Open Source Applications for Industrial Automation

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About OpenIN

- The **OpenIN** Project is a three year duration Project funded by **the European Union Erasmus+ Strategic Partnerships Programme** started in October, 2016 and it involves 4 partners across Europe.

- The development of professional automated industrial systems nowadays is still a "*proprietary technology*" at high costs, which in a way impede its development and makes its implementation complicated.

About OpenIN

- This project **aims at helping higher VET and HEIs institutions, Technical Universities as well as enterprises** using automation systems (especially SMEs) to cut costs and embrace innovation by **providing** them with **Training Courses** for both students and teachers on free open source hardware and software for designing automated systems.

OpenIN Partners

- **Coordinator**: Politeknika Ikastegia Txopierri, Spain
- **Partner**: APRO Formazione, Italy
- **Partner**: Insituto Superior de Engenharia do Porto, Portugal
- **Partner**: Technological Educational Institue of Crete, Greece

Overall Impact

The partners of **OPENIN** project are all committed to the promotion free open-source software as an effective way to modernize target organizations and promote innovation.





Overall Impact

ON STUDENTS:

- Students from EQF level 5 and above will be taught how to use free open source automation software and hardware
- They will be more competitive when looking for a job as being already acquainted with automation software and hardware

ON TEACHERS/ TRAINERS:

- Their everyday work will be facilitated by the implementation of the project outputs
- They will increase their opportunities for professional development
- Will be more motivated and confident regarding their professional skills
- Gain access to free and open source automation software/hardware

Overall Impact

ON PROJECT PARTNERS:

- They can modernize their education methods and use the latest technology
- The OPENIN project will foster the cooperation between high level VET/ HEI institutions and enterprises thus strengthening the “knowledge triangle” education, research and business

ON HIGHER VET CENTERS/ HE INSTITUTIONS/ INDUSTRIAL ENTERPRISES:

- Will have the opportunity to implement the free open source automation software/ hardware cutting overall costs.
- Have a methodology for training students and implement the free open source software/ hardware to modernize their organizations

Training Modules

The partnership carried out a research among companies and educational institutes in the four partner countries and following the outcomes of this research, partners worked on the structure of the Course and the structure of the description of the units and learning outcomes. Below is the final structure of the course separated into 4 Topics:

- **Topic A: Introduction**
- **Topic B: Sensors.**
- **Topic C: Communications.**
- **Topic D: Actuators.**

Each topic is separated into several units which are presented in the next slides

Training Modules

INTRODUCTION

- unit 1: First programs
- unit 2: Digital i/o and stops
- unit 3: Expresions, delays and sound
- unit 4: Take decissions and control functions
- unit 5: Analog signals
- unit 6: Lcd screens

SENSORS

- unit 7: Infrared sensors
- unit 8: Other sensors

COMMUNICATIONS

- unit 9: Communications
- unit 10: i2c bus
- unit 11: Communication protocol

ACTUATORS

- unit 12: Relays
- unit 13: PWM signals and servo motor controls
- unit 14: Driving motors

Learning based on examples

- Project-based learning is an increasingly popular method of instruction in which students drive their own learning by completing projects.

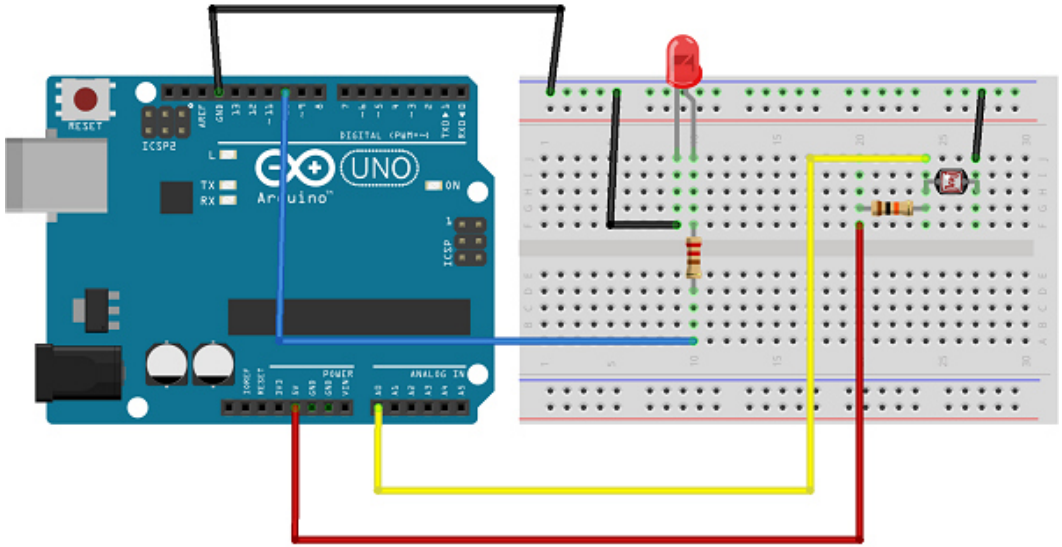
- Project-based learning can be best defined as a teaching method through which students work to answer a complex question or solve a complex problem. This problem solving includes researching the question, synthesizing the information, working with others, and presenting the work.

- Projects can last as long as they need to and can cover a wide variety of topics and subject areas.

In the following slides we will present you some simple examples based on the Units of OPENIN.

Luminosity Example

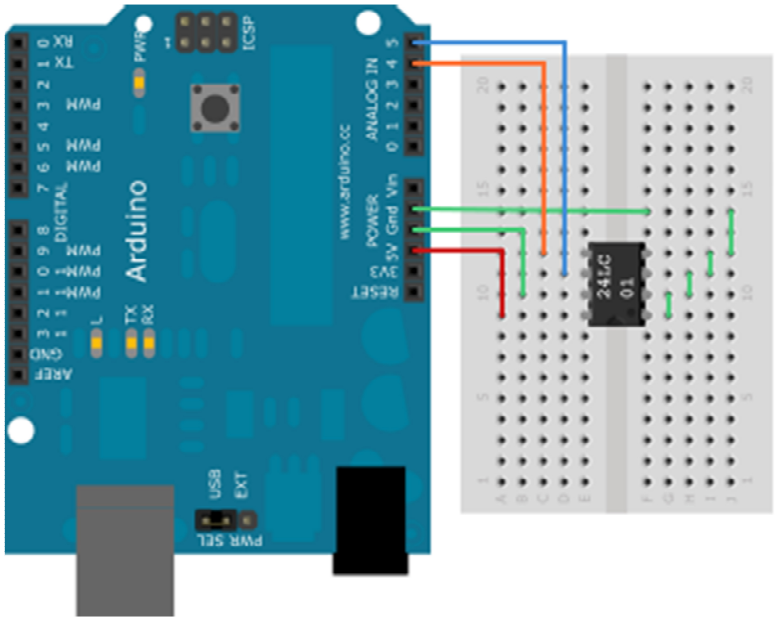
Using this example, students will create an dimming led based on the environmental conditions (luminosity). Students will learn the basics about analog signals and the way that are handled by the Arduino boards.



```
int luminosity;
int ledPin = 10;

void setup() {
}

void loop() {
  luminosity = analogRead(A0);
  luminosity = luminosity/4;
  analogWrite(ledPin, luminosity);
  delay(10);
}
```

I2C EEPROM Example

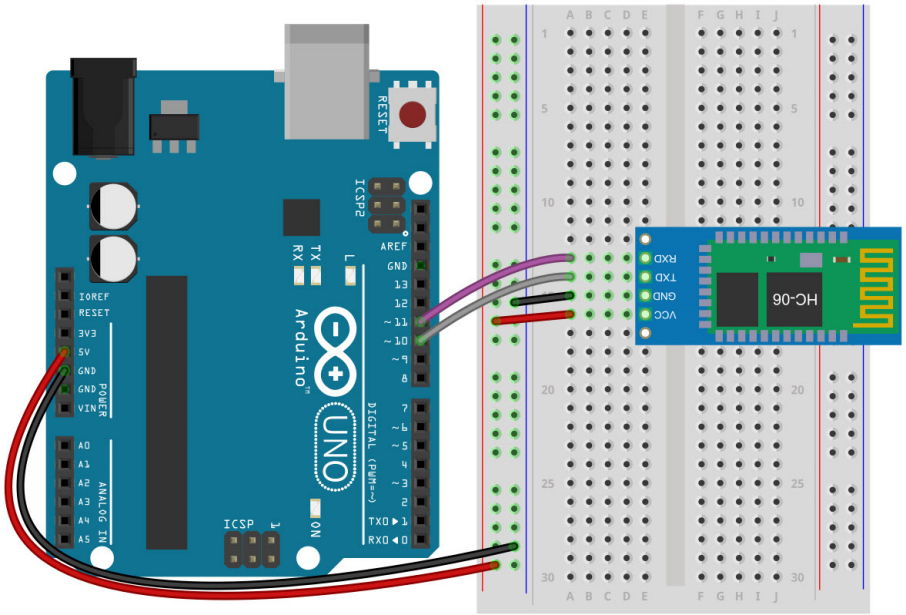
This example demonstrates the usage of I2C protocol as well as provide a solution to overcome a common memory restriction. (low capacity)




```
#include <Wire.h>

void eeprom_i2c_write(byte address, byte from_addr, byte data) {
  Wire.beginTransmission(address);
  Wire.send(from_addr);
  Wire.send(data);
  Wire.endTransmission();
}

byte eeprom_i2c_read(int address, int from_addr) {
  Wire.beginTransmission(address);
  Wire.send(from_addr);
  Wire.endTransmission();
  Wire.requestFrom(address, 1);
  if(Wire.available()) return Wire.receive();
  else return 0xFF;
}

void setup() {
  Wire.begin();
  Serial.begin(9600);
  for(int i = 0; i < 10; i++, delay(100))
    eeprom_i2c_write(B01010000, i, 'a'+i);
  Serial.println("Writen to memory!");
}

void loop() {
  for(int i = 0; i < 10; i++) {
    byte r = eeprom_i2c_read(B01010000, i);
    Serial.print(i);
    Serial.print(" - ");
    Serial.print(r);
    Serial.print("\n");
    delay(1000);
  }
}
```

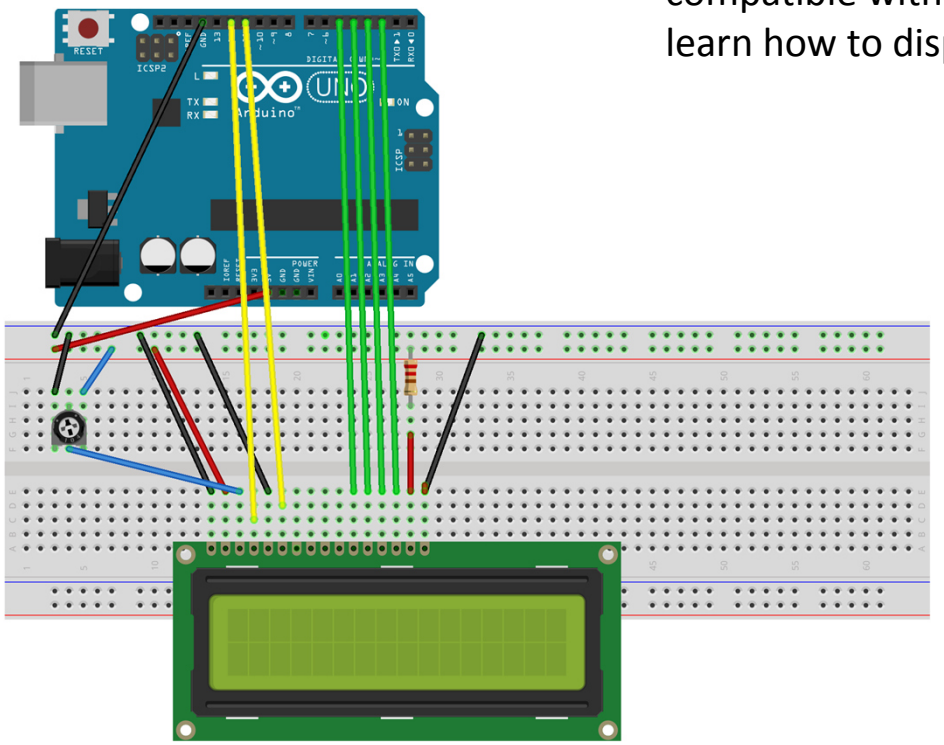
Serial Bluetooth Example

In this example, students will be able to understand serial protocols as well as the usage of Bluetooth/BLE communication.




```
#include <SoftwareSerial.h>

SoftwareSerial mySerial(10, 11);

void setup()
{
  Serial.begin(9600);
  mySerial.begin(9600);
}

void loop()
{
  if (mySerial.available())
    Serial.write(mySerial.read());
  if (Serial.available())
    mySerial.write(Serial.read());
}
```

Simple LCD Example

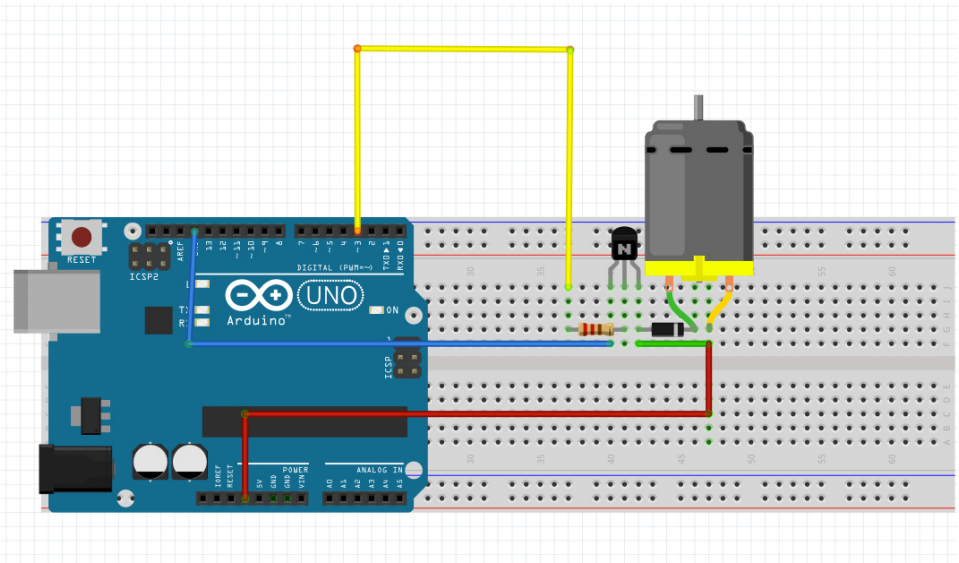


The LiquidCrystal library allows you to control LCD displays that are compatible with the Hitachi HD44780 driver. Using a LCD, students will learn how to display information.

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

void setup() {}

int i = 0;

void loop() {
  lcd.setCursor(i,0);
  lcd.print("Hello World.");
  delay(500);
  lcd.clear();
  i=!i;
}
```

Simple DC Motor Example

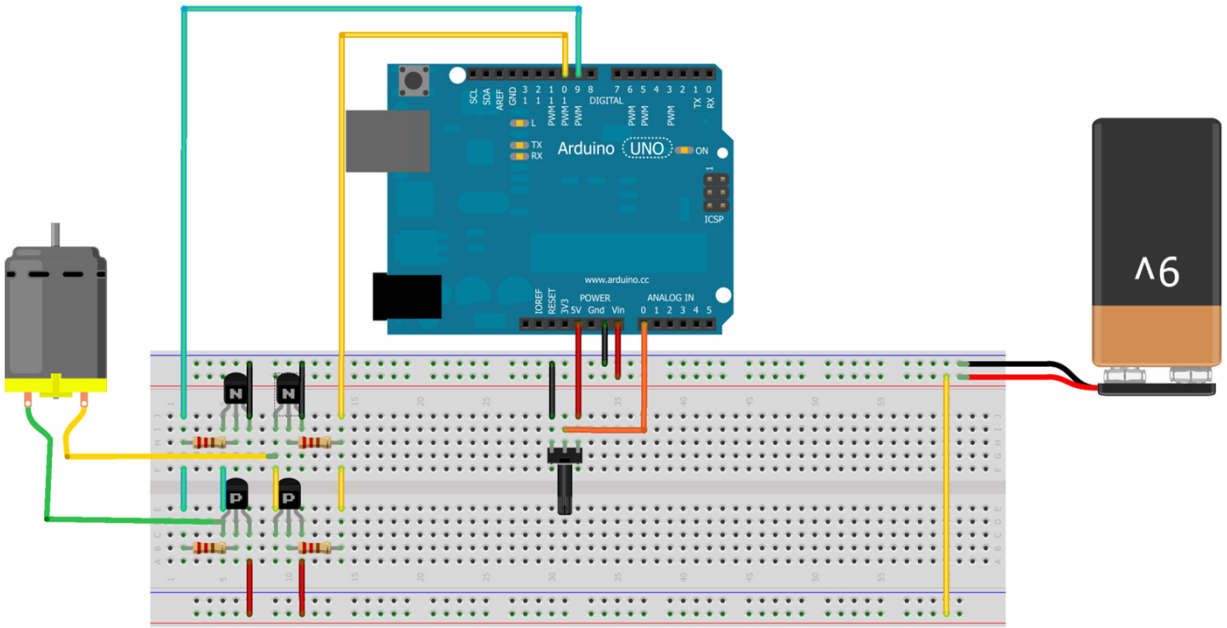
In this example, students will learn how to control a small DC motor using an Arduino and a transistor. They will use an Arduino analog output (PWM) to control the speed of the motor by sending a number between 0 and 255 from the Serial Monitor.




```
int motorPin = 3;

void setup()
{
  pinMode(motorPin, OUTPUT);
  Serial.begin(9600);
  while (! Serial);
  Serial.println("Speed 0 to 255");
}


void loop()
{
  if (Serial.available())
  {
    int speed = Serial.parseInt();
    if (speed >= 0 && speed <= 255)
    {
      analogWrite(motorPin, speed);
    }
  }
}
```

H-Bridge DC Motor Example

This example will help students to understand a more advanced way of controlling a DC motor using an H-Bridge circuit containing four switching elements, transistors or MOSFETs.




```
int portH1 = 9;
int portH2 = 10;
int potpin = 0;
int val;
int val1;
int val2;

void setup()
{
}

void loop()
{
  val = analogRead(potpin);
  val1 = map(val, 0, 519, 255, 0);
  val2 = map(val, 520, 1023, 0, 255);
  if (val > 520) val1 = 0;
  else val2 = 0;
  analogWrite(portH1, val1);
  analogWrite(portH2, val2);
}
```

Porto Training Meeting

- ✓ Held in Porto (ISEP facilities) from 5/2/18 – 9/2/18
- ✓ Trainers from participating countries discussed and analyzed the training materials developed by all partners to ensure consistency and logical order in its structure.
- ✓ Experimental demonstrations of several provisions were carried out and also improvements were proposed.
- ✓ The type of formatting and the final structure of the texts and presentations to be delivered by each partner were also decided.

Porto Training Meeting

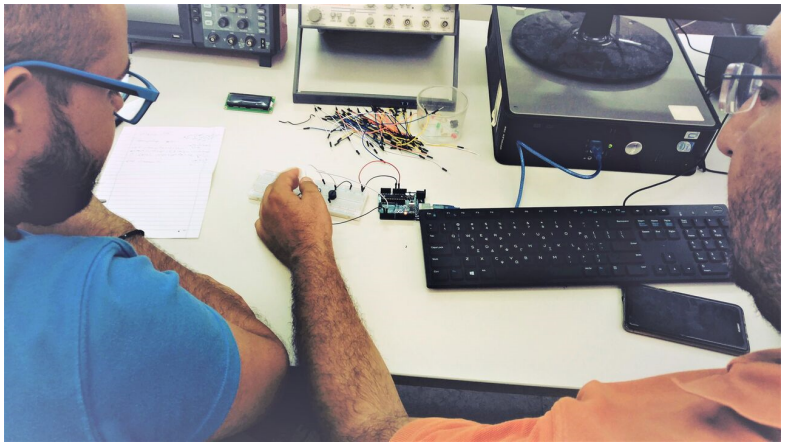
Heraklion Summer School

- Held in Heraklion on July 16-20, 2018 at the Technological Institute of Crete
- Over 50 applicants…
- 20 teachers of the secondary and technical education were chosen and attended the school

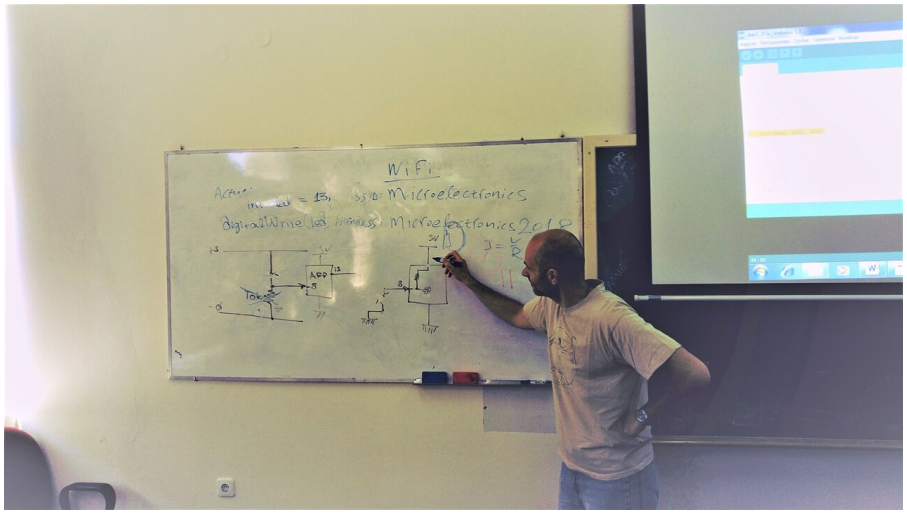
Heraklion Summer School Outline

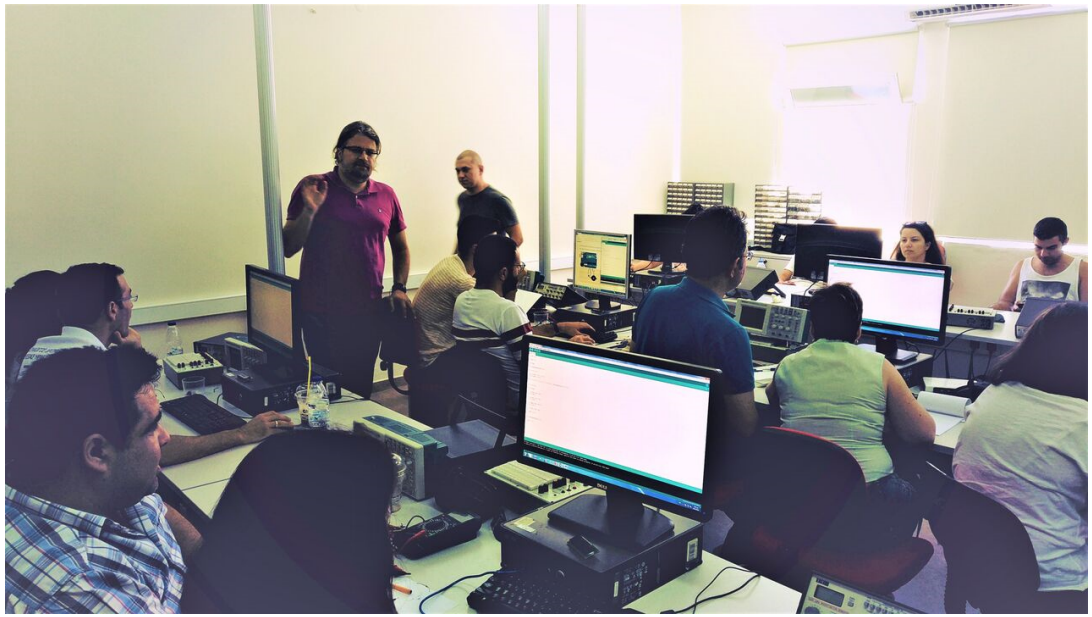
Day 1	*Day 2*	*Day 3*	*Day 4*	*Day 5*
➢ Programming with Arduino ➢ Digital Inputs/Outputs ➢ Analog Inputs/Outputs ➢ Interrupts ➢ LCD Display	➢ Light measurement with LDR ➢ Temperature – Humidity measurement with LM35 & DHT11 ➢ Infrared sensors ➢ Supersonic sensors	➢ Relays ➢ Solid state relays ➢ DC motors ➢ RC servo motors ➢ Stepper motors	➢ Serial Communication Protocols ➢ Asynchronous serial communication ➢ 1-Wire protocol ➢ I2C protocol ➢ Data communication protocols ➢ Bluetooth ➢ Ethernet ➢ Wifi	Manufacture of autonomous robotic vehicle

Heraklion Summer School Outline

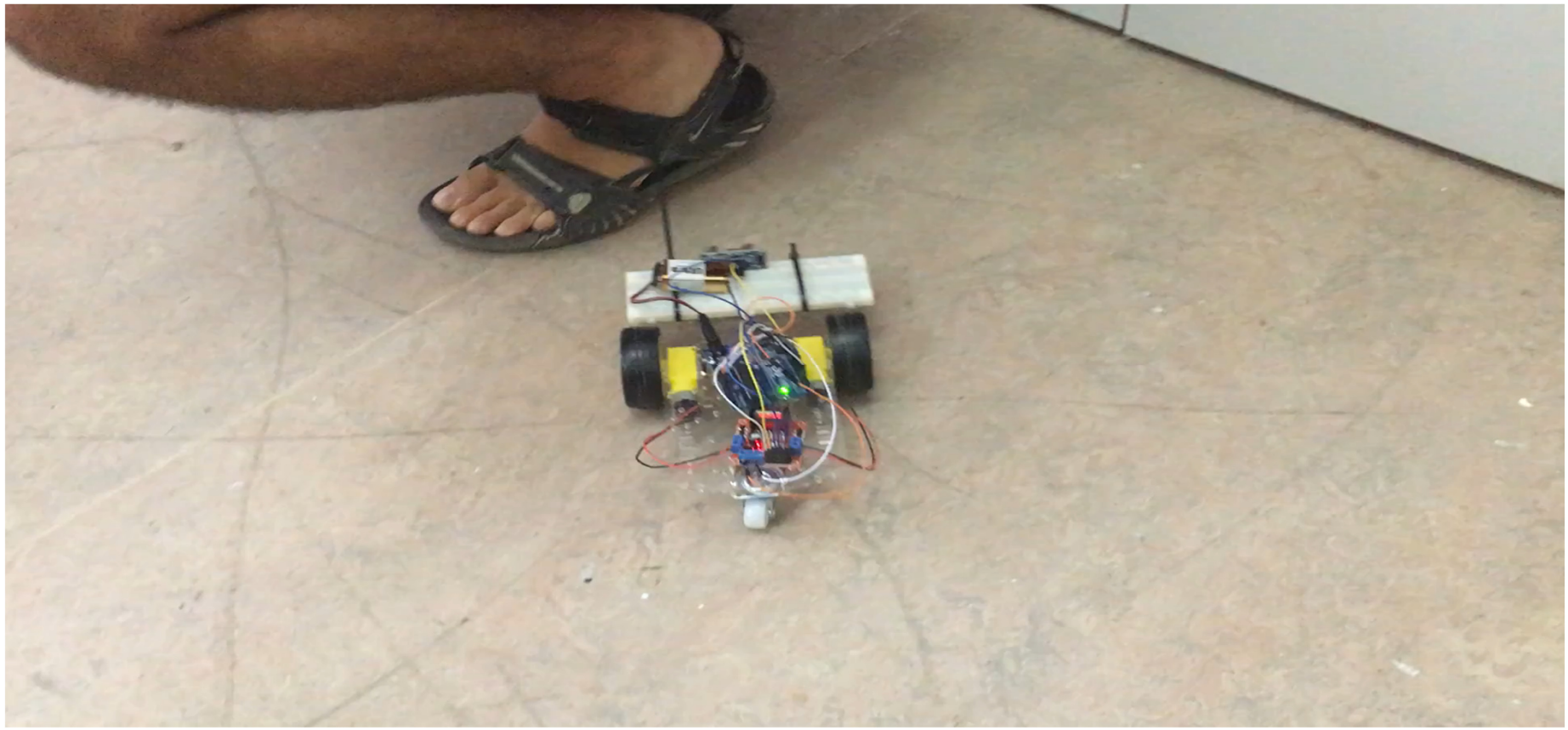


Heraklion Summer School Outline





Heraklion Summer School Outline



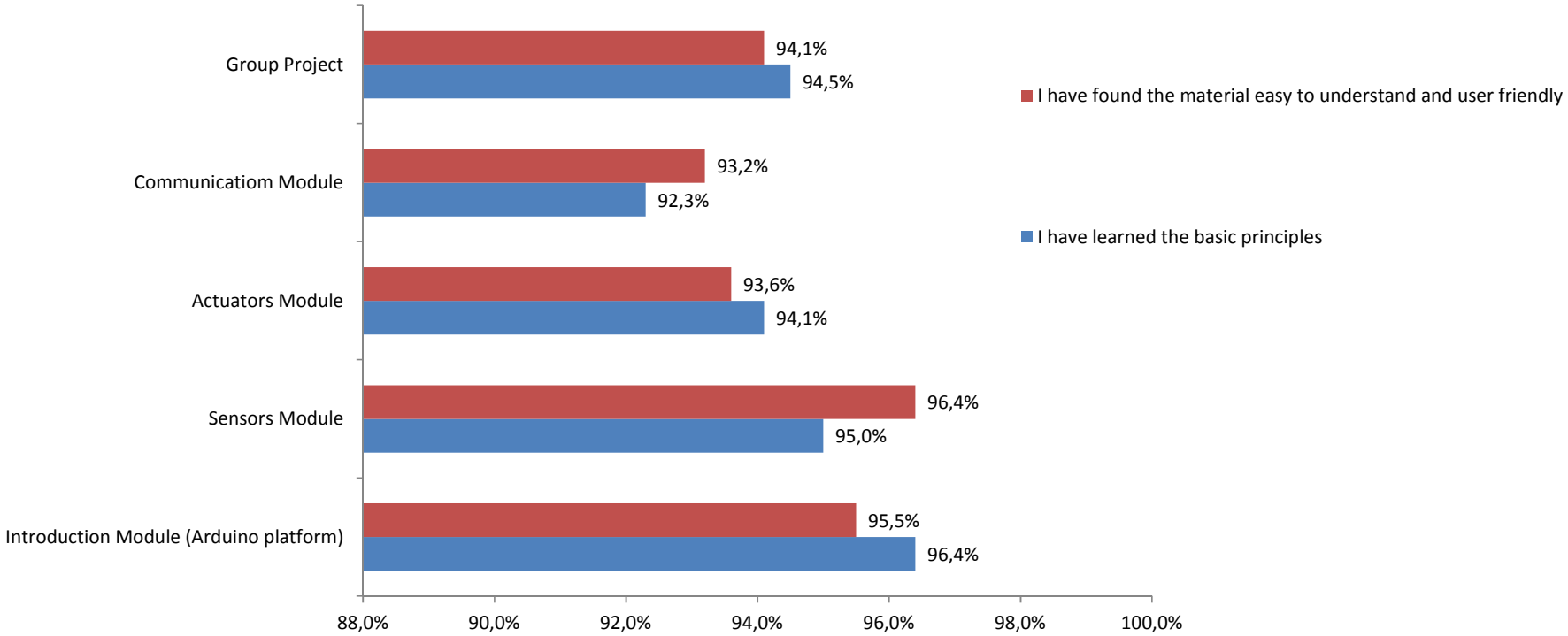
Heraklion Summer School Outline

Participants were asked to fill a questionnaire regarding the training course

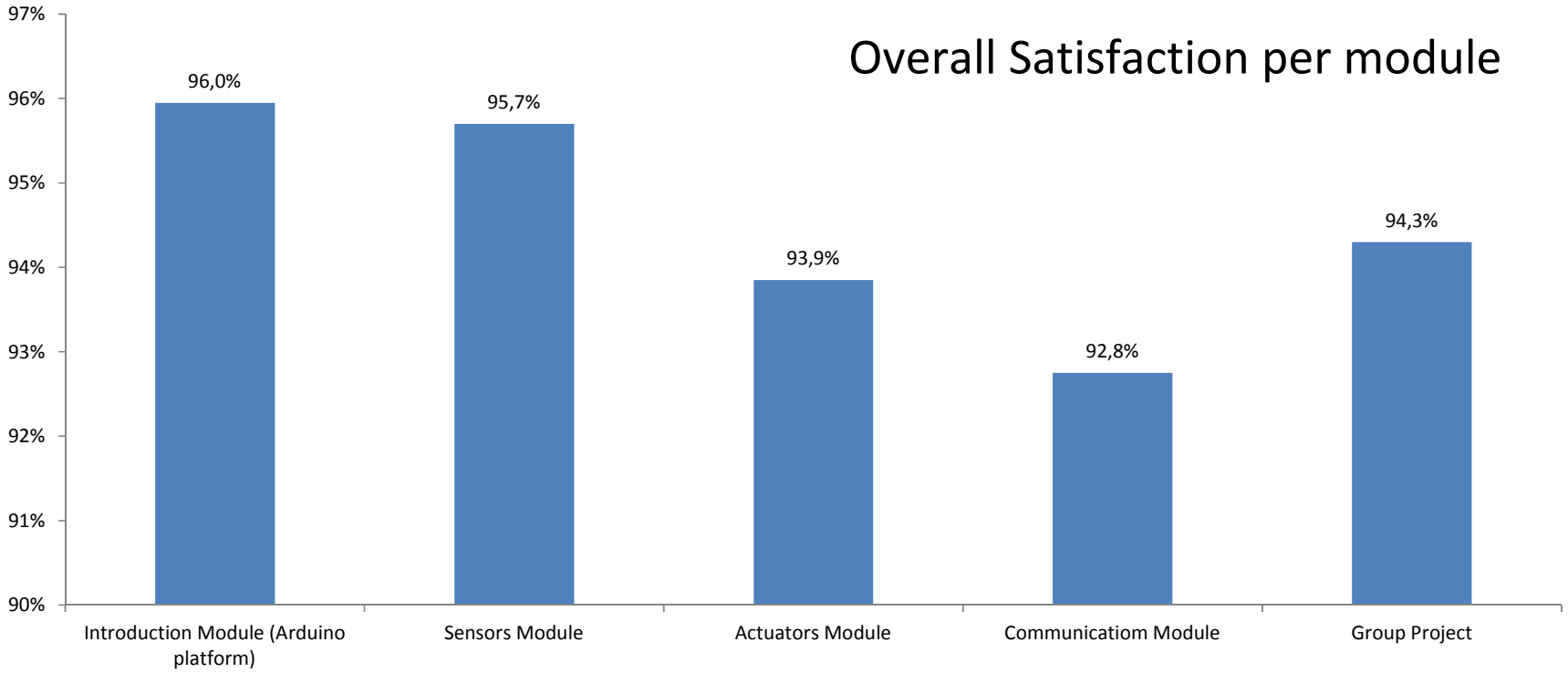
There were two major questions for each one of the four modules and the group project :

- Introduction Module (Arduino platform)
- Sensors Module
- Actuators Module
- Communicatiom Module
- Group Project

Heraklion Summer School Outline



Heraklion Summer School Outline



Open In

Thank you!

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