

Internet of Things (IoT)

Make It Yourself



Overview

- **Introduction to Internet of Things (IoT)**
- **IoT System Components**
 - Embedded Systems
 - Hardware & Software
 - Sensors & Actuators
 - Communication Network
- **Hands-On with IoT Development Platforms**
 - Hardware – NodeMCU
 - Software – Arduino Integrated Development Environment (IDE)
 - Do It Yourself (DIY) Experiments
- **Familiarizing Cloud Platforms**
 - ThingSpeak – www.thingspeak.com
 - Ubidots – www.ubidots.com
- **IoT Projects**

Embedded Systems

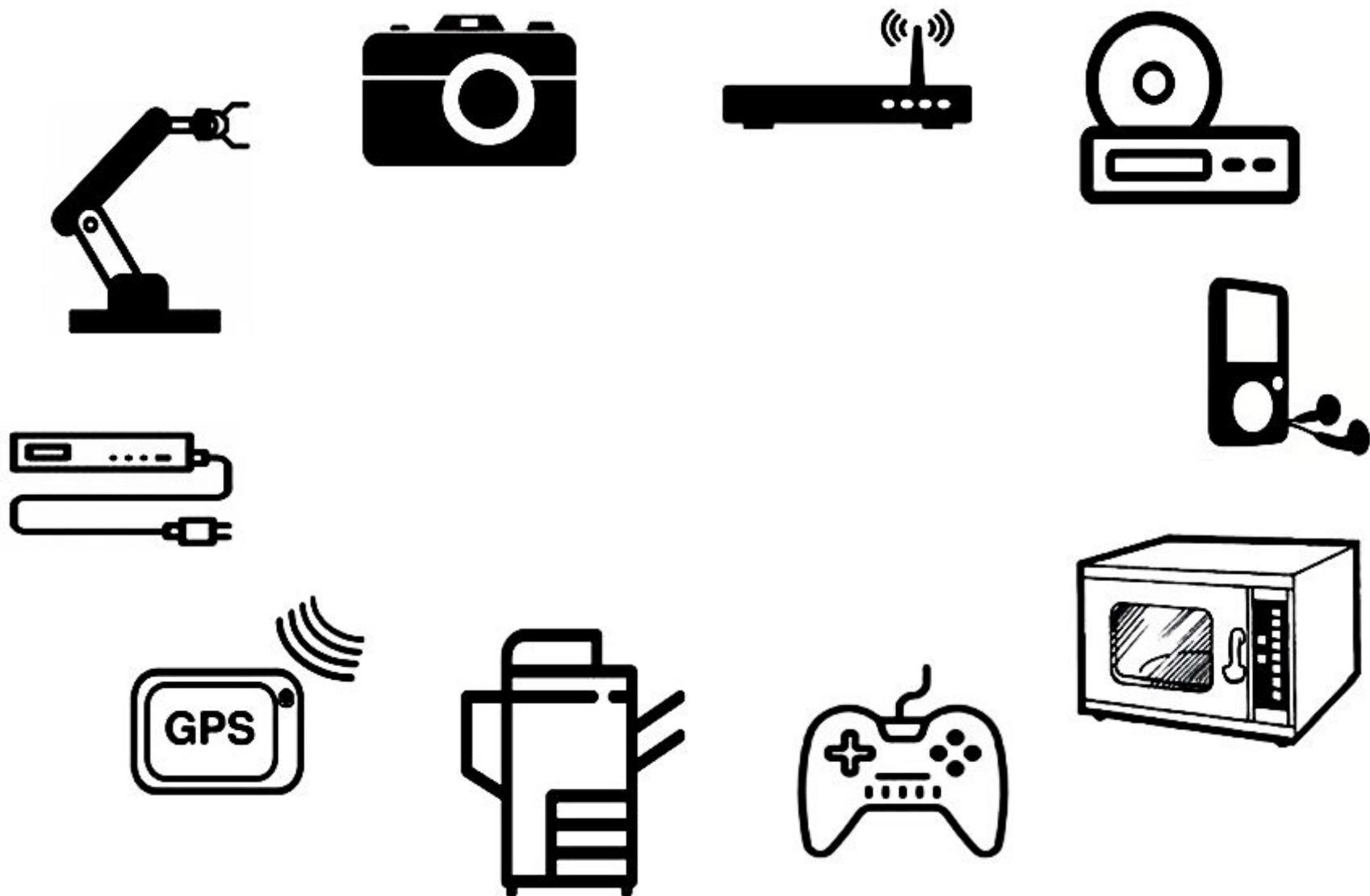


Image Source: <https://www.rs-online.com/designspark/rel-assets/dsauto/temp/uploaded/Embedded-System-and-Its-Real-Time-Applications-Image-31.jpg>

Sensors

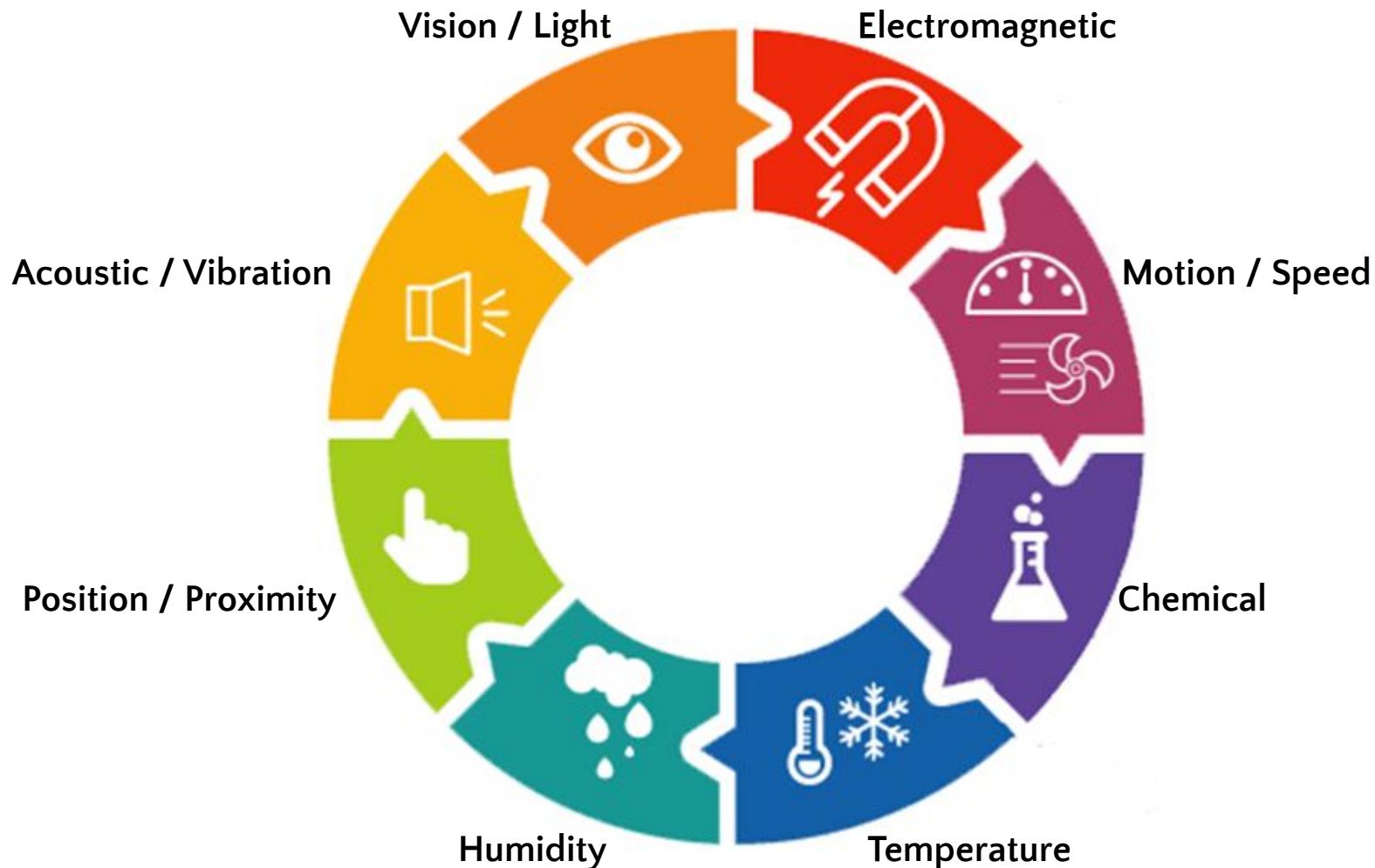


Image Source: <https://www.lanner-america.com/wp-content/uploads/2016/10/IoTsensoretech.png>

Actuators



Image Source: <https://techsee.me/wp-content/uploads/2018/10/IoT-onboarding.jpg>

Programming



Cloud



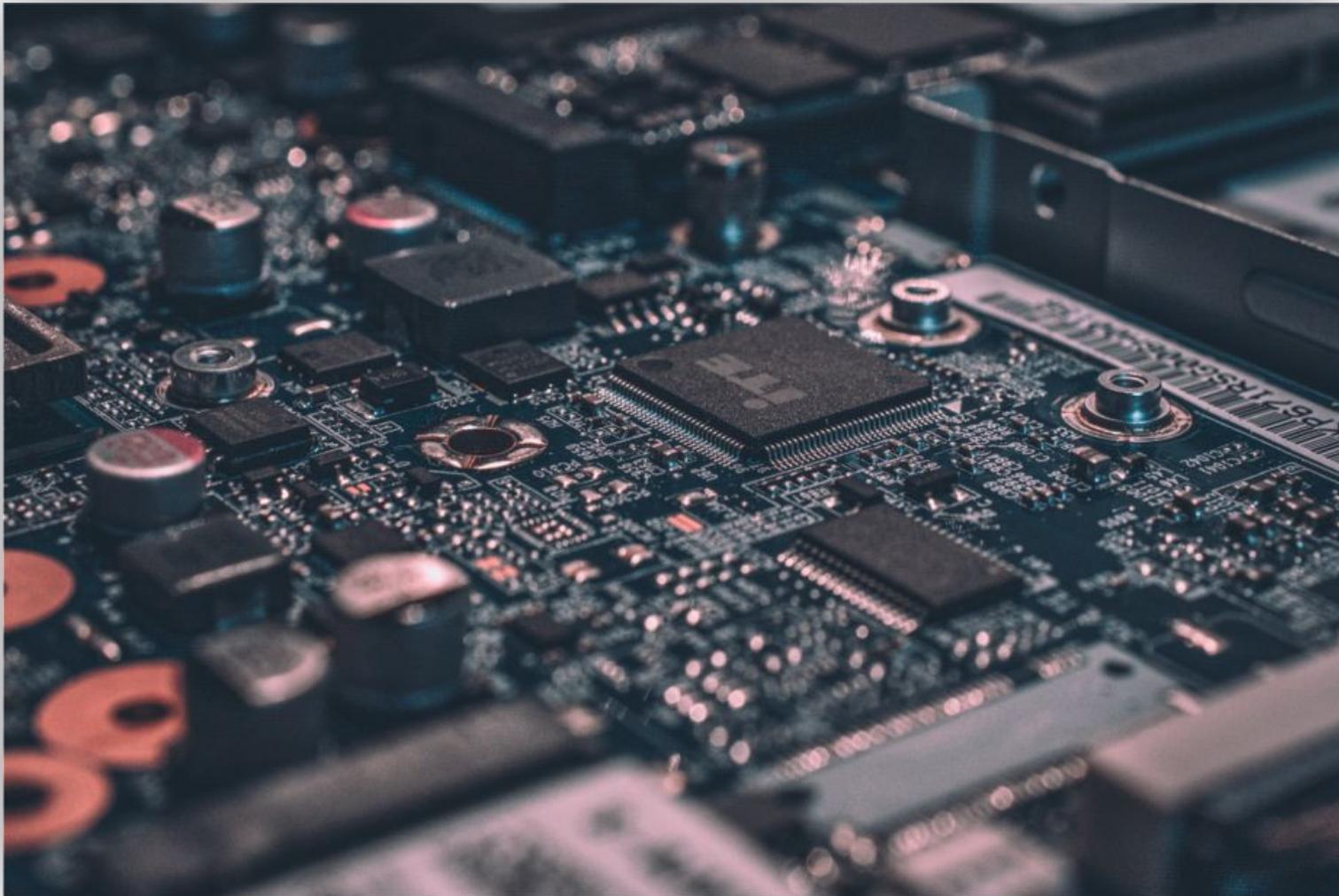
Image Source: <https://d15sh11kswkct0.cloudfront.net/wp-content/blogs.dir/1/files/2011/09/cloud-computing-3.jpg>

Internet of Things (IoT)



Image Source: Wikipedia®

Embedded Systems



Embedded Systems ...



Image Source: https://images-na.ssl-images-amazon.com/images/I/81pTG21EL7L._SL1500_.jpg

Embedded Systems ...



Image Source: <https://ae01.alicdn.com>

Embedded System meaning

An **Embedded System** is one that has Computer Hardware with Software embedded inside.

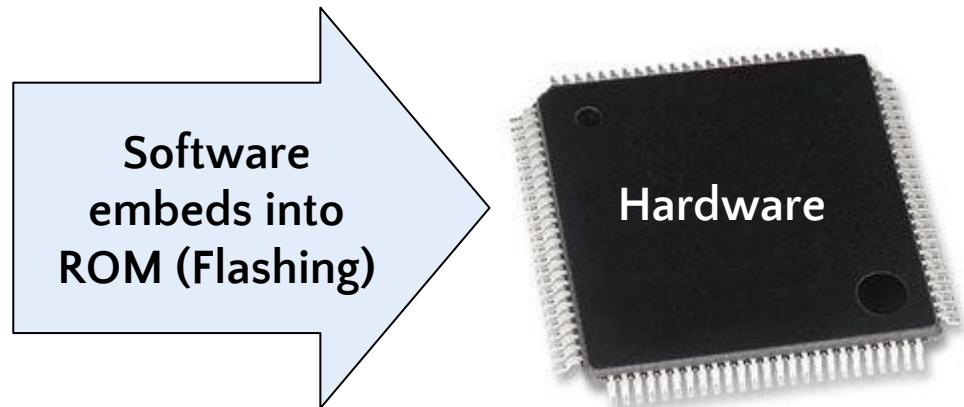
Software Program

```
#include "NodeMCU.h"
#define ledPin D0

void setup()
{
    pinMode(ledPin, OUTPUT);

}

void loop()
{
    digitalWrite(ledPin, HIGH);
    delay (1000);
    digitalWrite(ledPin, LOW);
    delay (1000);
}
```



Roles of Embedded System In Modern World

Health Care



Transportation



Home Appliances



Multimedia



Defence



Manufacturing



13

Demonstration

Obstacle Range Finder

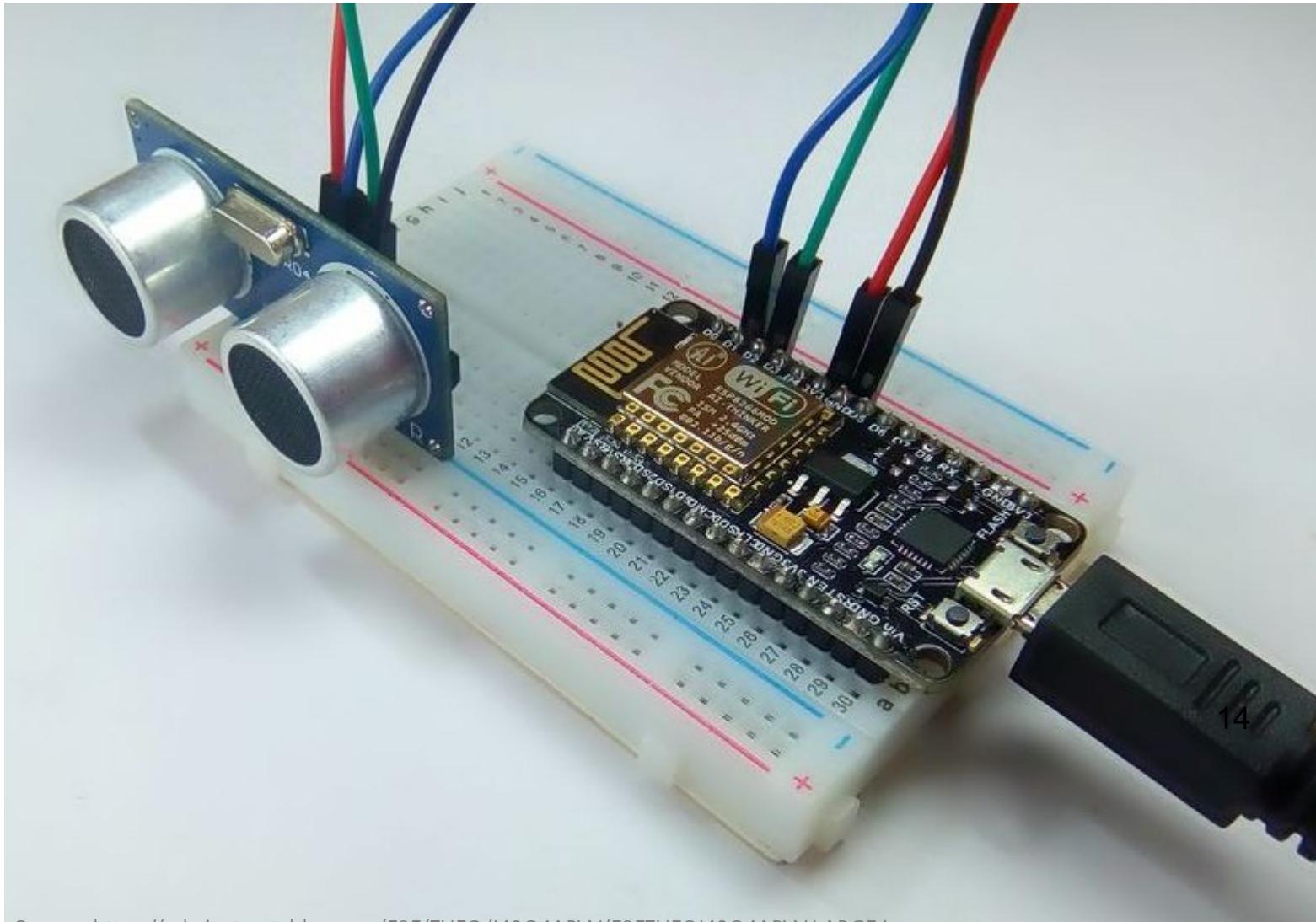
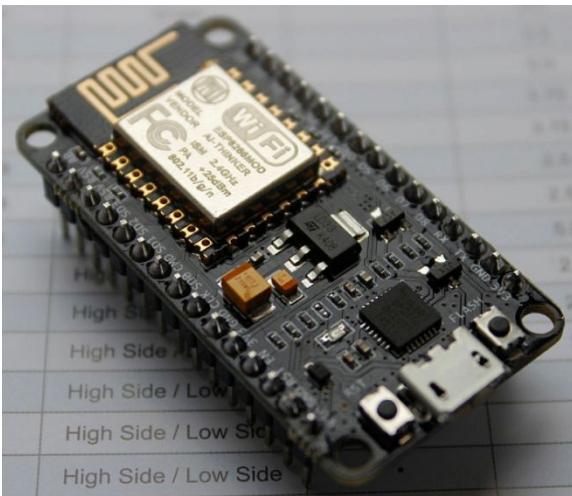


Image Source: <https://cdn.instructables.com/F9F/7UFQ/J48Q4APW/F9F7UFQJ48Q4APW.LARGE.jpg>

Demonstration

Obstacle Range Finder – Components

Hardware



NodeMCU

ESP8266 WiFi SoC based Open Source
Hardware Development Platform



Ultrasonic Sensor

HC-SR04
5V-12V, 0.2 – 0.45m range
with 0.03m precision

Software



ARDUINO 1.8.9

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.

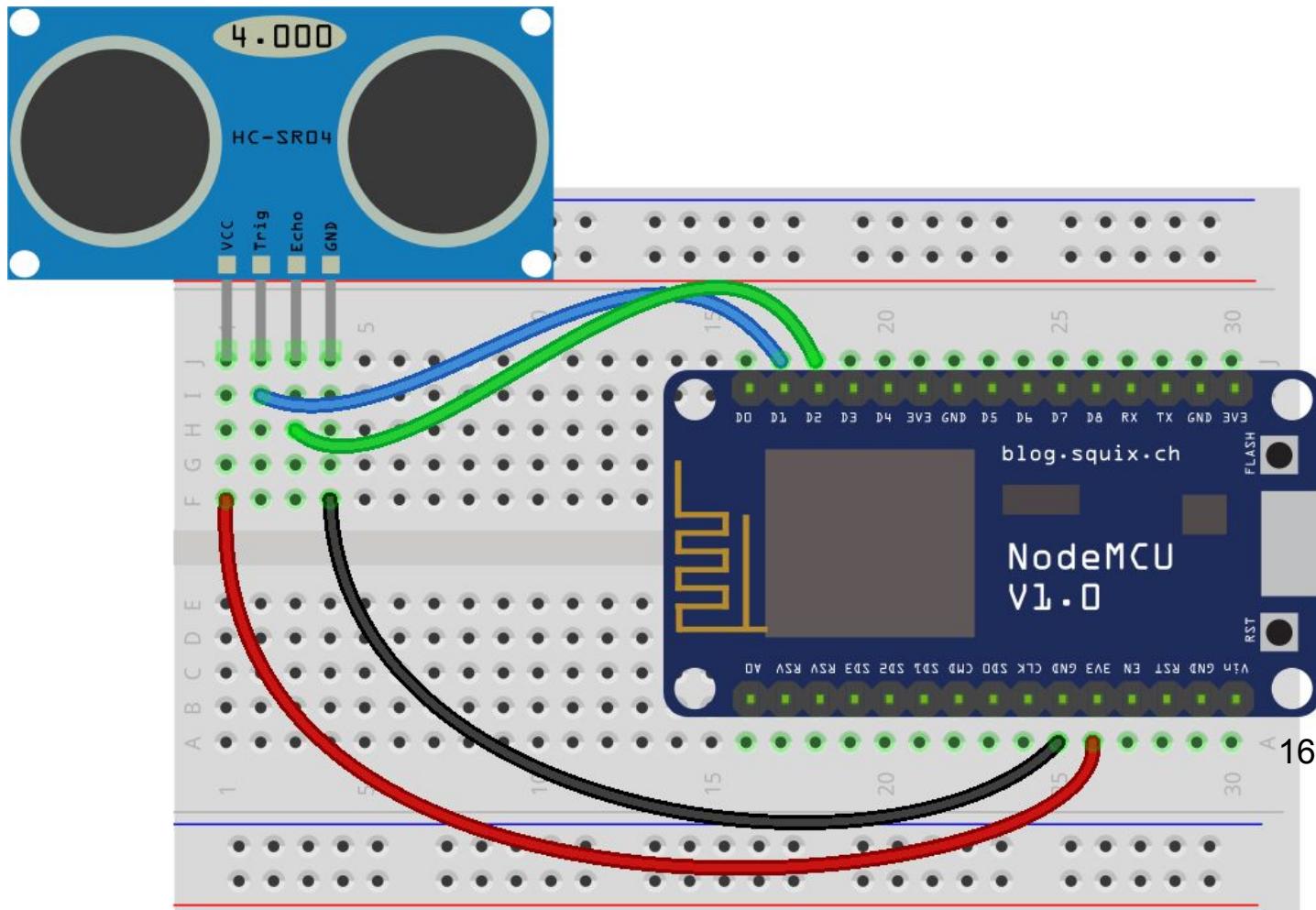
This software can be used with any Arduino board. Refer to the [Getting Started](#) page for [Installation](#) instructions.

Arduino IDE

C++ based Embedded Software
Integrated Development Platform

Demonstration

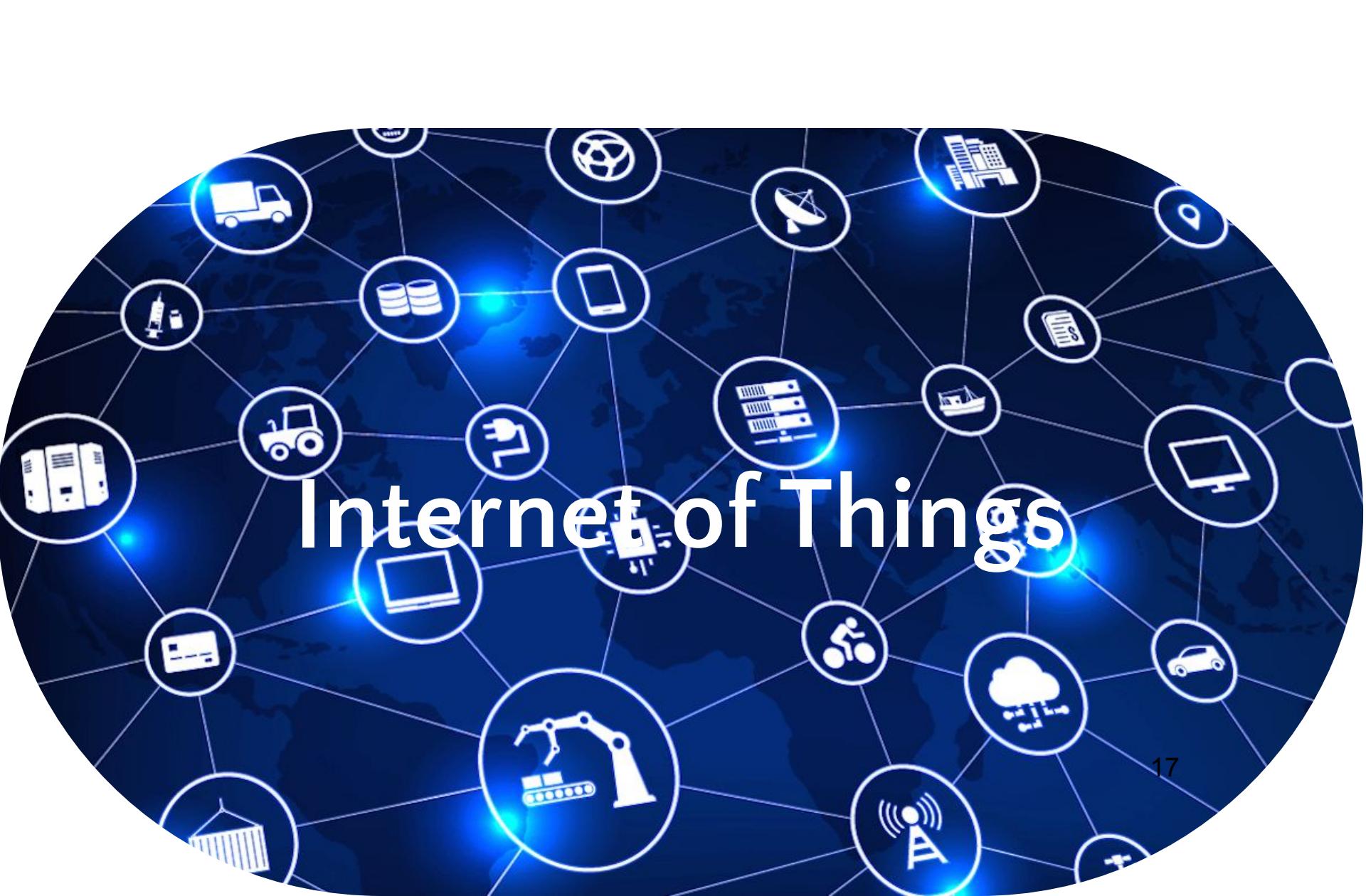
Obstacle Range Finder - Wiring



Layout designed using Fritzing® - <http://fritzing.org>

NodeMCU part Source: <https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

fritzing



Internet of Things

17

Image Source: https://martechtoday.com/wp-content/uploads/2018/08/Internet-of-Things_hvrxab.png

What is IoT ?

Internet of things (IoT) refers to the concept of connecting **any thing** to the Internet. It is the Idea that people can communicate with the objects and physical things

Things can be Humans, Animals, Buildings, Energy Stations, Smartphones, Tablets, Bicycle, Sensors, Cameras, Vehicles, Health monitoring devices and so on...

18



19

Image Source: <https://des.gbtcnd.com/uploads/pdm-desc-pic/Electronic/image/2017/03/21/1490059347782768.jpg>

Smart Wrist Band

Heart Rate Monitor



Sedentary Monitor

Pedometer



Calorie Monitor

Sports Monitor



Call Alert

Alarm Clock



20

Sleep Monitor

Image Source: <https://des.gbtcnd.com/uploads/pdm-desc-pic/Electronic/image/2017/03/21/1490059347782768.jpg>



21

Image Source: <https://fortunedotcom.files.wordpress.com/2014/05/google-gadgets-car.jpg>

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Driverless Cars



22

Image Source: <https://fortunedotcom.files.wordpress.com/2014/05/google-gadgets-car.jpg>

22 July 2019 Internet of Things – Do It Yourself Workshop 22

Driverless Cars

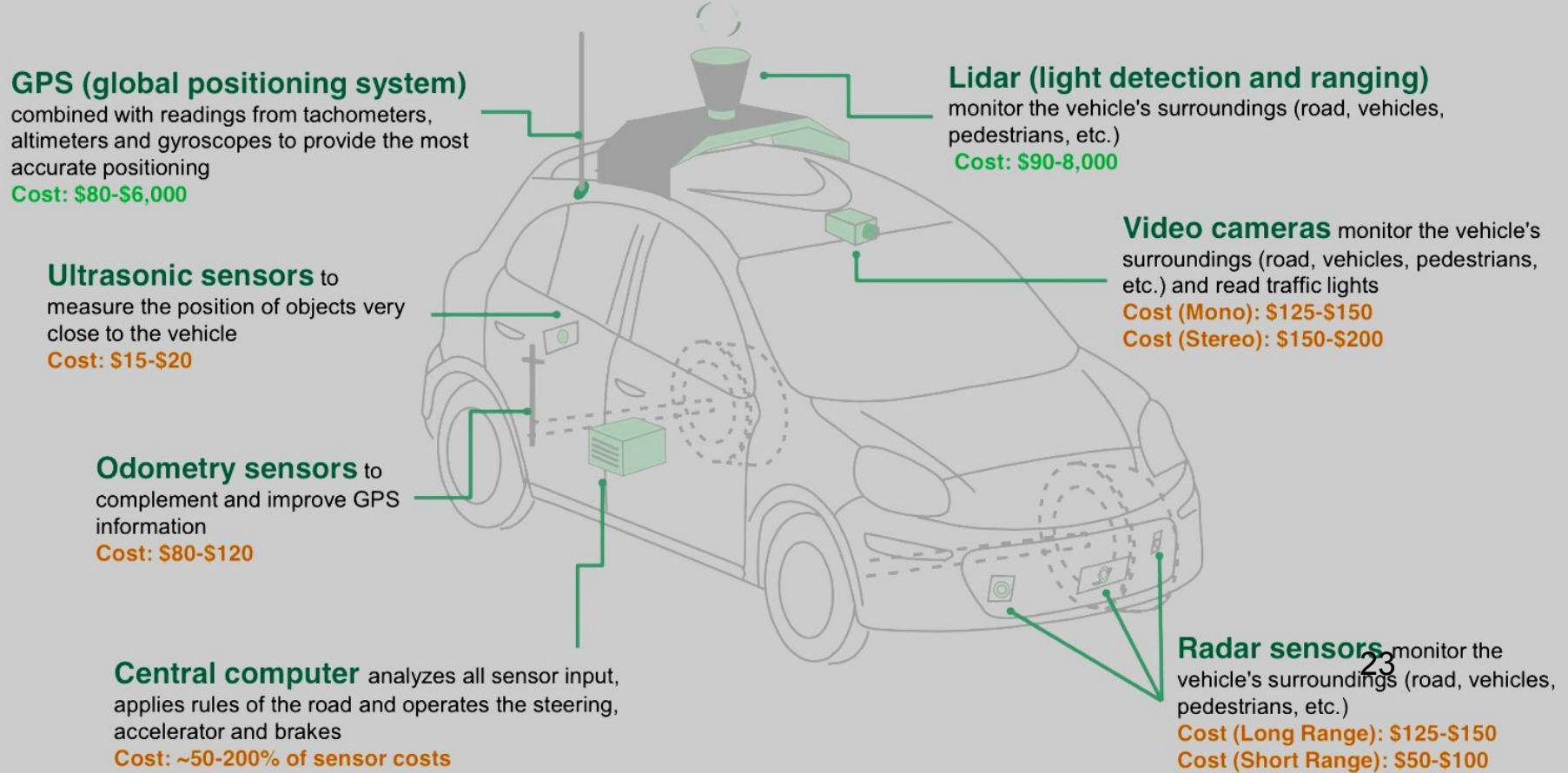


Image Source: https://media.wired.com/photos/59372bb59a93607bd17ca79a/master/w_1800,c_limit/sensor_info.jpg



24

Image Source: <https://informedmag.com/wp-content/uploads/2016/10/Best-Smart-Wifi-Outlets-1.jpg>

Smart Power Outlets



Wireless Control · Energy Monitoring & Conservation · Smart Device Integration 25

Image Source: <https://informedmag.com/wp-content/uploads/2016/10/Best-Smart-Wifi-Outlets-1.jpg>

Smart Key Chains & ID Cards



26

Image Source: Google®

Things !!!

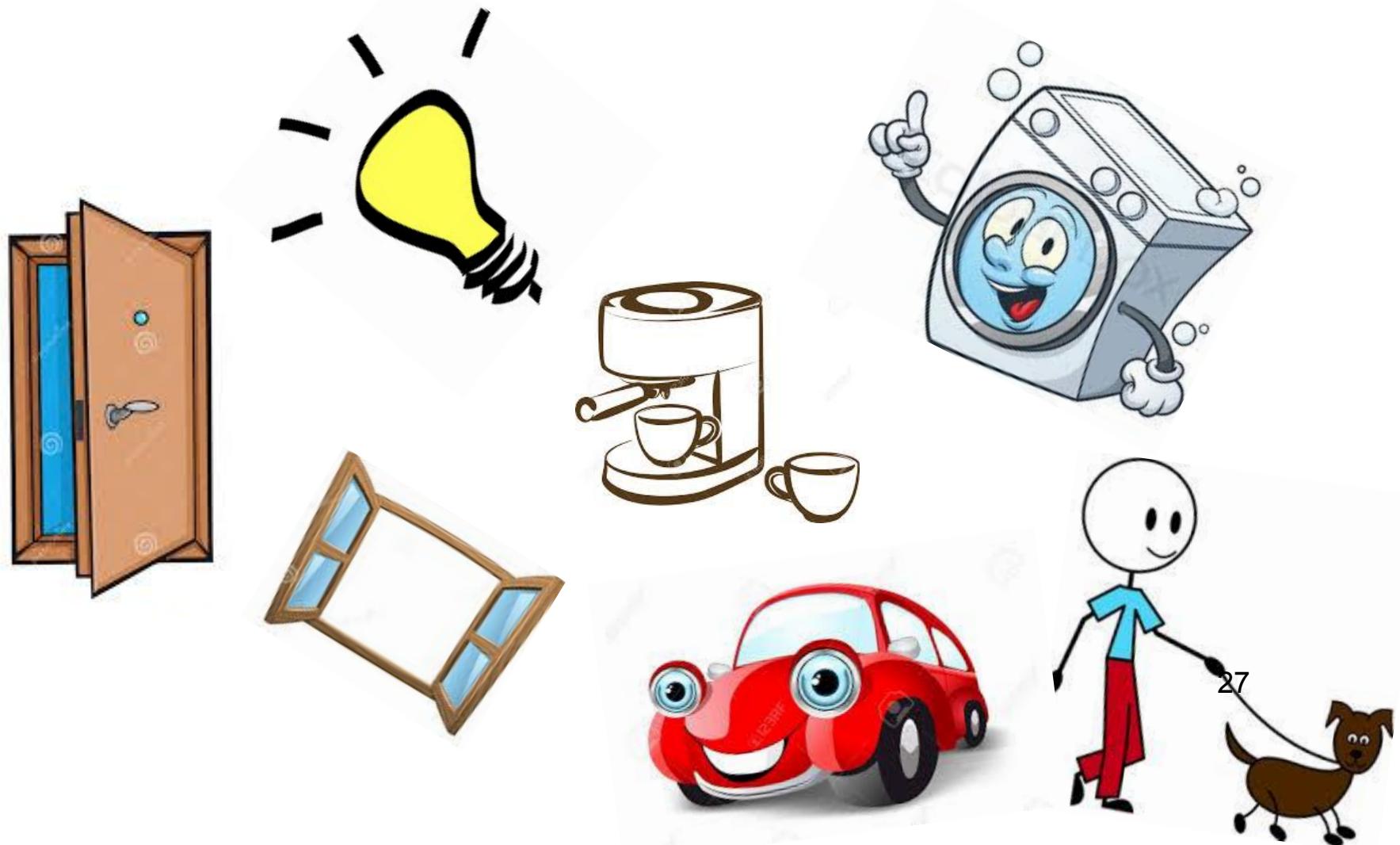


Image Source: Google®

How Things Communicate ?

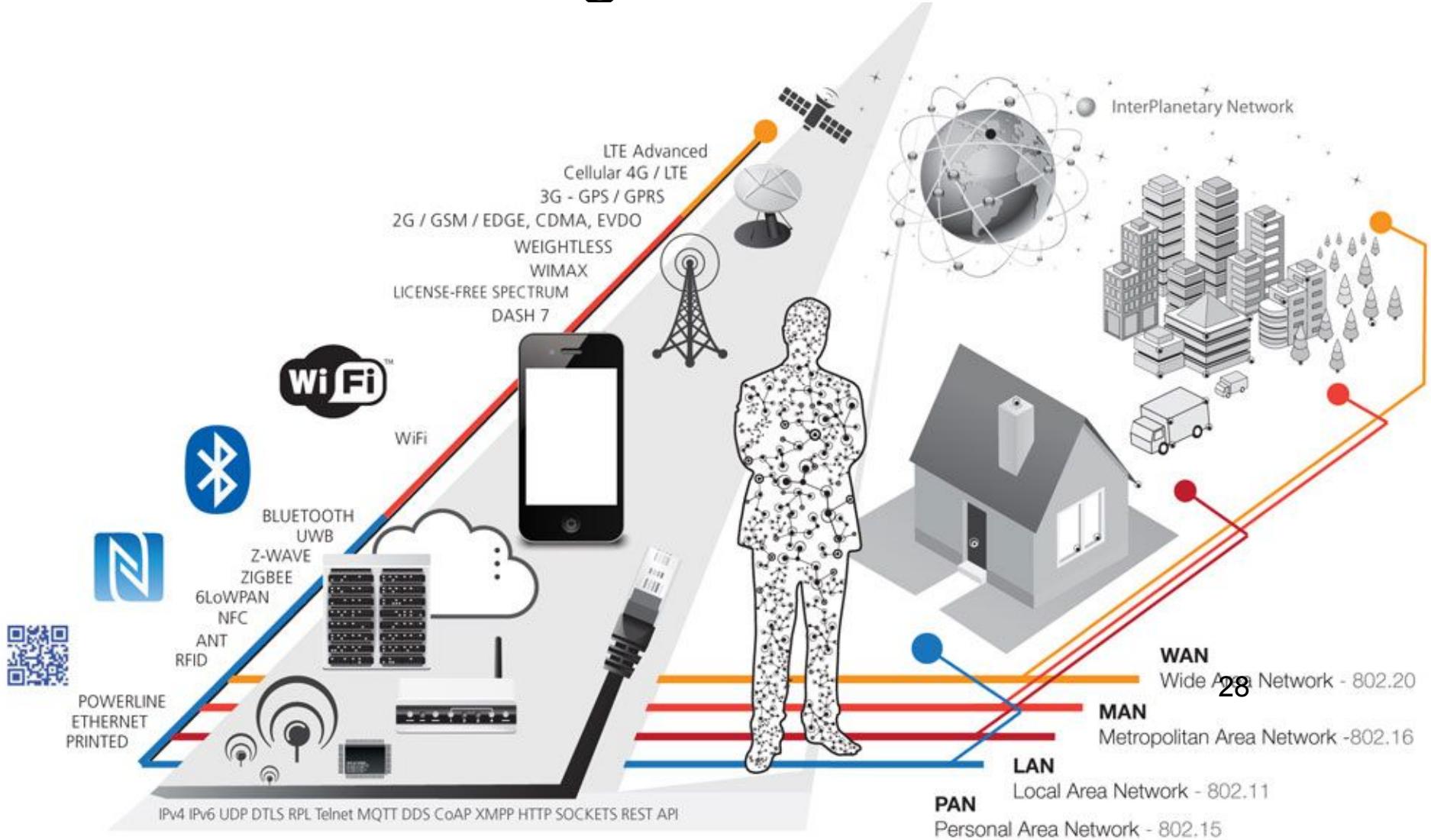


Image Source: <https://www.postscapes.com/wp-content/uploads/2018/03/connectivity-diagram.jpg>

Data Analysis & Action

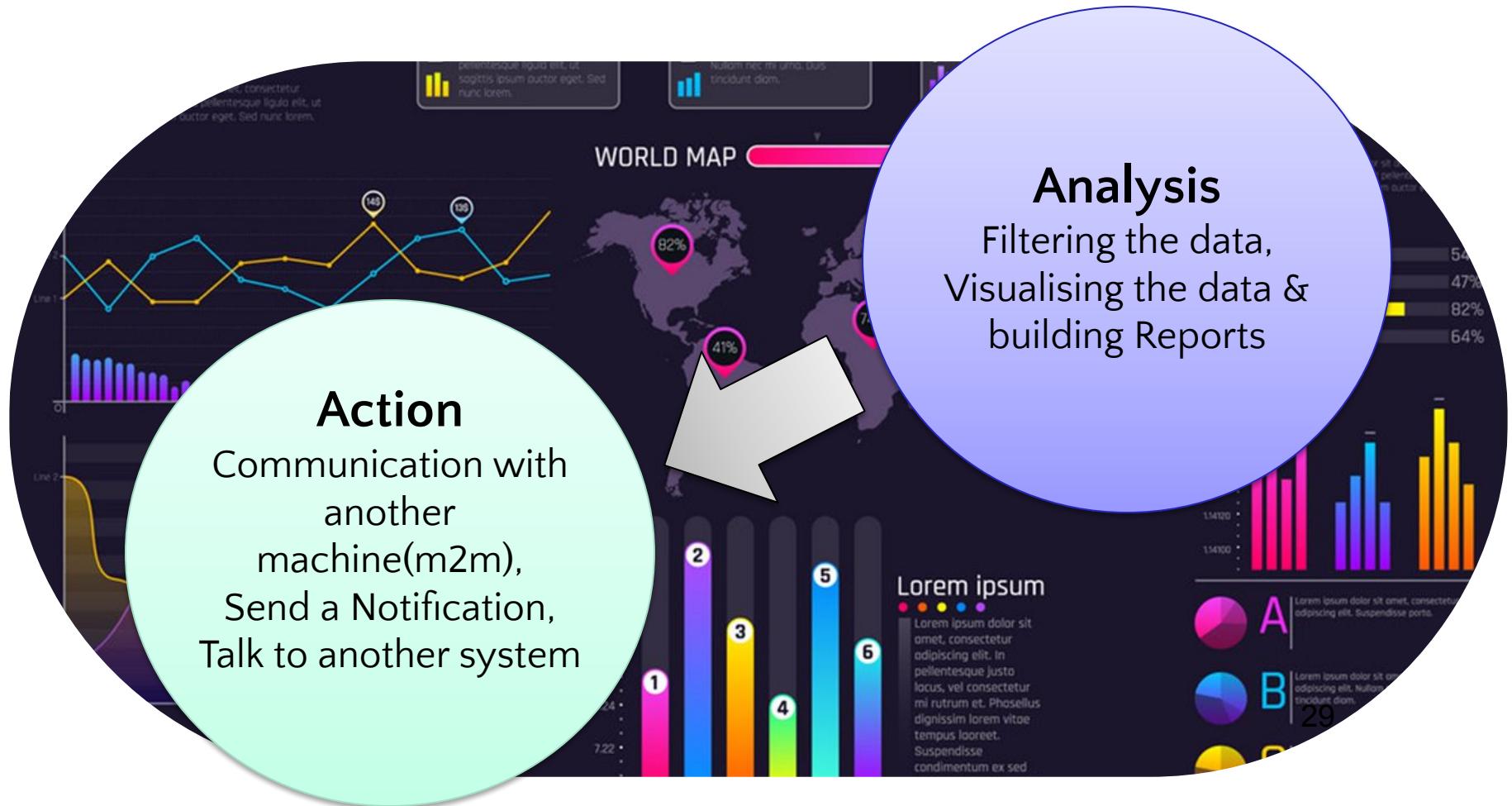


Image Source: <https://www.postscapes.com/wp-content/uploads/2018/03/connectivity-diagram.jpg>

IoT Life Cycle

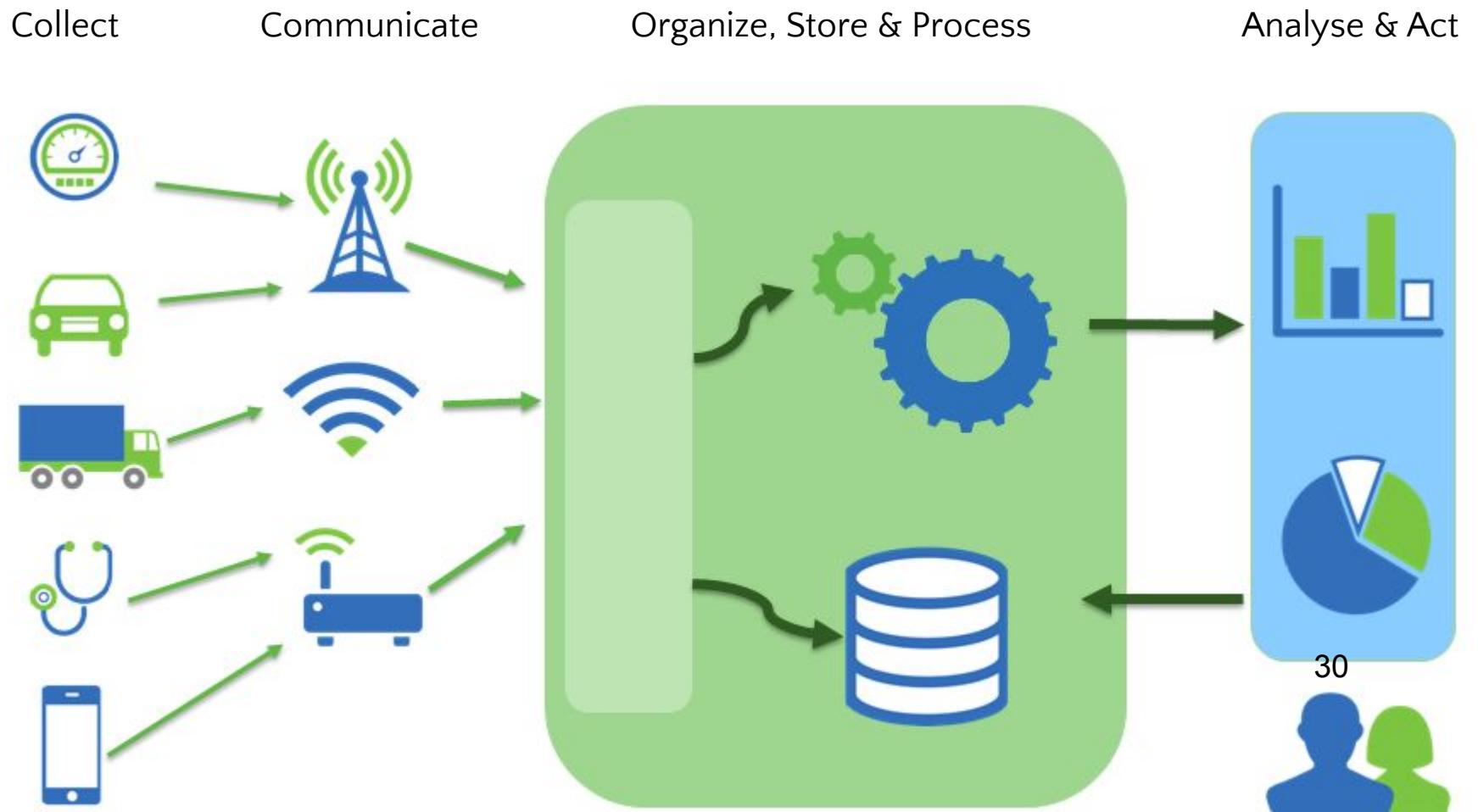


Image Source: <https://www.postscapes.com/wp-content/uploads/2018/03/connectivity-diagram.jpg>

Choosing the right Hardware Platform

Major Factors

- Processor
- Chipset
- Memory
- On-Board Peripherals
 - I²C, SPI, CAN, USB, HDMI, Parallel ports etc.
- System Clock options
- OS support
- Cost

31

NodeMCU Development Board



Image Source: <https://dziadainfpolx.cloudfront.net/blog/wp-content/uploads/2015/09/official-nodemcu-development-board.jpg>

NodeMCU Development Board

Specification & Pin Out

- Tensilica L106, 32-bit RISC Processor, 160 MHz
- 9 Digital I/O Pins (digital input/output pins)
- 1 Analog pin (10 Bit ADC)
- 4MB Flash (Program) memory
- 128KB Data Memory
- Inbuilt WiFi 802.11 b/g/n
- UART(2), SPI(2), I²C (1)
- USB Powered
- Operating Voltage 3.3V
- 3.3V & 5V Outputs available for external use

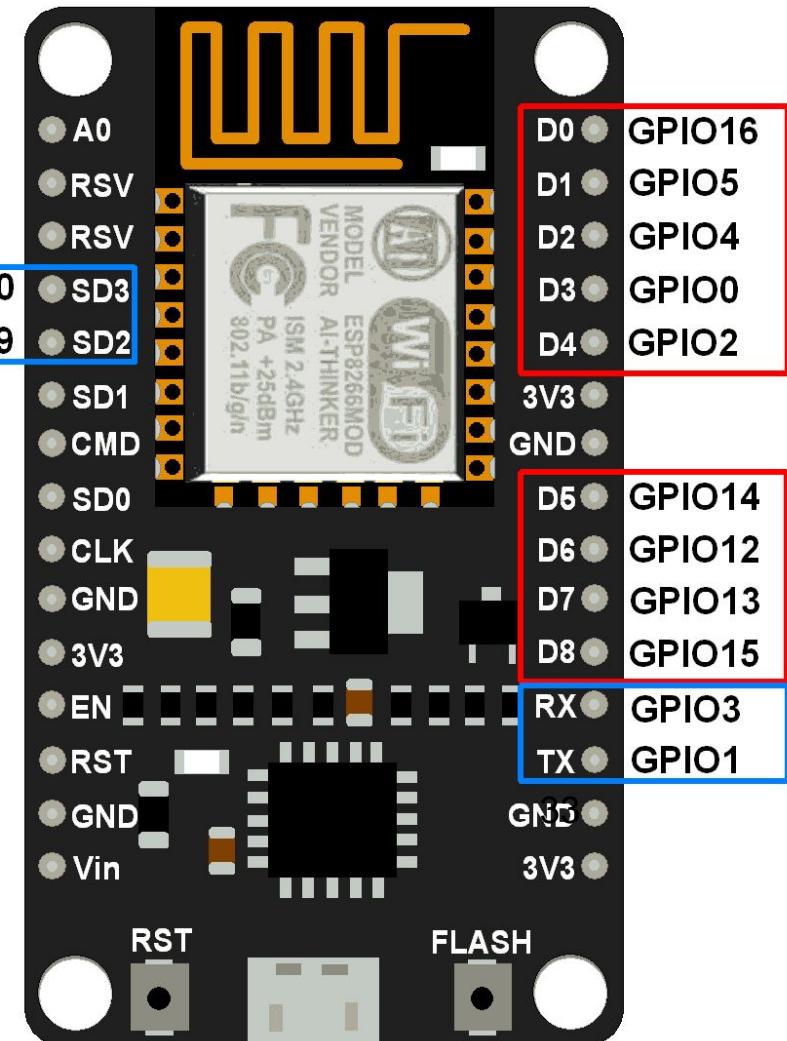


Image Source: <https://www.electronicwings.com>

NodeMCU Development Board

Pin Out

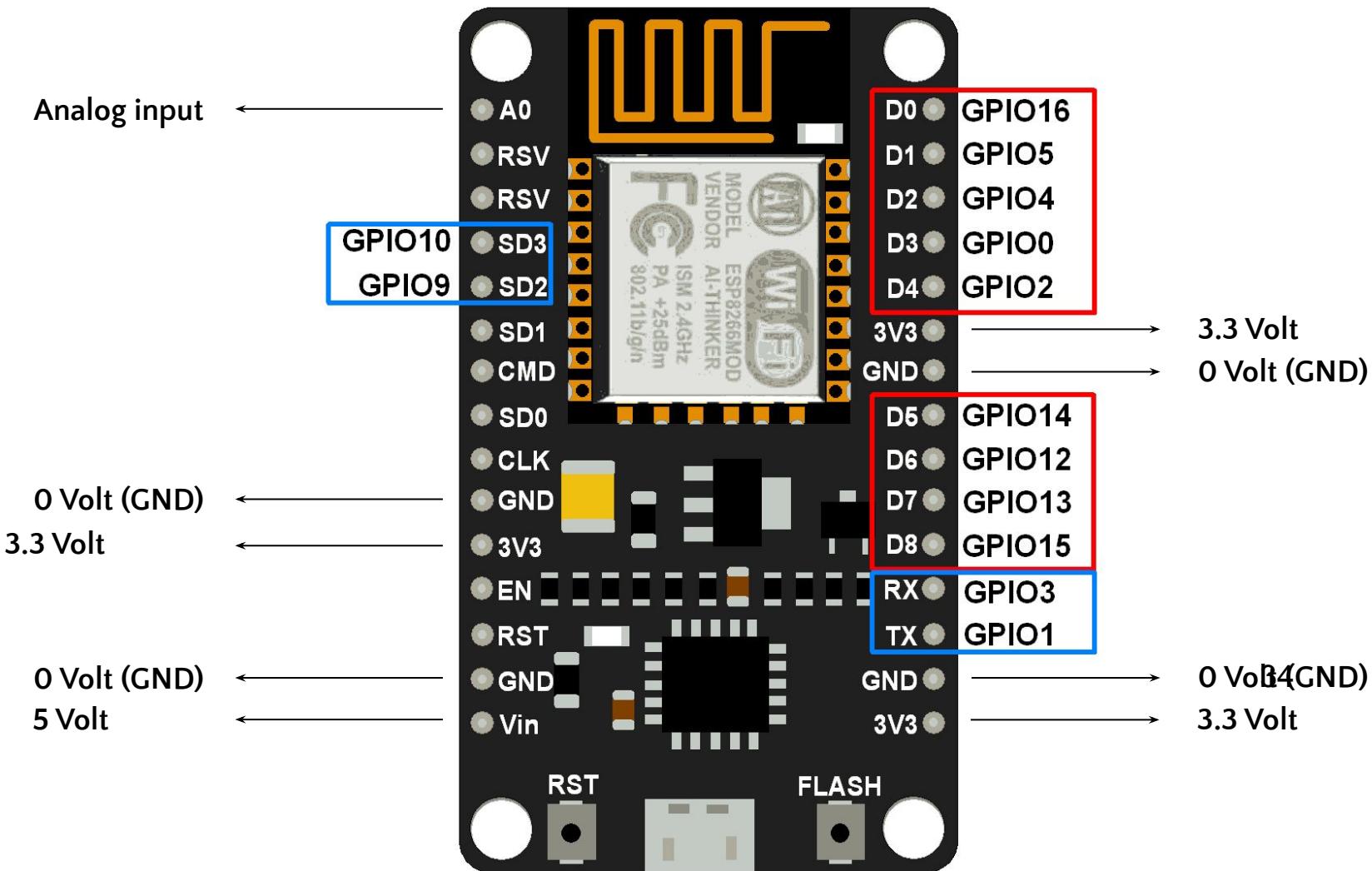


Image Source: <https://www.electronicwings.com>

Software Development Platform

Arduino® Integrated Development Environment (IDE)



ARDUINO

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This software can be used with any Arduino board. Refer to the [Getting Started](#) page for installation instructions.

<https://www.arduino.cc>

Windows Installer, for Windows XP and up

Windows ZIP file for non admin install

Windows app Requires Win 8.1 or 10



Mac OS X 10.8 Mountain Lion or newer

Linux 32 bits

Linux 64 bits

Linux ARM 32 bits

Linux ARM 64 bits

[Release Notes](#)

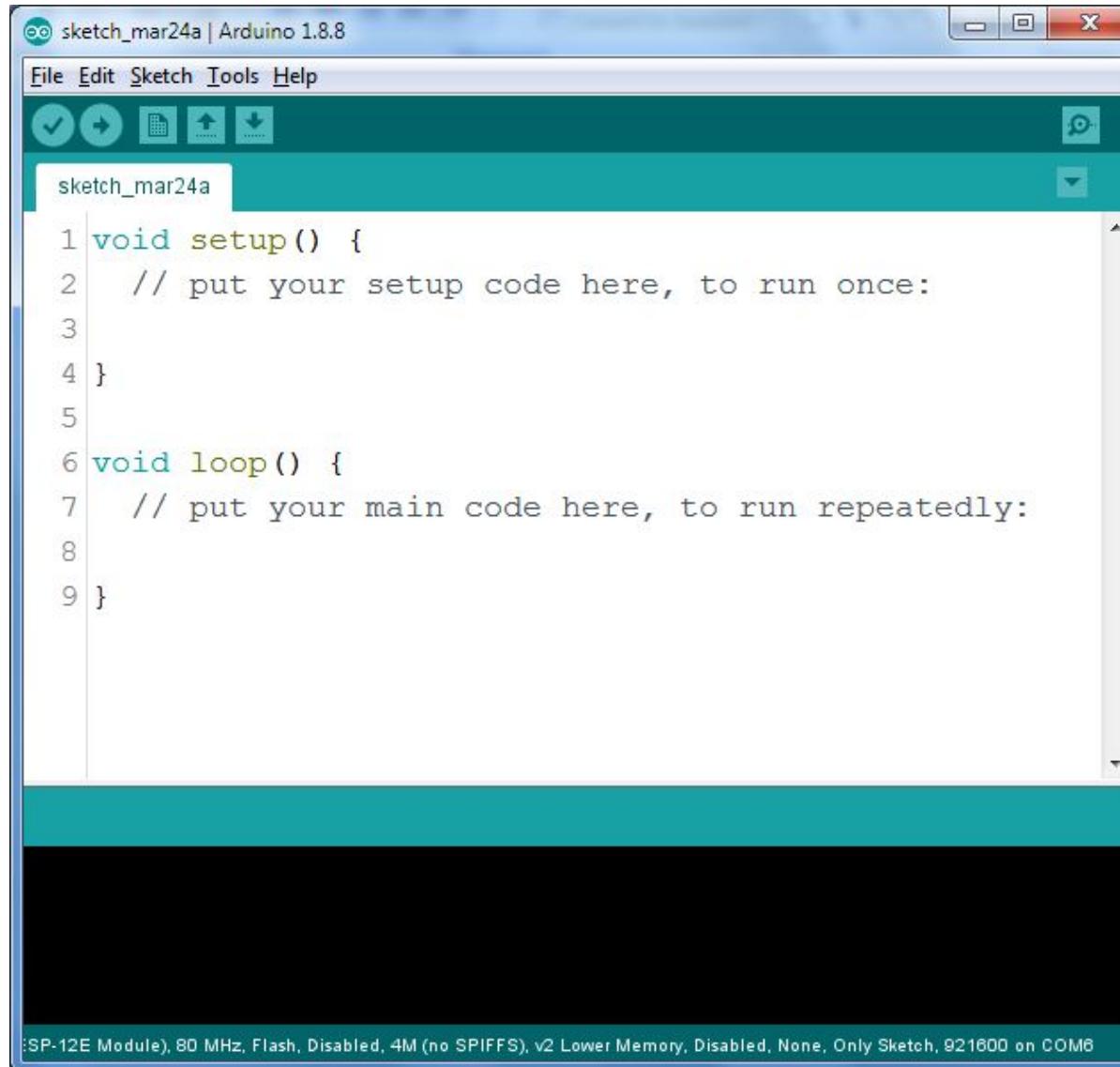
35

[Source Code](#)

[Checksums \(sha512\)](#)

Software Development Platform

Arduino® Integrated Development Environment (IDE)



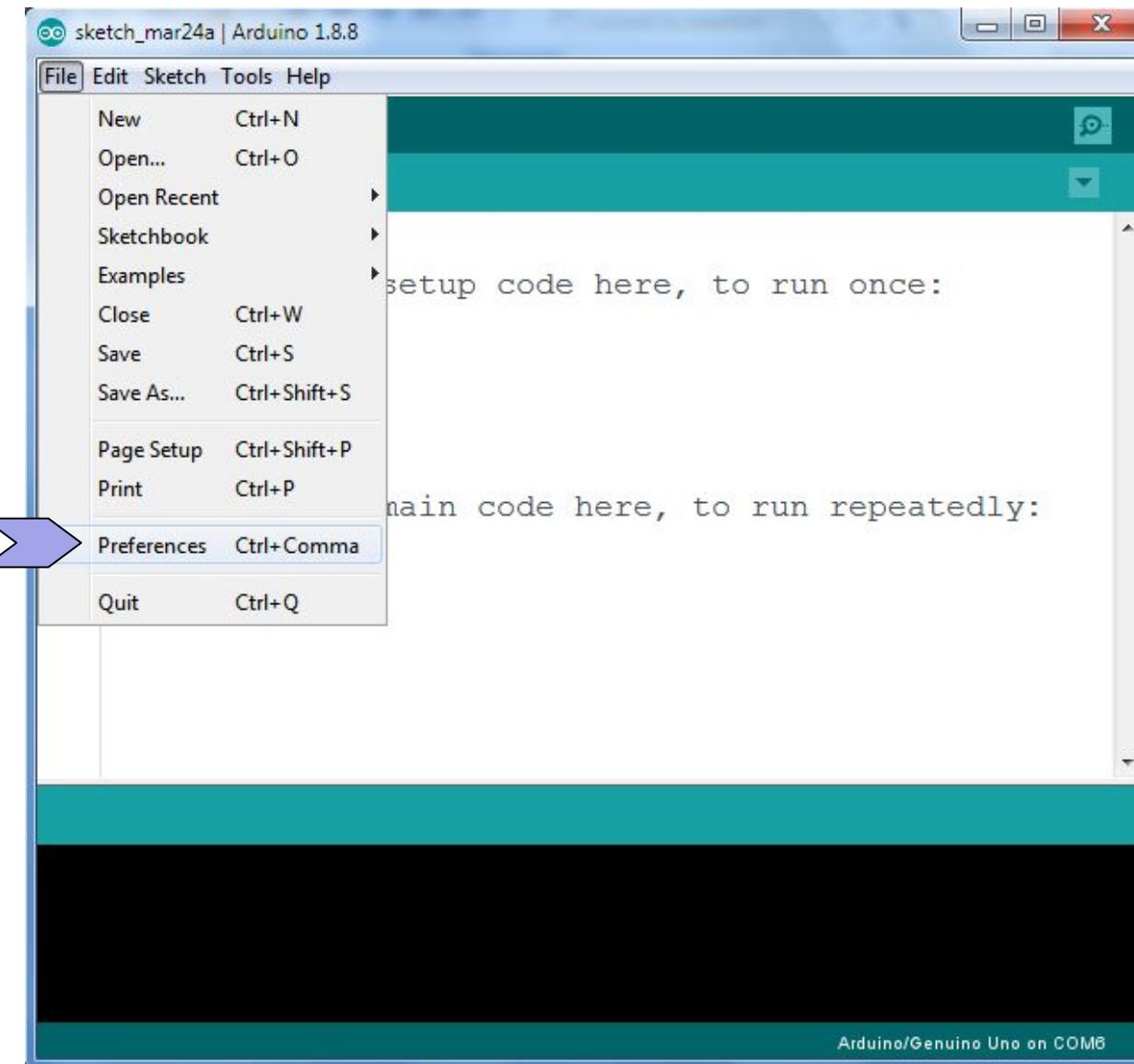
The screenshot shows the Arduino IDE interface with the following details:

- Title Bar:** sketch_mar24a | Arduino 1.8.8
- Menu Bar:** File Edit Sketch Tools Help
- Toolbar:** Includes icons for Save, Undo, Redo, Open, Upload, and Download.
- Sketch Editor:** Displays the following code:

```
1 void setup() {  
2     // put your setup code here, to run once:  
3  
4 }  
5  
6 void loop() {  
7     // put your main code here, to run repeatedly:  
8  
9 }
```
- Status Bar:** (SP-12E Module), 80 MHz, Flash, Disabled, 4M (no SPIFFS), v2 Lower Memory, Disabled, None, Only Sketch, 921600 on COM6

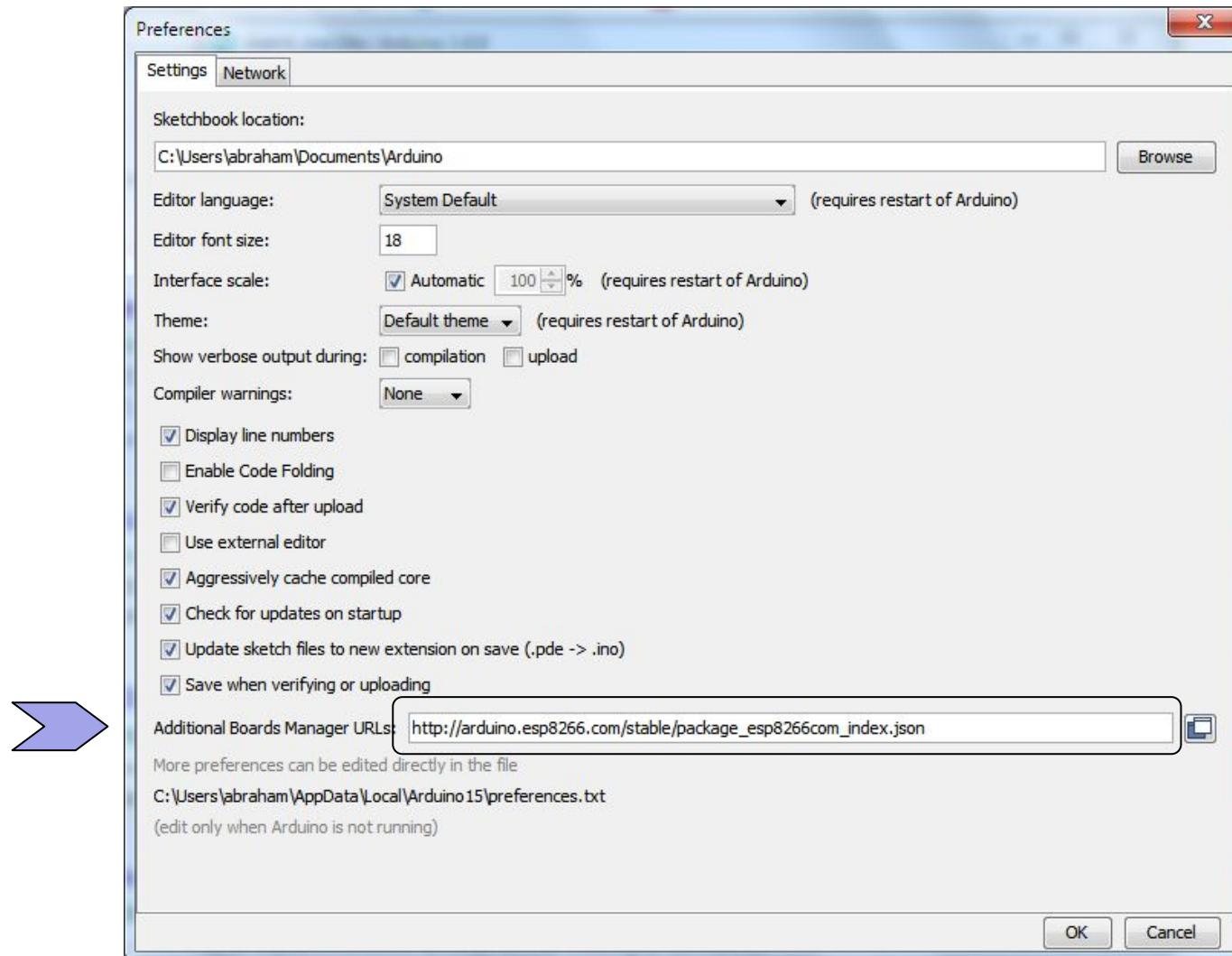
36

Setting up Arduino IDE for NodeMCU Board



37

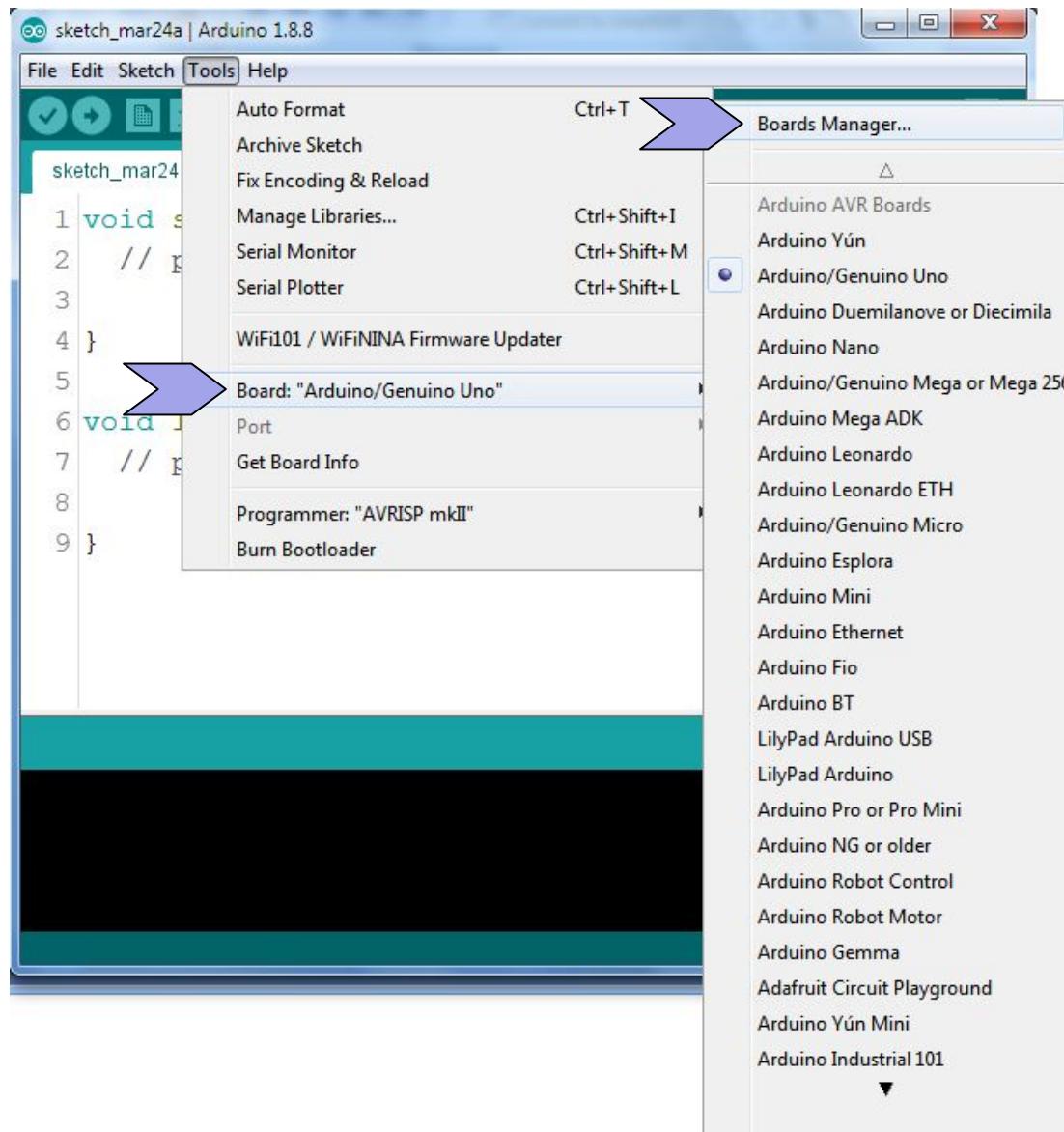
Setting up Arduino IDE for NodeMCU Board



38

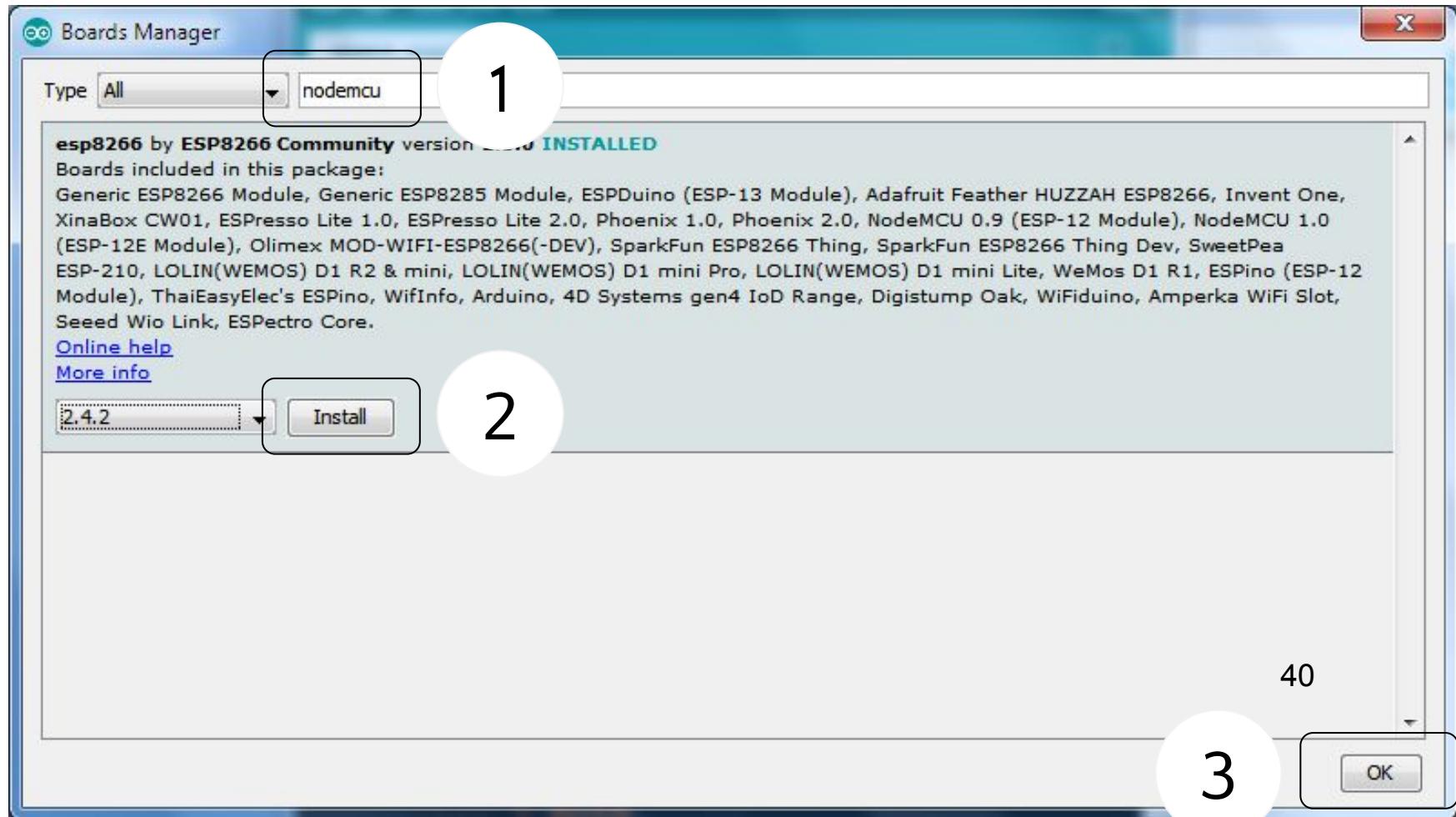
Google Search keyword: “Arduino additional Board manager URL for NodeMCU”

Setting up Arduino IDE for NodeMCU Board

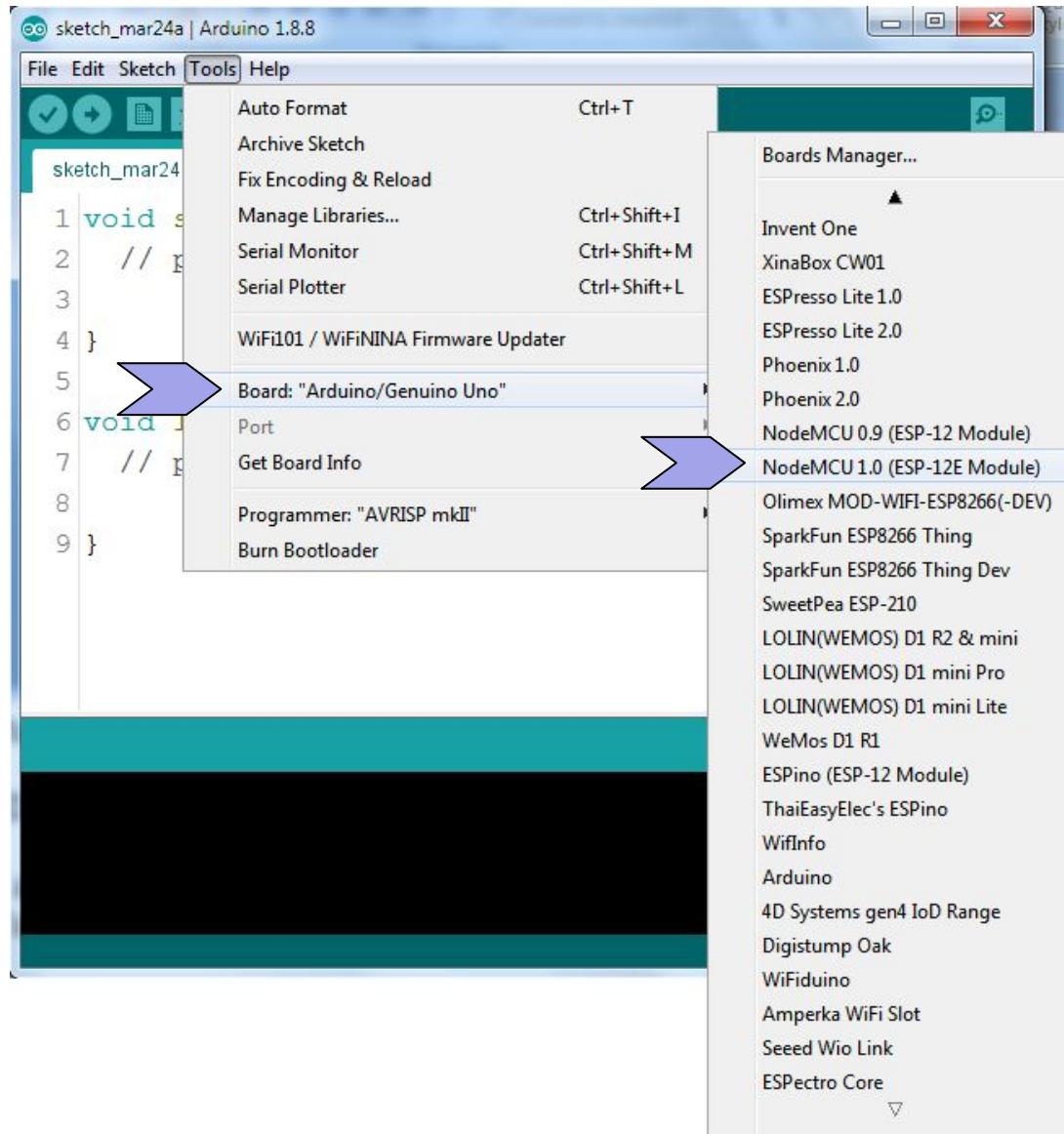


39

Setting up Arduino IDE for NodeMCU Board



Setting up Arduino IDE for NodeMCU Board



41

Programming NodeMCU

Commonly used Arduino Functions

Function	Purpose	Example Syntax
<code>pinMode()</code>	Used to configure pins as input/output	<code>pinMode(D0, INPUT);</code>
<code>digitalRead()</code>	Used to read digital signals from a pin	<code>digitalRead(D0);</code>
<code>digitalWrite()</code>	Used to write digital signals on to a pin: HIGH for 5V & LOW for 0V	<code>digitalWrite(D0, HIGH);</code>
<code>analogRead()</code>	Used to read analog signals from a pin using internal A to D Conversion	<code>analogRead(A0);</code>
<code>analogWrite()</code>	Used to generate width varying digital pulses using Pulse Width Modulation (PWM) which can be used to produce low frequency Analog signals with the help of additional filters.	<code>analogWrite(D6, 400);</code> 42

Programming NodeMCU

Commonly used Arduino Functions ...

Function	Purpose	Example Syntax
<code>Serial.print()</code>	Used to transmit data through serial interface for debugging / monitoring / communication purposes	<code>Serial.print("Hello World");</code>
<code>Serial.begin()</code>	Sets the data rate in bits per second (bps or baud) for serial data transmission.	<code>Serial.begin(115200);</code>
<code>delay()</code>	To delay the next command for a certain duration in milliseconds.	<code>delay(1000);</code>

Let's connect them together

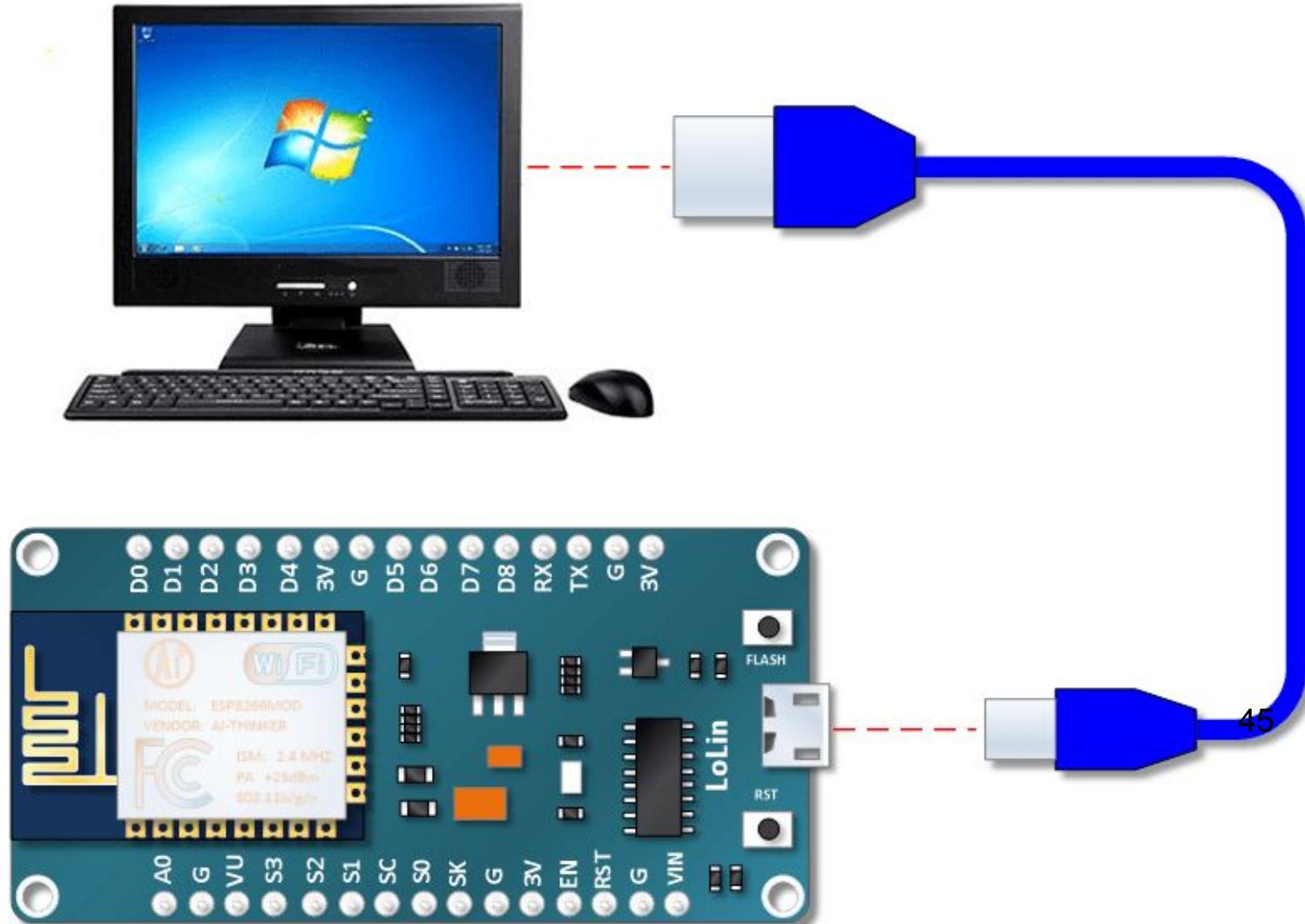


Image Source: <https://i0.wp.com/henrysbench.capnfatz.com/wp-content/uploads/2016/09/Connect-to-Computer.png>

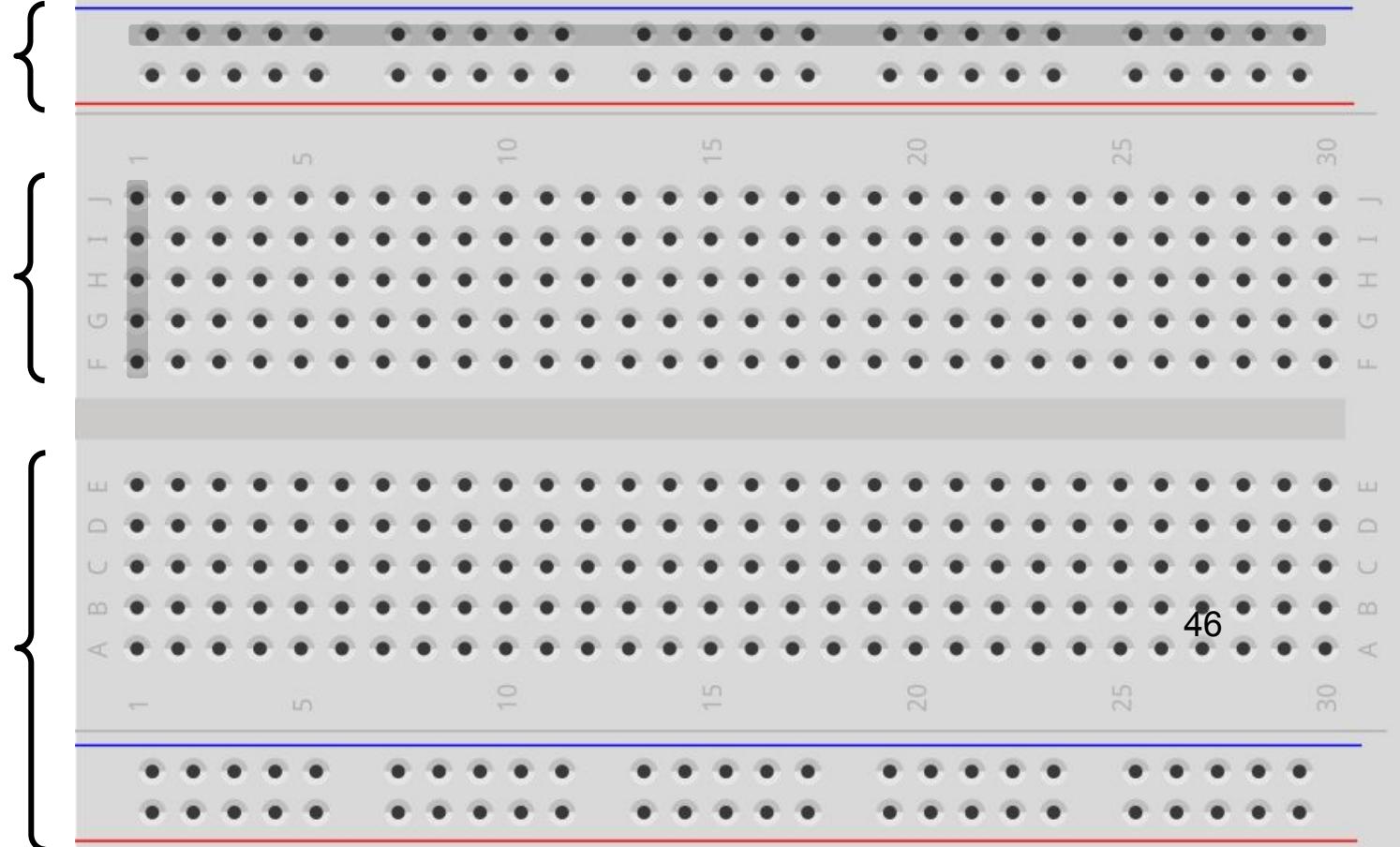
Breadboard Connection

The horizontal strips that run the length of the breadboard are electrically connected inside. The strips are usually used for power and ground connections

Power Bus

The 5 holes in each vertical rows are connected electrically through metal strips inside the breadboard

This horizontal portion of the breadboard is vertically symmetric with the top portion and the connections are similar

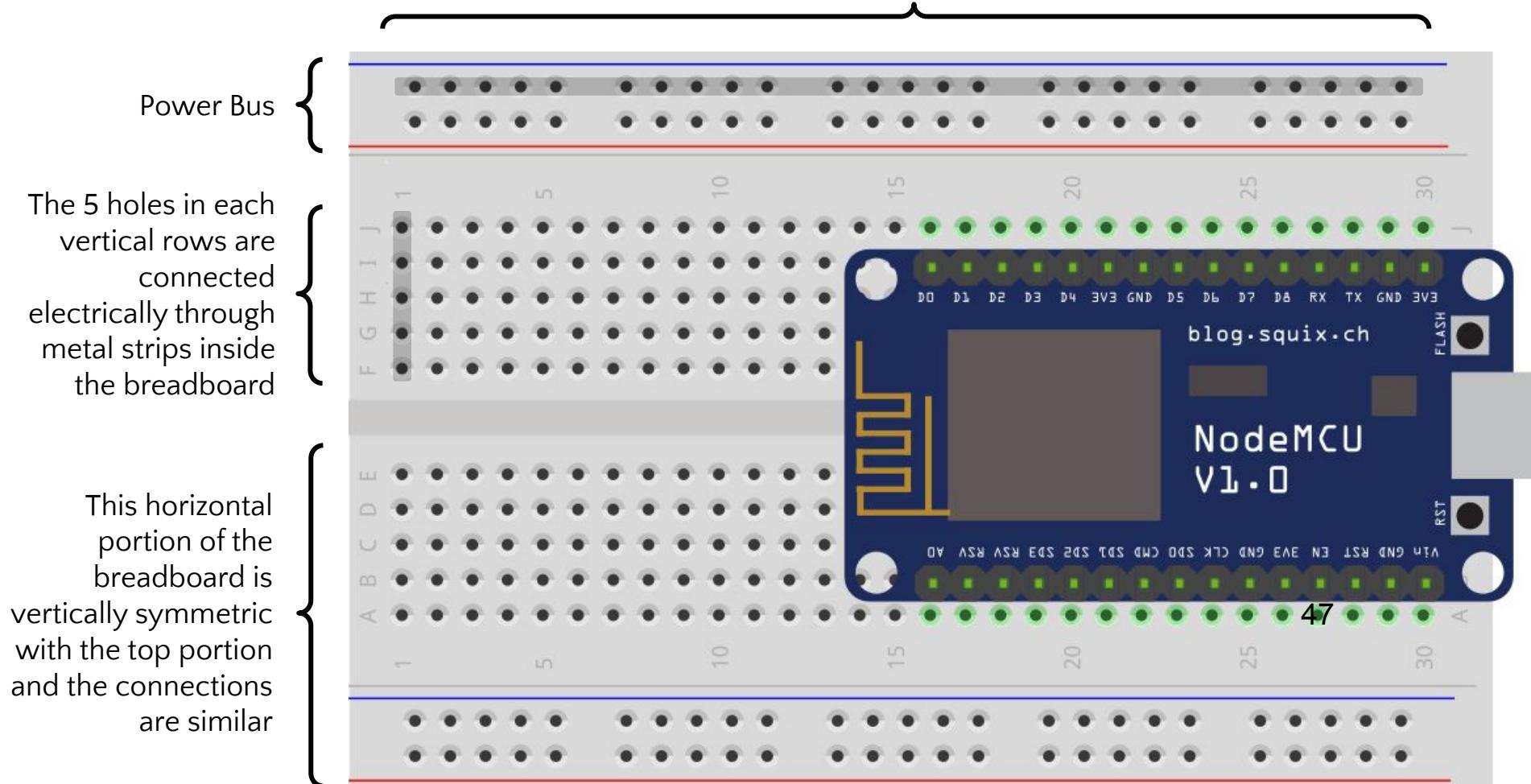


Reference: <https://diygeeks.org/wp-content/uploads/2018/01/BreadBoard-Labelling-1012x1024.jpg>

fritzing

Breadboard Connection

The horizontal strips that run the length of the breadboard are electrically connected inside. The strips are usually used for power and ground connections



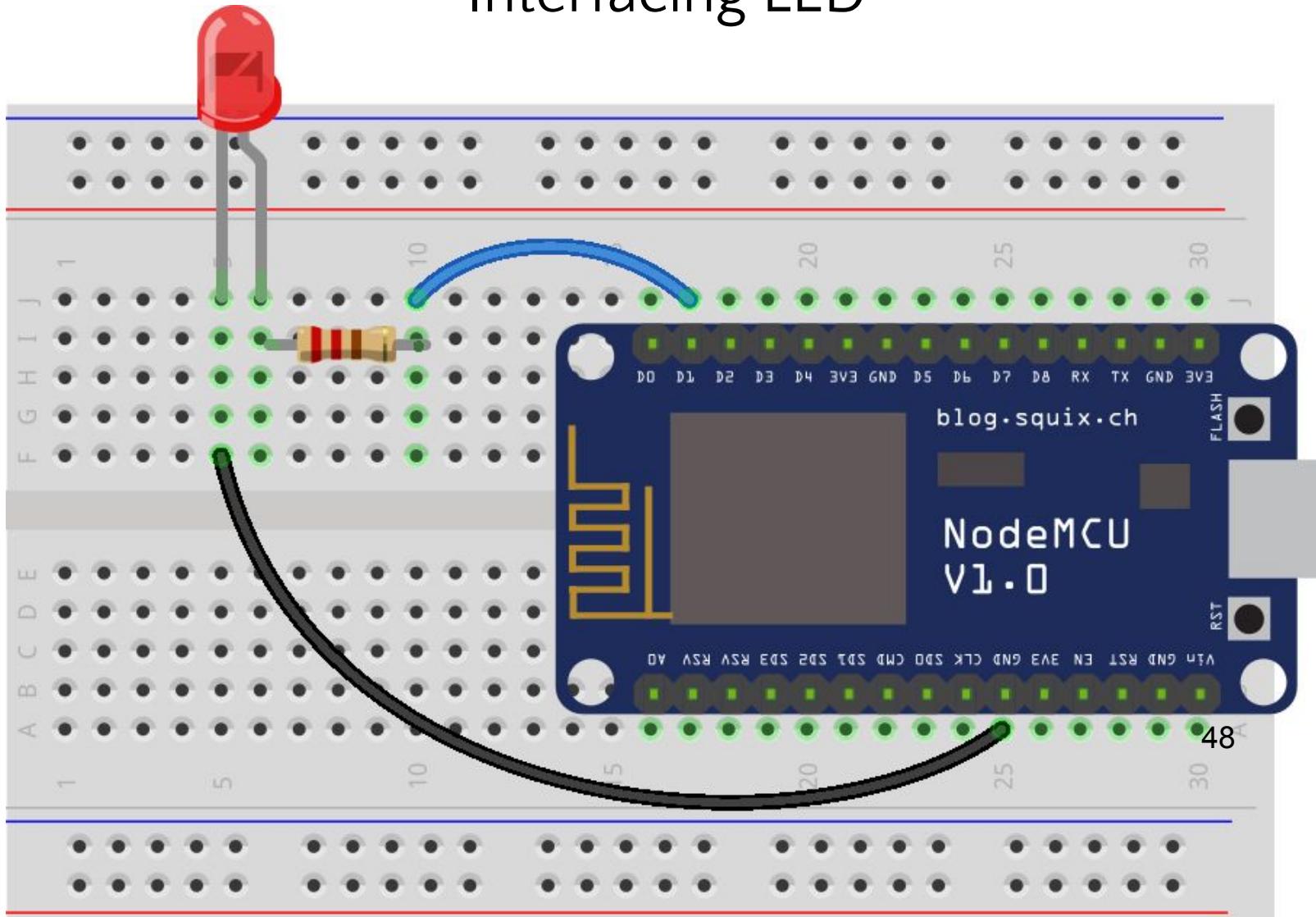
Reference: <https://diygeeks.org/wp-content/uploads/2018/01/BreadBoard-Labelling-1012x1024.jpg>

Layout designed using Fritzing® - <http://fritzing.org>, NodeMCU part Source(s):<https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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DIY Experiments with NodeMCU

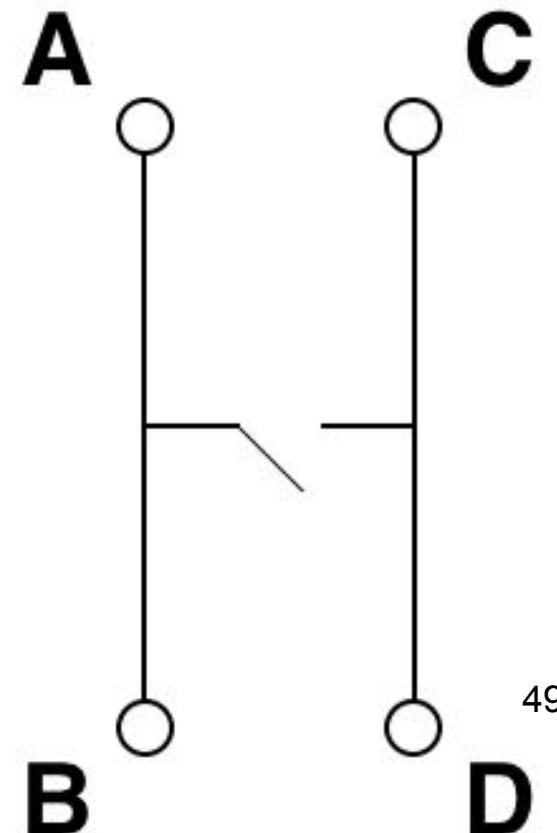
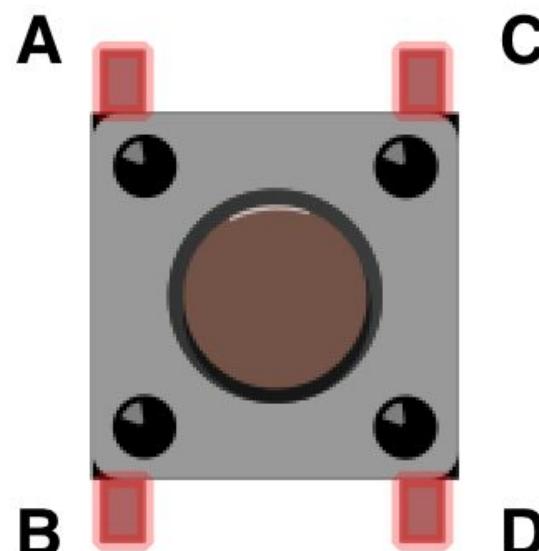
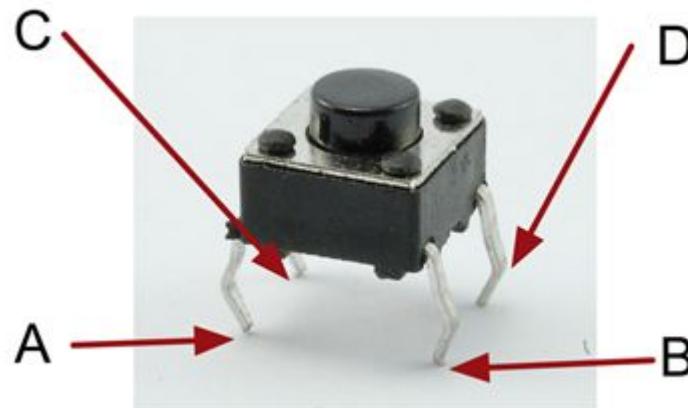
Interfacing LED



Layout designed using Fritzing® - <http://fritzing.org>

NodeMCU part Source(s):<https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

Momentary Tactile Push Button / Switch



49

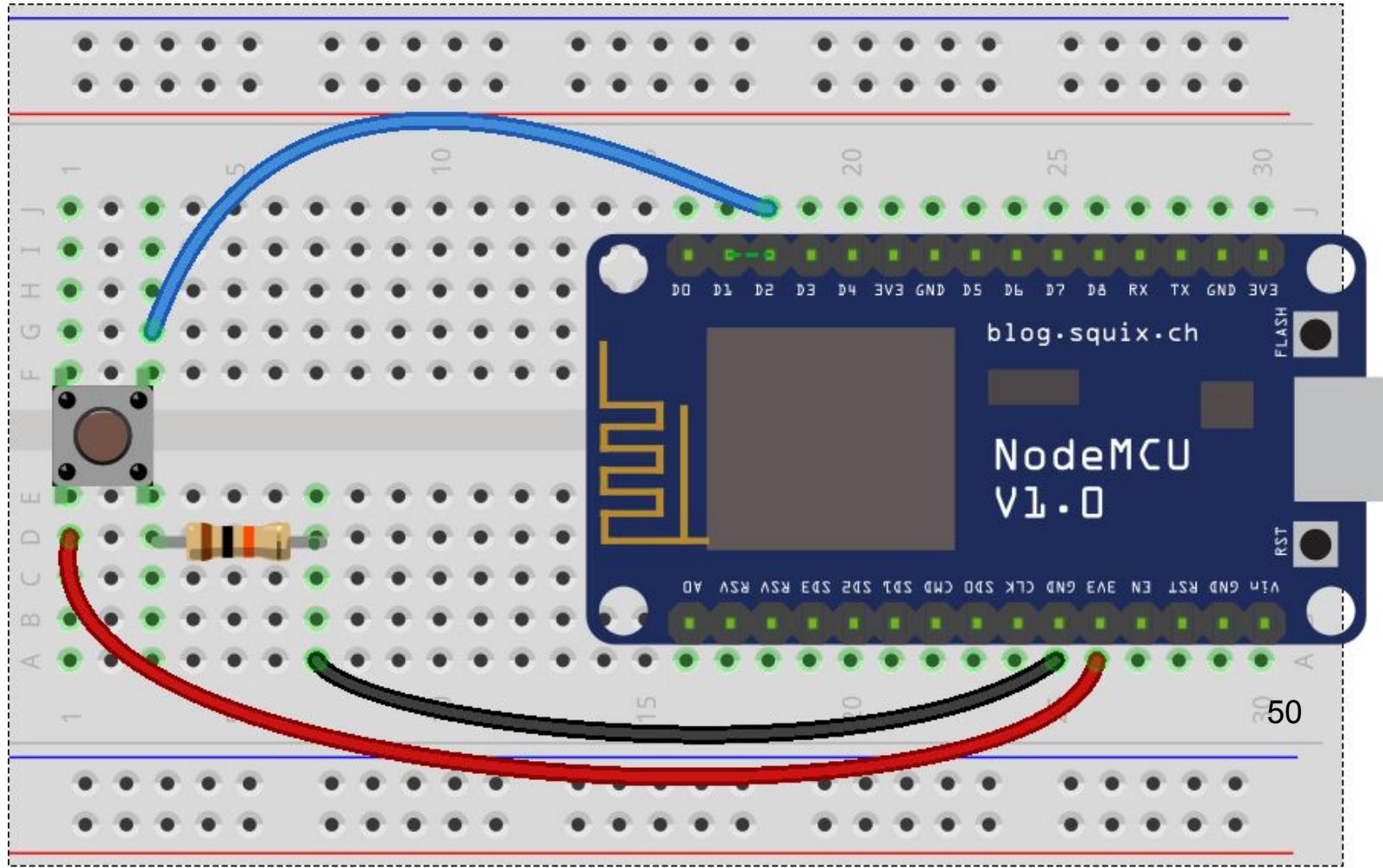
Image Source(s):

http://razzpisampler.oreilly.com/images/rpck_1102.png,

https://docs.labs.mediatek.com/resource/linkit7697-arduino/files/en/12880064/12880062/1/1498095674923/button_sch.png

DIY Experiments with NodeMCU

Interfacing Push Button Switch

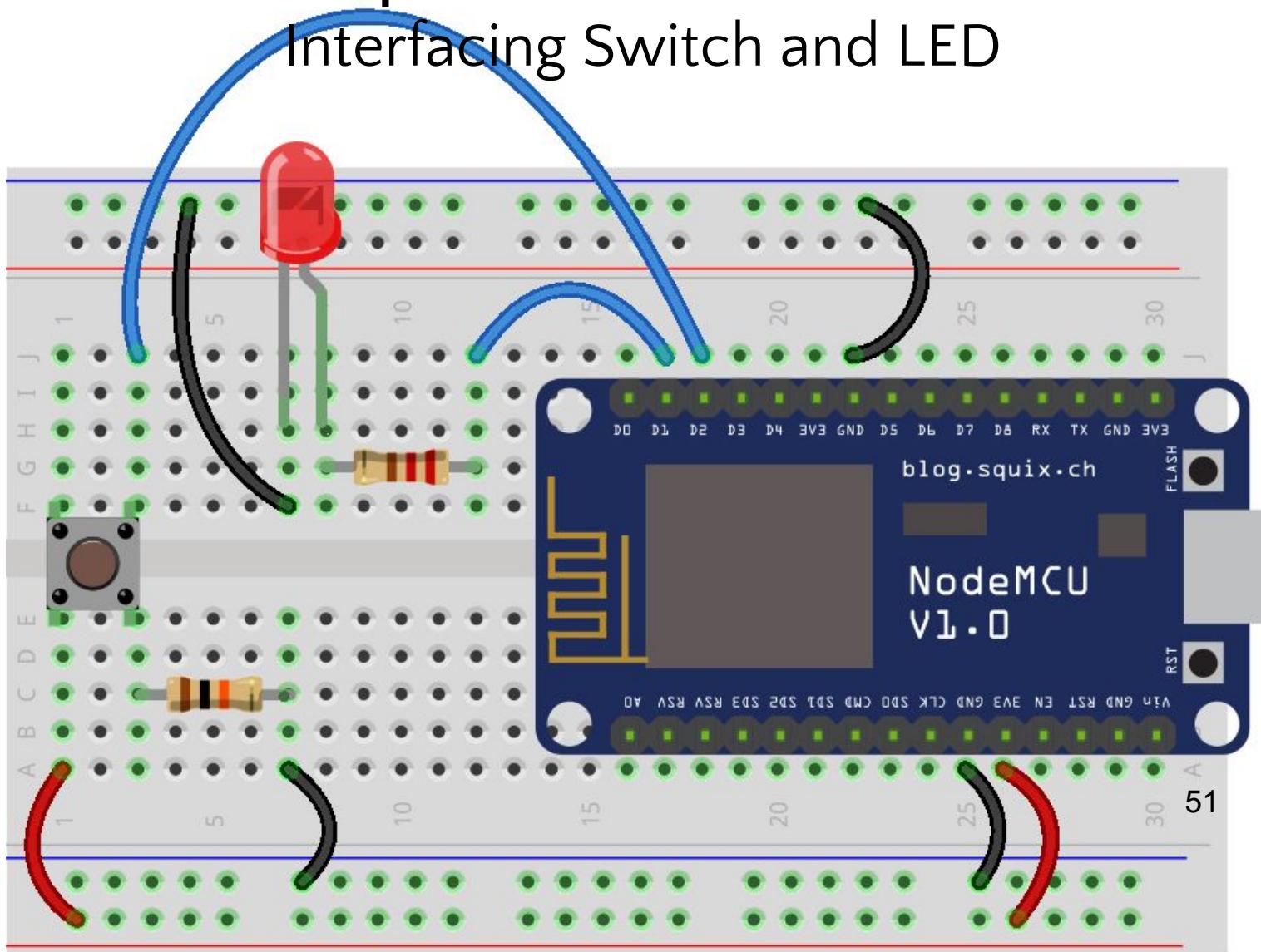


Layout designed using Fritzing® - <http://fritzing.org>

NodeMCU part Source: <https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

DIY Experiments with NodeMCU

Interfacing Switch and LED



Layout designed using Fritzing® - <http://fritzing.org>

NodeMCU part Source: <https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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Light Dependent Resistor (LDR)

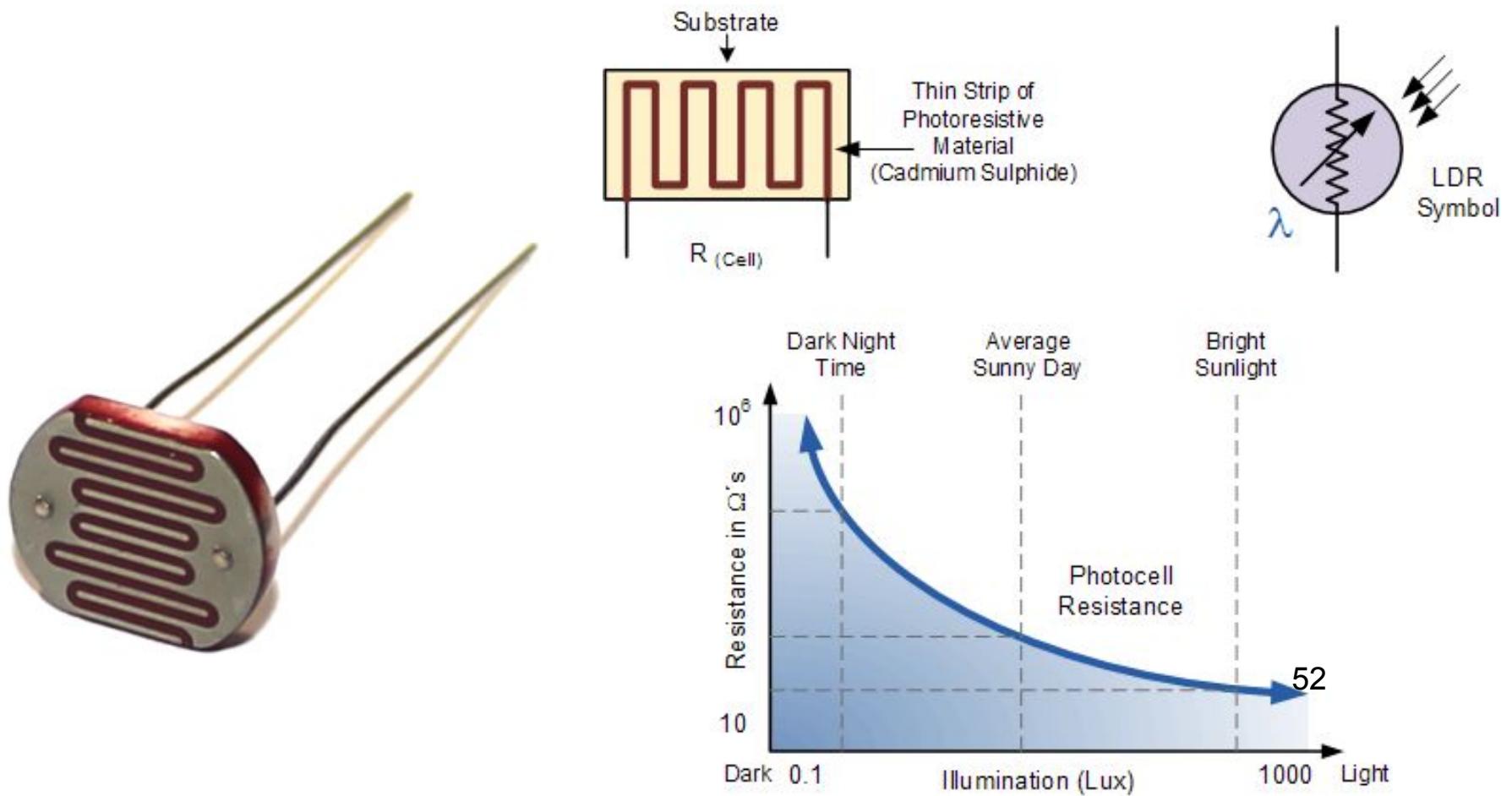
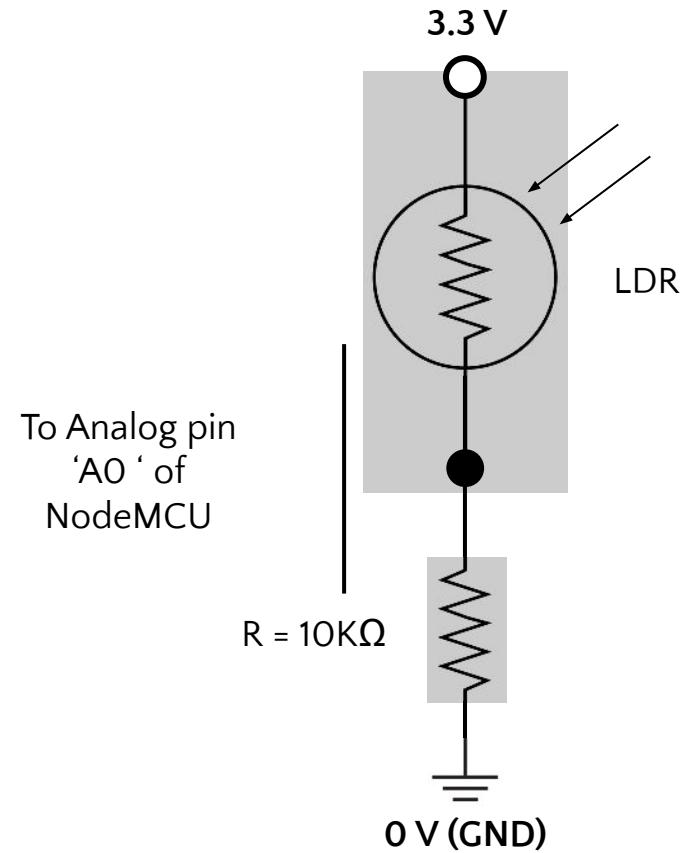


Image Source(s):

<http://www.electricalibrary.com/wp-content/uploads/2017/08/LDR-destaque.jpg>
<https://www.electronics-tutorials.ws/io/io19.gif>

LDR application circuit diagram

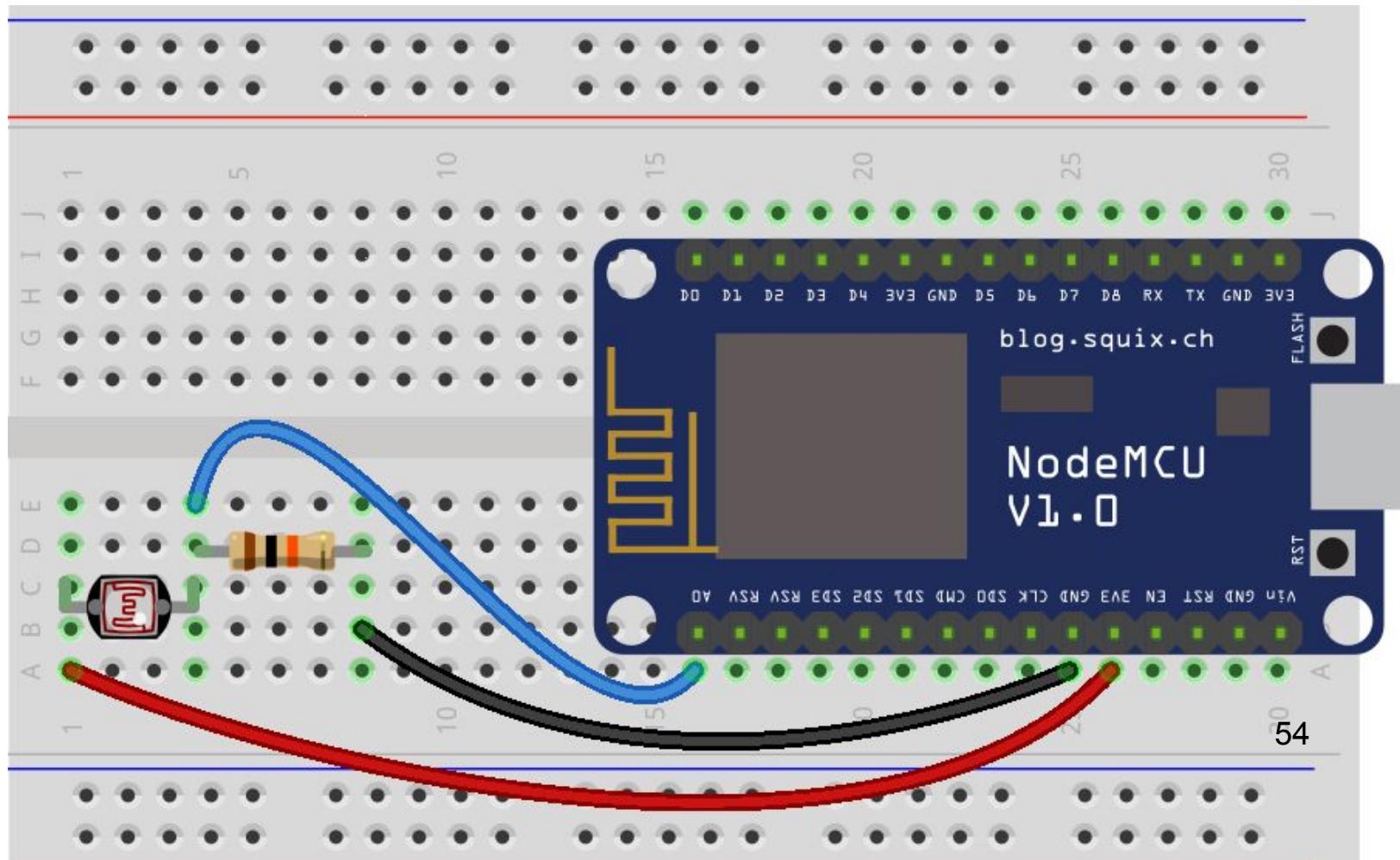


53

Image Source: <https://www.electronics-notes.com/images/light-dependent-resistor-photoresistor-circuit-symbol.svg>

DIY Experiments with NodeMCU

Interfacing LDR

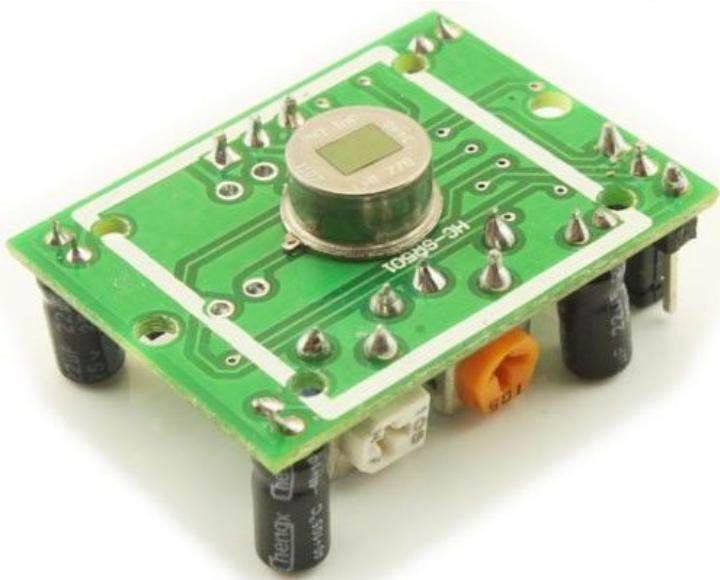


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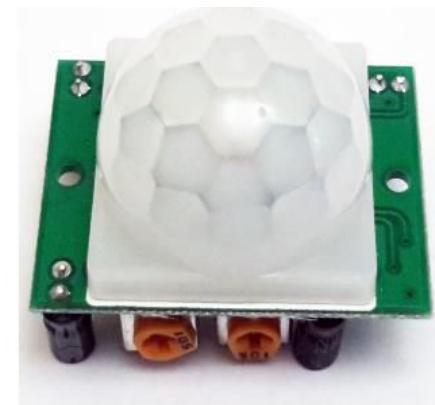
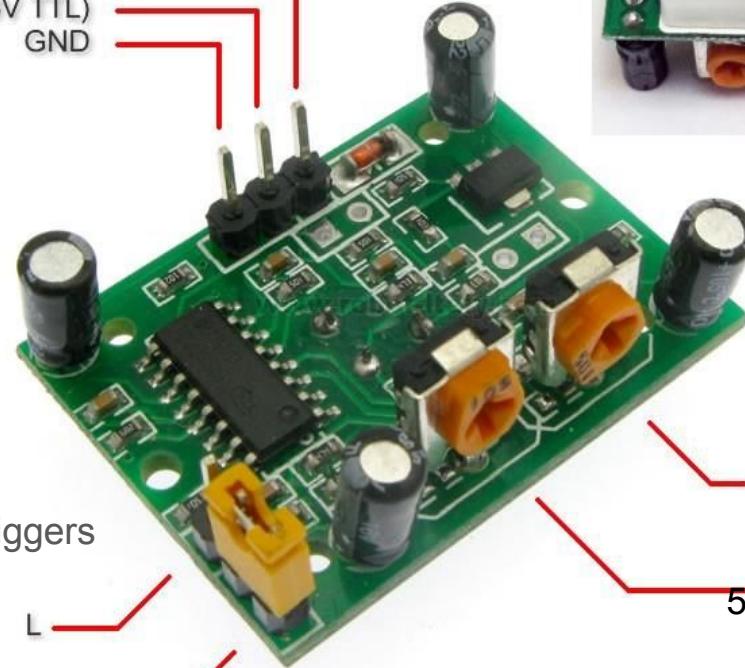
NodeMCU part Source: <https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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PIR Motion Sensor – HCR501



VCC 5-12VDC
OUT (3.3V TTL)
GND



Setting for Single or Repeatable Triggers

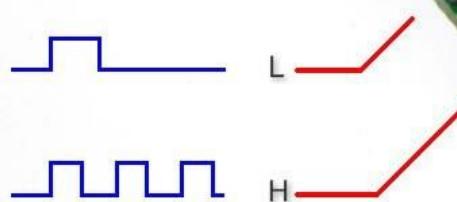


Image Source:: https://c.76.my/Malaysia/hc-sr501-motion-sensor-arduino-ir-bodypassive-infrared-sensor-module-redbean77-1711-20-F625876_1.jpg

PIR Motion Sensing

Fresnel Lens Focusing

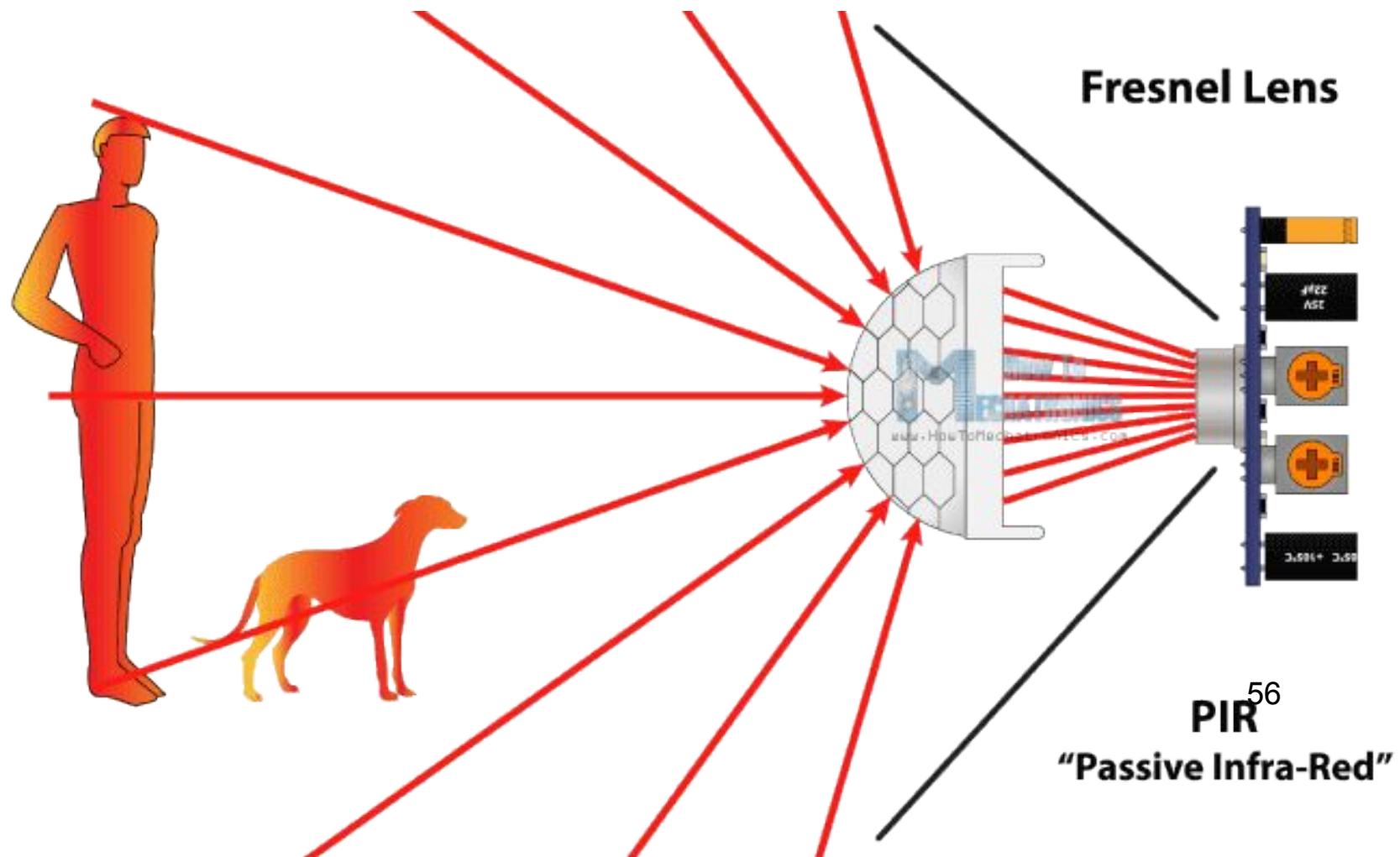
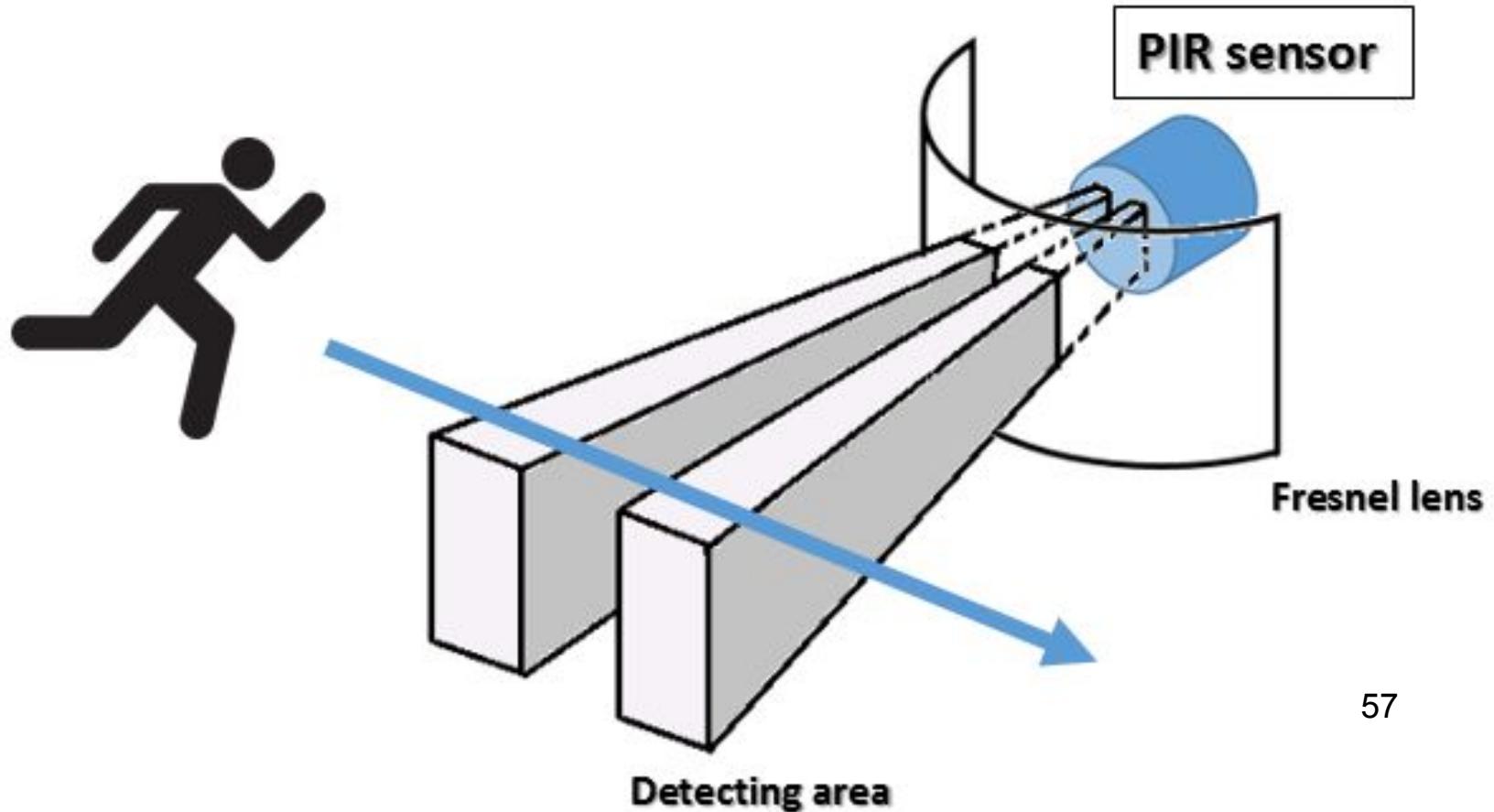


Image Source:: <https://howtomechatronics.com/wp-content/uploads/2015/09/PIR-Motion-Sensor-How-It-Works.png>

PIR Motion Sensing



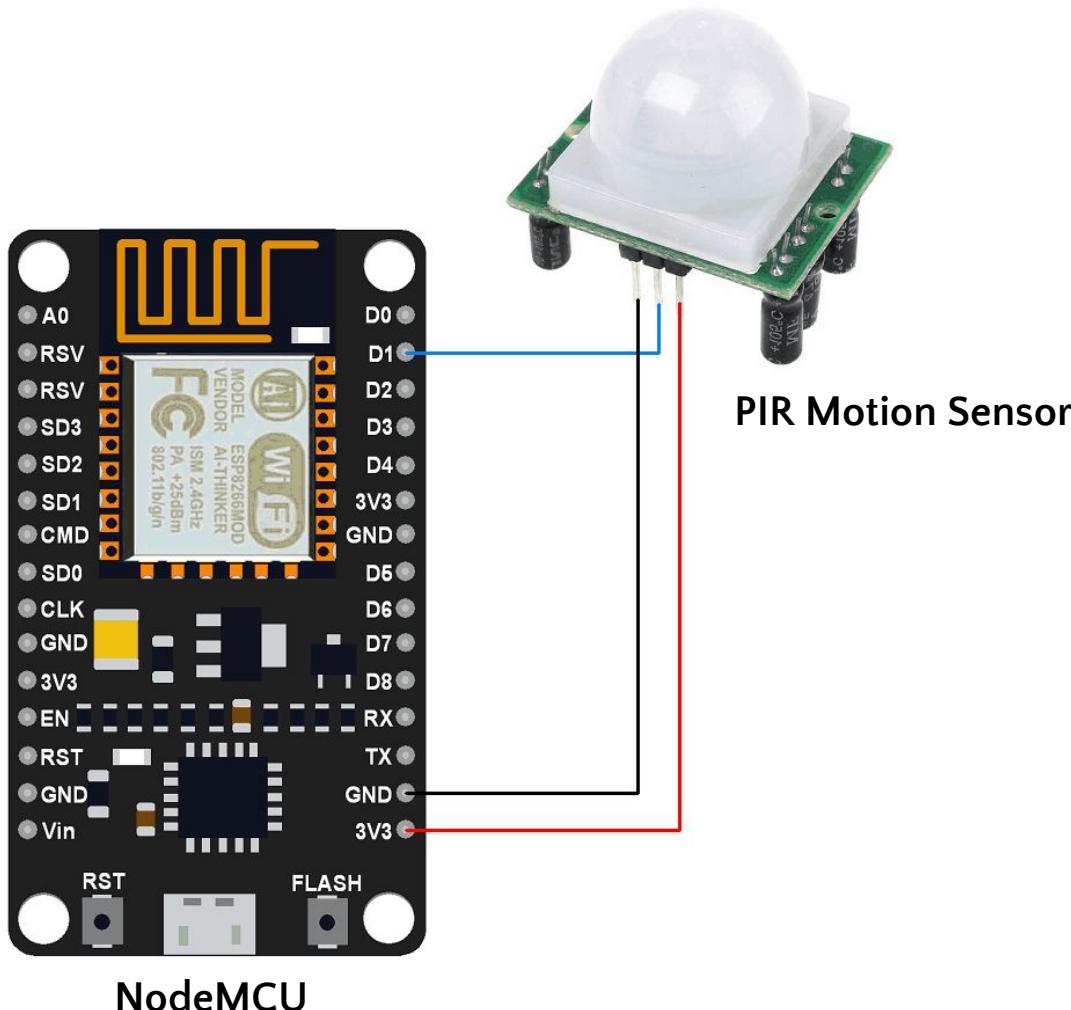
57

Image Source::

<https://static1.squarespace.com/static/557f31e6e4b0971f7f8bcac6/t/5b04a73e352f53cc9e14f413/1527031679239/Meccanismo-Complesso-PIR-sensor-how-to.png>

DIY Experiments with NodeMCU

Interfacing PIR Motion Sensor – HCR501



58

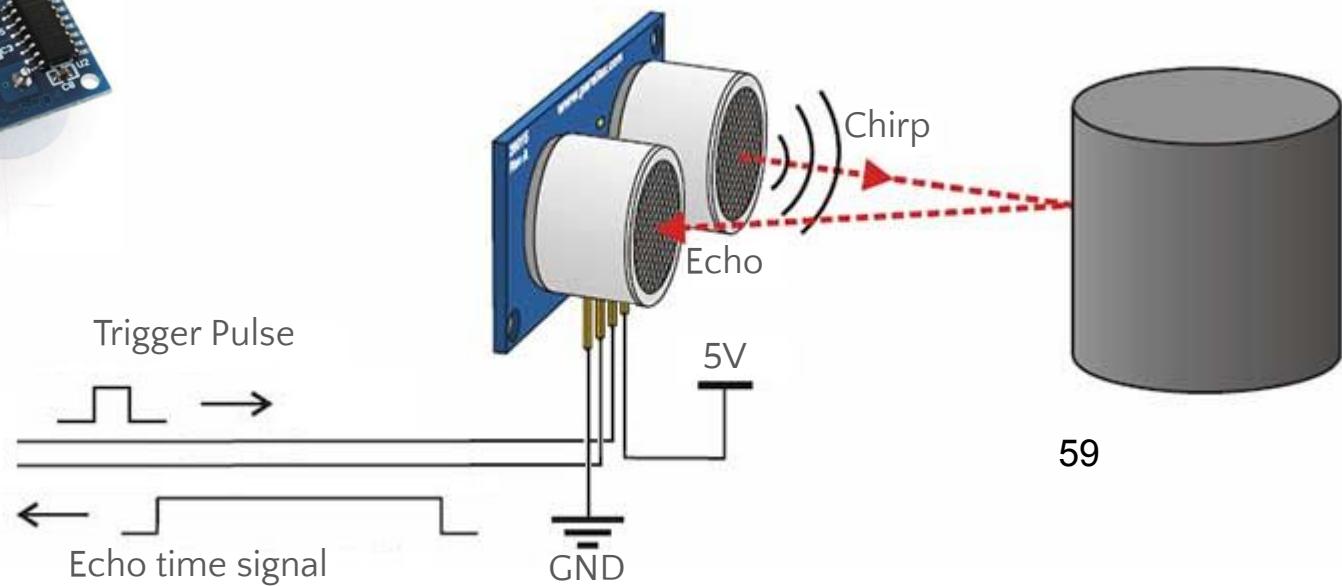
Image Source:: <http://www.electronicwings.com>

Ultrasonic Sensor – HC-SR04



HC-SR04

Working of HC-SR04



59

Image Source:: <https://cdn2.bjultrasonic.com/wp-content/uploads/2017/04/Ultrasonic-Sensors.jpg>

Ultrasonic Sensor HC-SR04

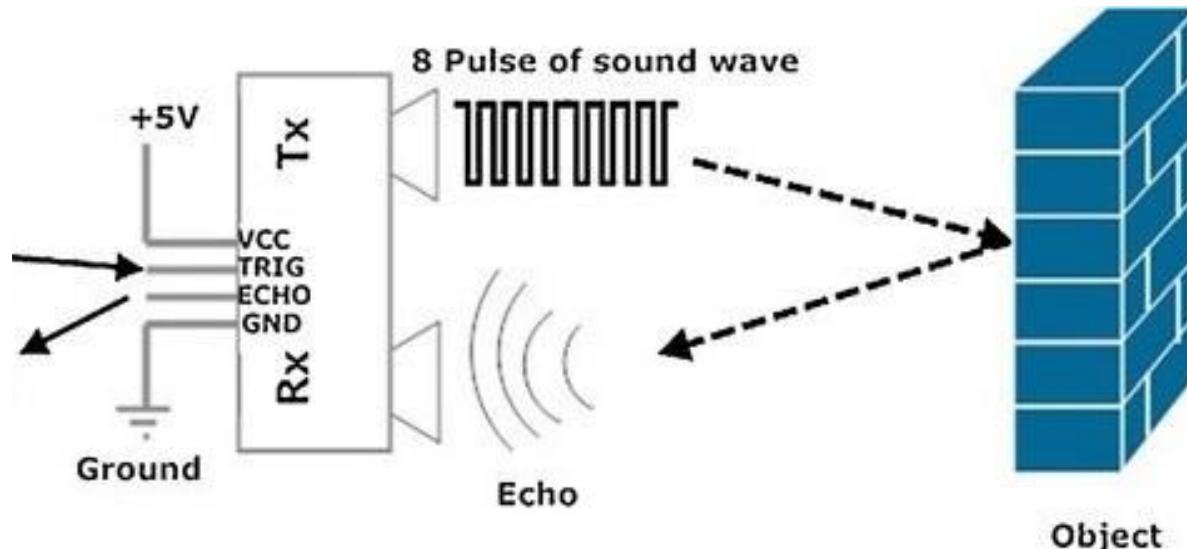
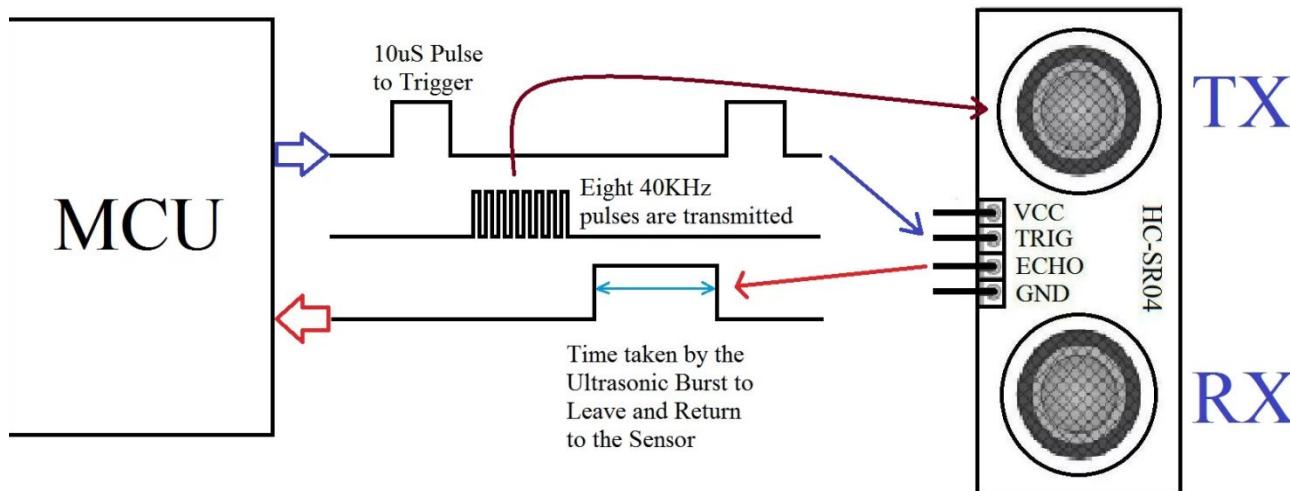
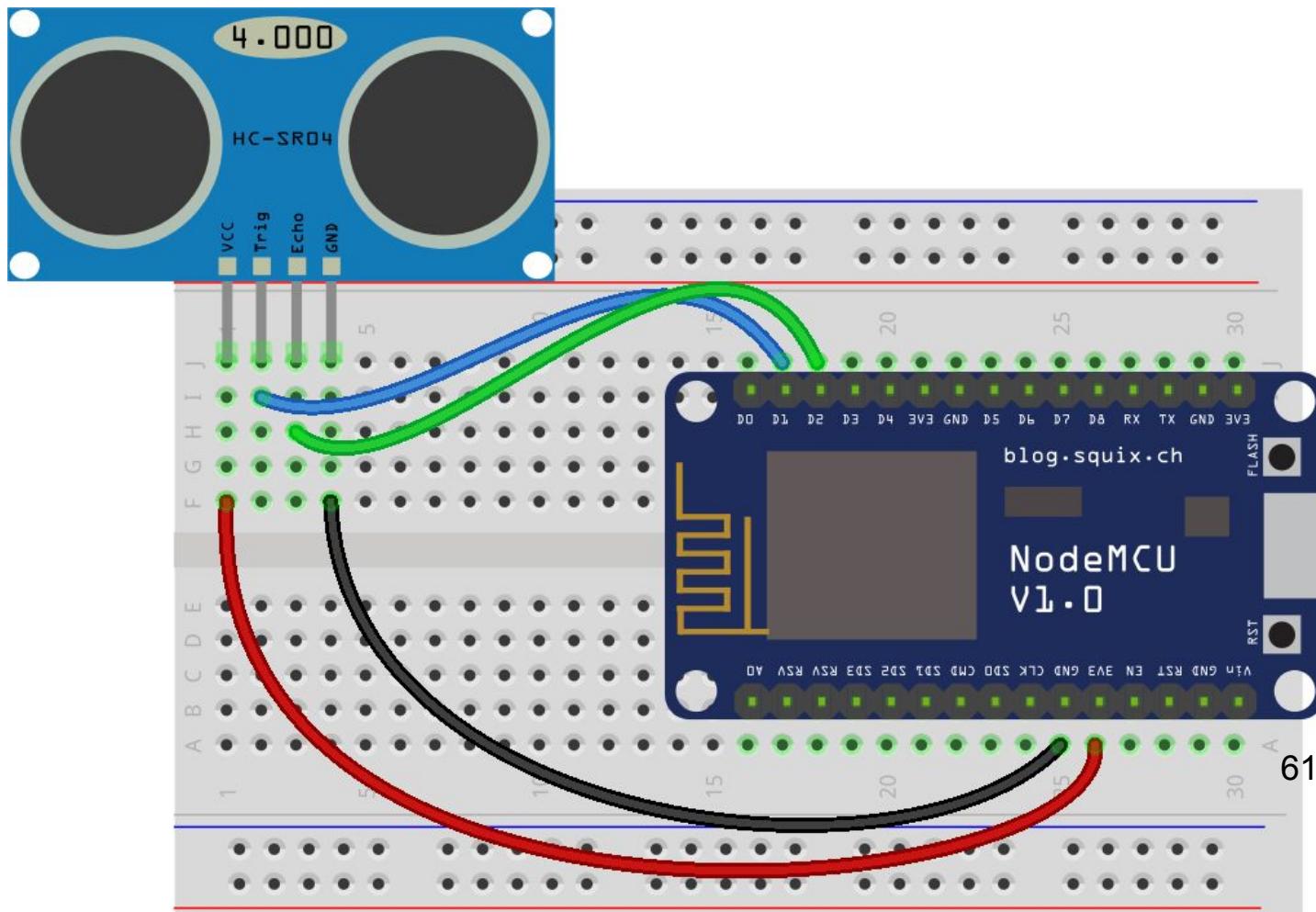


Image Source:

<https://electrosome.com/wp-content/uploads/2014/08/Working-of-HC-SR04-Ultrasonic-Sensor.jpg>
https://www.researchgate.net/figure/Working-principle-of-an-ultrasonic-sensor_fig1_304822025

DIY Experiments with NodeMCU

Interfacing Ultrasonic Sensor

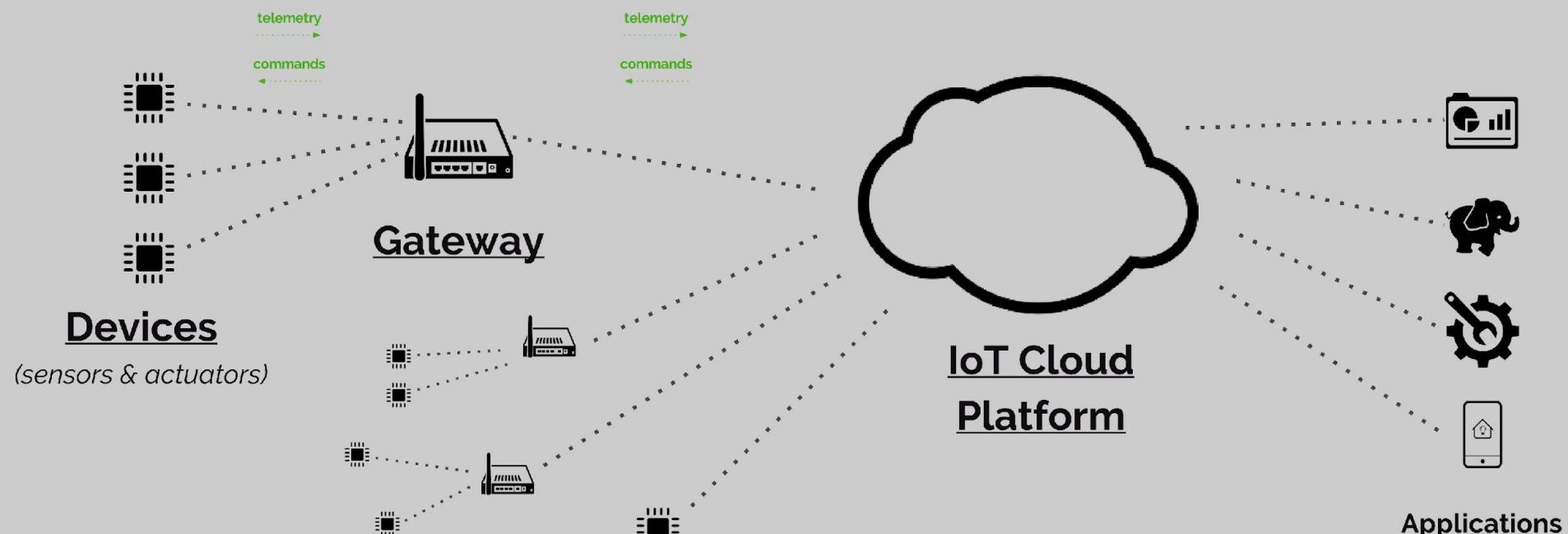


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fritzing

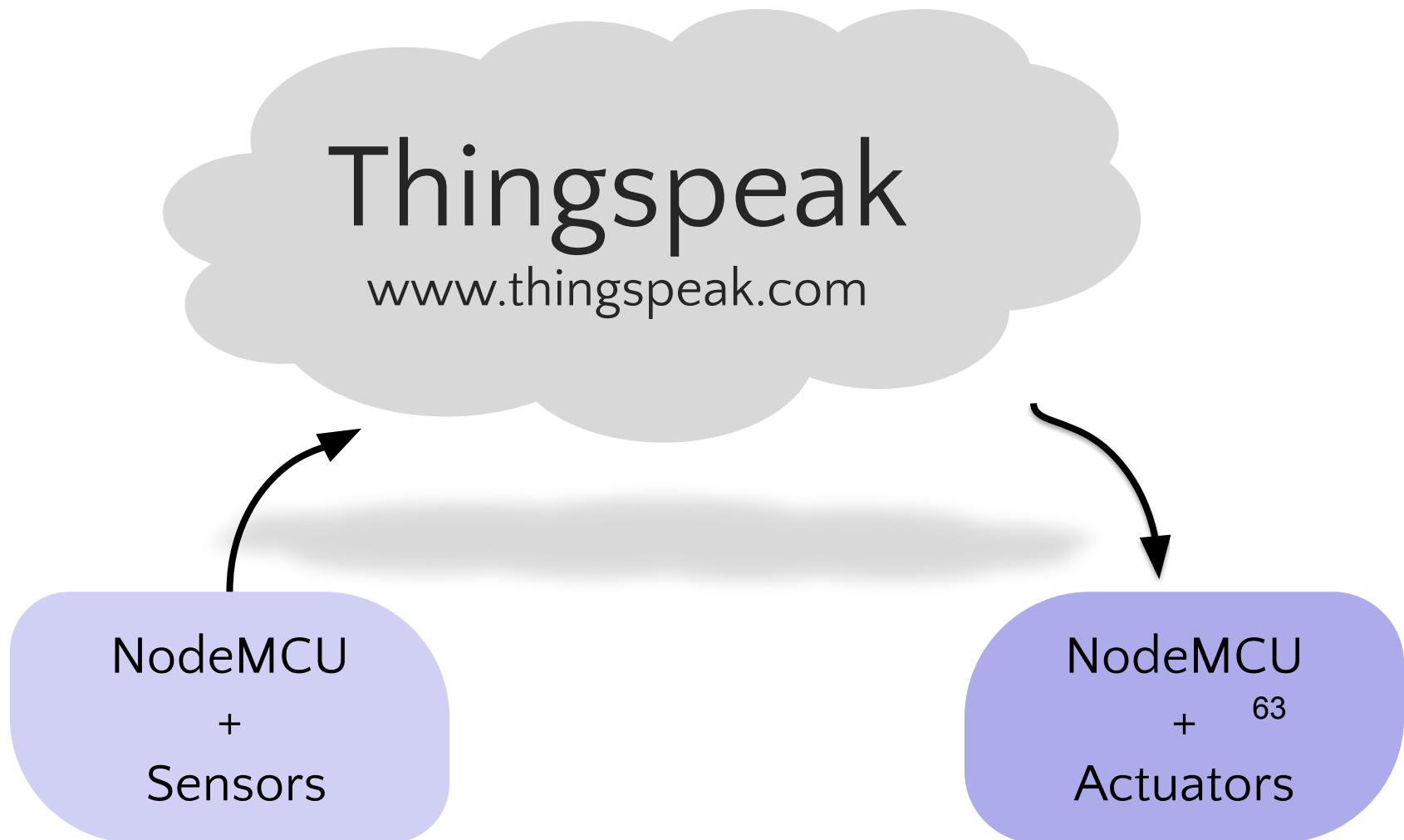
Cloud Platforms



62

Image Source: <https://iot.eclipse.org/resources/white-papers/iot-architectures/image/IoT-arch.png>

Cloud Platforms

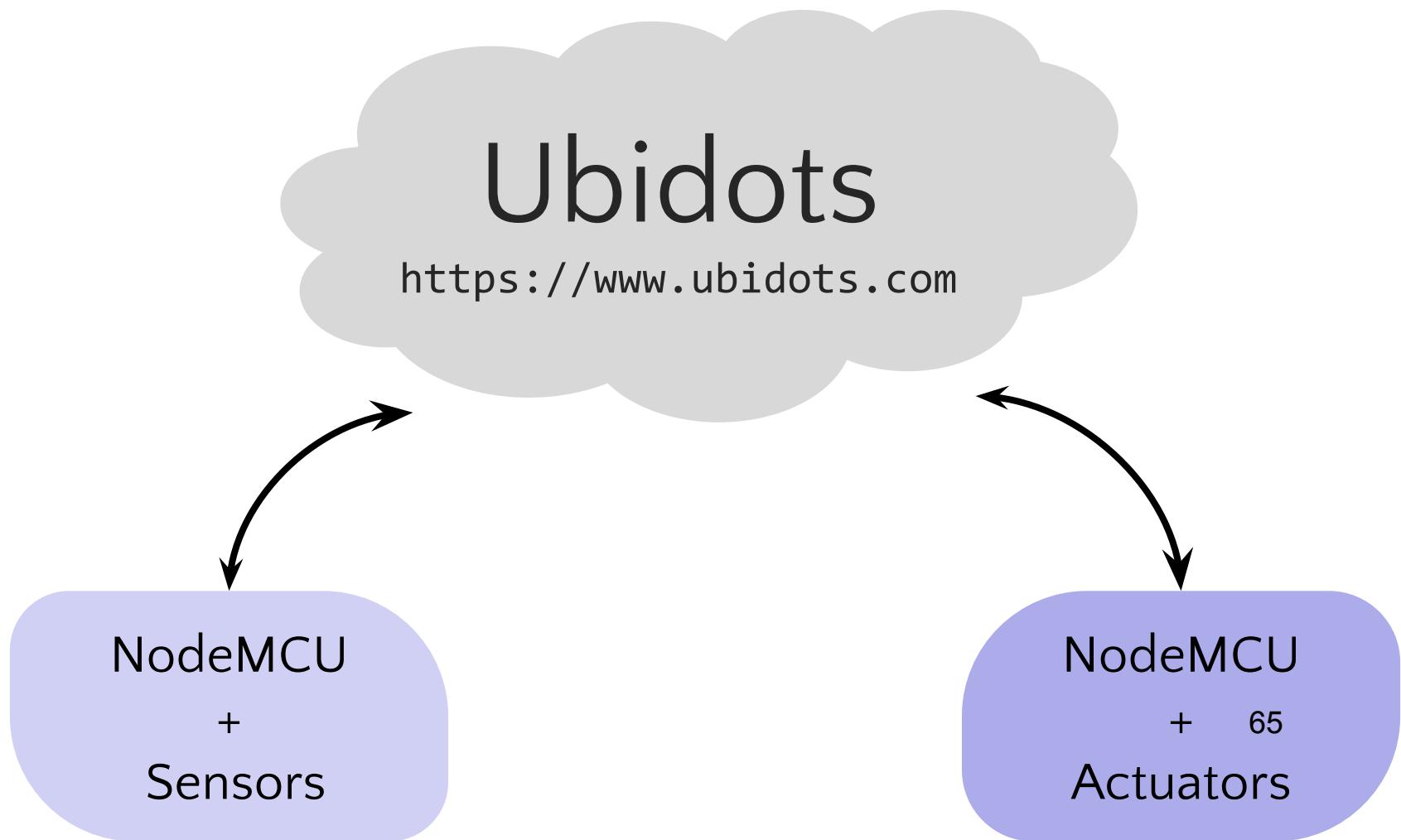


IoT Projects

Application of IoT in Smart Cities
Use Case: Urban Waste Management

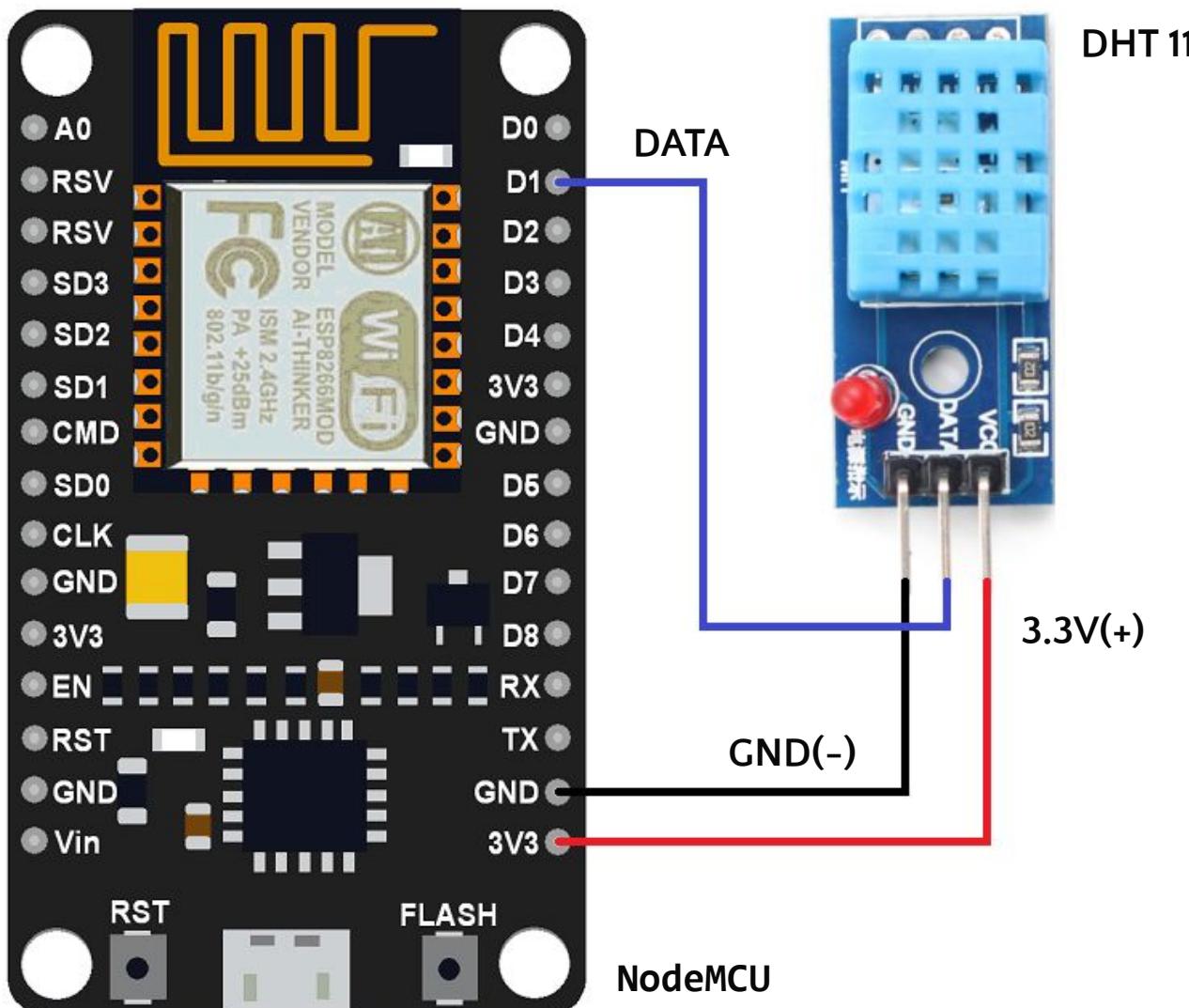
64

Cloud Platforms



DIY Experiments with NodeMCU

Interfacing Temperature & Humidity Sensor



IoT Projects

Application of IoT in Home Automation
Use Case: Remote Switching of Air Conditioner

67

