AI TRAINING SERIES

아두이노실습

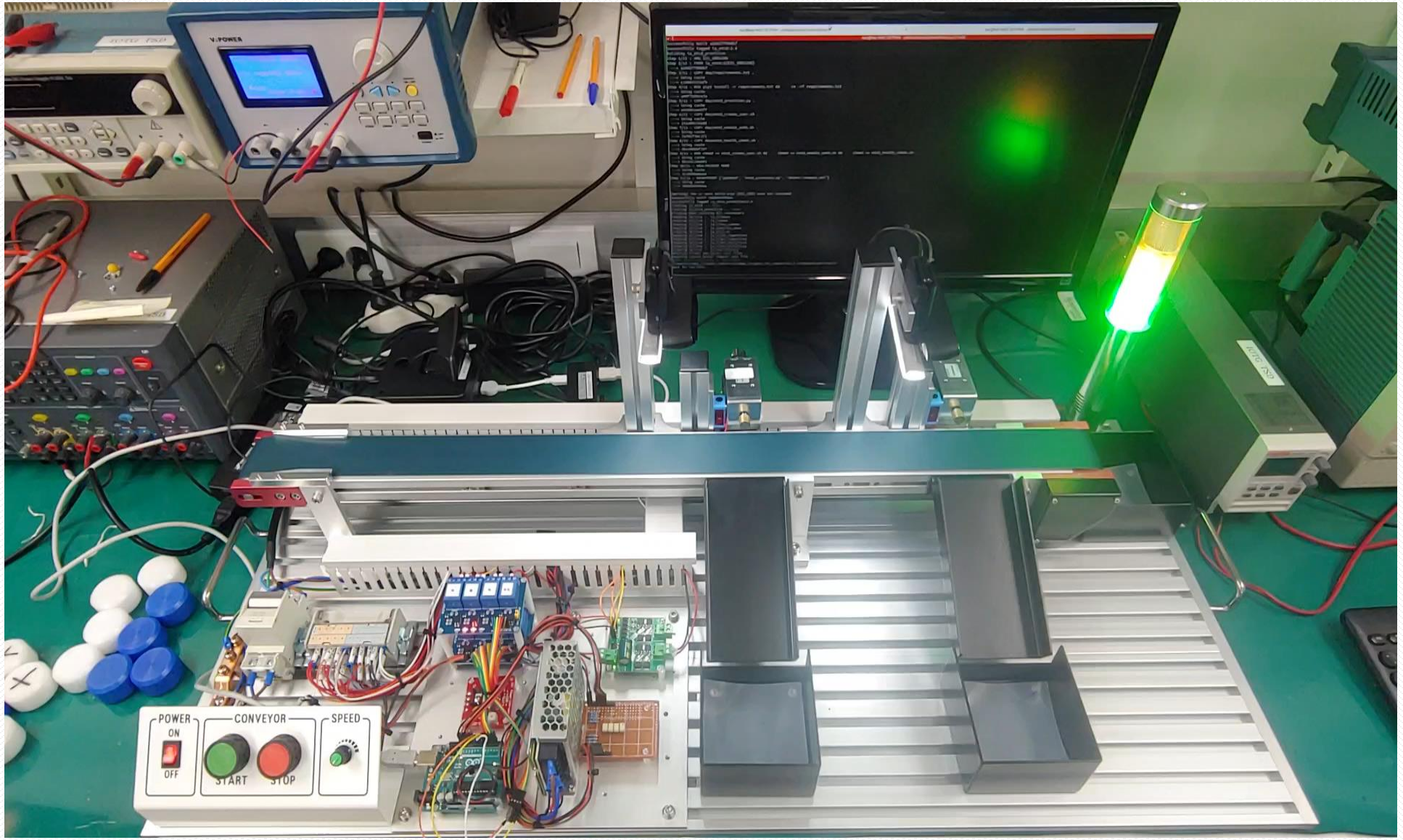
Using the Arduino Uno

Agenda

- *Hands-on System Overview*
- *Basic Hands-on*
- *Smart Factory Hands-on*
- *AI Hands-on*
- *Demo Implementation*
- *Why Arduino?*
- *Arduino Environment Overview*
- *Arduino Directory Analyze*
- *Arduino Control*

Hands-on System Overview

Smart Factory



Overview

NUC
NUC10i7FN

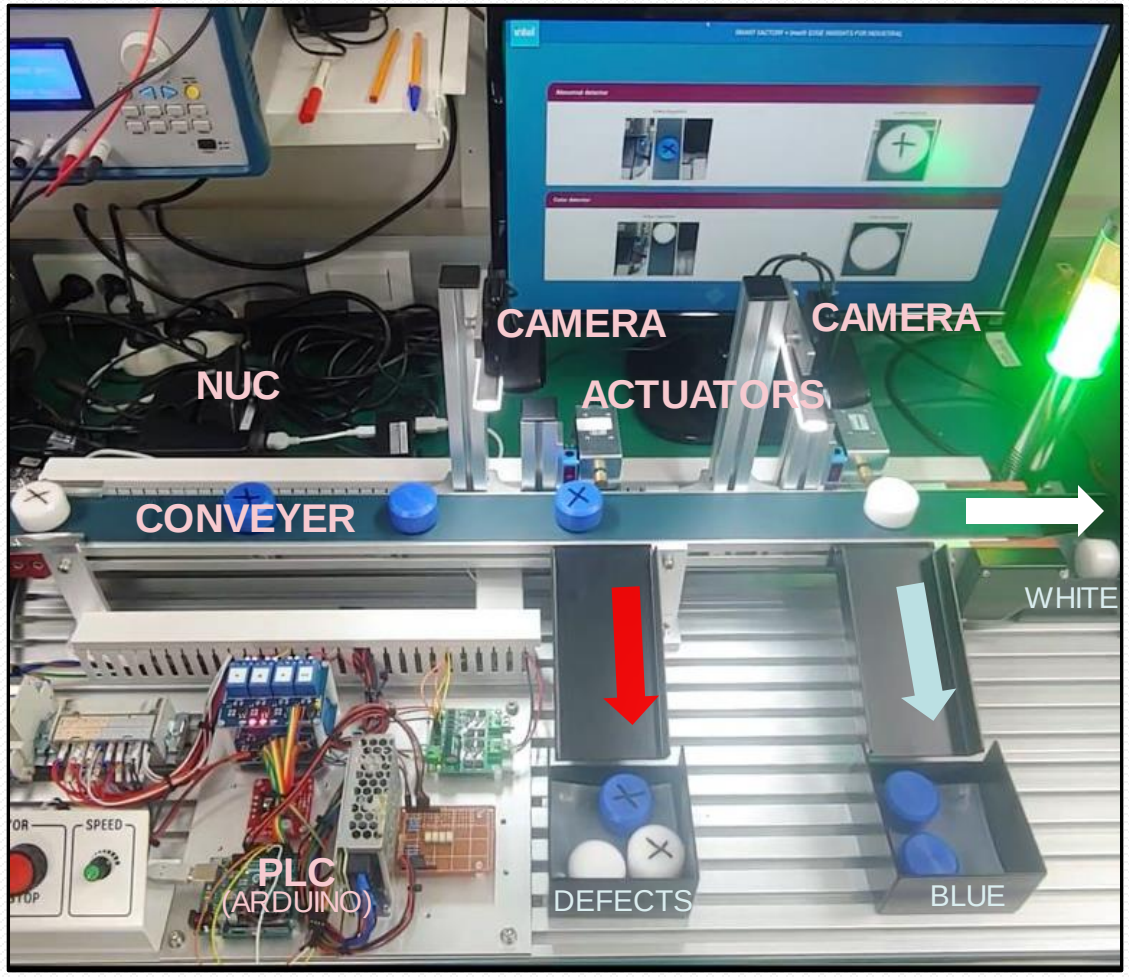
10th Generation Intel® Core™ i7-10710U
1.1 GHz – 4.7 GHz Turbo, 6 core, 12 thread, 12MB Cache
25W Intel® UHD Graphics, 300 MHz – 1.15 GHz

16GB RAM / 512GB SSD

CAMERA
LOGITECH HD PRO WEBCAM C920N

640x480 30 fps / up to 1920x1080 30 fps

ARDUINO
UNO

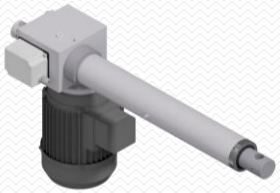


Overview (cont,)

Defect detect

Cam1

Status LED



Actuator1

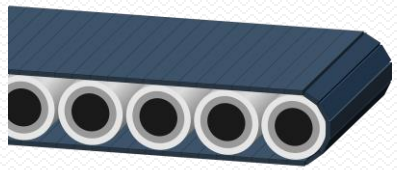
NUC
(Host Controller)

HMI
(Human-Machin Interface)

Arduino
(PLC Simulator)

Cam2

Color detect



Conveyor Belt

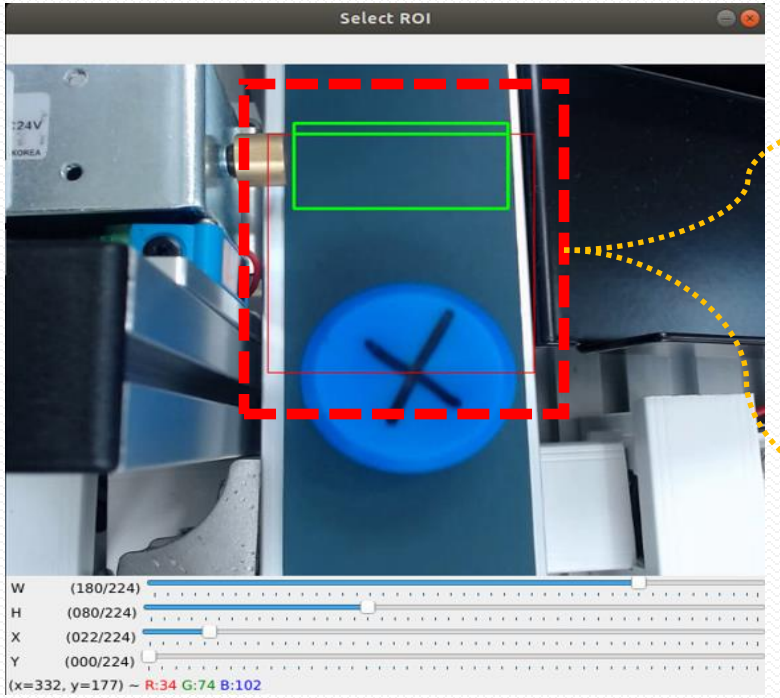
Actuator2

Tool Hands-on

Motion Detect

CALIBRATE CROP AND ROI BOX POSITION

Implement the codes for setting the ROI, motion detection and crop/save the images




```
"crop_box": [[262  83], [486 307]],
"roi_box": [[284  73], [464 153]],
```

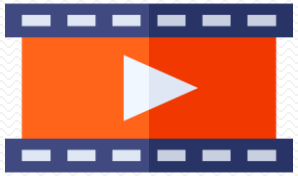
PRE-IMPLEMENTED TOOL

CROPPED IMAGE

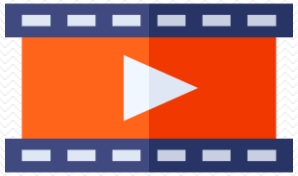
Multi-Threading with Queue

THREAD 1
(COLOR CAMERA)

THREAD 2
(DEFECT CAMERA)



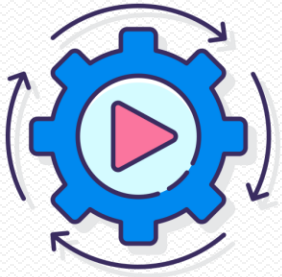
THREAD 1
(Video1)



THREAD 2
(Video2)

Queue the camera stream, receive it from the main and process it

QUEUE
BUFFER



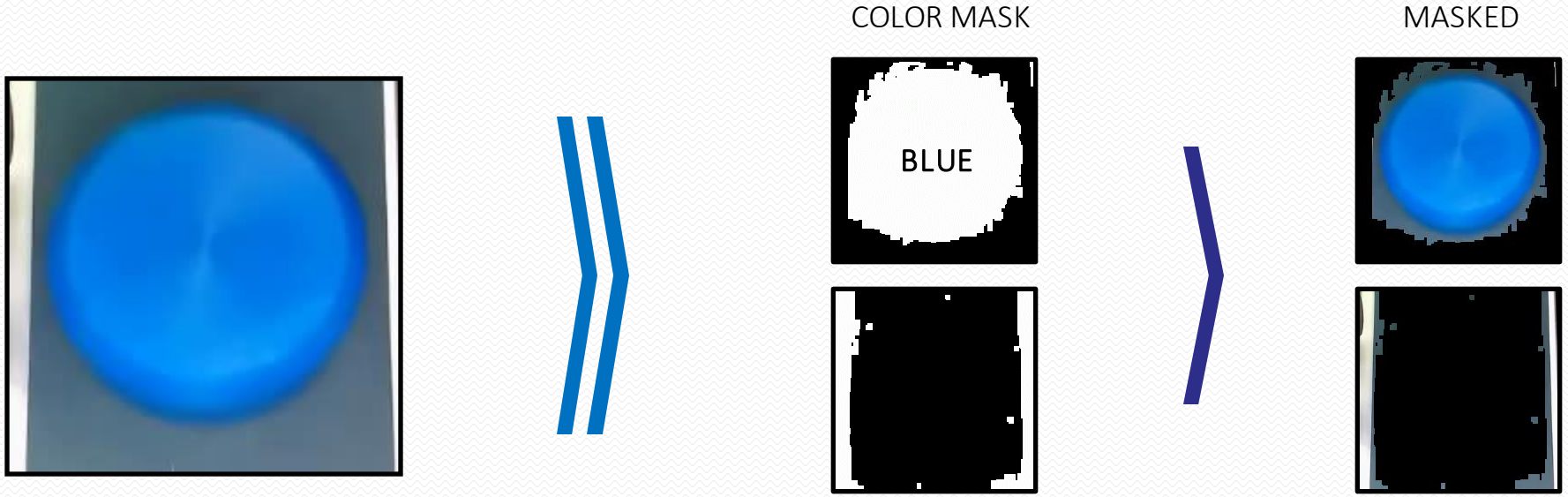
MAIN

QUEUE
BUFFER

Running 'imshow' on each thread can cause crash issues!

MAIN

Color Detect



APPLY COLOR MASKS TO THE FRAMES

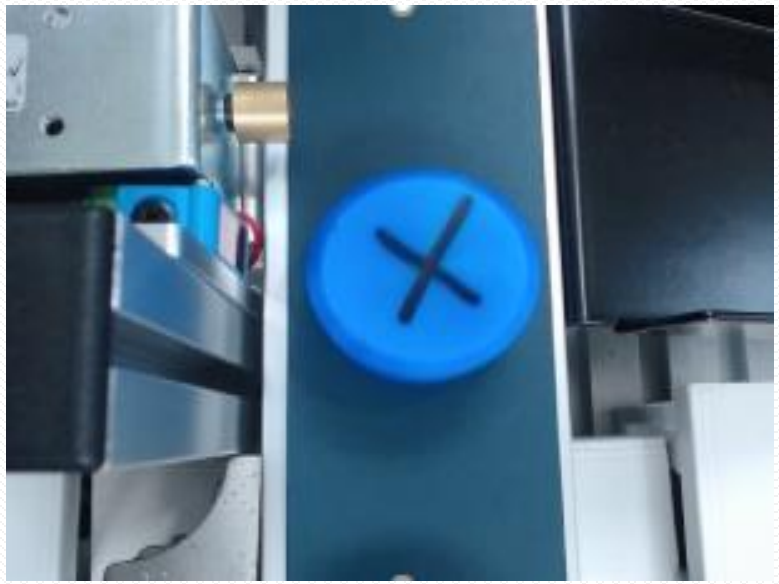
Using the HSV color model to specify the color position and color "purity"

COUNT THE MASKED PIXELS AND PREDICT COLORS

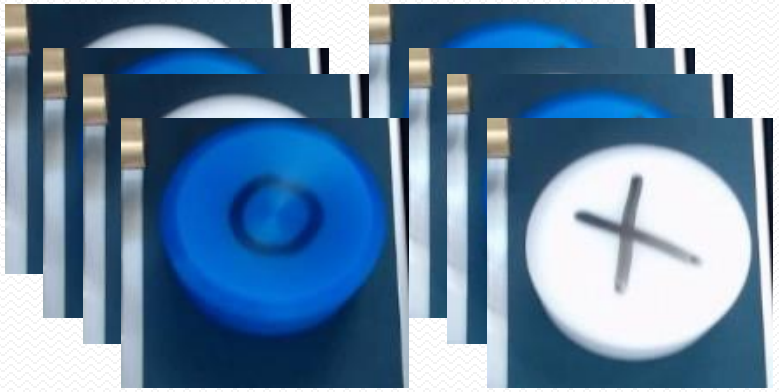
AI Hands-on

Data Preparation

Motion Detect



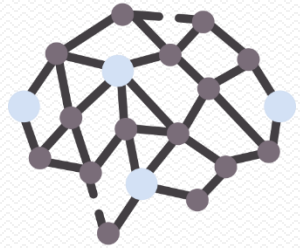
saved



Training

Prepared Images

EXPORT IR FILES



DATA TRAINING

OpenVINO™ Training Extensions

Why Arduino?

Smart Factory Overview

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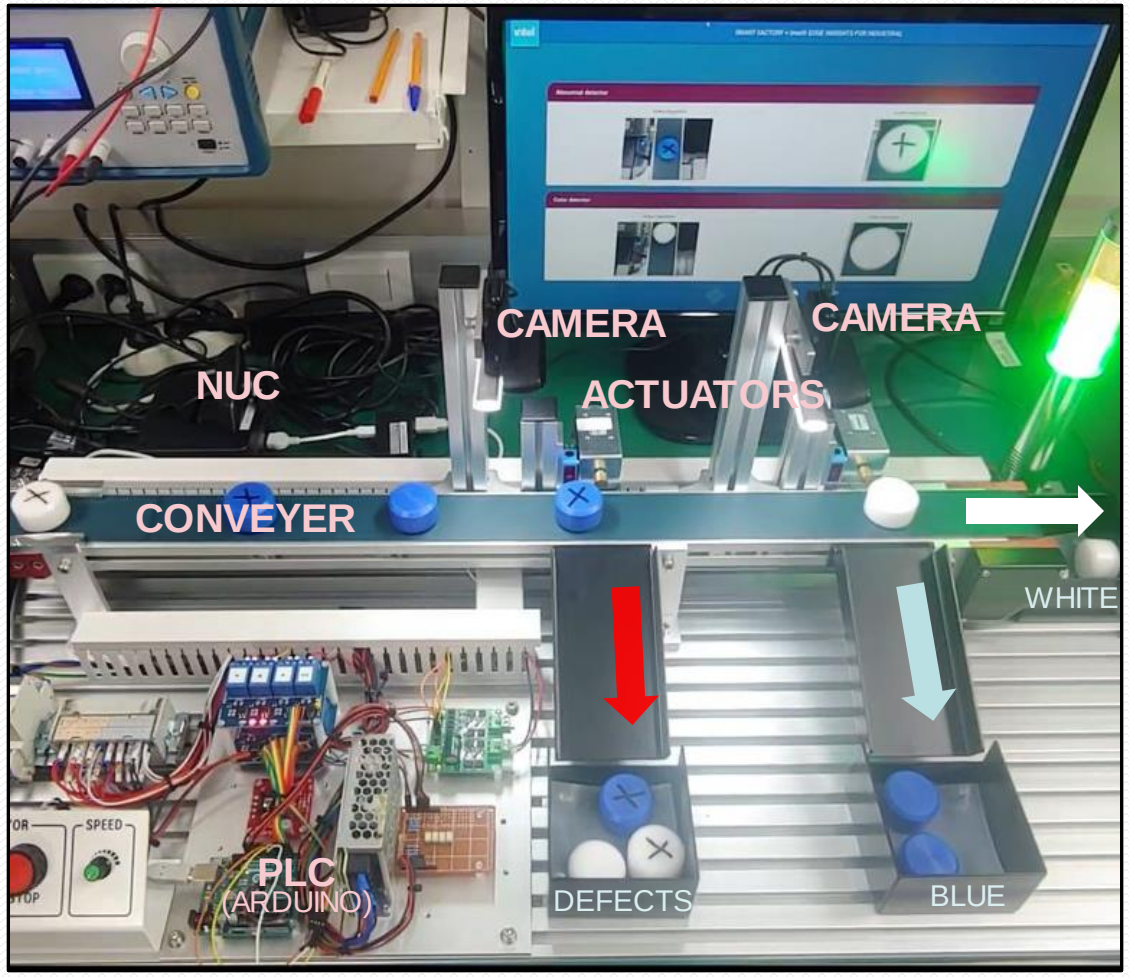
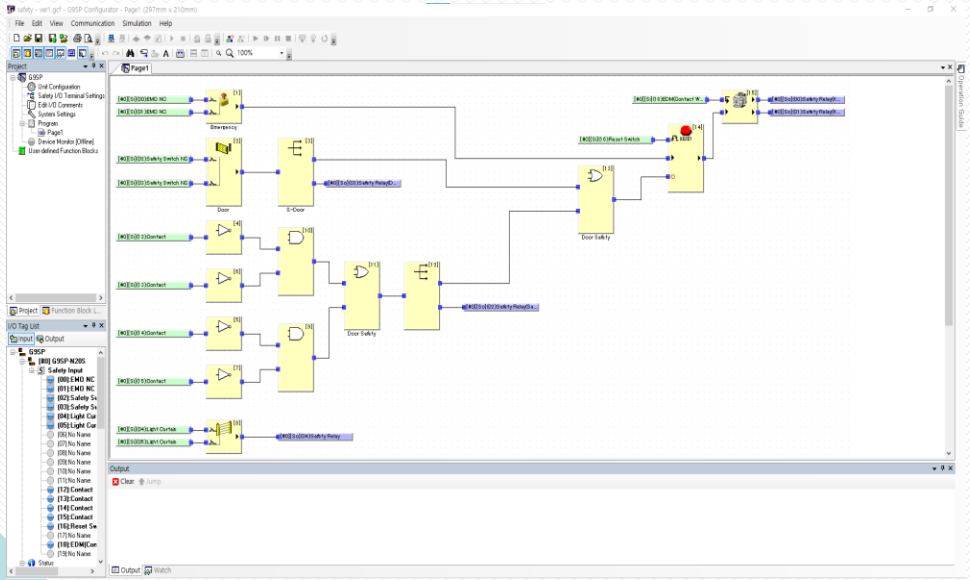
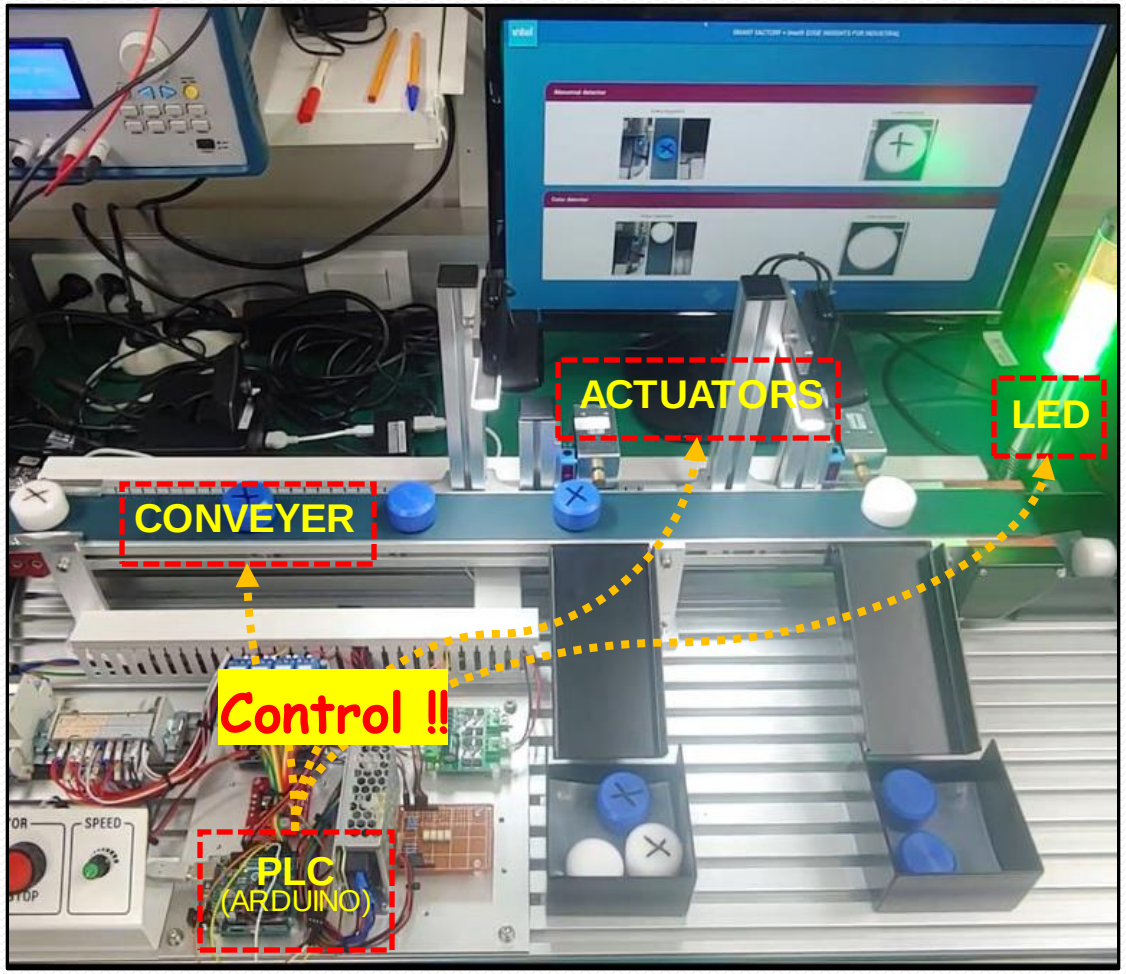
ARDUINO
UNO



PLC

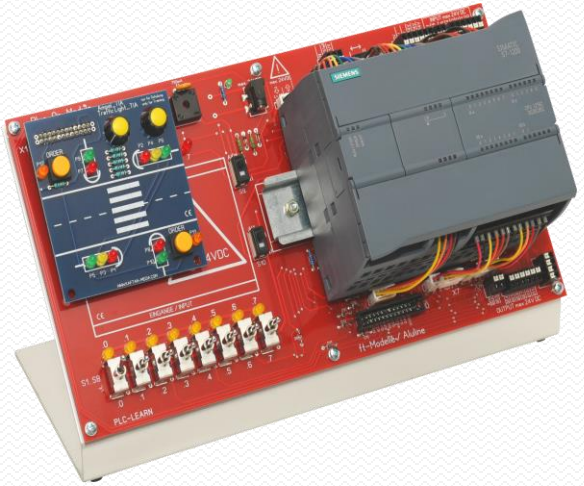
- Programmable Logic Controller
- Programming using Ladder Diagram





Arduino

- PLC Simulator



- HW ON/OFF Control
- Using Ladder Diagram
- Communication with Host PC

- GPIO Control only
  - Conveyor Belt Control (PWM)
  - LED Control
  - Actuator Control
- Using C language
- Communication with Host PC also

Arduino Environment Overview

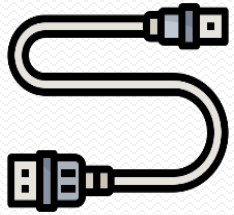
Where is to use the Arduino?

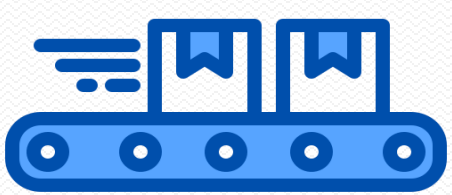
CONTROL the HW through ARDUINO */ UART*

Conveyer Belt On/Off

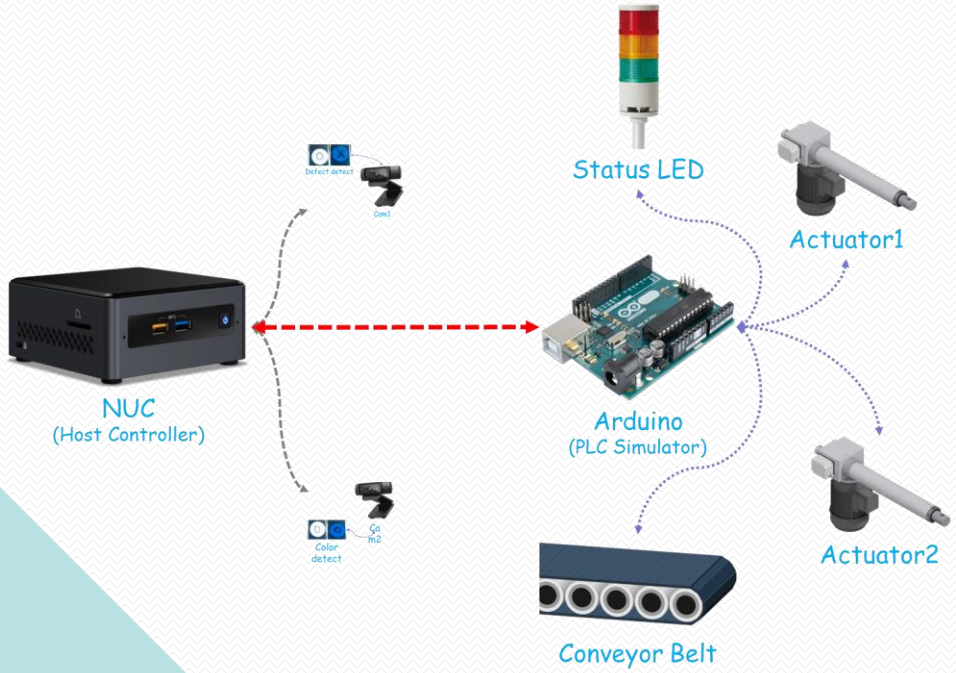
Actuator Motor Push/Release

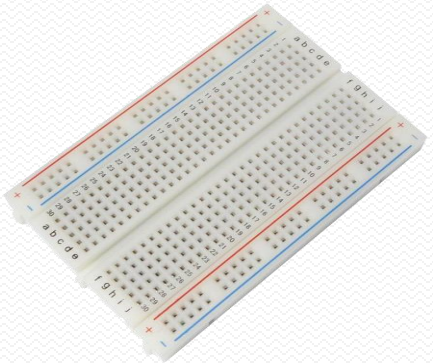
LED(Red/Orange/Green) Control

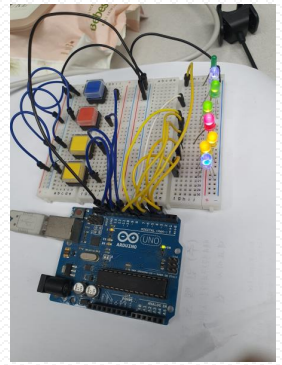




Arduino Setup for Simulation







LED — For RED LED — Pin 2

LED — For ORANGE LED — Pin 3

LED — For GREEN LED — Pin 4

LED — For CONVEYOR BELT — Pin 9

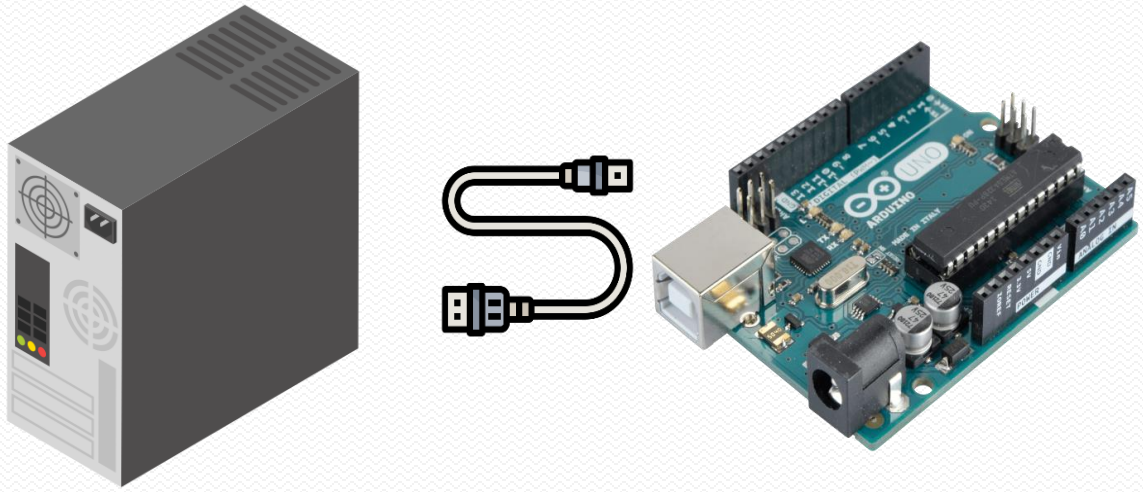
LED — For DEFECT ACUATOR — Pin 6

LED — For COLOR ACUATOR — Pin 7

Arduino Directory Analyze

Setup the Permission

- In arduino directory,
  $ cd <root dir>/arduino
- Connect the Arduino with the PC
- Check the permission
  $ ls -al /dev/ttyACM0
- Change the permission(Temporarily)
  $ sudo chmod a+rw /dev/ttyACM0
- Re-check the permission
  $ ls -al /dev/ttyACM0



- Add the user to group
  $ sudo usermod -aG dialout $USER

Arduino Connection & Flash

- Download Arduino CLI Application

  $ curl -fsSL https://raw.githubusercontent.com/arduino/arduino-cli/master/install.sh | sh

  $ cd bin && ls -al

- Setup the Environment

  $ ***arduino-cli*** config init --overwrite

  $ ***arduino-cli*** core install arduino:avr

- Build and Flash the Arduino

  $ ***arduino-cli*** compile -b ***arduino:avr:uno*** . -e –v

  $ ***arduino-cli*** upload -p ***/dev/ttyACM0*** -b ***arduino:avr:uno*** -t -v -i build/arduino.avr.uno/***arduino.ino.hex***

Make

- Make
  - A build automation tool that builds executable programs and libraries from source code by reading files called makefiles which specify how to derive the target program.

- In Makefile
  - make init
  - make build
  - make flash

Setup the basic environment using ***arduino-cli***

Source code build(***arduino.ino***)

Flash to the Real HW Arduino
(***build/arduino.avr.uno/arduino.ino.hex***)

Arduino Control

Arduino Control using Python

- Change directory for Python API
  $ cd <root dir>
  $ cd iotdemo/factory_controller
  $ ls -al

- factory_controller.py
  - Refer to the Public Properties/methods

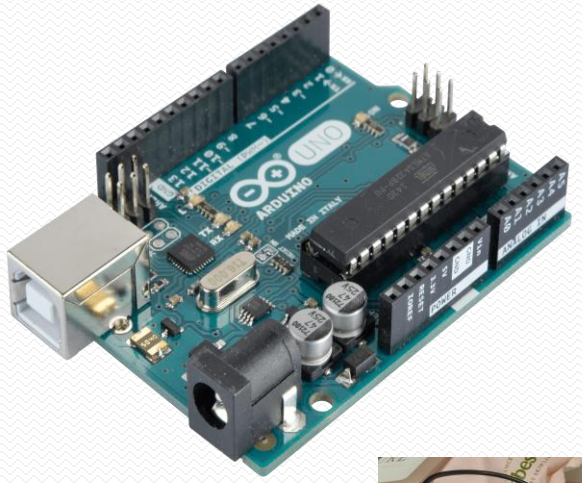
Hands-on

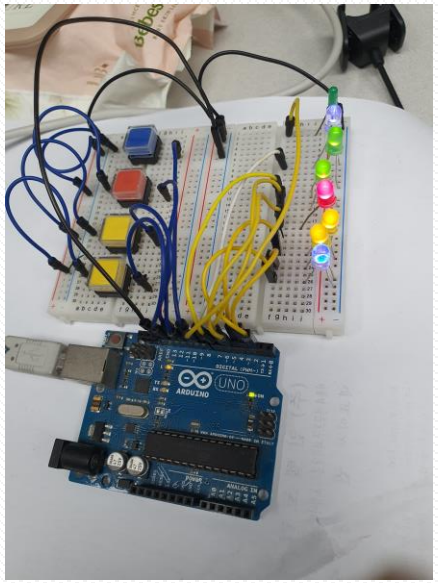
- Change the arduino directory and delete "***arduino-cli***"

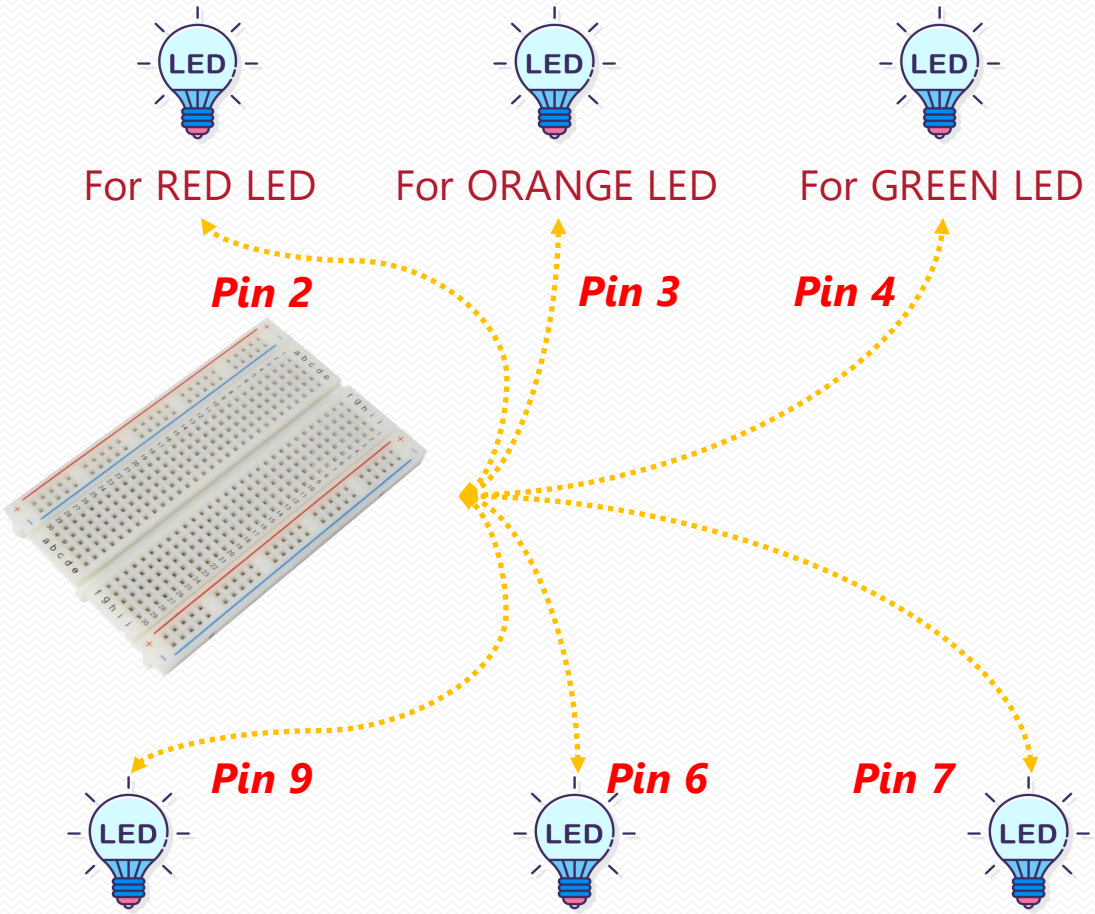
```
$ cd <root_dir>
$ cd arduino
$ rm ./bin/*
```

- Test what happens when executing the command below.
  - make init
  - make build
  - make flash
  - make clean

Hands-on with Real HW

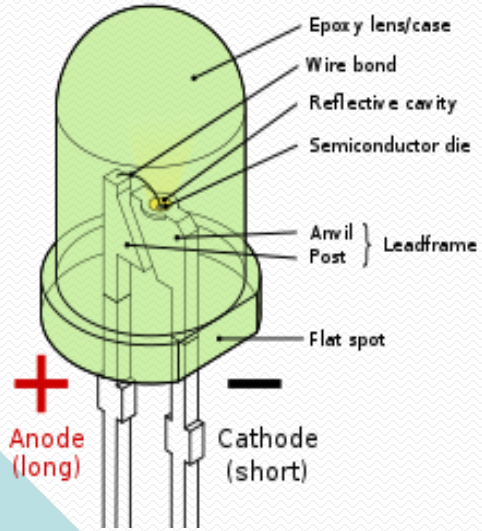


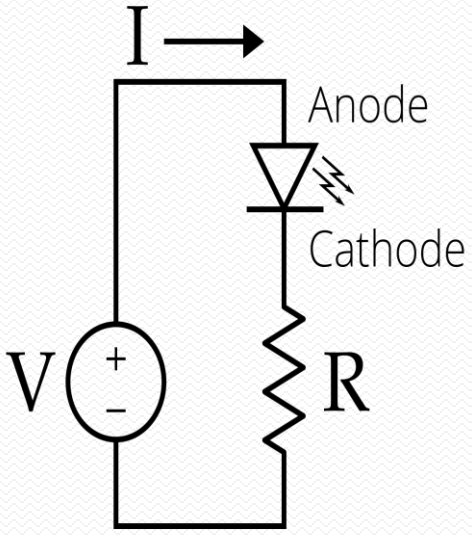


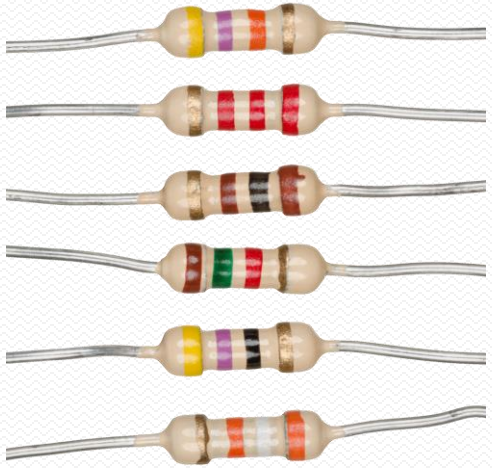


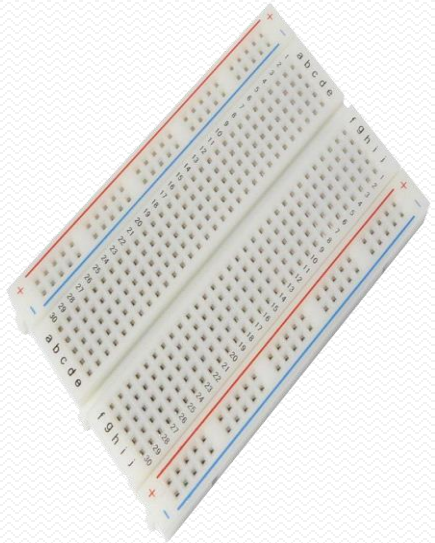
Hands-on with Real HW (cont,)

- How to connect wires, LEDs, resistors with Arduino?









Arduino Control using Python (cont,)

PYTHON MODULE APIs

(from iotdemo import FatoryController)

Init the system

- *with FactoryController('/dev/ttyACM0') as ctrl:*

  or ctrl = FactoryController('/dev/ttyACM0')

Close the system

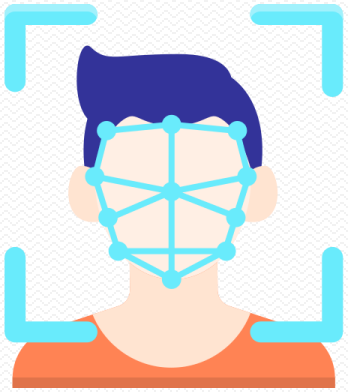
- *ctrl.close()*

For Micro Control the HW Module

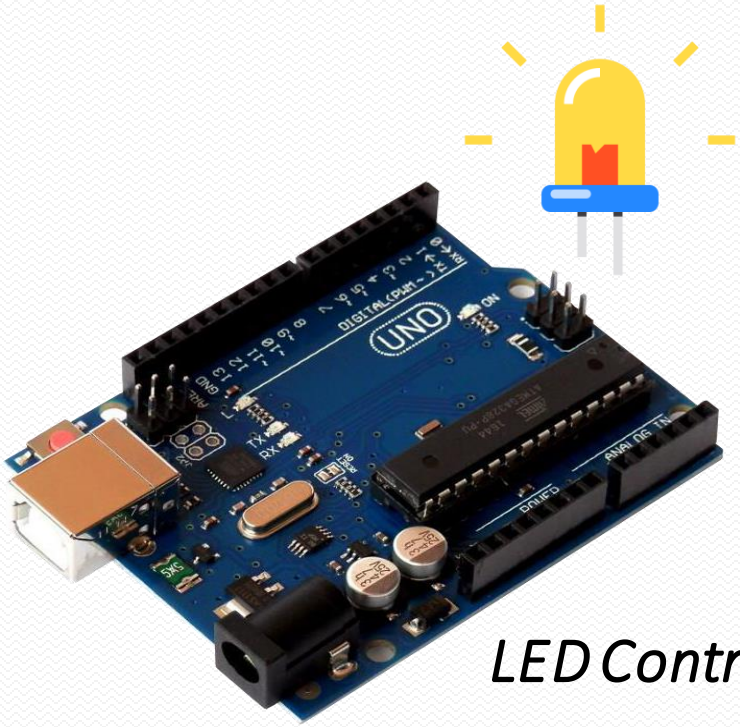
Input	API
1	system_start()
2	system_stop()
3	red
4	orange
5	green
6	conveyor
7	push_actuator(1)
8	push_actuator(2)

Basic Hands-on

HW Control



Inferencing Result



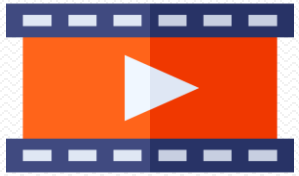
LED Control with Arduino

Utilize Arduino LED with Inferencing Result

Demo Implementation

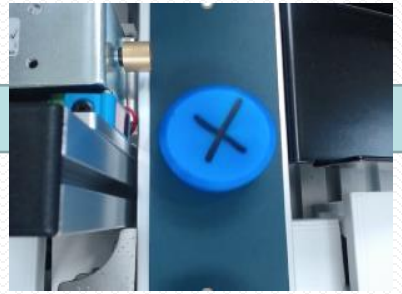
Demo on Localhost

VIDEO INPUT



./resources/factory/conveyor.mp4

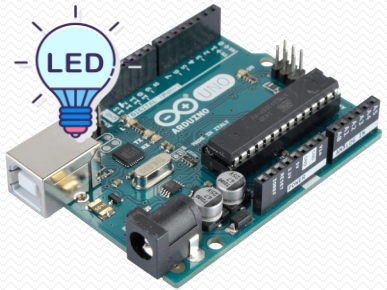
MOTION DETECT



COLOR DETECT

DEFECT DETECT

ARDUINO SIMULATION

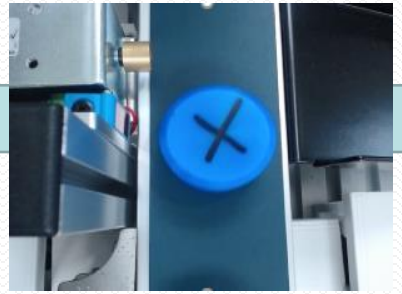


Let’s try Real HW World!

CAMERA INPUT

/dev/video*

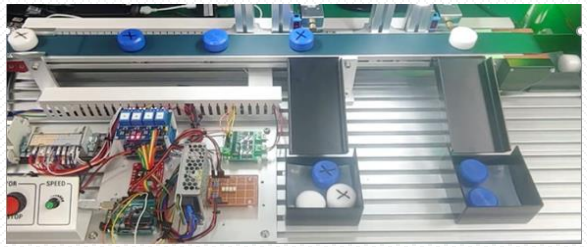
MOTION DETECT



COLOR DETECT

DEFECT DETECT

SMART FACTORY



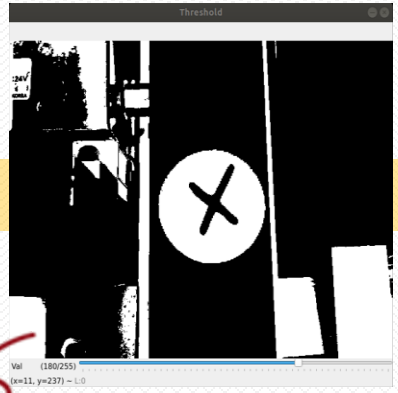
How to use tool?

Motion Detect

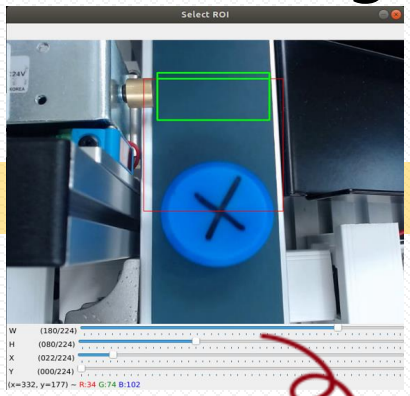
Region of Interesting

Camera Input

Binarization



ROI Setting

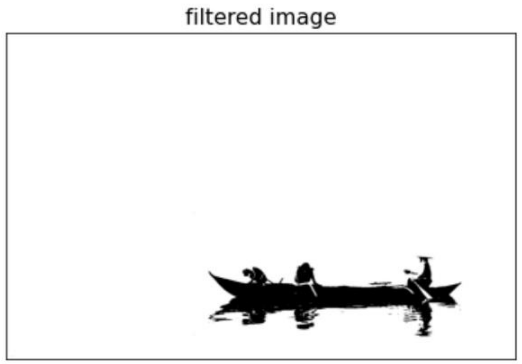


Motion Detect

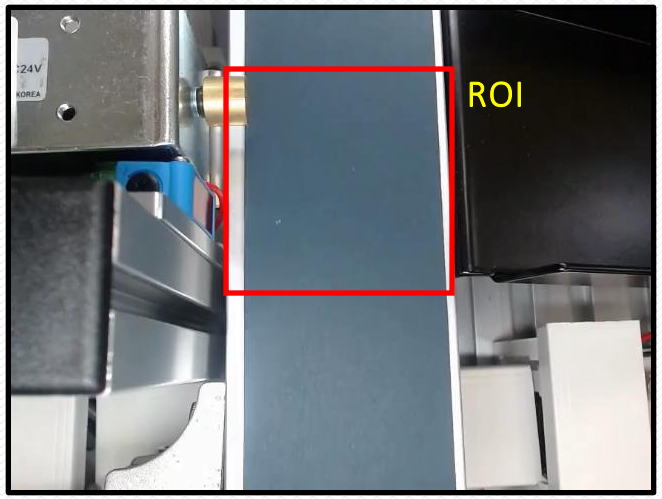
To drastically reduce the amount of information you have to work with

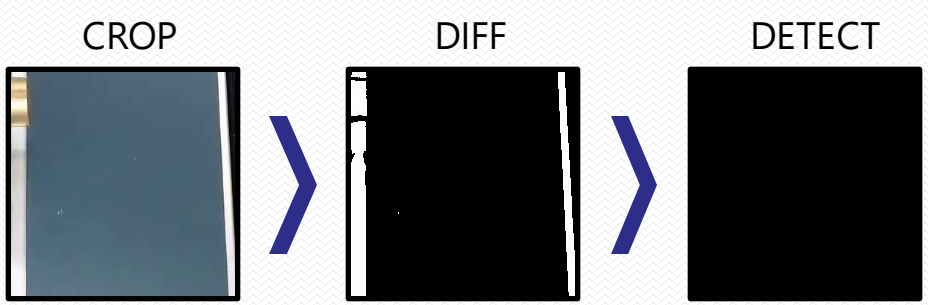
Video Stream with 640x480 resolution

224x224 image



Detailed Flow



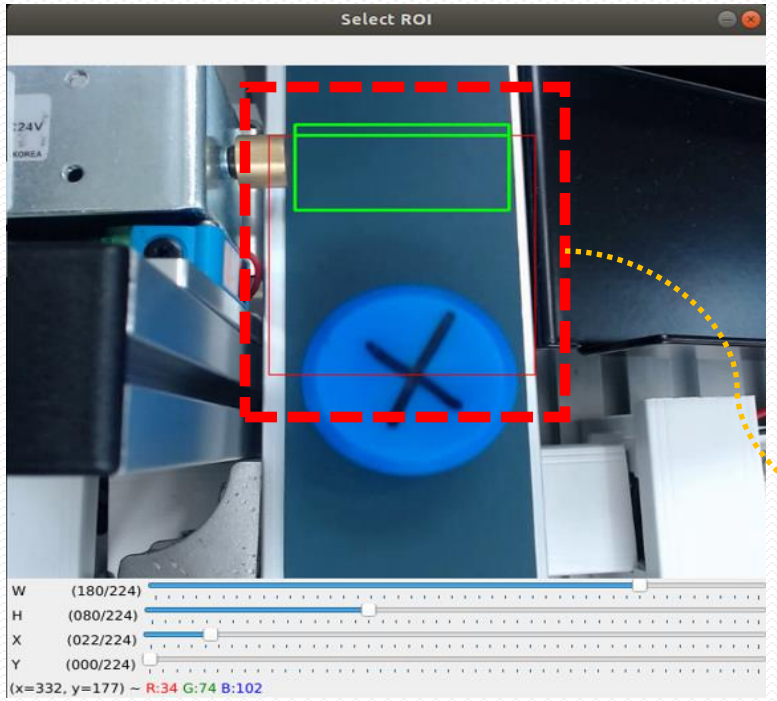


- *Crop the frame per selected ROI*
- *Calculate the frame difference*
  - Apply custom threshold with brightness value
- *Choose the best frames to pass*

Select ROI to Detect Motion

Python Tool (iotdemo-motion-detector)

iotdemo-motion-detector -l ./resource/factory/conveyor.mp4



Pre-Implemented Tool

Python Main (factory.py)

Detect the Frame (each Thread)

- *detected = det.detect(frame)*

if detected is None:
continue

Enqueue (each Thread)

- *q.put(('VIDEO: Cam1 detected', detected))*
- *q.put(('VIDEO: Cam2 detected', detected))*

```
[default]
inverted = False
flipped = False
top_margin = 10
threshold = 127
top_ratio = 0.6
mid_ratio = 0.4
skip_time = 0.099
roi_top_left = (12, 0)
roi_bottom_right = (212, 90)
crop_top_left = (0, 10)
crop_bottom_right = (224, 234)
```

motion.cfg

Cropped Image

Homework Submission

- There'll be several homework
- Submission
  - Fork the class GitHub https://github.com/kccistc/smart-factory/
  - Create your homework submission PR under **Class02/homework/<your_name>/hw##**

```
./Class02
└── homework
    └── <your_name>
        ├── hw1
        ├── hw2
        └── hw3
```

  - Deadline is by next day morning

THANK YOU

Back Up

Prerequisite

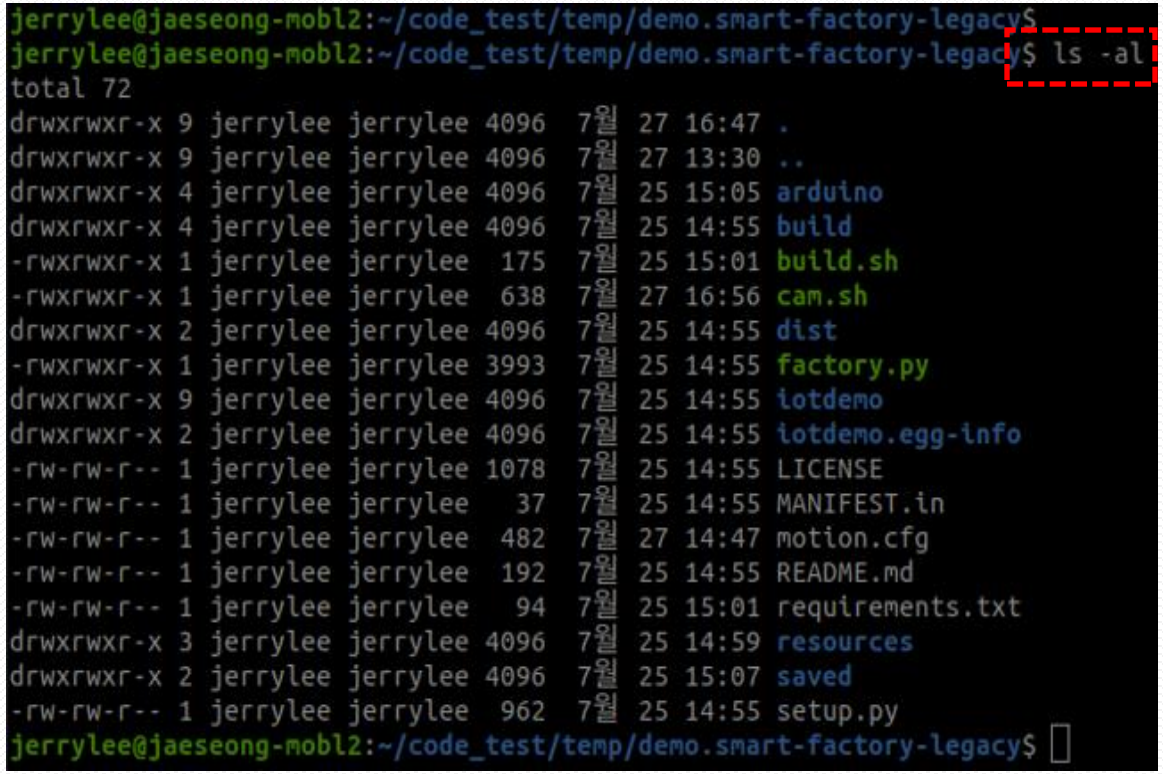
Terminal Command

- We use Terminator(Terminal) and Visual Studio Code(VSC)
  - Next page, explain how to install the Terminator and VSC

- Command on Terminator
  - $ ls -al

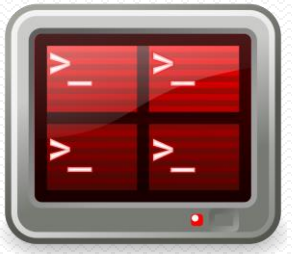
- <root dir>
  - It means the root directory from the Github code

~/code_test/temp/demo.smart-factory-legacy

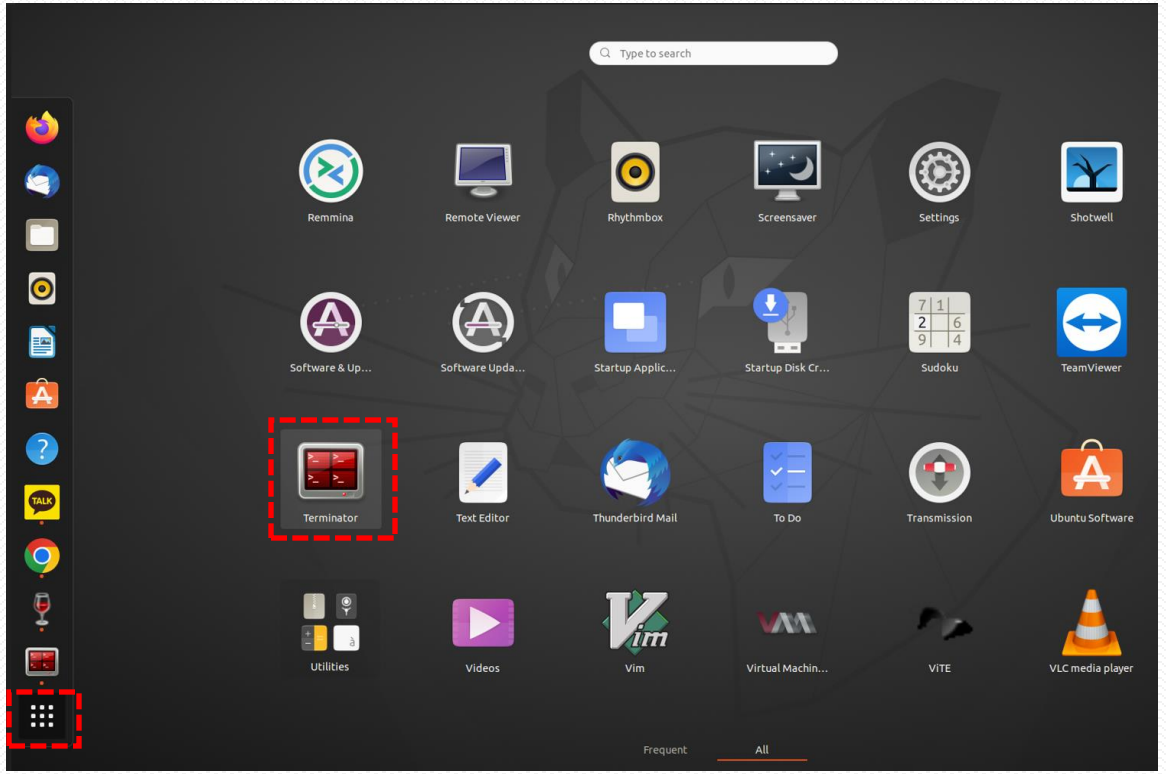


Terminator

- Install the Terminator
  $ sudo apt install terminator



- Execute the Terminator
  - Find in the all application on Ubuntu and Click the Terminator icon
  - On the Desktop, input the key below "*ctrl + alt + t*"



Visual Studio Code(VSC)

- Pre-packages Install
  $ sudo apt update
  $ sudo apt install software-properties-common apt-transport-https wget

- Get Microsoft GPG key
  $ wget -q https://packages.microsoft.com/keys/microsoft.asc -O- | sudo apt-key add –

- Add the apt repository for VSC
  $ sudo add-apt-repository “deb [arch=amd64] https://packages.microsoft.com/repos/vscode stable main”

- VSC install
  $ sudo apt install code

- Execution the VSC
  $ code

Arduino Basic

What is the Arduino

- A microcontroller board, contains the onboard power supply, USB port to communicate with PC, and an Atmel microcontroller chip
- It simplifies the process of creating any control system by providing the standard board that can be programmed and connected to the system without the need for any sophisticated PCB design and implementation
- It is open-source hardware, anyone can get the details of its design and modify it or make his own one himself

Why Arduino?

- It is Open Source, both in terms of Hardware and Software
- It is cheap, the hardware can be built from components or a prefab board can be purchased
- It can communicate with a computer via a serial connection over USB
- It can be powered from USB or standalone DC power
- It can run standalone from a computer (chip is programmable) and it has memory (a small amount)
- It can work with both Digital and Analog electronic signals. Sensors and Actuators.
- You can make cool stuff!!
  Some people are even making simple robots, and we all know robots are just cool.

What can Arduino do?

- Sensors
  - Push button, touch pads, tilt switches.
  - Variable resistors (e.g. volume knob / sliders)
  - Photoresistors (sensing light level)
  - Thermistors (temperature)
  - Ultrasound (proximity range finders)
- Actuators
  - Lights, LEDs
  - Motors
  - Speakers
  - Display (LCD)

The kinds of the Arduino

UNO R3

MEGA 2560

NANO

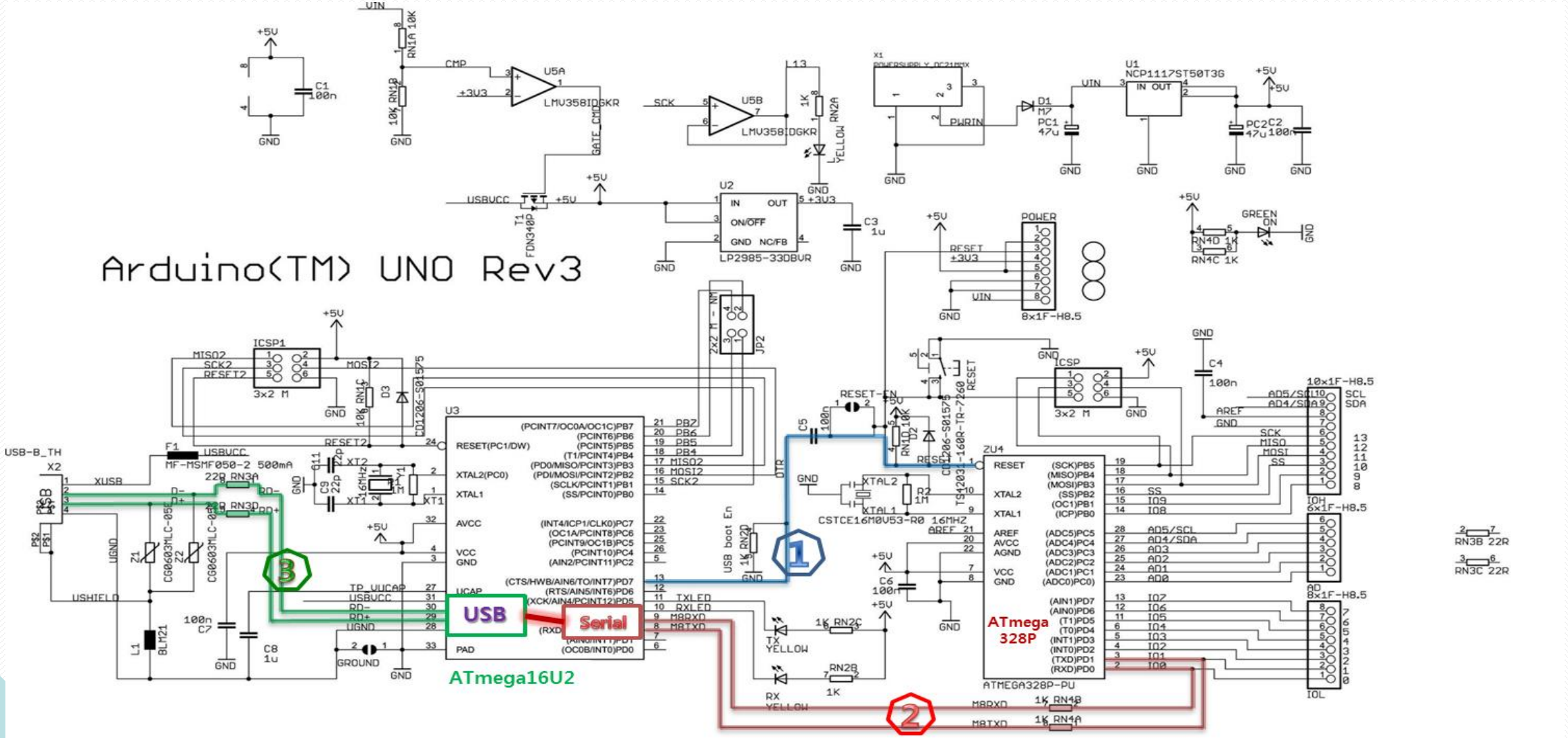
DUE

LILYPAD

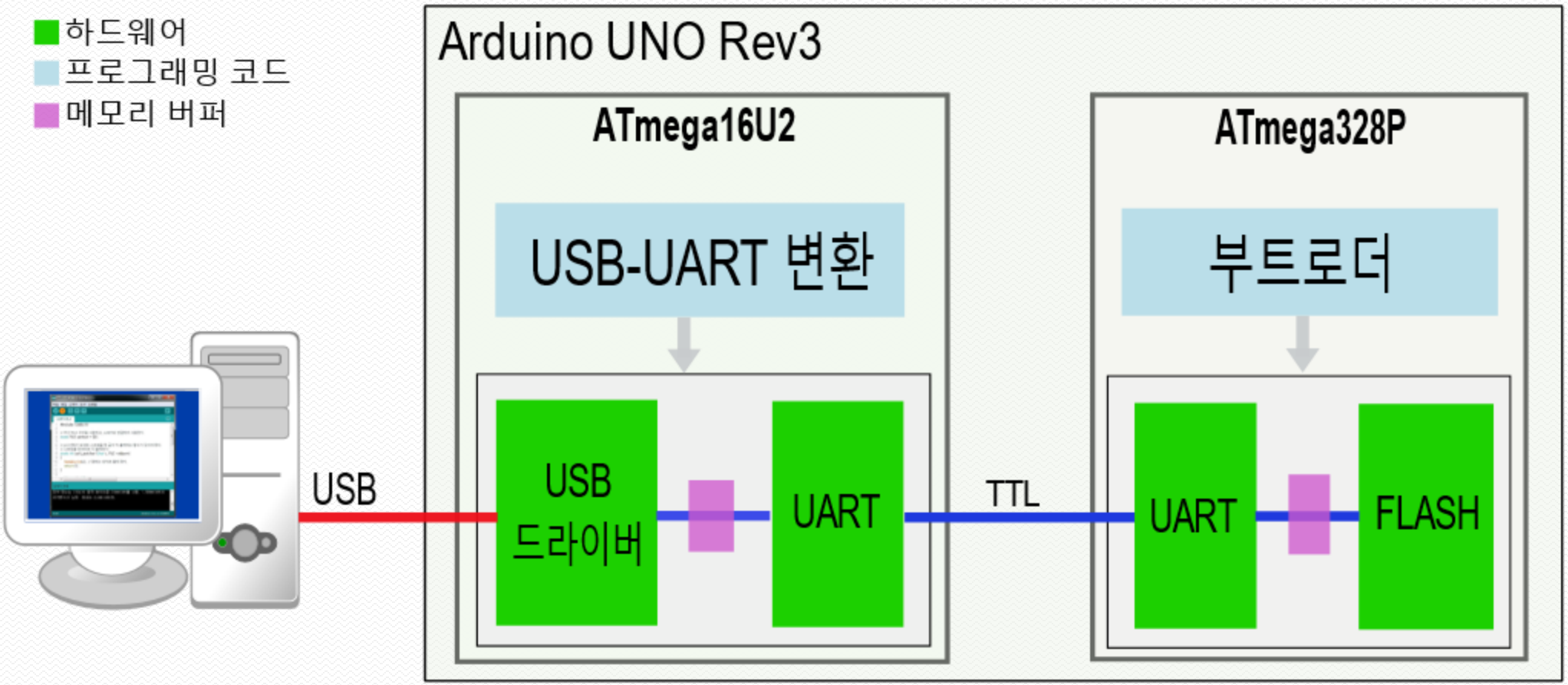
FIO

YUN

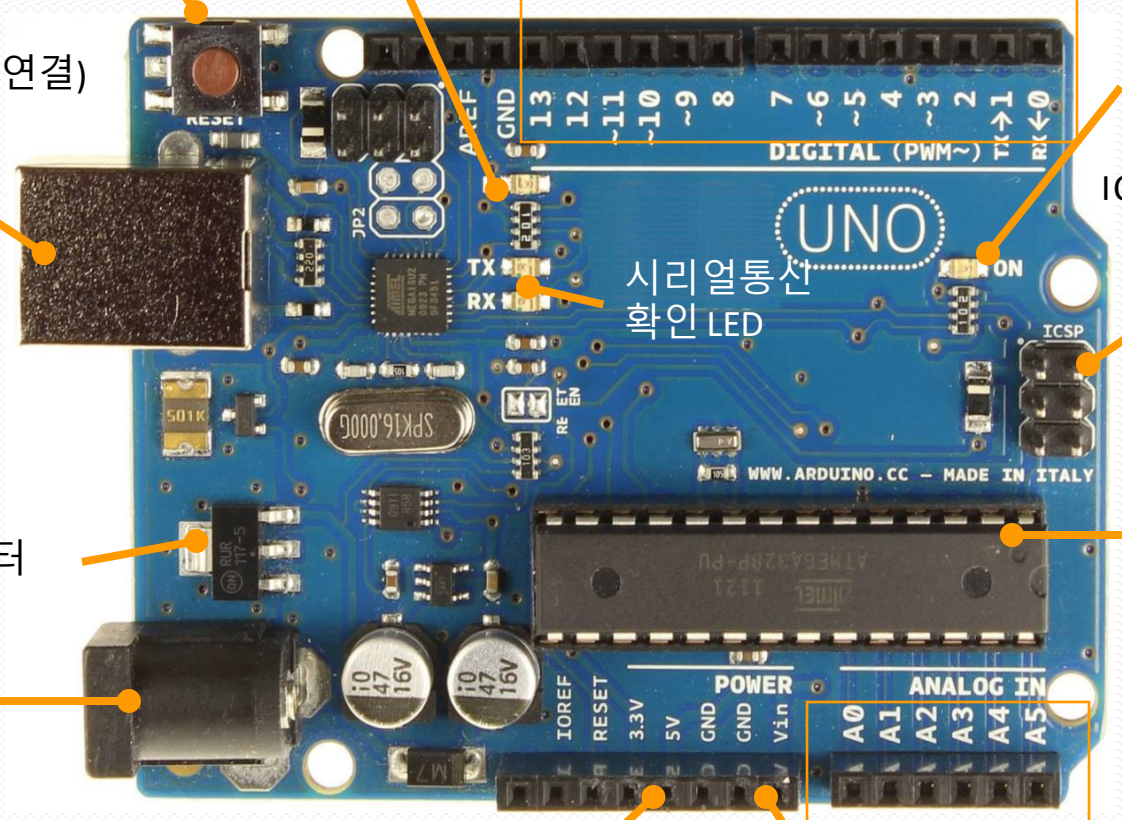
Arduino Uno Circuit



Environment using Arduino Uno



HW of the Arduino Uno



리셋버튼

디지털핀13번에 연결된 LED

디지털핀(물결표시는 PWM)

USB 전원 공급 및
프로그래밍 (컴퓨터에 연결)

전원 LED

ICSP핀: 부트로더 업로드

시리얼통신
확인 LED

메인프로세서
ATMEGA328P

정전압 레귤레이터

7-12V DC 입력

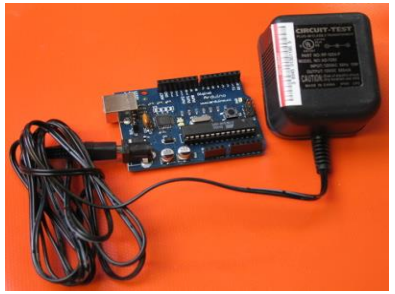
아날로그핀

3.3V 및 5V 출력

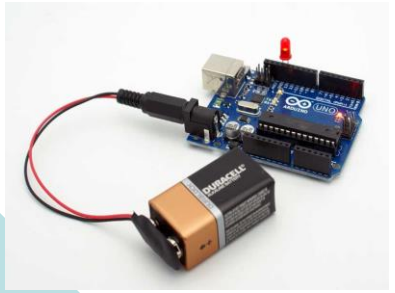
핀을 통한 전원 공급도 가능

Power for Arduino Uno

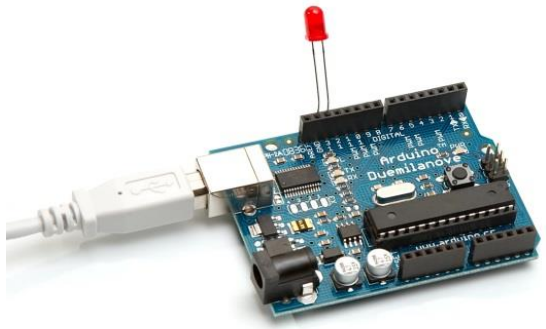
1. 배럴잭을 통한 전원 공급 (DC 어댑터를 사용하거나 배터리와 배터리홀더를 사용한 방법)
2. USB 케이블을 통한 전원 공급 (컴퓨터에 USB 케이블을 연결)
3. VIN과 GND를 통한 전원 공급 (배럴잭이 아닌 일반 전선을 사용할 경우)



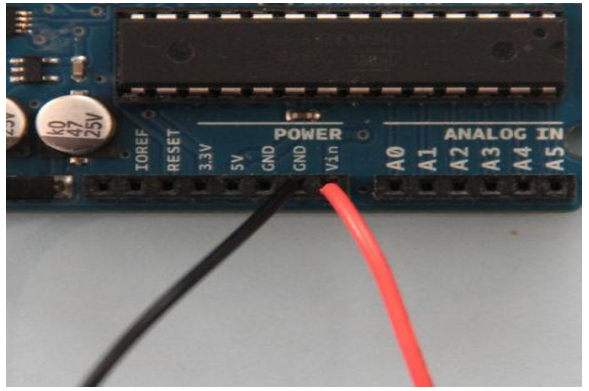
DC 어댑터의 배럴잭을 통한 전원 공급



9V 배터리와 배럴잭홀더를 통한 전원 공급



컴퓨터에 연결된 USB 케이블을 통한 전원 공급



배터리의 전선을 보드의 VIN과 GND 에 직접 연결하여 전원 공급

Digital or Analog

- All physical quantities are analog
- Analog means that the quantity can take any value between its minimum value and maximum value
- Digital means that the quantity can take specific levels of values with specific offsets between each other

- Ex - Digital
  - English alpha consists of 26 letters, there is no letter between A and B
- Ex - Analog
  - Temperature can take any value [-1, 12.8, 25.002, …]
  - Sine waves are analog

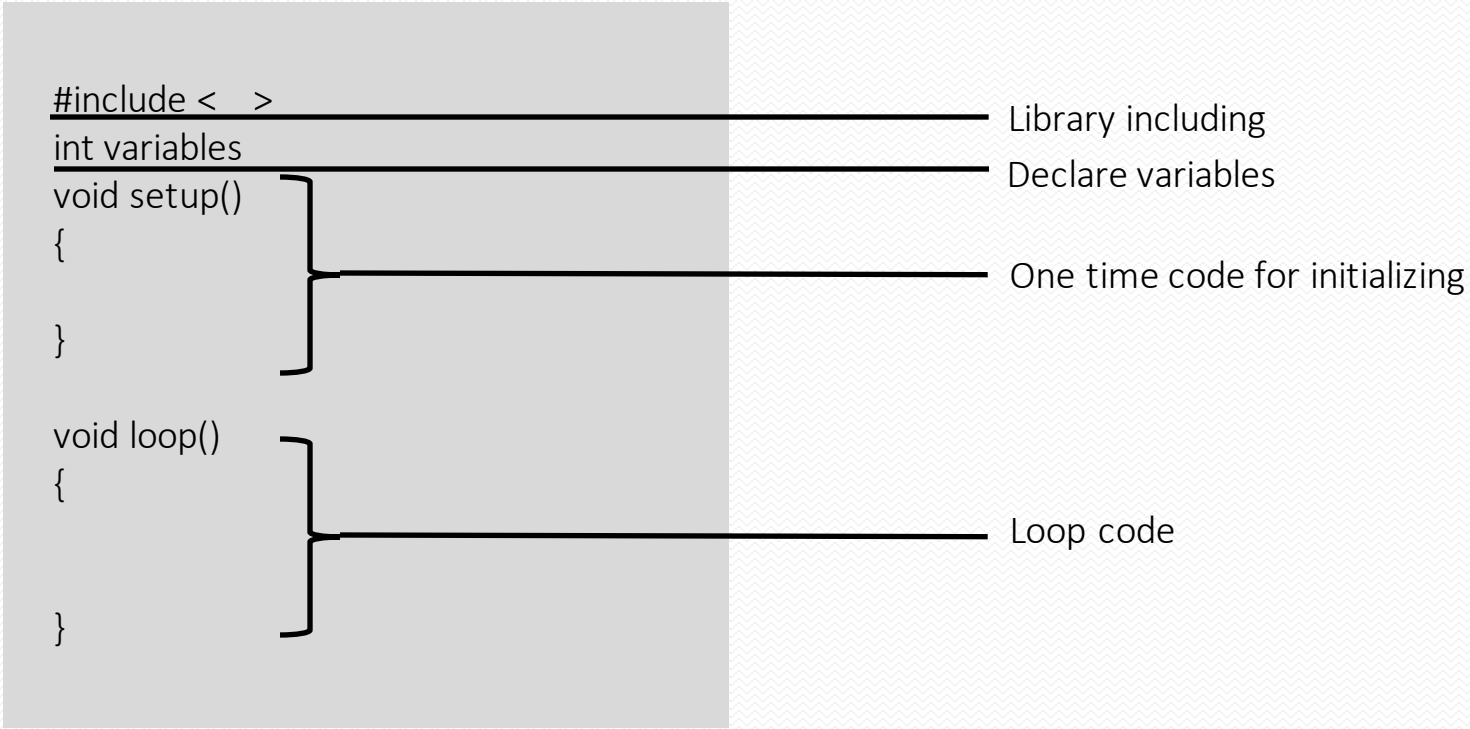
Download Arduino IDE

- https://www.arduino.cc/en/software

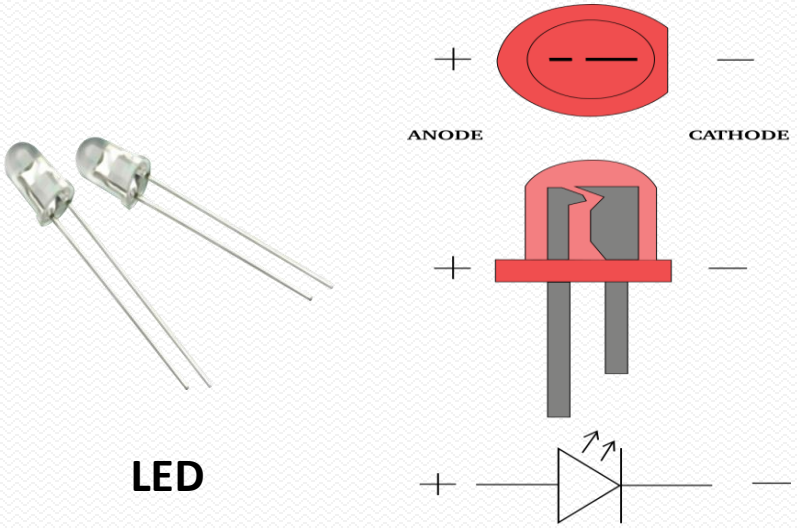
Downloads

Code Structure

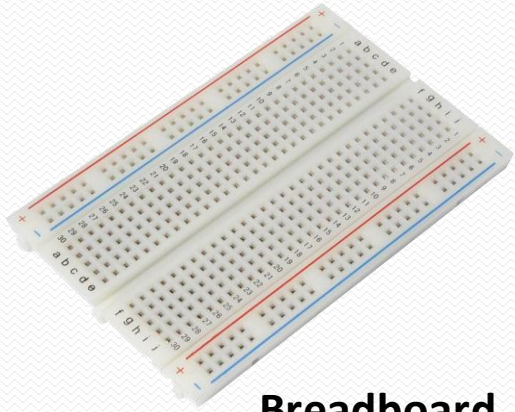
- void setup() {}
  - Used to indicate the initial values of system on starting
- void loop() {}
  - Contains the statements that will run whenever the system is powered after setup



How to deal with LED and Breadboard

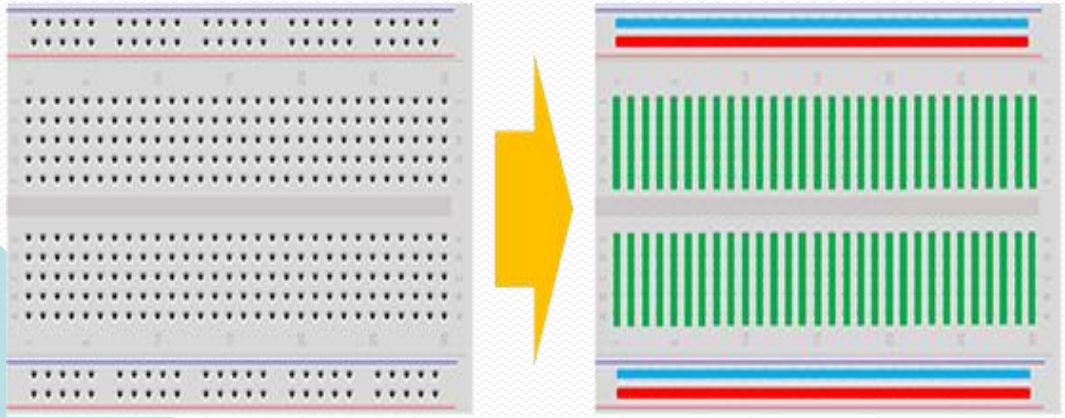


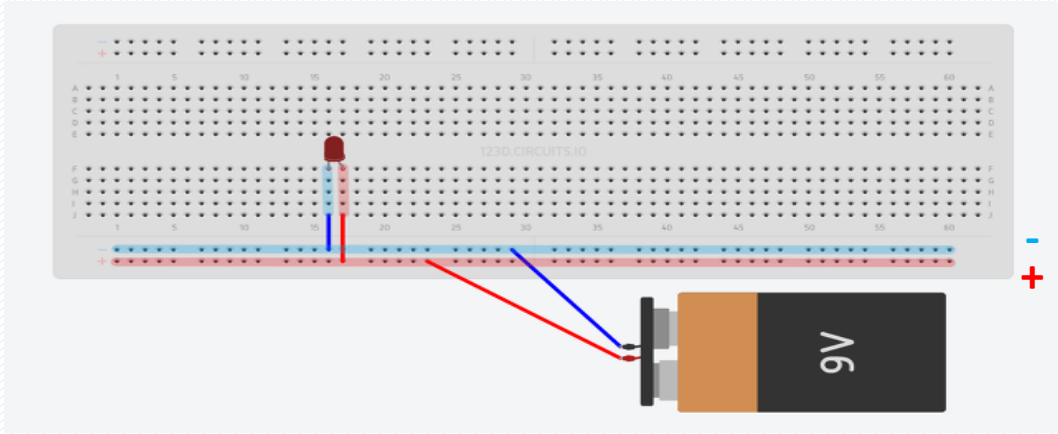
LED



Breadboard

How to connect the LED on the Breadboard





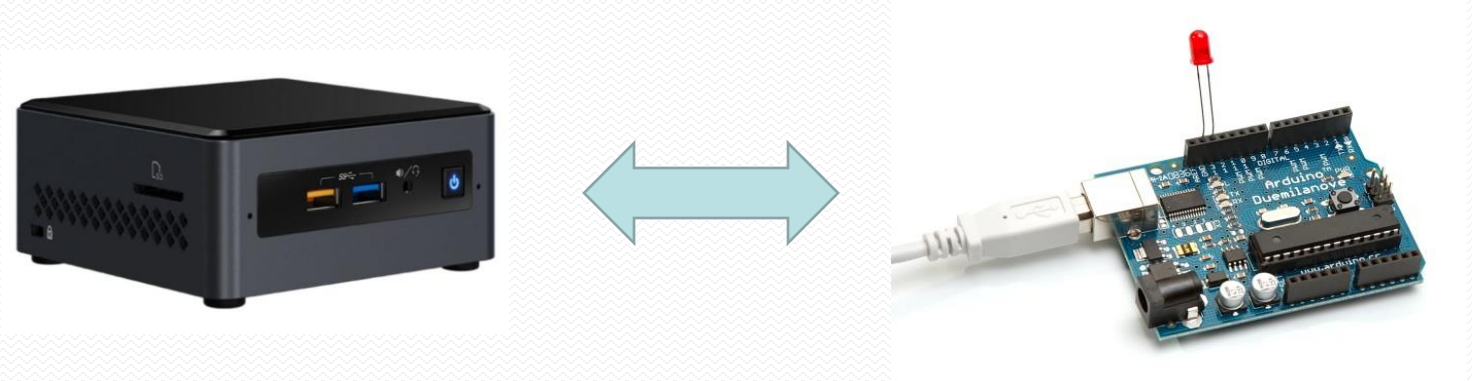
Let's implement

- LED on/off in every 1sec on the Arduino

- Used functions :
  Language Reference Link Click
  - pinMode()
  - digitalRead()
  - digitalWrite()
  - delay(time_ms)

Communicate with Arduino

- NUC sends command to Arduino via USB-UART to turn on LEDs.



References

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- http://mechasolution.com/
- https://www.arduino.cc/
- https://www.slideshare.net/avikdhupar/intro-to-arduino