Preliminary Design Review

MISCE project

Mechatronics for Improving and Standardizing Competences in Engineering

Competence: Automation Technology

Workgroup: University of Cagliari

University of Cassino and Southern Latio

This document is the Preliminary Design Review of the technical competence ‘Automation Technology’. Its briefly contains the experimental platform analysed in MISCE project, to be designed and standardised for improving the acquisition level of this competence on engineering degrees.

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Visit https://misceproject.eu/ for more information.

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1 Competence and skills

The conceptual design presented in this document is referred to the technical competence:

C1. Automation Technology

which related skills are (see Table I):

Table I. Skills of Automation Technology

S1.1.	To know the main electric/pneumatic and hydraulics elements
S1.2.	To be able to design the functional behavior of the system
S1.3.	To be able to understand the technical documentation of a project/product
S1.4.	To program the functional behavior of the device
S1.5.	To debug the final planned behaviour of the system

The different conceptual designs presented in this document have been analysed to ensure that can improve the acquisition level of the aforementioned competence.

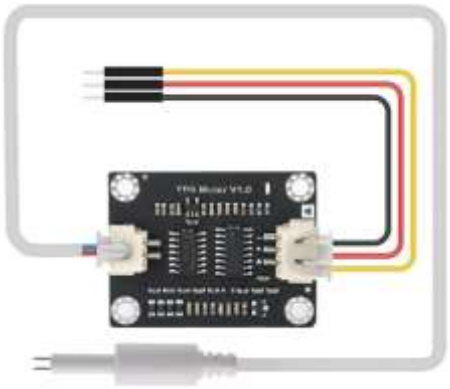
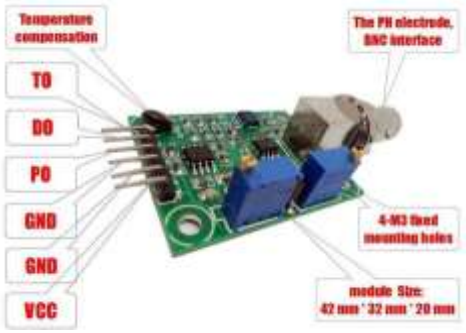
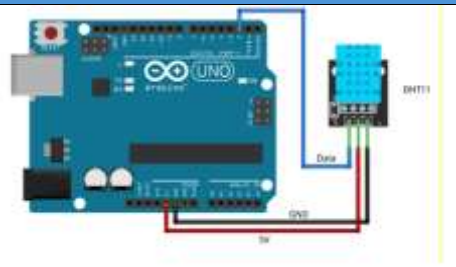
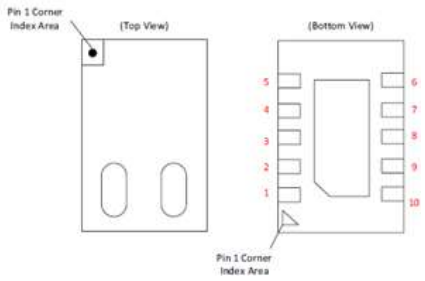
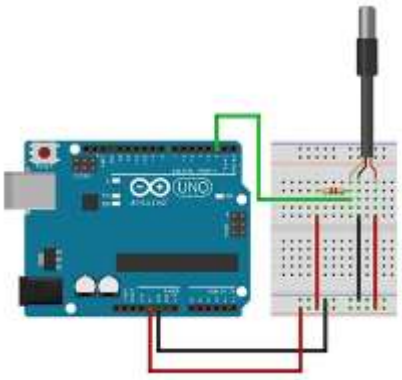
2 Experimental proposals

For this competence, MISCE project proposes the joint use of the devices in Table II and III, together with their corresponding teaching materials.

Table II. Proposed devices for 'automation technology' competence

	
Arduino R4 wifi	Peristaltic pumps
	
Relay module 1 channel	LICHIFIT 130 RC boat drive engines
	
TL-WA850RE Wireless Repeater	

Table III Proposed devices for 'automation technology' competence

	
Sensor TDS Meter	Sensor PH Meter
	
Temperature and humidity sensor DHT11	CO2 concentration sensor CCS811
	
Water level sensor; Model n: ZP4510	Temperature sensor DS18B20

In the following sections each device is detailed explained.

2.1 Arduino R4 wifi

The aim of the experimental platform is to implement an automatic control system for hydroponic crops capable of actively monitoring and controlling the process. The system is implemented using low-cost sensors with the use of Arduino (see Figure 1) and actuators managed through the use of a PLC equipped with HMI interface. The system must be able to meet requirements such as reliability, user-friendliness and versatility. The aim is to create a system capable of reading as input data the desired values for the control of process variables and informing the human controller about

all process parameters, by printing the values of the process variables and displaying the status of the actuators on the HMI screen as well as storing the same data in files.

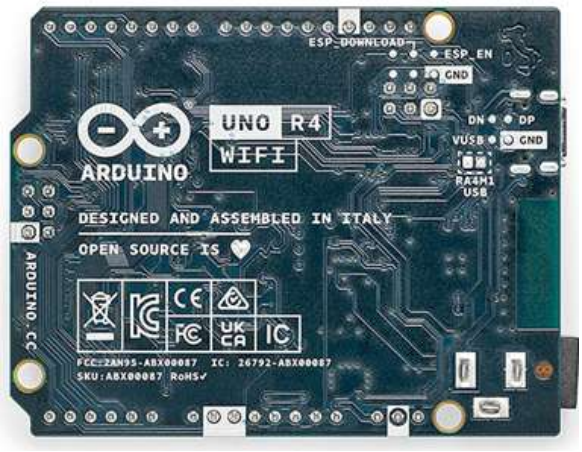


Figure 1. Arduino R4 Wi-Fi

The realization of the control system is based, of course, on the acquisition of data by sensors and on the ability to provide responses to the system through actuators. In the following sub-chapters will list these instruments.

2.2 Peristaltic pumps

A circulation pump is required to push water into the ducts or pipes of irrigation of the plant, 3 precision pumps, peristaltic pumps, (see Figure 2) for nutrient dosage control and pH control.

Figure 2. Peristaltic pumps

2.3 Relay module

One-way relay modules for Arduino are used to connect the peristaltic pumps and the mixer (see Figure 3).

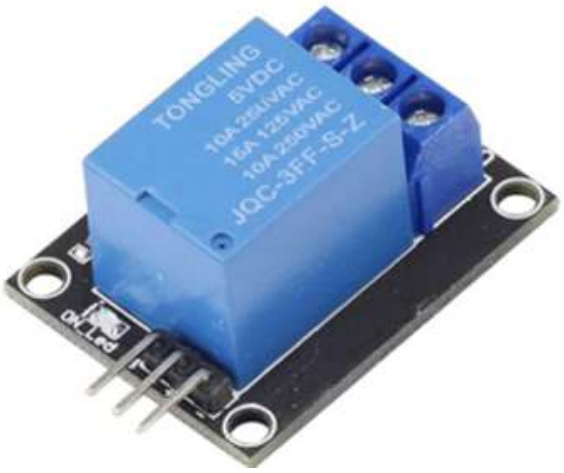


Figure 3. Relay module

These modules have a working voltage of 5 V, with an excitation current of about 70 mA in each direction, with the relay's LED status indicator.

2.4 LICHIFIT 130 Engines RC Boat Drive

To mix the water has been installed a simple propeller shaft kit powered by motor DC (see Figure 4).

Figure 4 LICHIFIT 130 Engines RC Boat Drive Set Engine Kit Shaft Propellers

2.5 TL-WA850RE Wireless Repeater

The Arduino UNO R4 Wi-Fi board is internally equipped with the ESP32 Wi-Fi module with which it can communicate wirelessly. The PLC provides the possibility of communicating via Ethernet cable with the HMI, so the physical system requires a Wireless Access Point (see Figure 5) to allow Arduino and PLC to communicate.

Figure 5 TL-WA850RE Wireless Repeater

2.6 Sensor TDS Meter

TDS (Total Dissolved Solids) indicates how many milligrams of soluble solids dissolved in a liter of water or particles per million (ppm). In general, the higher the TDS value, the more solid solubles are dissolved in water and less clean is the water (see Figure 6).

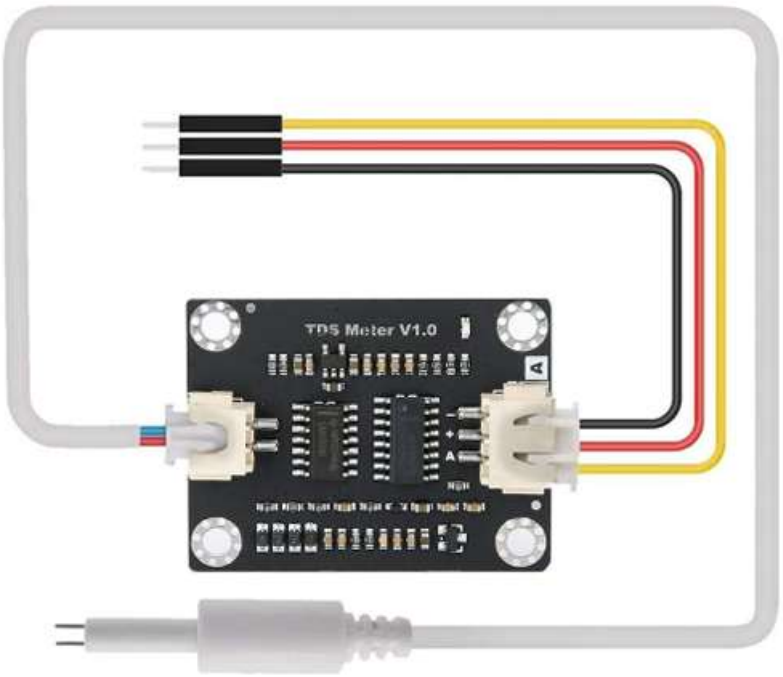


Figure 6 Sensor TDS Meter

2.7 Sensor PH Meter

The sensor consists of a solder and a card which can be connected to each other via a BNC connector (see Figure 7).

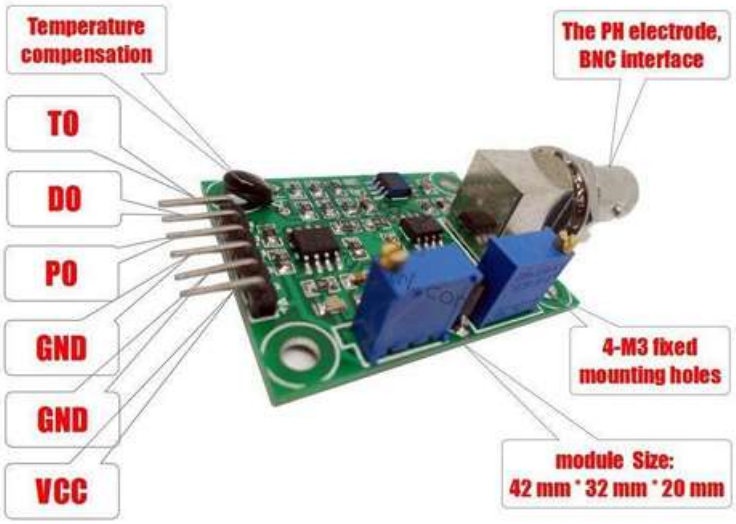


Figure 7 Sensor PH Meter

2.8 Temperature and humidity sensor DHT11

The DHT11 (see Figure 8) module is a composite sensor combining a thermometer and a hygrometer in one body. The DHT11 module is the simplest and cheapest. The module measures humidity and temperature values and, through an 8-bit microcontroller enclosed in it, transforms them into digital signals.

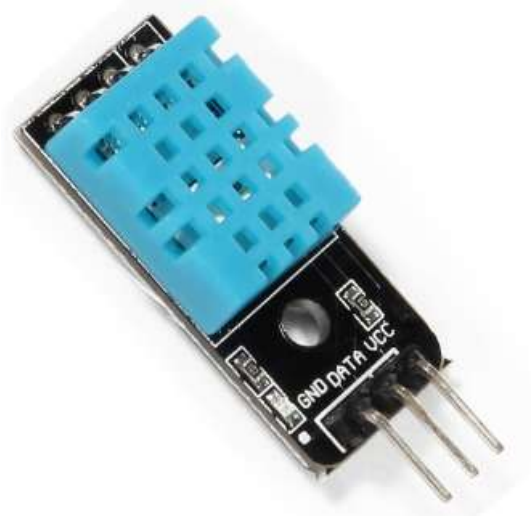


Figure 8 Temperature and humidity sensor DHT11

2.9 CO2 concentration sensor CCS811

The CCS811 (see Figure 9) is an ultra-low power digital sensor designed for indoor air quality monitoring. Uses micro-hotplate technology to detect a wide range of volatile organic compounds (VOCs) in the air. The sensor integrates a microcontroller (MCU) with an analog-to-digital converter (ADC) and an I 2 C interface for communication. To measure the amount of CO2 equivalent (eCO2), the CCS811 uses intelligent algorithms to process sensor raw measurements and return a TVOC value or eCO2 levels.

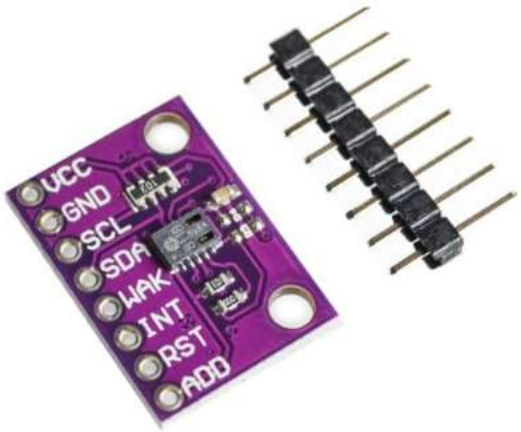


Figure 9 CO2 concentration sensor CCS811

2.10 Water level sensor; Model n: ZP4510

The ZP4510 (see Figure 10) water level sensor is a compact and reliable float switch, well-suited for monitoring liquid levels in various applications, from domestic tanks to industrial systems. Thanks to its simple installation and magnetic operating principle, it offers an effective solution for level detection in university projects.

Figure 10 Water level sensor; Model n: ZP4510

2.11 Temperature sensor DS18B20

This type of sensor (see Figure 11) is suitable for measuring the temperature of the environment, but also of soil or liquids thanks to the waterproof weld connected by rubber-coated cable. The DS18B20 is accurate enough to measure temperatures from -55°C to +125°C with an accuracy of 0.5°C and the integrated chip converts the analog signal into a digital signal from 9 to 12 bits (configurable).

Figure 11 Temperature sensor DS18B20

3 Competence and skills analyses

Table III summarises the competence and skills analyses of the proposed experimental platform attending to the contribution of acquisition of the technical competence ‘automation technology’ and their corresponding skills in Table I.

Table IV. Contribution of each proposed platform to automation technology competence and its corresponding skills

Platform	S1.1	S1.2	S1.3	S1.4	S1.5	**Overall competence contribution**
Actuation of a single acting pneumatic cylinder	Know the main electric/pneumatic and hydraulics elements	To be able to design the functional behaviour of the system.	Ability to understand the technical documentation of a project/product.	Ability to program the functional behaviour of the device	Capability to debug the final planned behaviour of the system	4.2
Actuation of a double acting pneumatic cylinder	Know the main electric/pneumatic and hydraulics elements.	To be able to design the functional behaviour of the system.	Ability to understand the technical documentation of a project/product.	Ability to program the functional behaviour of the device	Capability to debug the final planned behaviour of the system.	3.6
Movement-Phase" displacement	Know the main electric/pneumatic and hydraulics elements	To be able to design the functional behaviour of the system	Ability to understand the technical documentation of a project/product.	Ability to program the functional behaviour of the device	Capability to debug the final planned behaviour of the system	4.0

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[15] TDS sensor Datasheet by Keystudio;

[16] Immagini schemi Little Endian/Big Endian (Figure 122 e 123) reperibili su: https://www.instructables.com/ARDUINO-HACK-PLC-SIEMENS-THROUGH LANWIFI-INDUSTRIA/

[17] Web Server help, “AWP commands supported by the S7-1200 Web server” - estratto gratuito e selezionato dall'utente della documentazione che Siemens ha messo a disposizione per questo prodottohttps://support.industry.siemens.com/