DEMETER PROJECT

1st june 2022

Implementation of a metal detector with discrete components and Arduino

"Will robots inherit the earth? Yes, but they will be our children". Marvin Minsky

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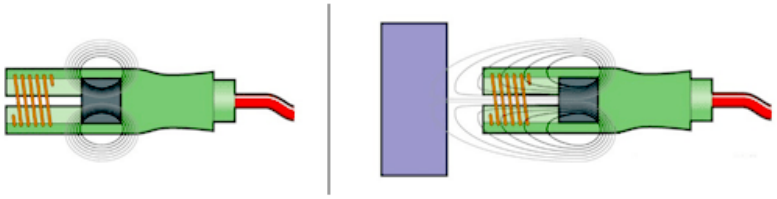
UNIT. Implementation of a metal detector with discrete components and Arduino

The goal of this unit is to implement a commercial metal sensor using Arduino as control technology. We are going to build a prototype that in the presence of metals will emit a sound and acoustic signal.

Lessons One: Physical Principles

Lesson description:

In this lesson, students will investigate the physical principles and the different metal sensors on the market, looking at technical characteristics and cost.



Objectives:

- Understand the physical principles of inductive sensors.
- Research commercial sensors and understand their differences

Methodology:

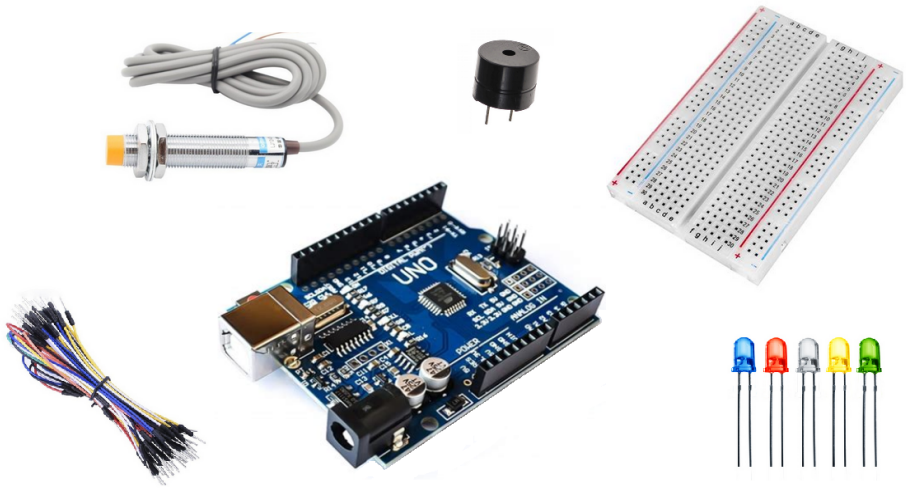
In a first session, the students will be grouped in pairs and each pair will investigate the physical principles of the inductive sensors and will prepare a comparative table with the different models.

In a second session we will open a debate on this type of sensor, the usefulness and usability of the different sensor models on the market will be assessed.

Evaluation:

The description of the sensors and the comparative table will be evaluated, in addition to the contribution to the debate in class.

Lesson Two: Resources - Components Budget



Lesson description:

In this lesson the students will make a first approximation to the prototype. The input to the prototype will be provided by the inductive sensor, the students will decide how their prototype will generate the outputs, which may be sound, light or vibration.

The students will identify the necessary components and prepare a budget.

Objectives:

- Identify the necessary components to make the prototype, defining its function.
- Prepare a budget with market prices.

Methodology:

For this lesson we will only need one session, groupings of three students will be made.

Each group will mark the objectives of their project. They will prepare a list of components:

- Arduino Uno
- Protoboard

- Jumpers
- Leds
- Resistors
- Buzzer
- etc.

The students will justify the function of each component in the prototype.

Evaluation:

Each group will deliver a spreadsheet with the list, description and price of each component. Indicating the total cost.

The teacher will evaluate if the budget is correct and if the prototype is viable.

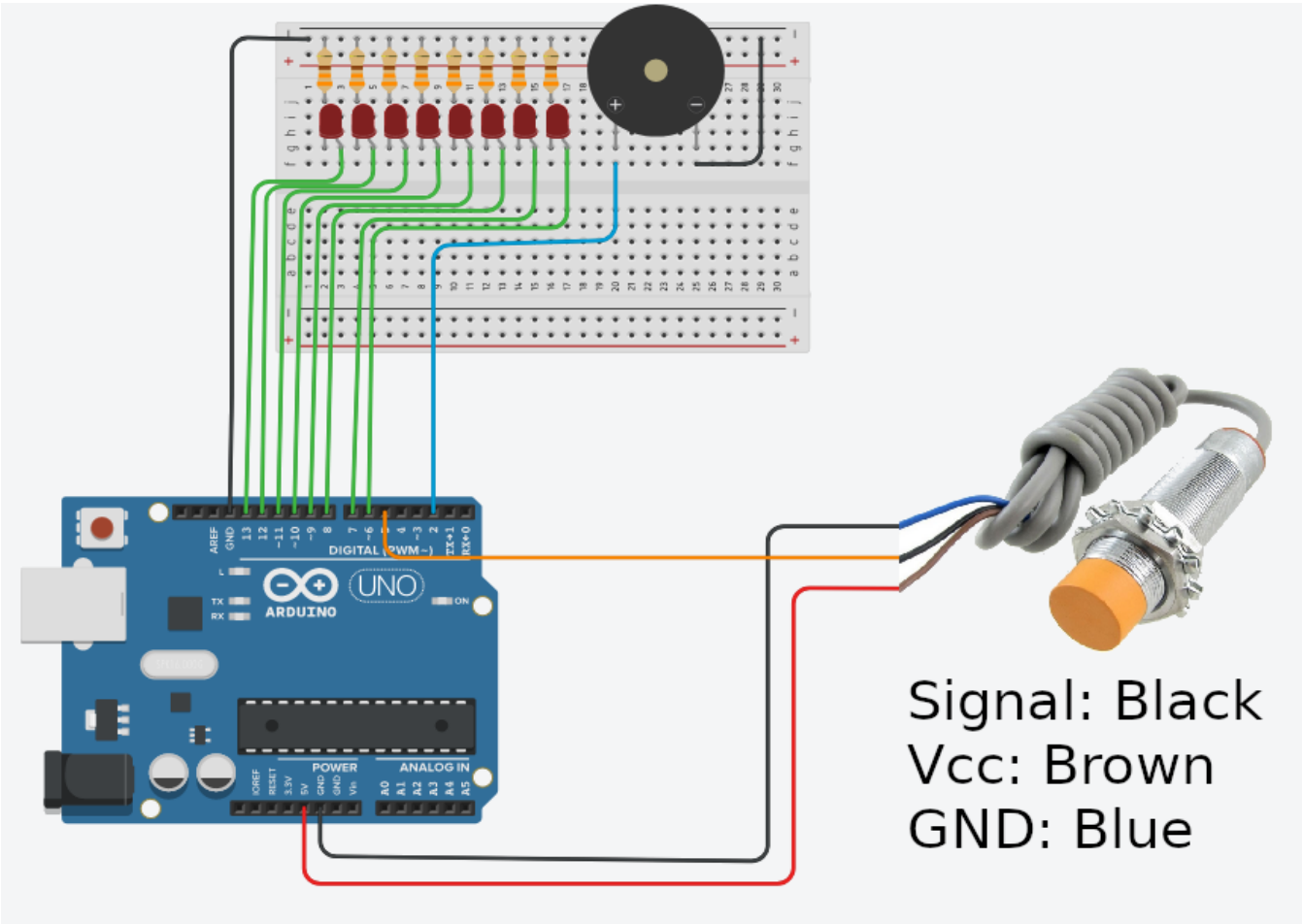
Lesson Three: Hardware design and implementation - Prototype construction

Lesson description:

In this lesson, students will design, implement and program a first version of their prototypes.

Objectives:

- Design a prototype using assisted design tools.
- Assemble the prototype according to security measures.
- Modify the code of a provided program adjusting it to the characteristics of the project.



Methodology:

Firstly, students will design a prototype using Thinkercad or similar. Taking care of Input/Output connections. Once reviewed by the teacher, the students will assemble the prototype with the materials available in the workshop. If necessary, adjustments will be made to the prototype.

Starting from a basic code, provided by the teacher, the students will make the necessary modifications, to generate the output, based on the components integrated in the prototype.

Depending on the difficulty of the prototype, students will need two or three sessions. The groupings from the previous lesson will be kept.

Basic Code:

```
const int sensorPin = 5;
void setup()
{
  Serial.begin(9600);
}
void loop()
{
  //send message to serial port based on the value read
  bool state = digitalRead(sensorPin);

  if (state == LOW)
  {
    Serial.println("Metal Detected");

    //here the actions would be executed depending on
    //the output signals of the prototype
  }
```

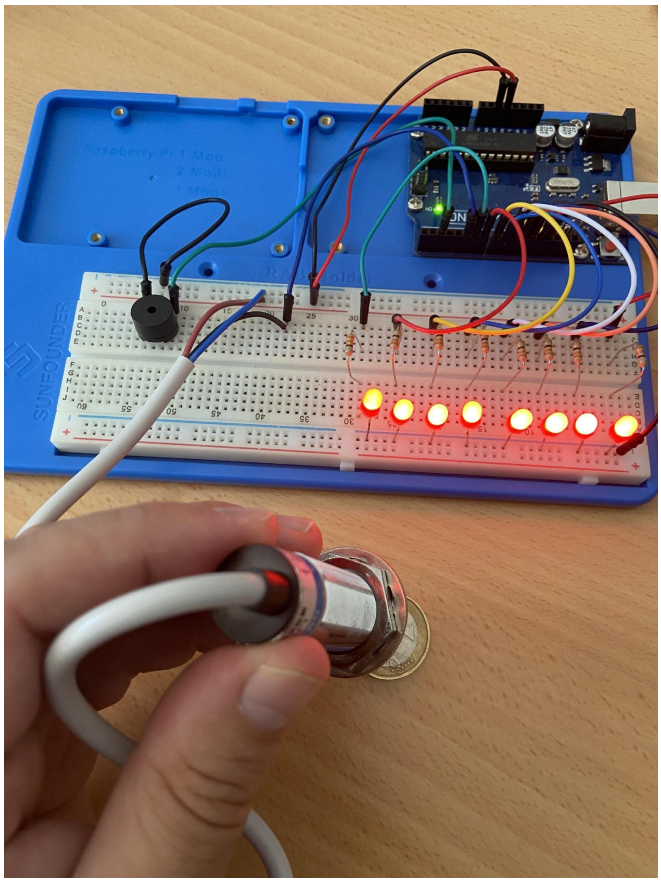
Evaluation:

Once finished, the students will deliver the commented prototype design. As well as photographs of the prototype. The originality, effectiveness and difficulty of the prototype will be valued.

Examples of prototypes:

Prototype B

Prototype A



Code Example: Prototype A

This code generates an output that will grow if the sensor remains on the metal over time.

```
const int sensorPin = 5;
const int speaker = 2;
int serie=0;

void Deteccion();

void setup()
{
  Serial.begin(9600);
  // Usaremos del pin 6 al 13 como salidas paa los
leds
  pinMode( 6 , OUTPUT);
  pinMode( 7 , OUTPUT);
  pinMode( 8 , OUTPUT);
  pinMode( 9 , OUTPUT);
  pinMode( 10 , OUTPUT);
  pinMode( 11 , OUTPUT);
  pinMode( 12 , OUTPUT);
  pinMode( 13 , OUTPUT);
}

void loop()
{
  bool state = digitalRead(sensorPin);

   //mandar mensaje a puerto serie en función del
valor leido
  if (state == LOW)
  {
    Serial.println("Detección");
    Serial.println(serie,DEC);
    if (serie<8) serie++;
    Deteccion();

  } else {
    serie=0;
  }
  //delay(1000);
}

void Deteccion() {
 int i;

 for ( i = 6 ; i <= 6+serie ; i++)
  {
   digitalWrite( i , HIGH);
  }

   tone(speaker,serie*100);   // suena la nota frec
recibida
   delay(100-(serie*8));         // durante un tiempo
determinado
   noTone(speaker);          // paramos el tono
    delay(100-(serie*8));             // mantenemos el
silencio durante un tiempo

  for ( i = 6 ; i <= 6+serie ; i++)
  {
   digitalWrite( i , LOW);
  }
}
```

Lesson Four: Test and documentation

Lesson description:

In this lesson, students will test the effectiveness of their prototype and discuss possible improvements and modifications. In addition, the students will prepare a manual where they will explain the entire process, they will deliver a document rich in format that will contain images and diagrams.

Objectives:

- Test the prototype in standard and extreme situations.
- Analyze the functioning of the prototype and propose improvements.
- Prepare a prototype construction manual.

Methodology:

We will need three sessions for this lesson and the groupings will remain. Students will test their prototype, detecting and correcting anomalies in its operation. Each team will take photos and videos of their model running.

In this lesson, students will prepare a construction manual for their prototype, this manual will have the following sections:

- Introduction
- List of components and budget.
- Assembly diagram.
- Annotated programming.
- Improvement proposals

Evaluation:

The teacher will evaluate the materials provided by each team, as well as the participation of each team member. For the global evaluation of the unit, a weighted average of the evaluation of each lesson will be made, taking into account the timing of each one.

Final debate: sharing and proposal for improvements

Finally, there will be a sharing of the work carried out, the problems raised and the most successful solutions. The students will propose practical applications of the prototypes and their integration with other systems.

Bibliography

- Llamas, L. 23/10/2016. *Detector de metales con arduino y sensor inductivo*. Luis Llamas. . Retrieved from: Luis Llamas - Metal detector with Arduino and inductive sensor