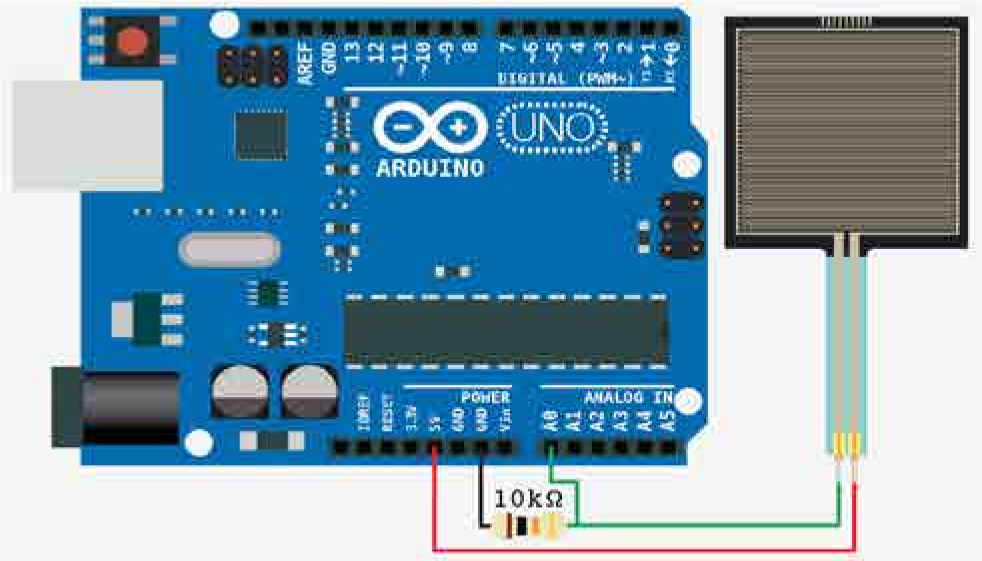
Force Sensitive Resistor (FSR)

Purpose - To detect the applied force.

Connection - To arduino analog pins.

Example - Can be placed under the door mat, outside your door and used to detect guests at your home, when they step over the mat.

Reference - [Arduino Force Sensitive Resistor.]()



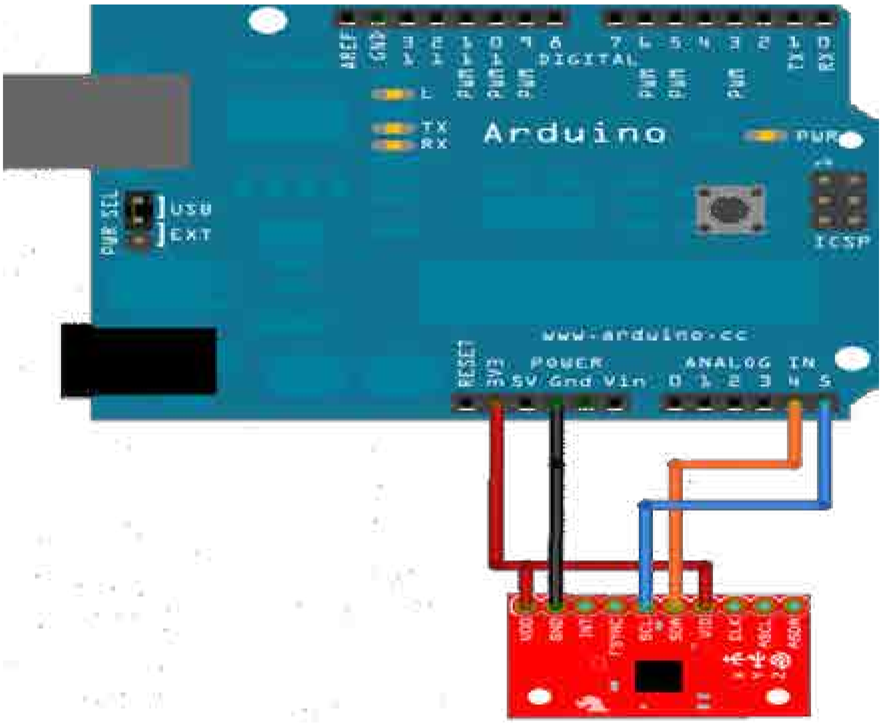
IMU (Inertial Measurement Unit) Sensor

Purpose - To detect movement in 3D space.

Connection - To arduino I2C pins (analog 4,5), other variants use normal analog pins too.

Example - If you have this sensor placed on your hand, you can program arduino to control a robot or other stuff based on the gestures you make with your hand.

Reference - [Arduino IMU Sensor.]()



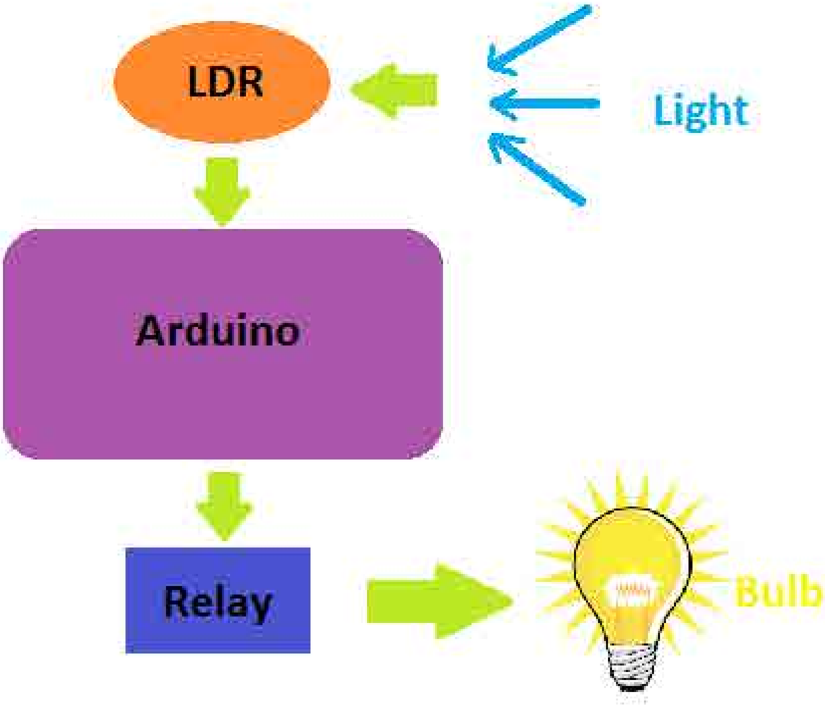
Arduino DIY Project - Auto lights

Wouldn't it be cool if we could eliminate darkness? In this beginner arduino project, I have posted a very simple project that focuses on eliminating darkness.
What it does is that- whenever a room gets dark due to a fused bulb or any other factors, a light bulb automatically turns ON. This can be used even as an emergency lighting system, which automatically turns a light ON whenever there isn't sufficient light in a room.
Here, in order to detect the intensity of light or darkness, we use a sensor called LDR (Light Dependent Resistor). The LDR is a special type of resistor which allows higher voltages to pass through it (low resistance) whenever there is high intensity of light and passes a low voltage (high resistance) whenever it is dark. We can take advantage of this factor of the LDR and use it in our DIY project. Check this link to know more about LDR.

What are the stuff required to do this project?

Hardware:
Arduino or an arduino clone board (freeduino).
LDR (you can buy it online or from a local electronics store very cheaply)
5V SPDT Relay
9V Battery and connector
Connecting wires

Software:
Arduino IDE



How does it work?

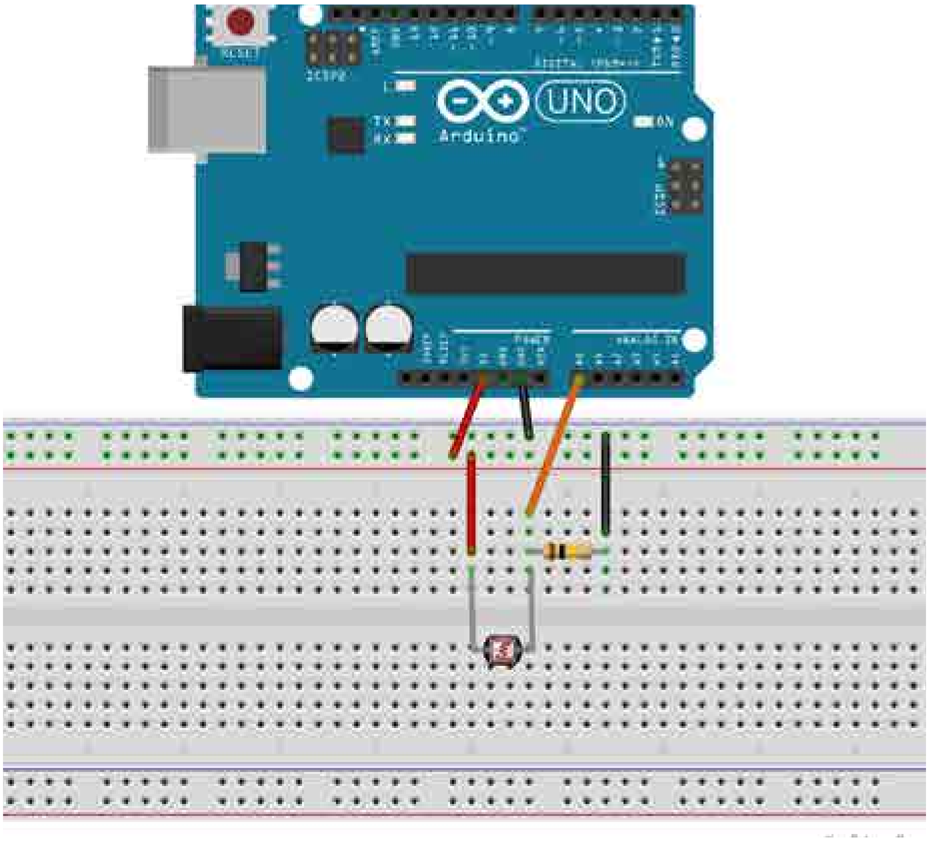
This system works by sensing the intensity of light in its environment. Here, the sensor that can be used for detecting light is an LDR, you can buy it from any local electronics store or online, for a very cheap price.

The LDR gives out an analog voltage when connected to Vcc (5V), which varies in magnitude in direct proportion to the input light intensity on it. That is, greater the intensity of light, greater will be the corresponding voltage from the LDR. Since the LDR gives out an analog voltage, it is connected to the analog input pin of the arduino. The arduino, with its inbuilt ADC (Analog to Digital Converter) then converts the analog voltage (from 0-5V) into a digital value in the range of (0-1023). Thus, when there is sufficient light in its environment or on its surface, the converted digital values read from the LDR through the arduino will be in the range of 800-1023.

Furthermore, we then program the arduino to turn ON a relay and hence correspondingly turn ON an appliance (light bulb), when the light intensity is low (can be done by covering the surface of the LDR with any object). That is, when the digital values read are in the higher range than usual.

Step 1: Connecting the components together

First of all, you need to connect the LDR to the analog input pin 0 of arduino. You have to use a voltage divider configuration to do this. The connection diagram for the arduino is as given below:



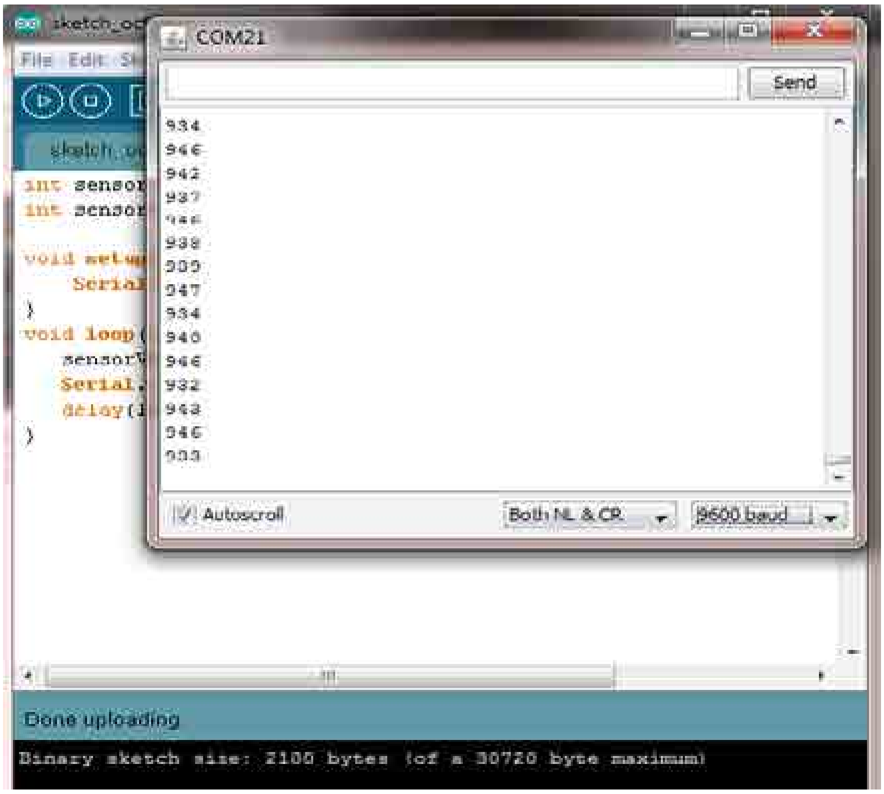
Here, one leg of the LDR is connected to VCC (5V) on the arduino, and the other to the analog pin 0 of the arduino, a 100K resistor is also connected to the same leg and grounded.

Step 2: Uploading the code and testing the LDR

Now, after connecting the LDR to arduino, we can check for the values coming from the LDR via arduino. For this, connect the arduino via USB to your PC and open up the arduino IDE or software. Now, paste this code and upload it to arduino:

```
int sensorPin = A0;   // select the input pin for ldr
int sensorValue = 0;  // variable to store the value coming from the sensor
void setup() {
    Serial.begin(9600); //sets serial port for communication
}
void loop() {
   sensorValue = analogRead(sensorPin);   // read the value from the sensor
   Serial.println(sensorValue); //prints the values coming from the sensor on the screen
   delay(100);
}
```

After uploading the code, click on the button on the arduino IDE called “Serial monitor“. This will open a new window, which prints different values on the screen. Now, test out the sensor, block its surface from light and see what all values you get on the serial monitor. This is how it looks:



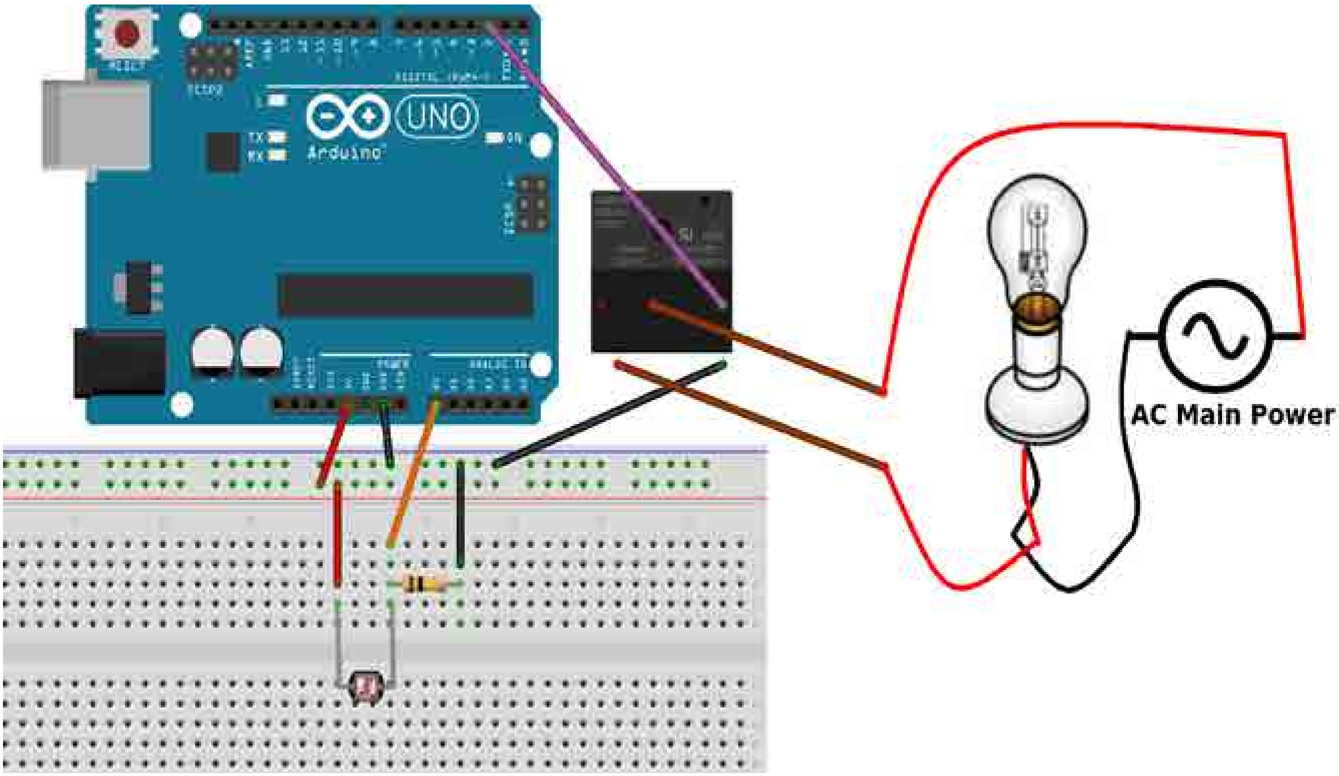
```
934
946
942
937
946
938
939
947
934
940
946
932
943
946
933
```

Done uploading

```
Binary sketch size: 2100 bytes (of a 30720 byte maximum)
```

Step 3: Connecting the relay to arduino

A relay is an electro mechanical switch; it can be used to turn ON/OFF an appliance working on AC/DC. Here, when the arduino supplies HIGH voltage (5V) to the relay, it turns it ON (the switch is ON), else it remains OFF. You can learn more about it in detail here.
In this project, we are using a 5V SPDT (Single Pole Double Throw) relay and connecting one terminal of the coil to arduino digital pin 2, and the other end to GND. We are connecting a light bulb to it as well, since we are dealing with high power AC voltages, do take proper precautions. If you are still confused about connecting a relay to an appliance, check this link. The overall circuit is now as shown:



After connecting the arduino as shown above, next we need to test it by uploading the final code to arduino. The final sketch can be found here: arduino code.
In this sketch, we have set a threshold light value as 700, but it can vary for your projects, you need to find out the particular value, below which the light bulb should turn ON. This needs to be done after testing it empirically. So basically, the arduino turns ON the light bulb (via the relay) whenever the light intensity falls below 700, and when it is above 700, it turns the light bulb OFF. Finally a video showing it in action:

Youtube Video.

To know more about this project and others, check out: http://diyhacking.com.

Some Arduino DIY Projects

Secret knock detecting lock

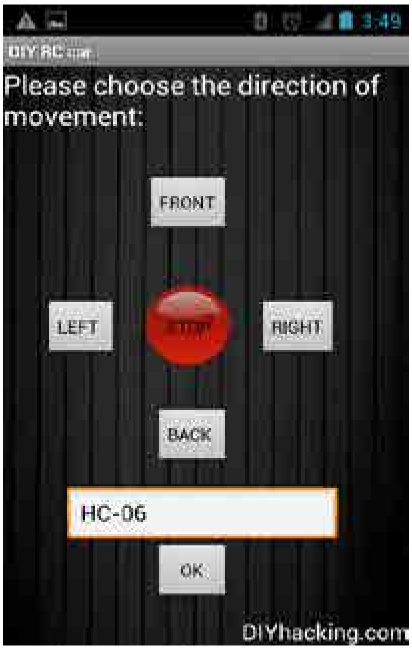
Protect your privacy by making your own intelligent door lock that unlocks based upon a pre programmed secret knock combination. Watch it in action:
Youtube Video.
Tutorial: Instructables Tutorial.

Arduino kitten feeder

Make an automated pet feeder with this easy tutorial. It uses a linear actuator to pass the correct amount of pet feed.
Tutorial: Arduino Kitten Feeder Tutorial.

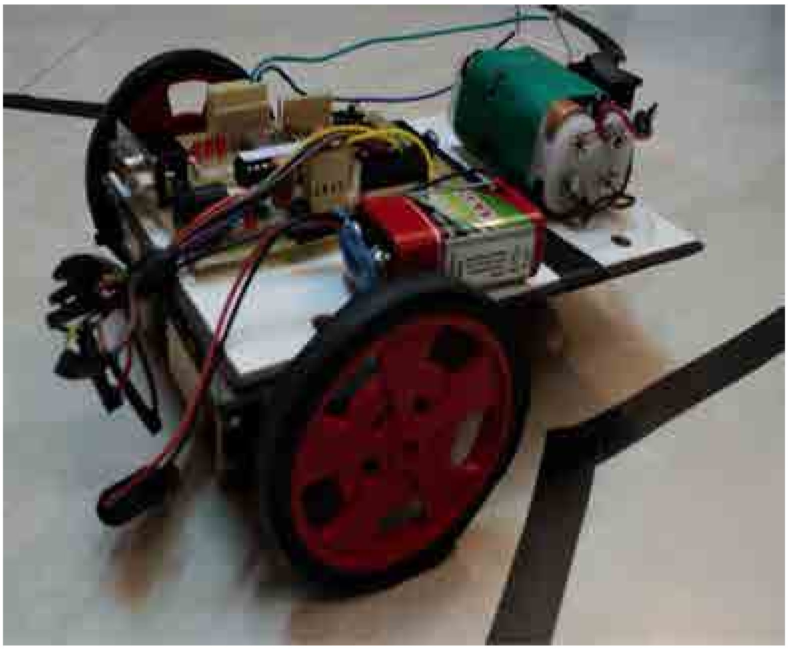
Smartphone controlled robot

Make a really cool android smartphone controlled robot with this tutorial. Use your smartphone as a remote control, to control your robotic car. Watch it in action:
Youtube Video.
Tutorial: DIY Hacking Tutorial.



Please choose the direction of movement:

HC-06



And several more, available on http://diyhacking.com/ .

Additional Resources and Tutorials

Arduino Tutorial Series:

Check out this arduino beginner tutorial series to get a feel of working with arduino, there are several other tutorial series similar to this available on YouTube:
Arduino Youtube Tutorial Series.

Support and guidance:

Whenever you are beleaguered with errors on arduino, you can always search through Google for the solution. I can guarantee that there would be several others who would have faced the same problems/errors and who would have found solutions to it. Hence, readymade solutions to several of them would already be present in the net.

You can also use arduino forums, to post your queries or doubts regarding arduino, if you were unable to find an appropriate solution to it: http://forum.arduino.cc/

Raspberry Pi

The tiny and super cool mini PC

The raspberry pi is an extremely sleek and tiny computer board. It is about the size of a normal credit card, and runs on a linux based operating system called the raspbian. This board can be thought of as a miniaturized version of the motherboard in your CPU. It might not offer the same powerful processing capabilities as a normal PC, but it gets the job done. The raspberry pi can be manipulated to turn ON/OFF relays, LEDs, motors, etc using its GPIO pins and by using python programming (one of the easiest programming languages).

Just like how you need to hook up your CPU to a monitor, keyboard, mouse and LAN. The raspberry pi also offers USB ports for hooking up a keyboard and mouse, an HDMI (High Definition Multimedia Interface) port to connect a monitor/TV and an ethernet port to hook your LAN cable, to gain internet access. And the raspberry pi is powered using a micro USB port on it (5v, 1A), you can use your normal smartphone charger to connect and power it.

Just like you have a hard disk on normal computers, the raspberry pi has an SD card that acts as the hard disk. The OS is loaded into the SD card and plugged into the board. You can use various memory capacity SD cards: 8GB, 16GB, 32GB, etc.

You can buy these boards online from popular sites like EBay or others for about Rs.2,800 (40$).

Now, check out this cool introduction video about raspberry pi from raspberry pi.org: Raspberry Pi Introduction Video.

Getting Technical with Raspberry Pi

There are different versions of the raspberry pi:

1. Raspberry pi model A
2. Raspberry pi model B
3. Raspberry pi model B+

However, most of the boards out there are model B or B+, so you are more likely to end up with them. B+ is the latest and updated version of model B, offering four USB ports and other features. Whereas, the model B was introduced as the updated and more powerful version of the model A.
The basic specifications of the latest model B+ board are as follows:

Specifications:

Chip	Broadcom BCM2835 SoC
Core architecture	ARM11
CPU	700 MHz Low Power ARM1176JZFS Applications Processor
GPU	Dual Core VideoCore IV® Multimedia Co-Processor Provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure
Memory	512MB SDRAM
Operating System	Boots from Micro SD card, running a version of the Linux operating system
Dimensions	85 x 56 x 17mm
Power	Micro USB socket 5V, 2A

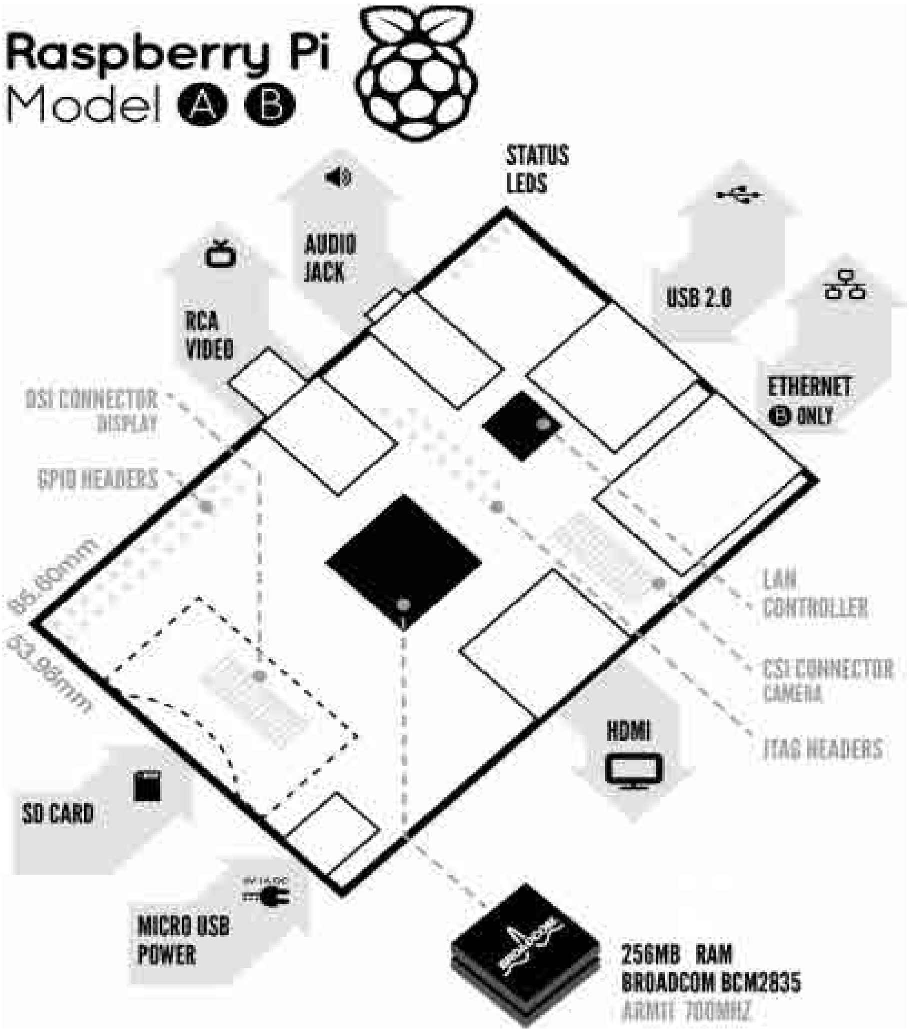
Connectors:

Ethernet	10/100 BaseT Ethernet socket
Video Output	HDMI (rev 1.3 & 1.4) Composite RCA (PAL and NTSC)
Audio Output	3.5mm jack, HDMI
USB	4 x USB 2.0 Connector

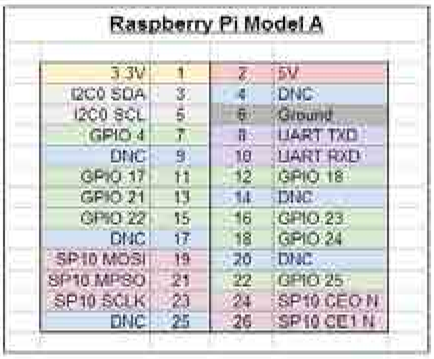
GPIO	Connector 40-pin 2.54 mm (100 m) expansion header: 2x20 strip Providing 27 GPIO pins as well as +3.3 V, +5 V and GND supply
Camera Connector	15-pin MIPI Camera Serial Interface (CSI-2)
JTAG	Not populated
Display Connector	Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane
Memory Card Slot	SDIO

To view the specifications of the model A, B and B+ and to compare their features, please check out: http://elinux.org/RPi_Hardware

The raspberry pi offers USB ports for connecting various peripherals like: keyboards, mouse, pen drives, webcams, etc. It also offers a LAN port, HDMI, composite video plugs, audio output jack, GPIO pins, etc. Check out the following diagram:

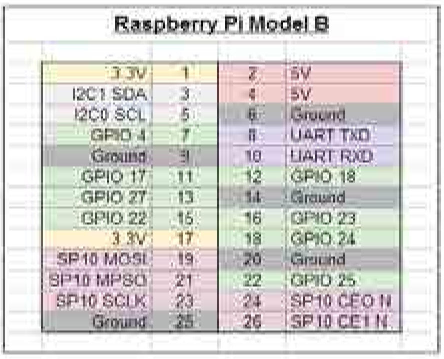


GPIO (General Purpose Input/Output) pins



Raspberry Pi Model A

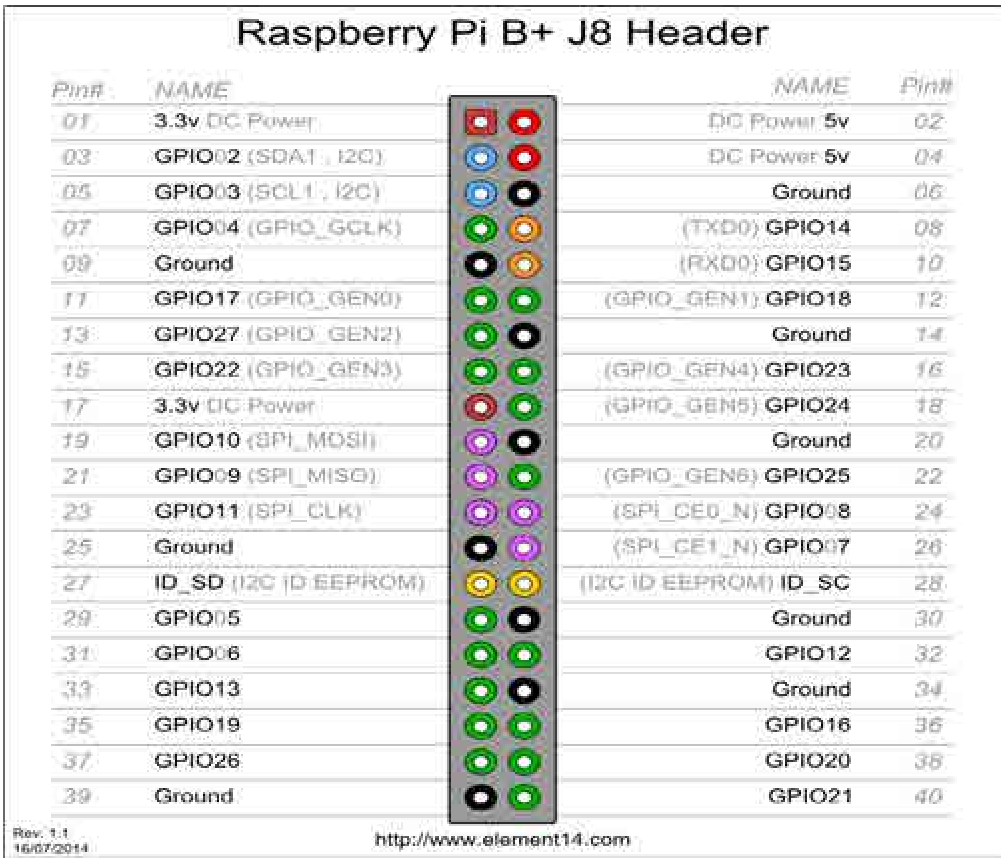
3.3V	1	2	5V
I2C0 SDA	3	4	DNC
I2C0 SCL	5	6	Ground
GPIO 4	7	8	UART TXD
DNC	9	10	UART RXD
GPIO 17	11	12	GPIO 18
GPIO 21	13	14	DNC
GPIO 22	15	16	GPIO 23
DNC	17	18	GPIO 24
SP10 MOSI	19	20	DNC
SP10 MPSO	21	22	GPIO 25
SP10 SCLK	23	24	SP10 CEO N
DNC	25	26	SP10 CE1 N



Raspberry Pi Model B

3.3V	1	2	5V
I2C1 SDA	3	4	5V
I2C0 SCL	5	6	Ground
GPIO 4	7	8	UART TXD
Ground	9	10	UART RXD
GPIO 17	11	12	GPIO 18
GPIO 27	13	14	Ground
GPIO 22	15	16	GPIO 23
3.3V	17	18	GPIO 24
SP10 MOSI	19	20	Ground
SP10 MPSO	21	22	GPIO 25
SP10 SCLK	23	24	SP10 CEO N
Ground	25	26	SP10 CE1 N

While working on your robotics or other kinds of projects with your raspberry pi, the GPIO pins act as the interface between the board and the external circuit of your project (relays, LEDs, motors, arduino, etc).



Raspberry Pi B+ J8 Header

Pin#	NAME	NAME	Pin#
01	3.3v DC Power	DC Power 5v	02
03	GPIO02 (SDA1 , I2C)	DC Power 5v	04
05	GPIO03 (SCL1 , I2C)	Ground	06
07	GPIO04 (GPIO_GCLK)	(TXD0) GPIO14	08
09	Ground	(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)	(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)	Ground	14
15	GPIO22 (GPIO_GEN3)	(GPIO_GEN4) GPIO23	16
17	3.3v DC Power	(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)	Ground	20
21	GPIO09 (SPI_MISO)	(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)	(SPI_CE0_N) GPIO08	24
25	Ground	(SPI_CE1_N) GPIO07	26
27	ID_SD (I2C ID EEPROM)	(I2C ID EEPROM) ID_SC	28
29	GPIO05	Ground	30
31	GPIO06	GPIO12	32
33	GPIO13	Ground	34
35	GPIO19	GPIO16	36
37	GPIO26	GPIO20	38
39	Ground	GPIO21	40

Rev. 1.1
16/07/2014

http://www.element14.com

In order for the board to control these external peripherals, you just need to connect them to the GPIO pins and write the corresponding python program to power ON/OFF a particular pin, which consequently turns ON/OFF the device attached to that pin (LEDs, relays, etc).

You can also connect sensors or other peripherals that communicate using I2C (Inter-Integrated Circuit), SPI (Serial Peripheral Interface) and UART (Universal Asynchronous Receiver Transmitter). The raspberry pi has dedicated GPIO pins for communicating using each of these protocols as shown above.

For more information on using GPIO pins and to learn to connect an LED to it, check this: http://www.raspberrypi.org/documentation/usage/gpio/

Hands - On with your Raspberry Pi

Before moving on to hooking up your raspberry pi, check out this really cool and short quick start video from raspberrypi.org:
Raspberry Pi Quick Start Video.

The tools required for you to begin working on your raspberry pi project are:

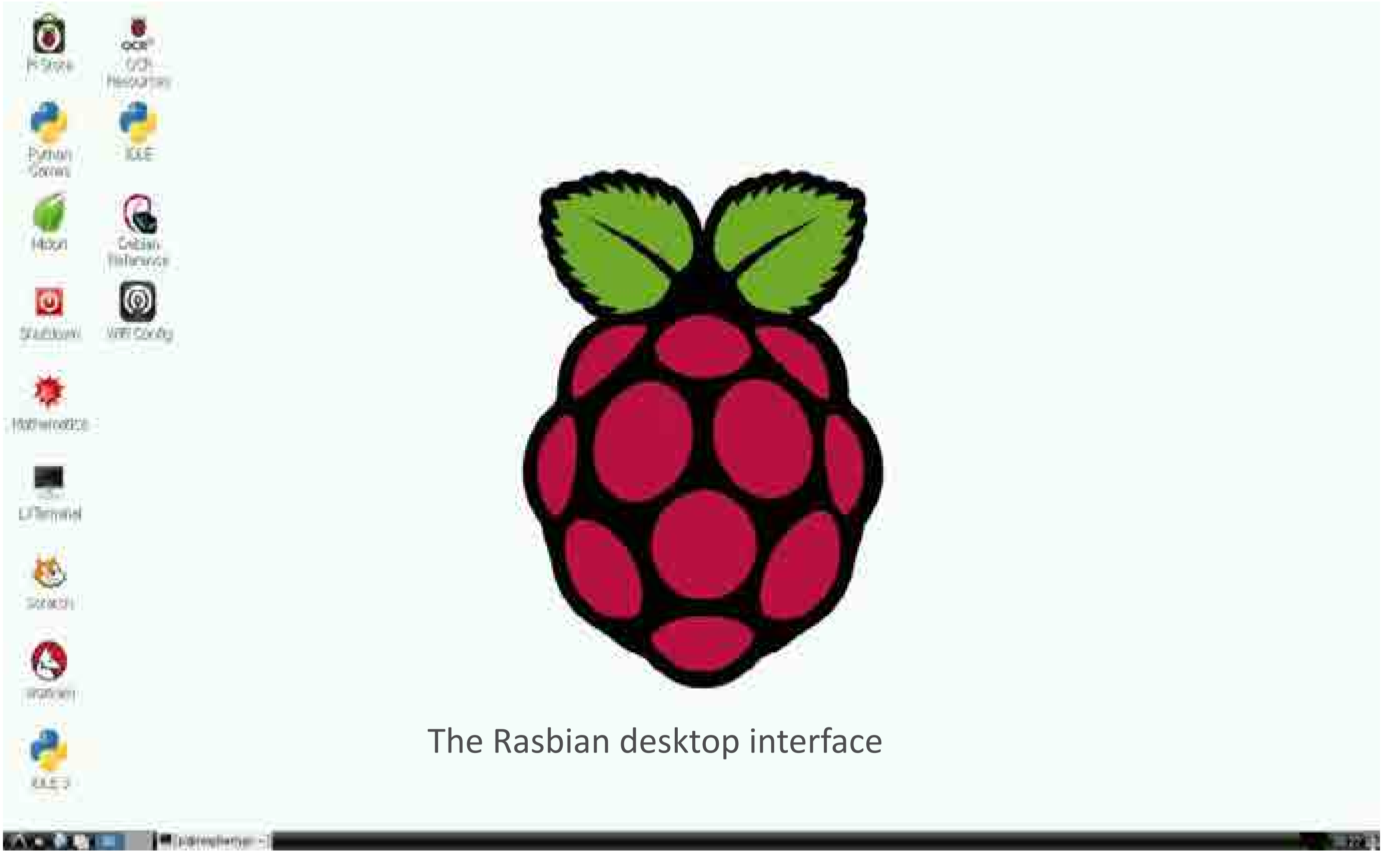
1. Raspberry pi model B/B+
2. A class 4 SD card (minimum- 8GB) with NOOBS software
3. Micro USB smartphone charger
4. USB keyboard
5. HDMI/composite video cable
6. HDMI monitor/TV
7. USB mouse
8. LAN cable and modem for connecting to the internet (optional, but preferred)

Now, let's load the OS onto your SD card. Alternatively, you can also buy SD cards that are already loaded with this software. Or you can download the NOOBS (New Out Of the Box Software) software from: http://www.raspberrypi.org/downloads/

Next, connect your SD card to your computer using an USB SD card adapter and extract the zip file into your SD card from your computer. For instructions on downloading and copying the files to your SD card, check out this video till 01:34 minutes and then go through the following link after it:
Installing the OS in Raspberry Pi.

http://www.raspberrypi.org/help/quick-start-guide/

Plug in the SD card to your raspberry pi and power it using your smartphone charger. You can now hook up your raspberry pi with a USB keyboard, mouse and to a HDMI monitor/TV to boot it up, follow the steps for installing the OS as in the same video above, from 01:34 and watch it till 04:50 minutes.
Select the Raspbian OS and install it, as it is the recommended and best OS for your pi board. If you are stuck with the terminal (black screen with commands), you can enter the command "startx" and hit enter, to load the desktop environment and UI (User Interface).



The Rasbian desktop interface

Congrats! You have successfully booted your raspberry pi for the first time.
You can now begin using your raspberry pi like a normal computer, by navigating with the help of a keyboard and a mouse.

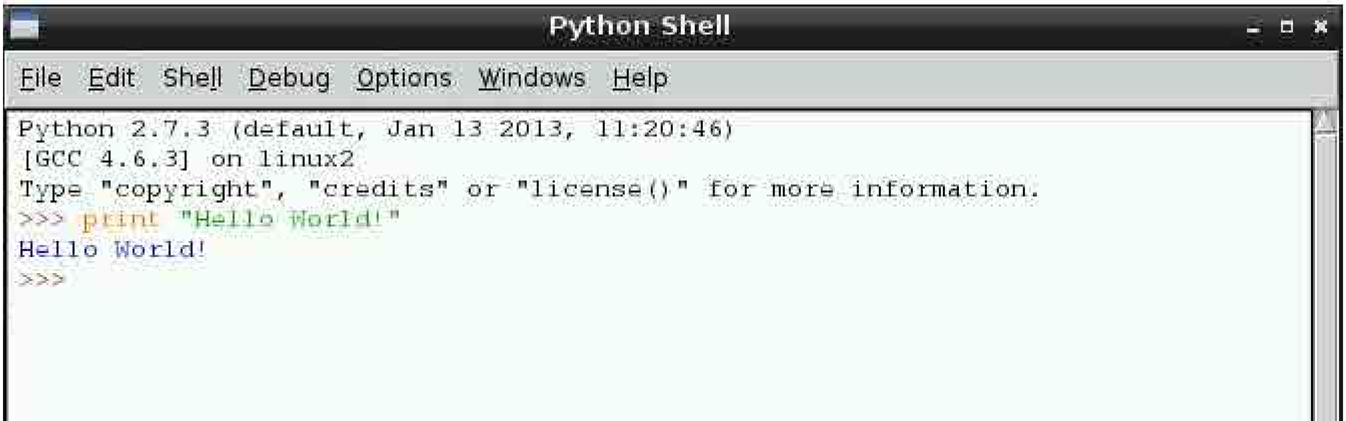
Python on the Raspberry Pi

Before moving on to learning to program using the python programming language, it would be useful if you could check out a few basic linux commands, while working on the terminal. You can access the terminal from the Start menu → Accessories → LXterminal.

Check out this video, showing a few basic terminal commands:
[Basic Linux Terminal Commands.]()

Python is the easiest programming language out there, so you don’t need to hesitate if you don’t know to use it. It is recommended to be one of the first computer programming languages to learn, due to its ease of use.
Check out this documentation from the raspberry pi foundation for python beginners:
http://www.raspberrypi.org/documentation/usage/python/

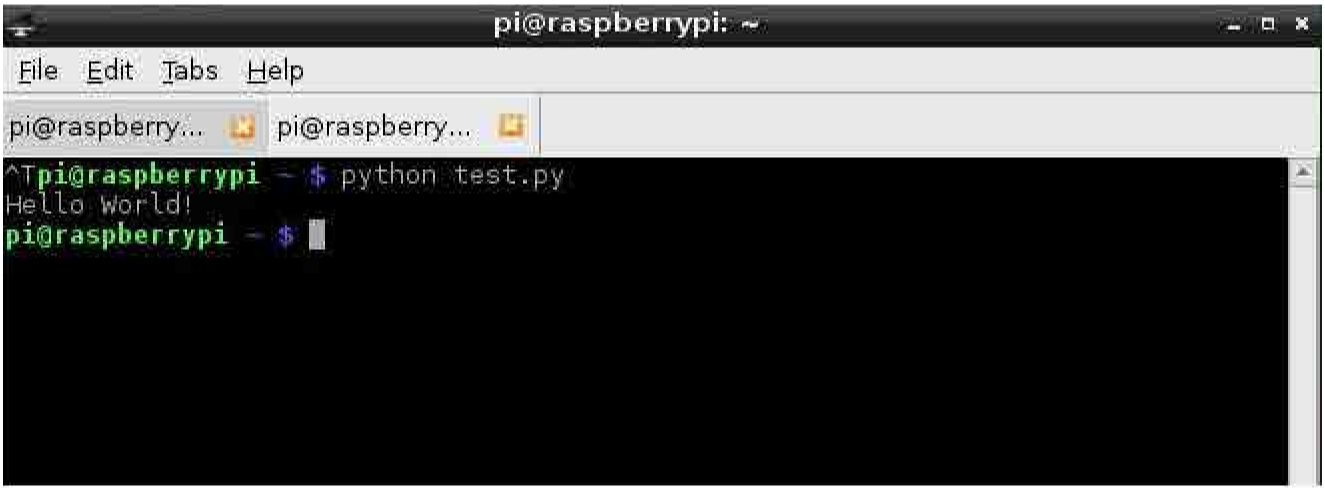
To do a simple “hello world” on python, you can either open IDLE or open the Leafpad text editor in Accessories, inside the start menu.
In IDLE, you just need to enter:
print “Hello World”



```
Python 2.7.3 (default, Jan 13 2013, 11:20:46)
[GCC 4.6.3] on linux2
Type "copyright", "credits" or "license()" for more information.
>>> print "Hello World!"
Hello World!
>>>
```

Hello World in Idle

If you are doing it using the Leafpad text editor, type in the above command and then save the file name as “test.py” (something.py). The “.py” extension is used to mark it as a python script.
Now, to run this, open the terminal from Accessories and enter the command:
python test.py
It will then print “Hello World”.



```
^Tpi@raspberrypi ~ $ python test.py
Hello World!
pi@raspberrypi ~ $ 
```

Hello World in Terminal

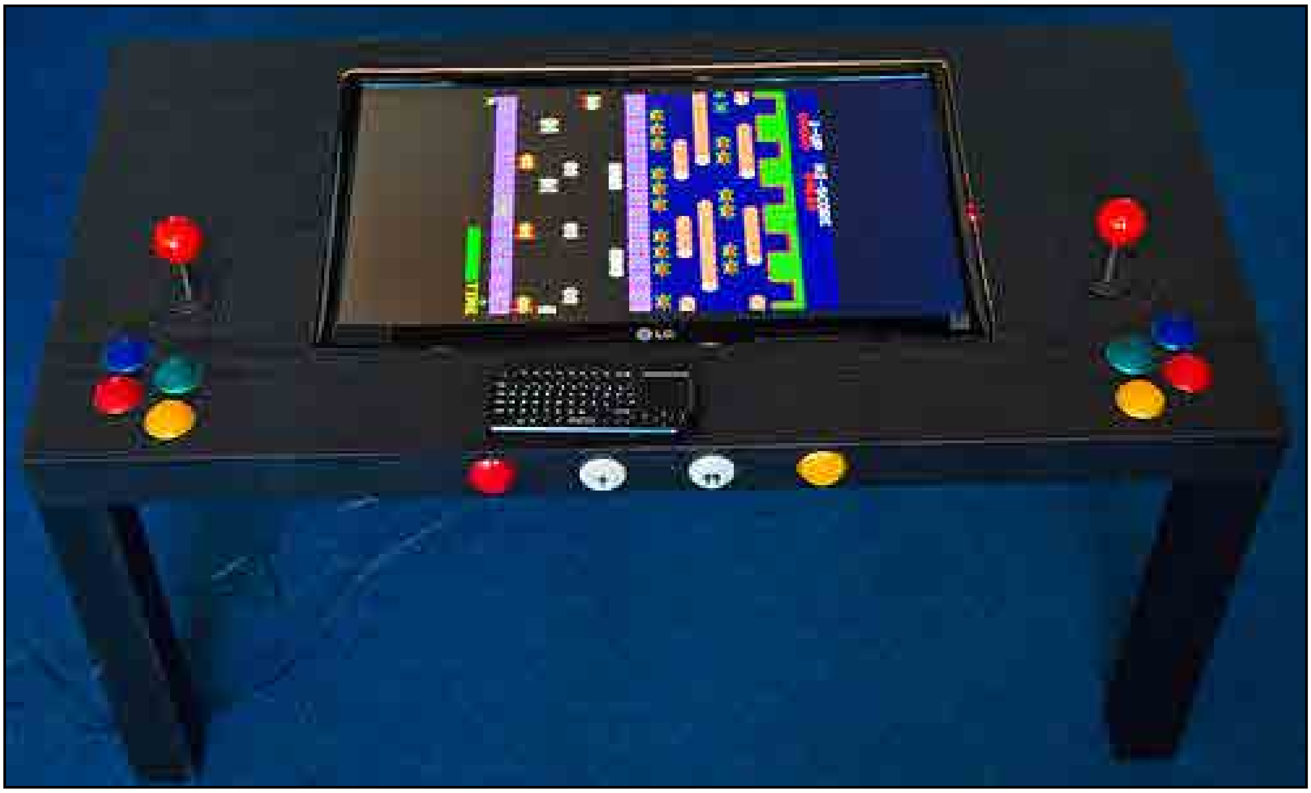
Now to learn more about python on raspberry pi, check out a few python tutorial videos: Raspberry Pi Python Tutorial Videos.

Or to learn more about python programming language, check out the several tutorials available online, like: Python Tutorial Video Series and http://www.learnpython.org/ and several more!

Next, learn how to blink an LED using a python program and the GPIO pin of a raspberry pi: Blinking an LED using the Raspberry Pi.

Some Raspberry Pi DIY Projects

Raspberry pi powered arcade gaming table



Check out this really cool application of using a raspberry pi to power an arcade gaming table. Hook up your pi to a gaming joystick and some buttons to create an arcade gaming table.

Check it out in action:

Youtube Video.

Tutorial: Instructables Tutorial.

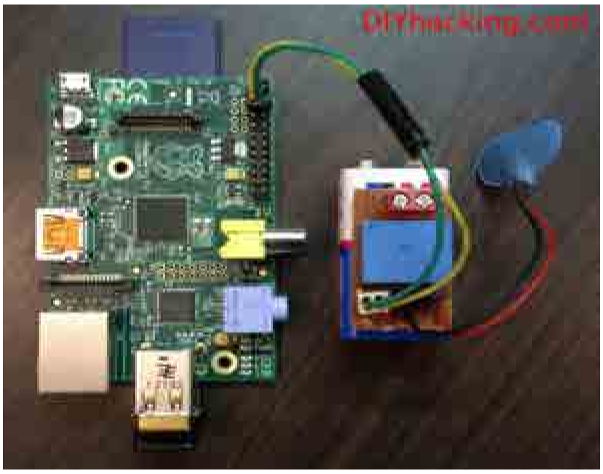
Face tracking with the raspberry pi

Use a webcam with your raspberry pi and make a cool face tracking system. It can be deployed outside the door of your room to track guests or people. Watch it in action:

Youtube Video.

Tutorial: Instructables Tutorial.

Home automation using Internet of Things



Check out this tutorial to learn how to control the lights or other appliances in your room through the internet. Watch it in action:
Youtube Video.
Tutorial: DIY Hacking Tutorial.

And several more, available on http://diyhacking.com/ and on the internet.

Additional Resources and Tutorials

Raspberry Pi Tutorial Series

Check out these tutorial videos on raspberry pi, to learn more about it in detail: Raspberry Pi Youtube Tutorial Series.

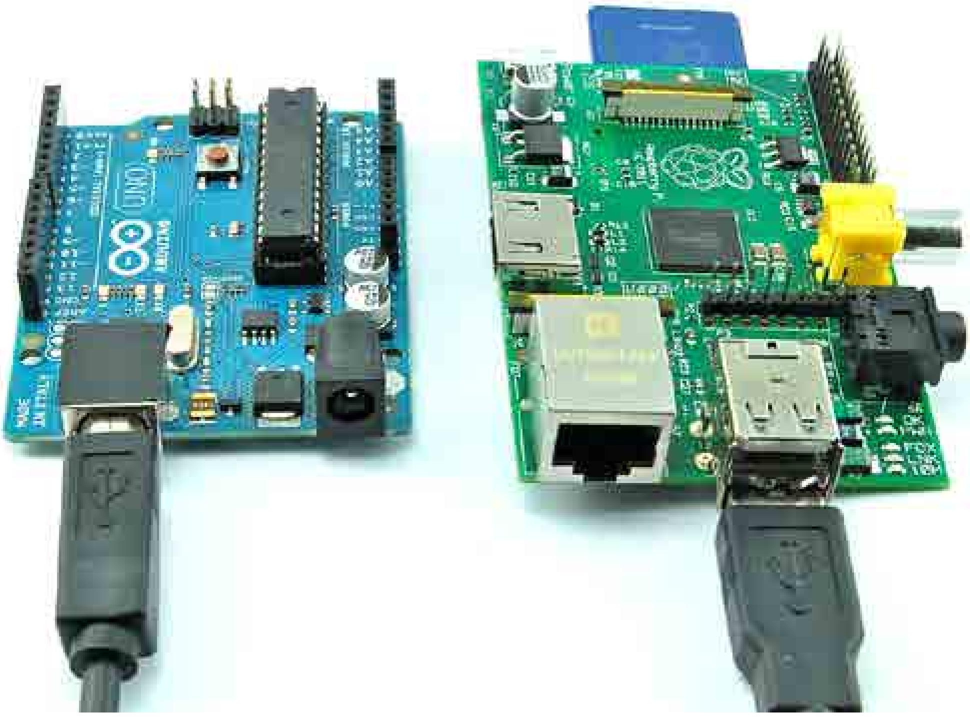
Support and guidance

There is tons of support available for raspberry pi on the internet. Hence, whenever you are facing an error or need to troubleshoot, you can search for it online and find solutions for it from people who have been in the same situation.

You can also post your queries on http://www.raspberrypi.org/forums/, to get solutions from experts on raspberry pi.

Arduino or Raspberry Pi?

Which is the right board for you!



After going through all this information, you might be thinking about which board to use for your project idea, or which board is better. However, the arduino and raspberry pi are two completely different boards. It would be like comparing an apple with a banana.
Both these boards excel in their particular fields. To bring a bit more clarity to help you choose the right board, I will list out a few use cases for each:

Arduino can be used for

- Connecting lots of analog/digital sensors.
- Connecting lots of motors and servos.
- Making a simple and cost effective project.
- Making simple robots like: line followers, obstacle avoiding robots, etc.
- Performing simple logical operations and programs.

Raspberry pi can be used for

- Connecting LCD touch displays and monitors.
- Connecting webcams and performing image processing.
- Running highly complex programs, requiring powerful processing.
- Making internet dependent applications.

In certain applications, you can even use both the boards together. Here, raspberry pi can do complex stuff like processing, image recognition, etc and then the arduino connected to the pi via UART can control motors or servos.

To get a better understanding of the differences between arduino and raspberry pi, check out this video:
Comparing the Arduino and Pi Video.

Free DIY Projects

Stay updated on the latest DIY projects

In order to get First and Free access to all latest content from DIY Hacking, including latest DIY projects (head mounted displays, wearables, Internet of Things, etc), Ebooks, tutorials and other awesome stuff, you just need to do these two things:

1 .Just LIKE the Facebook page by clicking on the button below:

facebook

2. After that on the page, post this message on the wall- “I am a Maker“

I will be adding you to my elite members group through this action and alerting you First on all other future stuff that might benefit you.

3D Printing

An introduction to 3D printing

3D printing is definitely going to be big, so equipping yourself with the knowledge to use this, will be a boon for you. 3D printing allows you to make three dimensional objects in your home using a 3D printer, you might have used a normal 2D printer to print on paper. But, imagine printing a physical object in 3D.

For those of you, who don't know what 3D printing is all about, check out this video: What is 3D Printing.

For printing objects, you can use design files available online (http://www.thingiverse.com/) and feed it to the 3D printer for printing that particular object. Or you can even use a 3D scanner to scan any object you like to replicate.
Sketch up is one of the popular 3D designing softwares available: http://www.sketchup.com/3Dfor/3D-printing

For example: I recently broke the handle on the door of my refrigerator, if I have a 3D printer, I could just search for design files of similar handles online and then download the file and print it using a 3D printer. These printers use ABS plastic as the ink to print objects in 3D.

Check out this video of a 3D printer in action: Live 3D Printing Video.

The future of 3D printing is enormous; it is even used to print human organs, food, weapons, prosthetic limbs and even houses. It can be used for making any physical object or to even print another 3D printer.
Check out this video showcasing the future scope of 3D printing:
Future of 3D Printing Video.

The Final Step

What is the final step to being a MAker?

A maker is someone who shares their work with the world. They post their projects online along with videos and pictures, so that other people would also get benefitted by it, just like how you were able to take advantage of this free information.

If you want to become a Maker or if you already are a Maker, please click this button below. DIY Hacking will be organizing a bunch of future events including workshops, newsletters, more Ebooks, etc for you guys. We will be letting you know about all these activities through the information you have entered here. We will also be providing a platform for you guys to post your projects through DIY Hacking. Click this button:

I want to be a MAker

There are lots of platforms you can use for posting your projects online, you can either make your own blog using Google blogspot or even post to DIY Hacking, to help friends around you, with your knowledge. To post to DIY Hacking, you can contact me at: ars@diyhacking.com and I will be happy to help you out.

You become a true maker or open source contributor, only after posting any of your projects online. Hence, I strongly encourage you to do the same, that is to give back to the community and contribute.

To get an idea of the format for posting your project to DIY Hacking or other platforms, check out this sample project post: http://diyhacking.com/make-line-follower-10-minutes/

The Future

Few examples of the technologies of tomorrow

The future holds many exciting technologies. They range from drones and robots to even self-driving cars. Check out a couple of these technologies below.

Some of the most blossoming technologies are those based on drones or UAVs (Unmanned Aerial Vehicles). The most common of them are quadrotors. Quadrotors are really powerful, since they consist of four propelling motors, that allow to carry huge payloads. Check out these videos, showing the power of quadrotors:

Quadrotor Video 1.
Quadrotor Video 2.

The future also flaunts self driving car technologies. Audi has already created a prototype of it, check out this cool auto parking car.

Auto Parking Car.

Robots are also being extensively tested in the military. The future promises to safeguard the lives of soldiers by using humanoids and other robots for military missions, Check out this cool video of one such robot:

Military Robots.

About the Contributors

Profile: Personal Profile
Blog: Personal Blog
Follow him on Twitter: @ArvindSanjeev

Author - Arvind Sanjeev
Arvind hails from Cochin and is an Electronics Engineer and Inventor. Following his passion for electronics and robotics, he has developed many innovative gadgets, some of them which were even featured on Techcrunch, BBC, Yahoo, etc.

He has won several accolades for his ingenuity and the "Most Promising Innovator" award from Yahoo-Accenture being one of them.

He aspires to shorten the gap between the technological resources available in India to those possessed by its counterparts abroad. DIY Hacking is one of the initiatives he uses to achieve this, through information dissemination. He also thanks his parents (Dr.Sanjeev and Dr.Usha) in supporting him in all of his initiatives.

Illustration - Nidhiya V Raj
Nidhiya is a student entrepreneur, open source enthusiast and Mozillian based in Cochin. She runs a startup company with her six classmates.

She is in to software development, UI / UX Design Strategy and is highly passionate in the field of electronics.

She has won the Angelhack Hackathon, 2014. You can find her in organizing many reputable events as well.
Profile: Personal Profile
Company Profile: Webaccede

Design - Muhammed Shabeer
Muhammed is a multidisciplinary visual artist. He has cofounded the startup- Webaccede based in Cochin, Kerala and is currently a student at Cochin University of Science and Technology.

He has a profound skill set in designing and multimedia editing. He is also well equipped with an experience in Nokia App development.

Profile: Personal Profile
Linked in: Profile

Video Promotion - CAT Entertainments
CAT entertainments is an completely inhouse media production team, with a fully fledged and outstandingly talented crew. With a vision to create refreshingly different and artistically significant visual depictions of various real world scenarios. The team also boasts an extremely sound and advanced technical team that allows them to work in a more streamlined and produce awesome innovative interpretations of their projects.

CAT is a media content creation company that specializes in corporate videos, ad film and TV shows . Their team of highly talented and creative individuals strives to deliver high quality content to their clients in a timely manner.

Company profile: Profile

The layout and illustration for the second eBook ”**10 Easy Electronics DIY Projects**”, which will be launched soon has been done by **Sahana Rao**, a pass out from College of Fine Arts, Bangalore. Contact: sahana1992.rao@gmail.com

Pitch - In

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