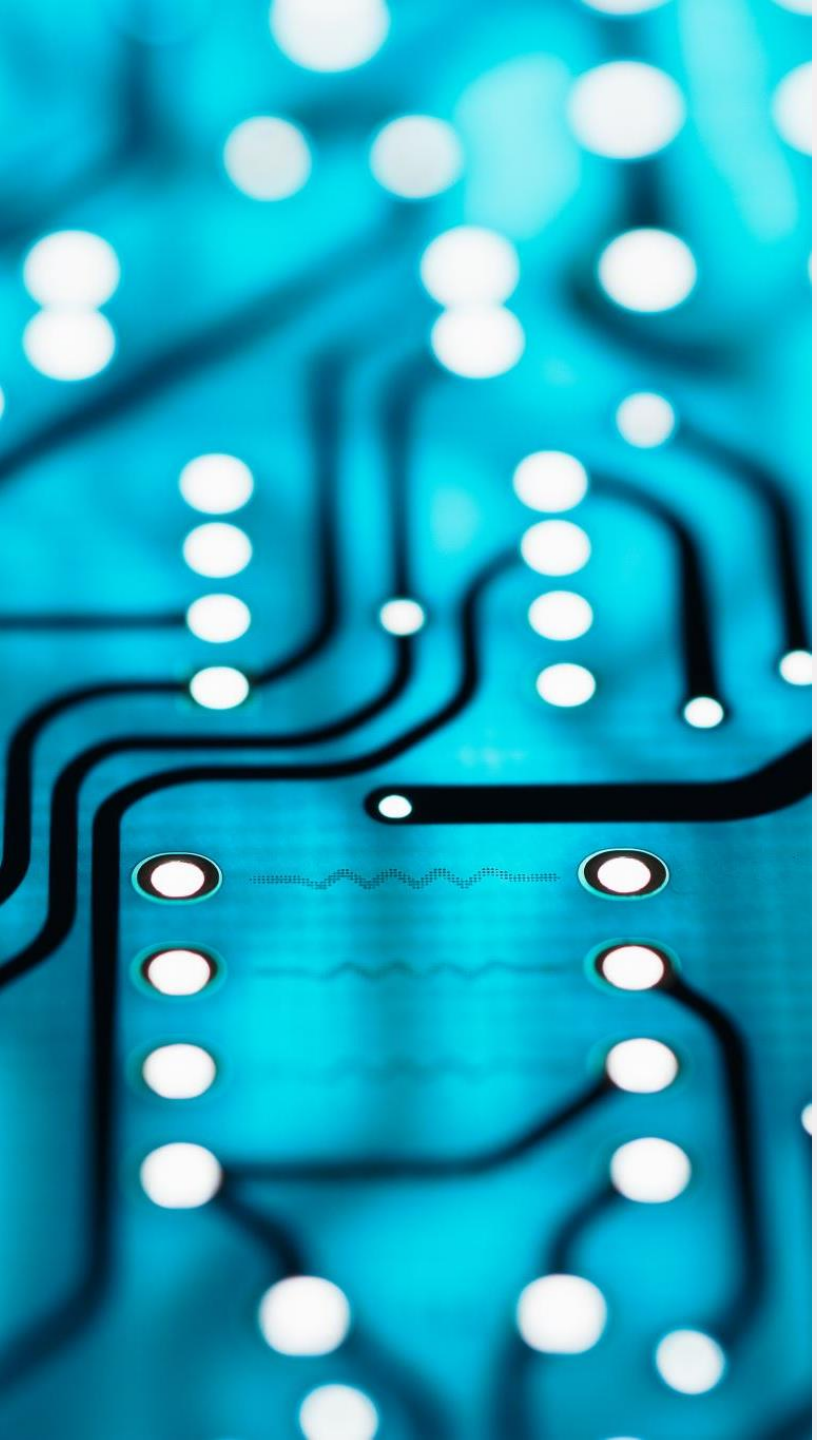
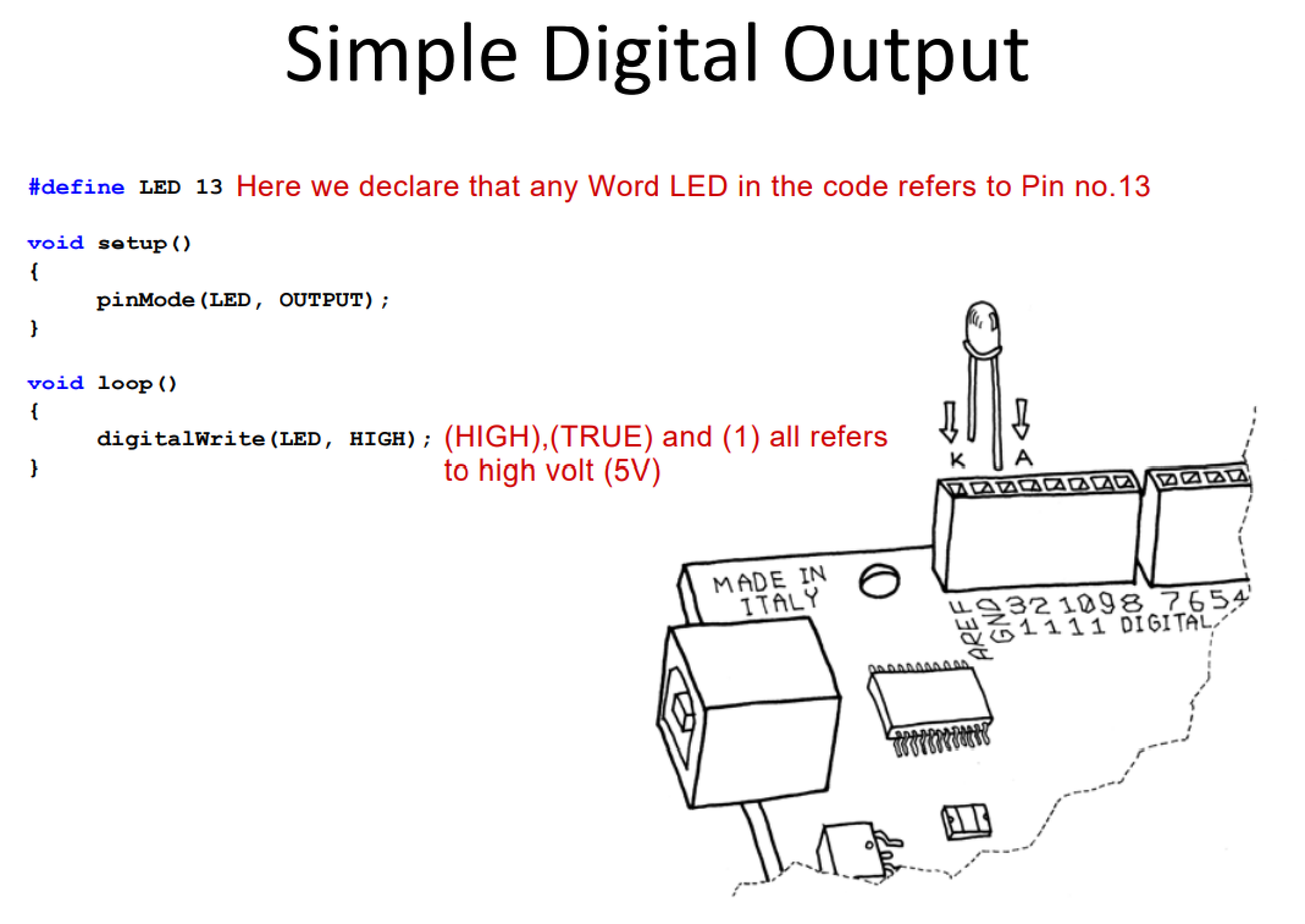


Embedded Systems (EPM)

Lecture (3) Summary

Digital Input / Output:



Simple Digital Output

```
#define LED 13
```

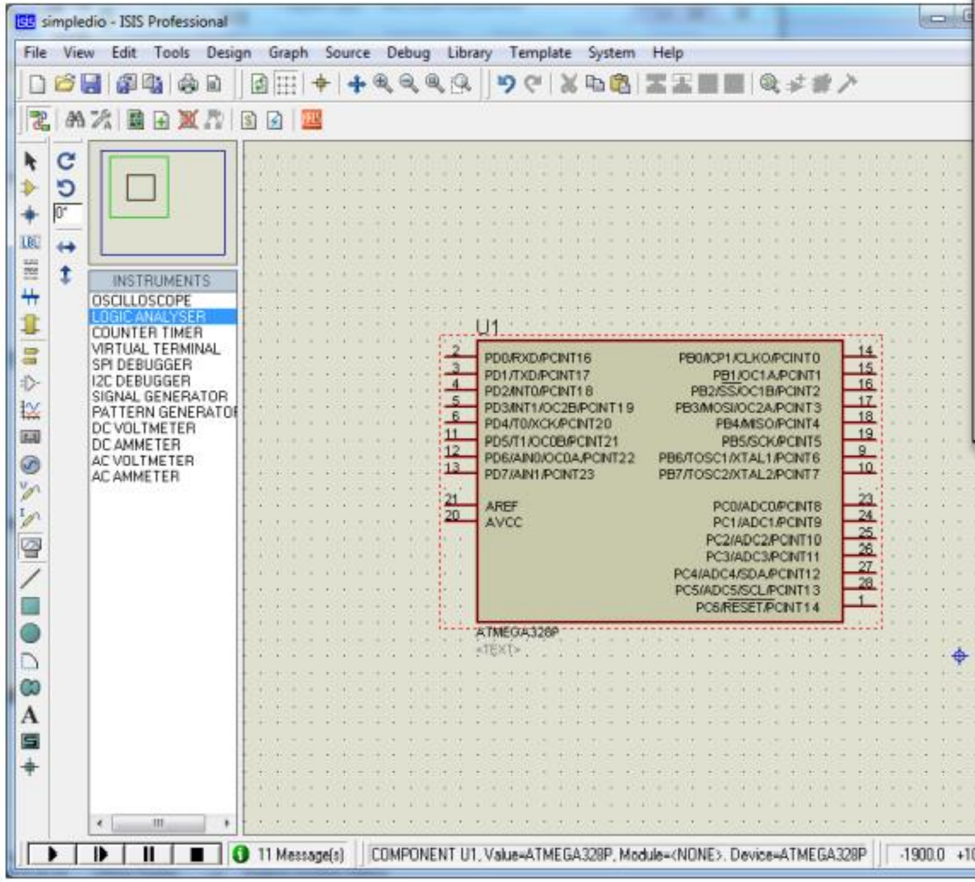
Here we declare that any Word LED in the code refers to Pin no.13

```
void setup()
{
    pinMode(LED, OUTPUT);
}

void loop()
{
    digitalWrite(LED, HIGH);
}
```

(HIGH),(TRUE) and (1) all refers to high volt (5V)

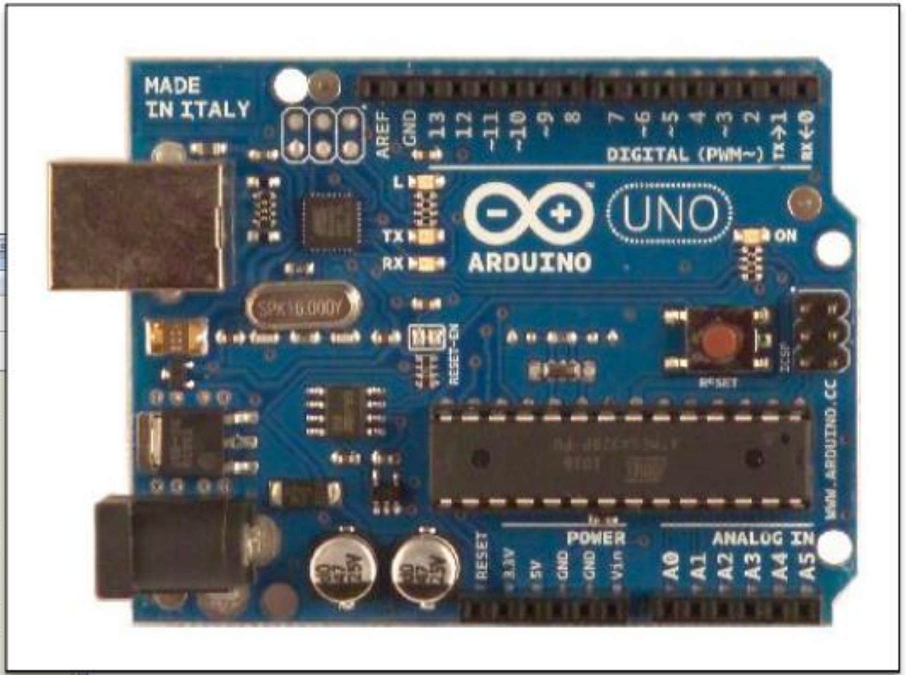
ATMega328P Microcontroller:

Simulator with ATMega328P Chip Model



11 Message(s)

COMPONENT U1, Value=ATMEGA328P, Module=<NONE>, Device=ATMEGA328P

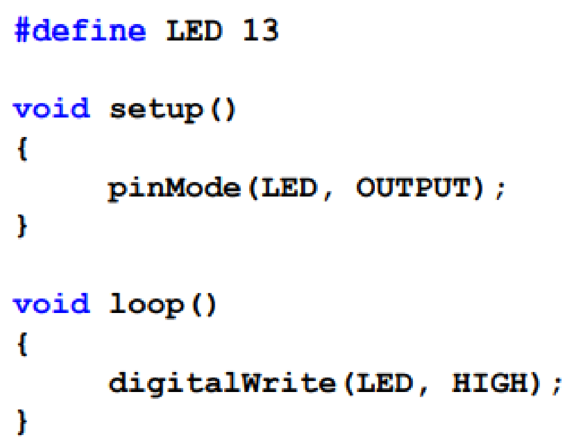


Real Arduino UNO Board with
Real ATMega328P Chip

Note: pin 13 in the Board not same as pin 13 of ATMega328P Chip.

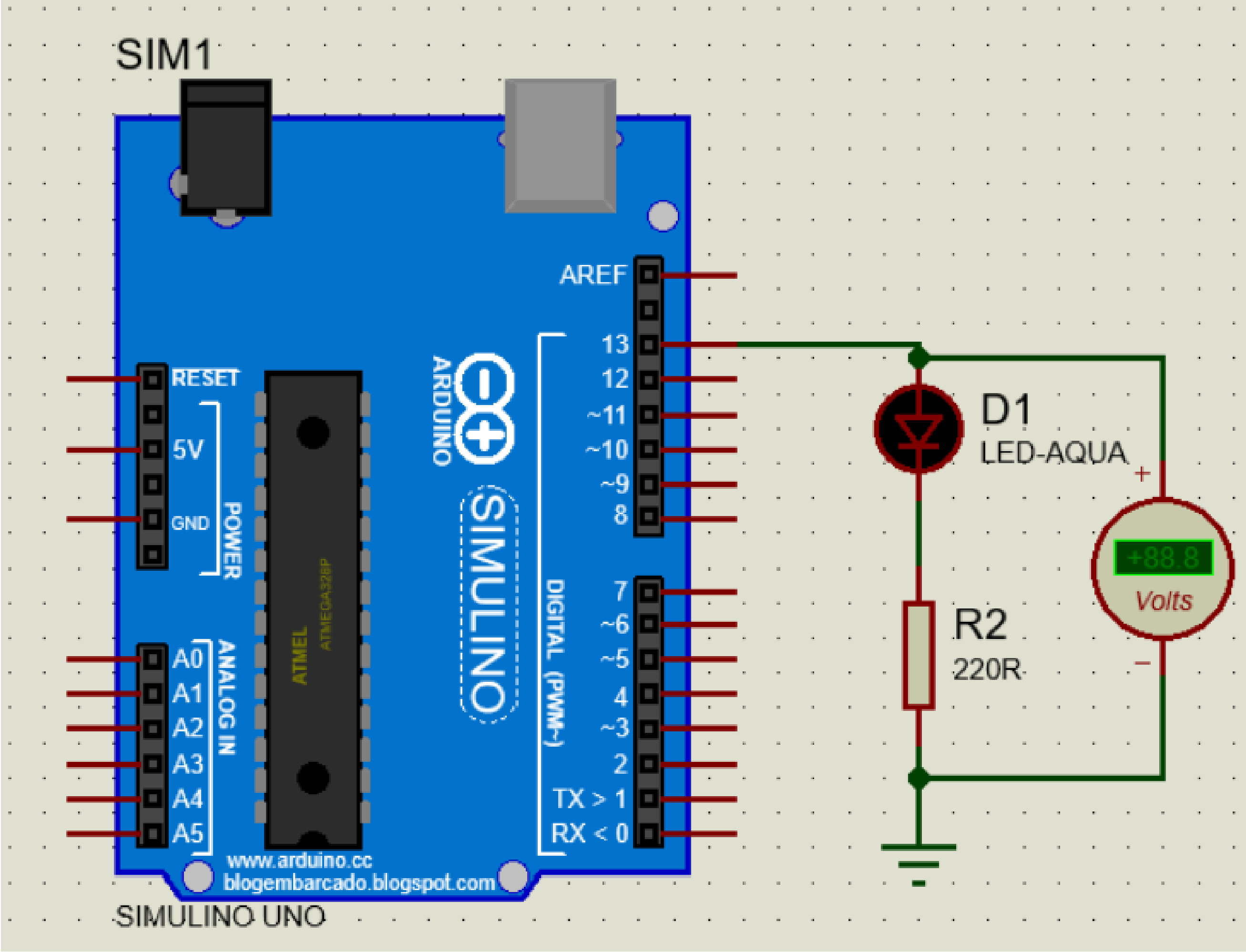
Some Lecture Examples:

Ex(1):



```
#define LED 13

void setup()
{
      pinMode(LED, OUTPUT);
}

void loop()
{
      digitalWrite(LED, HIGH);
}
```

we put this Resistance Series to the Led to Safe The Board from Damaging

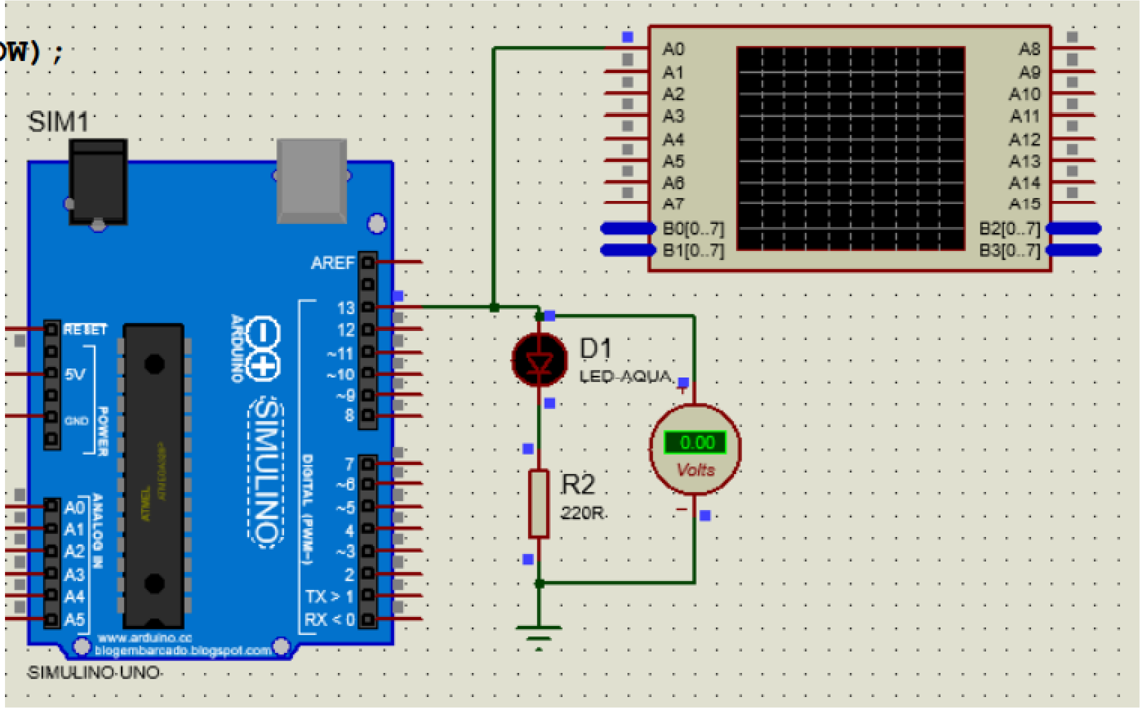


Ex(2):

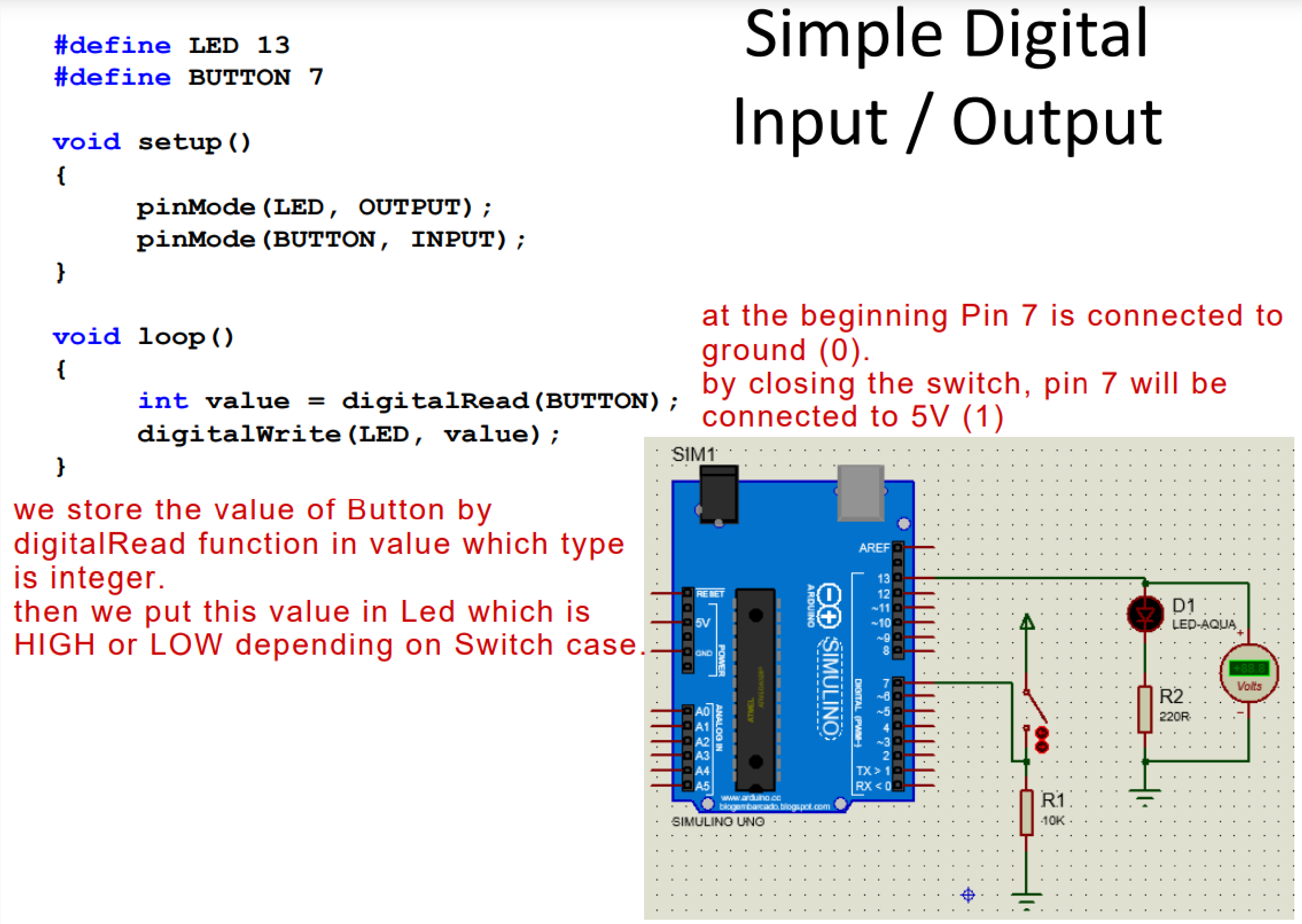
Square Signal

```
#define LED 13
#define DT  10

void setup()
{
      pinMode(LED, OUTPUT);
}

void loop()
{
      digitalWrite(LED, HIGH);
      delay(DT);
      digitalWrite(LED, LOW);
      delay(DT);
}
```

delay function: stops the microcontroller for DT milliseconds



Ex(3):



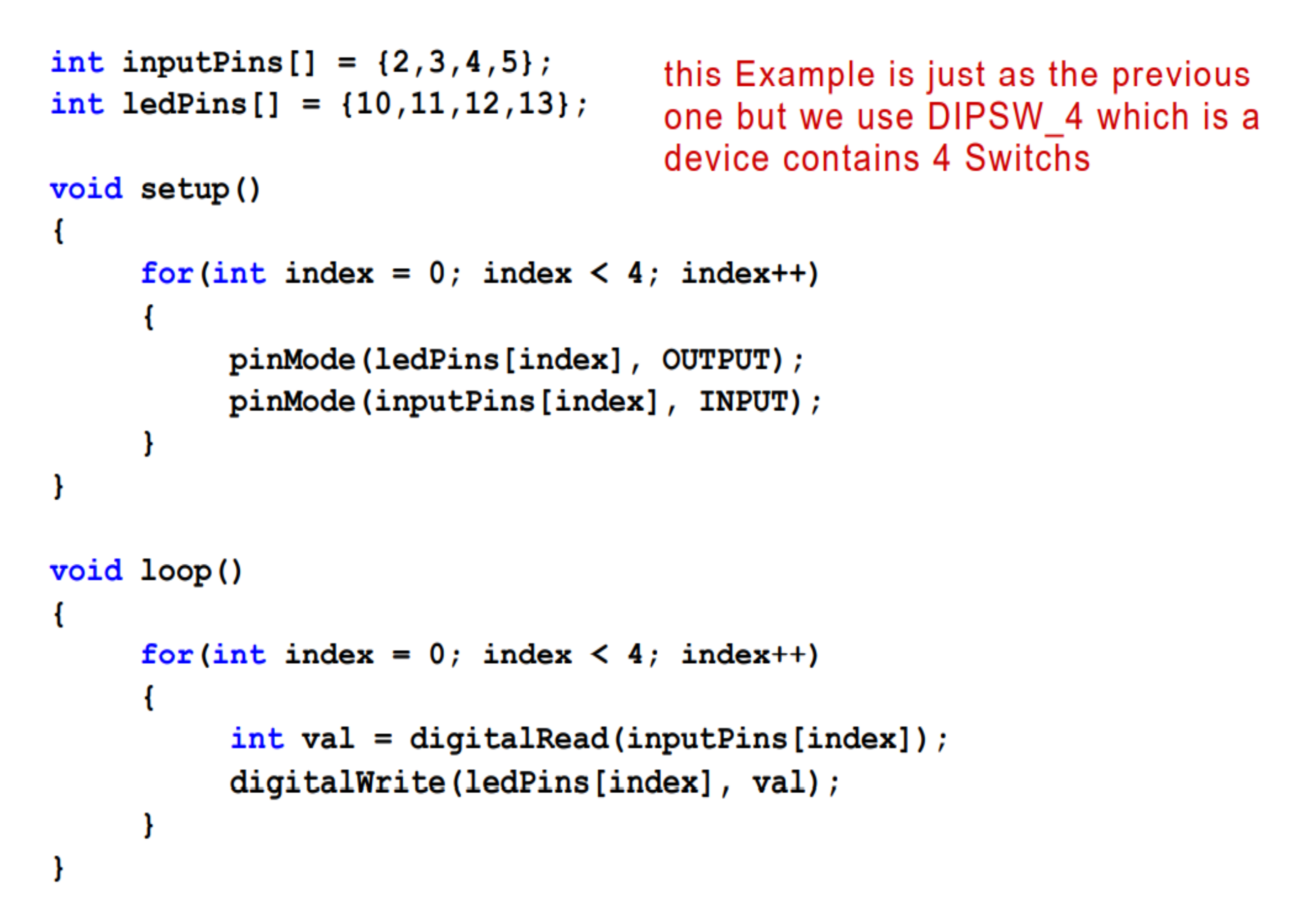
Simple Digital Input / Output

```
#define LED 13
#define BUTTON 7

void setup()
{
      pinMode(LED, OUTPUT);
      pinMode(BUTTON, INPUT);
}

void loop()
{
      int value = digitalRead(BUTTON);
      digitalWrite(LED, value);
}
```

we store the value of Button by digitalRead function in value which type is integer.
then we put this value in Led which is HIGH or LOW depending on Switch case.

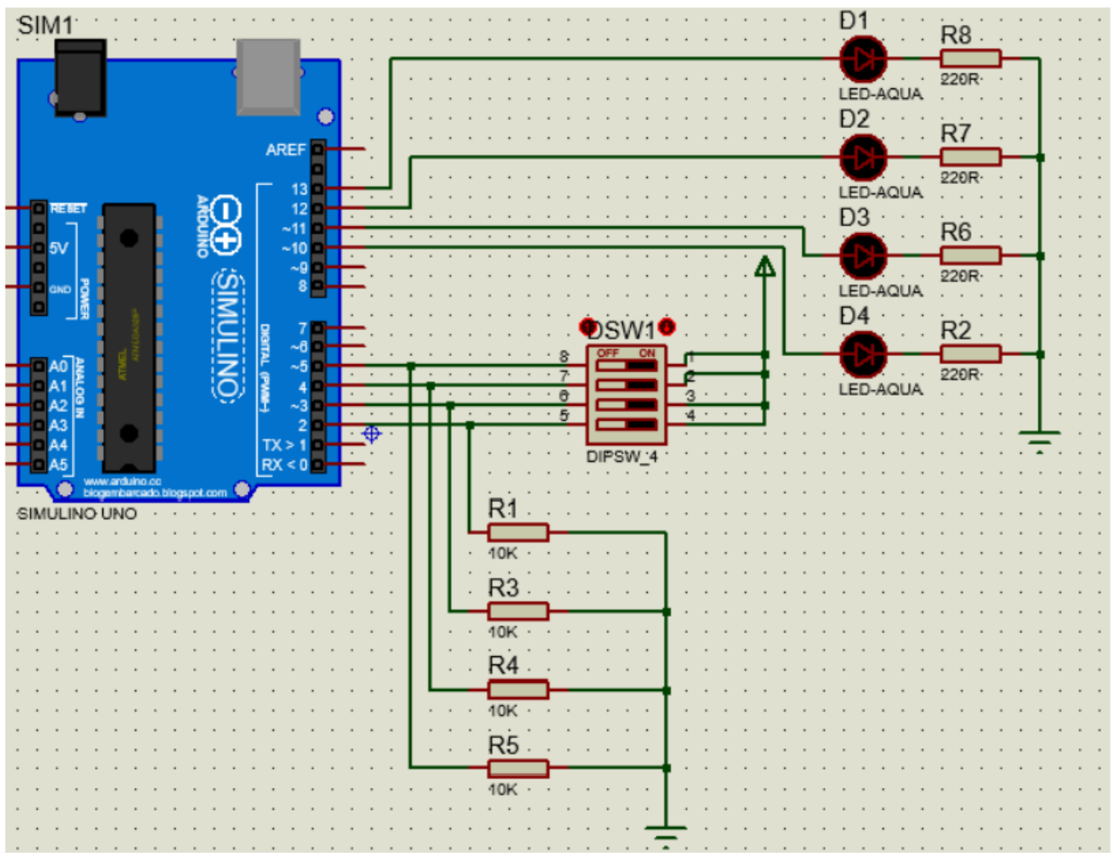
at the beginning Pin 7 is connected to ground (0).
by closing the switch, pin 7 will be connected to 5V (1)

Ex(4):



```
int inputPins[] = {2,3,4,5};
int ledPins[] = {10,11,12,13};

void setup()
{
    for(int index = 0; index < 4; index++)
    {
        pinMode(ledPins[index], OUTPUT);
        pinMode(inputPins[index], INPUT);
    }
}

void loop()
{
    for(int index = 0; index < 4; index++)
    {
        int val = digitalRead(inputPins[index]);
        digitalWrite(ledPins[index], val);
    }
}
```

this Example is just as the previous one but we use DIPSW_4 which is a device contains 4 Switchs



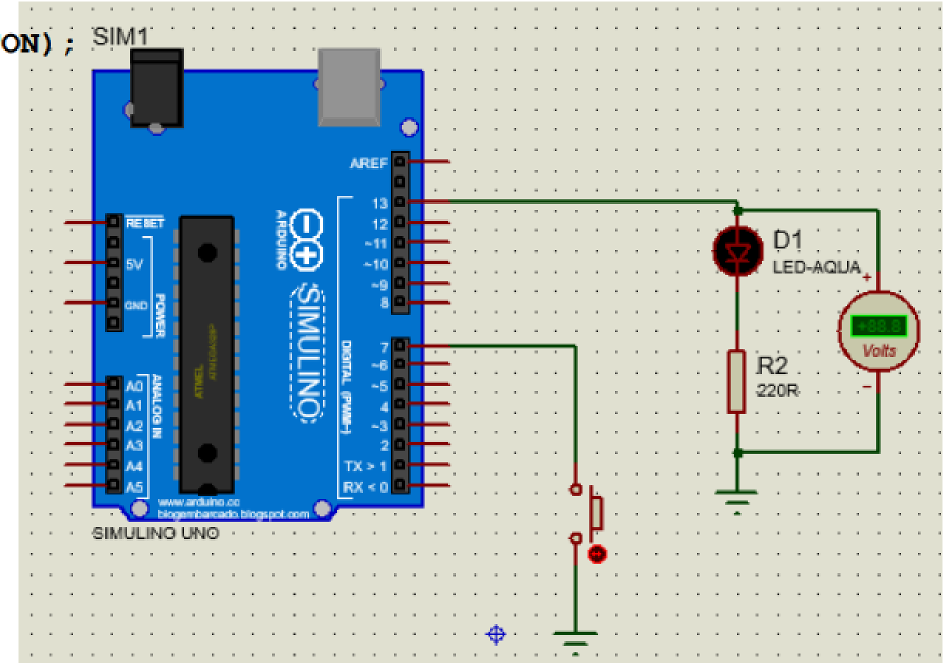
Ex(5):

Simple Digital Input / Output with Input Pull-up Resistance

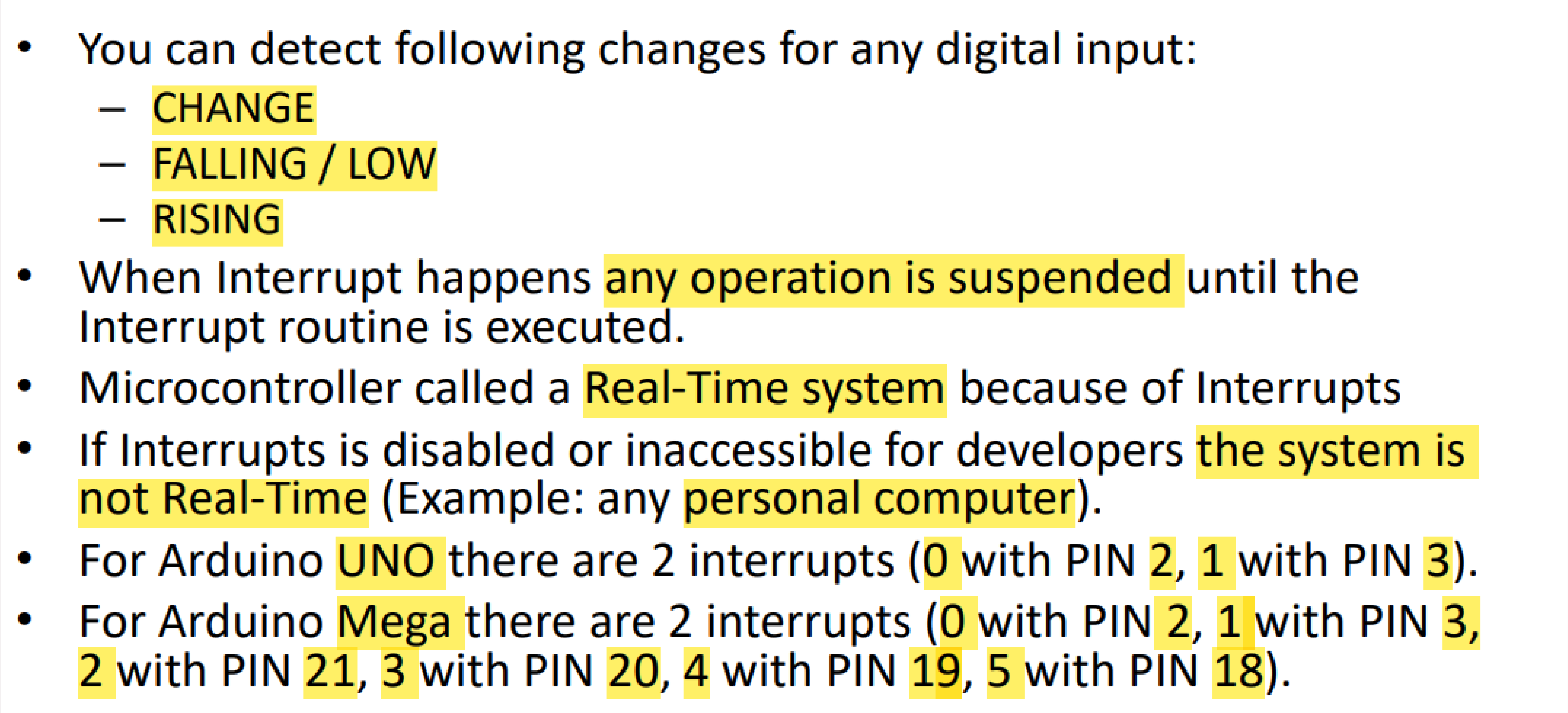
```
#define LED 13
#define BUTTON 7

void setup()
{
     pinMode(LED, OUTPUT);
     pinMode(BUTTON, INPUT);
     digitalWrite(BUTTON, HIGH);
//Enable pull-up resistor at input
}
```

digitalWrite(BUTTON,HIGH): Means that we initally put Pin 7 High

```
void loop()
{
     int value = digitalRead(BUTTON);
     digitalWrite(LED, value);
}
```

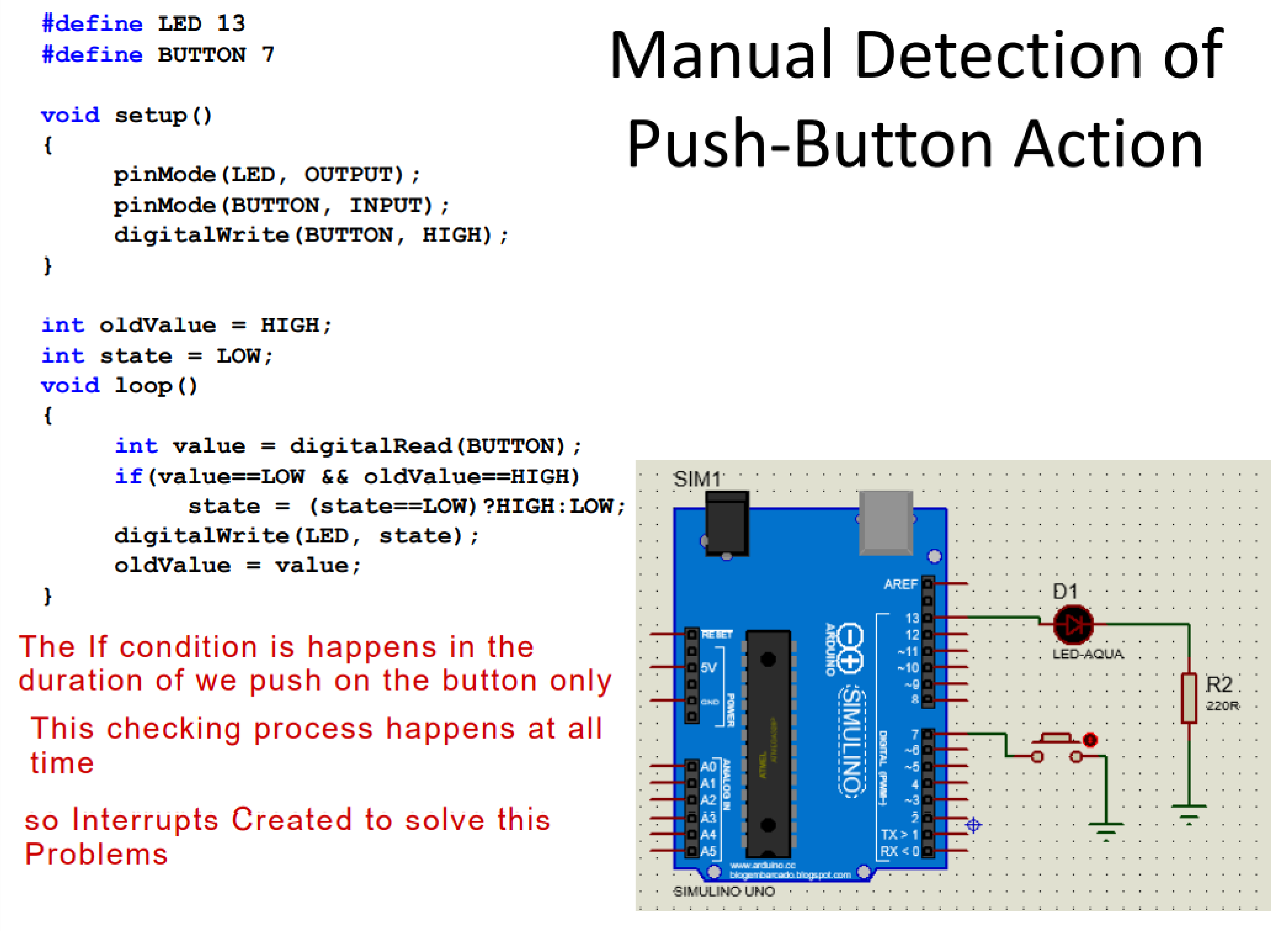


Interrupts:



- You can detect following changes for any digital input:
  - CHANGE
  - FALLING / LOW
  - RISING
- When Interrupt happens any operation is suspended until the Interrupt routine is executed.
- Microcontroller called a Real-Time system because of Interrupts
- If Interrupts is disabled or inaccessible for developers the system is not Real-Time (Example: any personal computer).
- For Arduino UNO there are 2 interrupts (0 with PIN 2, 1 with PIN 3).
- For Arduino Mega there are 2 interrupts (0 with PIN 2, 1 with PIN 3, 2 with PIN 21, 3 with PIN 20, 4 with PIN 19, 5 with PIN 18).

Example without Interrupts:



Manual Detection of Push-Button Action

```
#define LED 13
#define BUTTON 7

void setup()
{
      pinMode(LED, OUTPUT);
      pinMode(BUTTON, INPUT);
      digitalWrite(BUTTON, HIGH);
}

int oldValue = HIGH;
int state = LOW;
void loop()
{
      int value = digitalRead(BUTTON);
      if(value==LOW && oldValue==HIGH)
            state = (state==LOW)?HIGH:LOW;
      digitalWrite(LED, state);
      oldValue = value;
}
```

The If condition is happens in the duration of we push on the button only

This checking process happens at all time

so Interrupts Created to solve this Problems

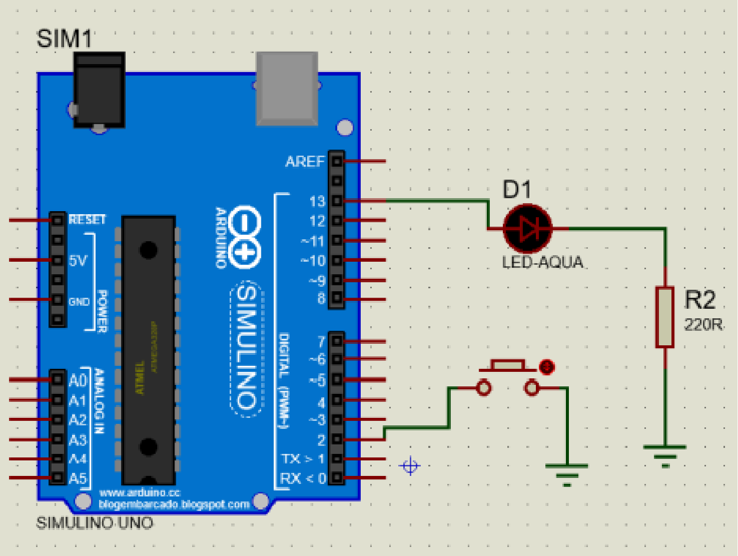
Example with Interrupts:

Detection of Push-Button Action using Interrupts

```
#define LED 13
#define BUTTON 2

int state = LOW;
void changeState()
{
  state = (state==LOW)?HIGH:LOW;
  digitalWrite(LED, state);
}

void setup()
{
  interrupts();
  pinMode(LED, OUTPUT);
  pinMode(BUTTON, INPUT);
  digitalWrite(BUTTON, HIGH);
  attachInterrupt(0, changeState, FALLING);
}

void loop()
{
}
```

Pin 2 calling the function

after using interrupts we notice that
void loop is Empty , so the power consumed
by the board decreases


SIM1
AREF
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX > 1
RX < 0
DIGITAL (PWM~)
RESET
5V
GND
POWER
A0
A1
A2
A3
A4
A5
ANALOG IN
ARDUINO
SIMULINO
ATMEL
www.arduino.cc
blogembarcado.blogspot.com
SIMULINO UNO
D1
LED-AQUA
R2
220R