Figure 8 shows the power cord that connects the Arduino Uno board to the computer or laptop.

Fig. 8. Power wire

For the two mechatronic applications, resistors with a value of 220 Ω are also used, which have the role of limiting the electric current, i.e., to control its value, protecting the components to which the resistors are inserted.

To calculate the value of a resistor you need the color code and knowledge of the meanings of the lines on the resistor, so that: the first 2 lines represent the value of the resistor, the third represents the multiplier, and the last represents the tolerance. Correct reading of the value of a resistor is done from left to right, never from the gold or silver lines (these colors are specific to the meaning of tolerance).

Fig. 9. Resistor

The buzzer, illustrated in fig. 10, is a device that uses the piezoelectric effect to measure changes in pressure, acceleration, tension, or force, turning them into an electric charge. The principle of operation is that the alternating audio frequency voltage is applied to the armature of the piezoelectric element. The element begins to oscillate mechanically at the same frequency. The oscillations are transmitted to the membrane fixed rigidly by the piezoelectric element, which produces sound vibrations.

Fig. 10. Buzzer

The HC-SR04 ultrasonic sensor is a sensor used to measure distance or to detect objects. It emits ultrasound at a frequency of 40,000 Hz flowing through the air, and if it encounters an obstacle it will return to the mode, thus taking into account the speed of sound, the distance to the object can be calculated.

Fig. 11. HC-SR04 ultrasonic sensor

The first part of the study refers to the mechatronic assembly that measures the temperature, displays it on the 16x2 LCD screen and makes a light signal through one of the three LEDs mounted depending on the temperature range in which the detected value is.

This assembly can be used in various fields of activity, such as: for domestic use, in agriculture (greenhouses), in industry - thermal power plants, cars, etc. [2].

Figure 12 shows the modeling in the specialized software application TINKERCAD of the mechatronic assembly for temperature measurement and its display on a 16x2 LCD screen, with the facility of visual warning of critical temperature ranges (by connecting and assembling electronic components necessary for optimal operation of the first application).

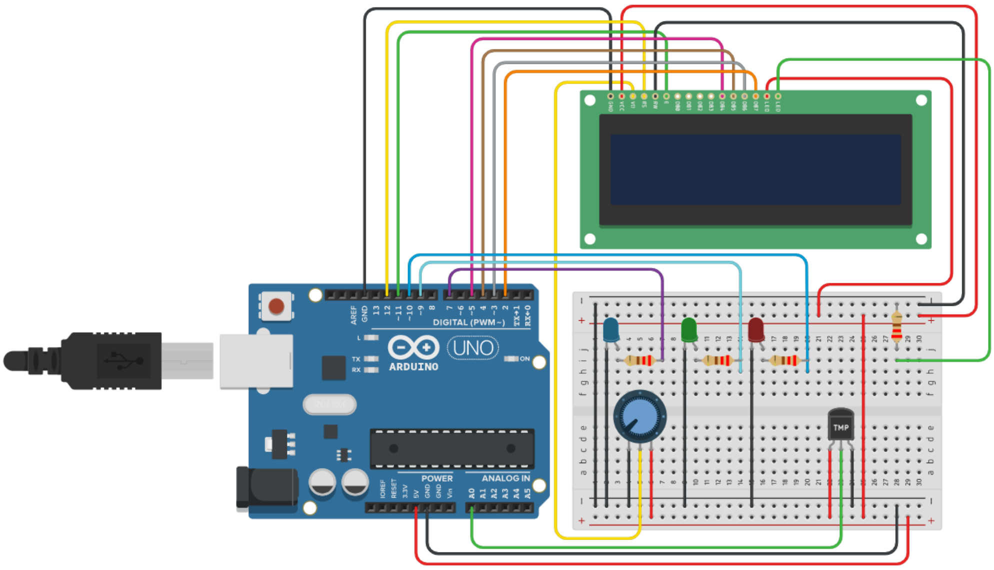

Fig. 12. Making the first mechatronic assembly, by connecting and assembling specific components

The mode of operation of the application developed for the first mechatronic assembly is as follows: the TMP36 temperature sensor, which can measure in the range -40ºC… + 125ºC, will transmit to the 16x2 LCD screen the detected temperature and, depending on its value, we have the following situations:

– the blue LED will light up if the temperature ("Tmp") falls in the temperature range -40ºC to + 10ºC;
– the green LED will light up, if Tmp falls in the temperature range + 11ºC to + 30ºC;
– the red LED will light up if Tmp is in the temperature range + 31ºC to + 125ºC.

For example, Figure 13 shows the three situations listed above, made through the Simulation Module of the specialized software application TINKERCAD.

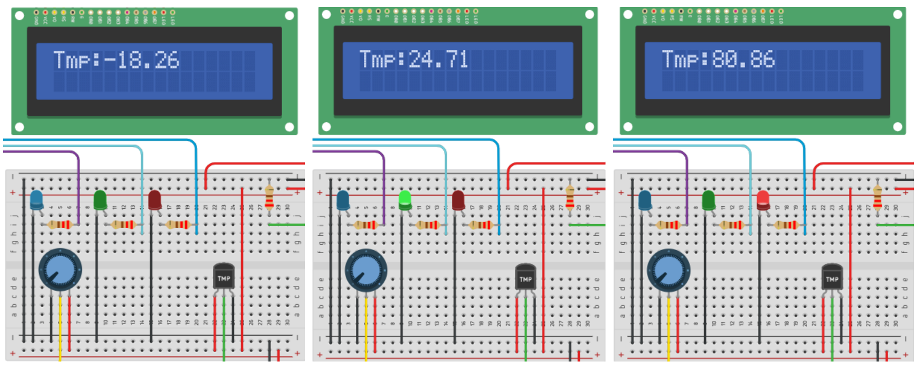

Fig. 13. Simulation of LED lighting and distinct messages displayed,
depending on the temperature measured for the first mechatronic modeled assembly

The authors also developed a programming code in the TINKERCAD virtual software application, for transmitting messages on Serial Monitor, for the three distinct temperature ranges, such as: “COLD!”, “MODERATE!” and “HOT!” depending on the temperature indicated in real time by the specialized sensor on this mechatronic assembly.

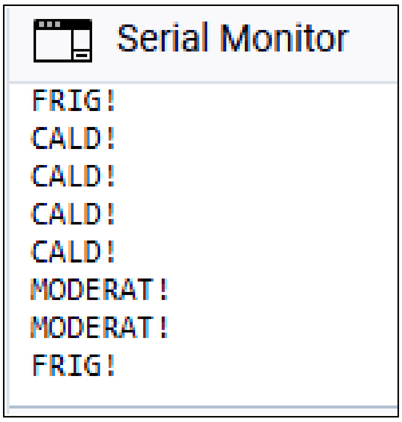

Fig. 14. Messages sent to the Serial Monitor by the temperature sensor

In order for the LCD application for the first mechatronic assembly to work under the conditions presented above, the following developed programming code is required:

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(12,11,5,4,3,2);
float value;
int tmp = A0;
int LED1 =7;
int LED2 = 9;
int LED3 = 10;
const int FRIG = 10;
const int CALD = 30;

void setup()
{pinMode(tmp,INPUT);
  pinMode(LED2, OUTPUT);
  pinMode(LED3, OUTPUT);
  Serial.begin(9600);
  Serial.println("Secvență nouă");
  randomSeed(analogRead(A0));}

void loop()
{value = analogRead(tmp)*0.004882814;
 value = (value - 0.5) * 100.0;
  lcd.setCursor(0,1);
  lcd.print("Tmp:");
  lcd.print(value);
  delay(1000);
  lcd.clear();
if (value < FRIG)
{digitalWrite(LED1, HIGH);
  digitalWrite(LED2, LOW);
  digitalWrite(LED3, LOW);
  Serial.println("FRIG!");}
else if (value > CALD)
{digitalWrite(LED1, LOW);
  digitalWrite(LED2, LOW);
  digitalWrite(LED3, HIGH);
  Serial.println("CALD!");}
else
{digitalWrite(LED1, LOW);
  digitalWrite(LED2, HIGH);
  digitalWrite(LED3, LOW);;
  Serial.println("MODERAT!");}}
```

The second part of the study refers to the realization of the mechatronic assembly that measures the distance, displays it on a 16x2 LCD screen and warns, both visually, by lighting some LEDs, and acoustically, by emitting sounds by a buzzer at certain distances. This assembly can be used in various fields of activity, such as: in industry - aeronautics, automobiles, intelligent robots, etc. [3].

Fig. 15 shows the realization by modeling in the specialized software application TINKERCAD of the mechatronic assembly for measuring the distance by displaying it on a 16x2 LCD screen, with the facility of sound and acoustic warning of critical values (by connecting and assembling the electronic components necessary for optimal operation). second mechatronic applications).

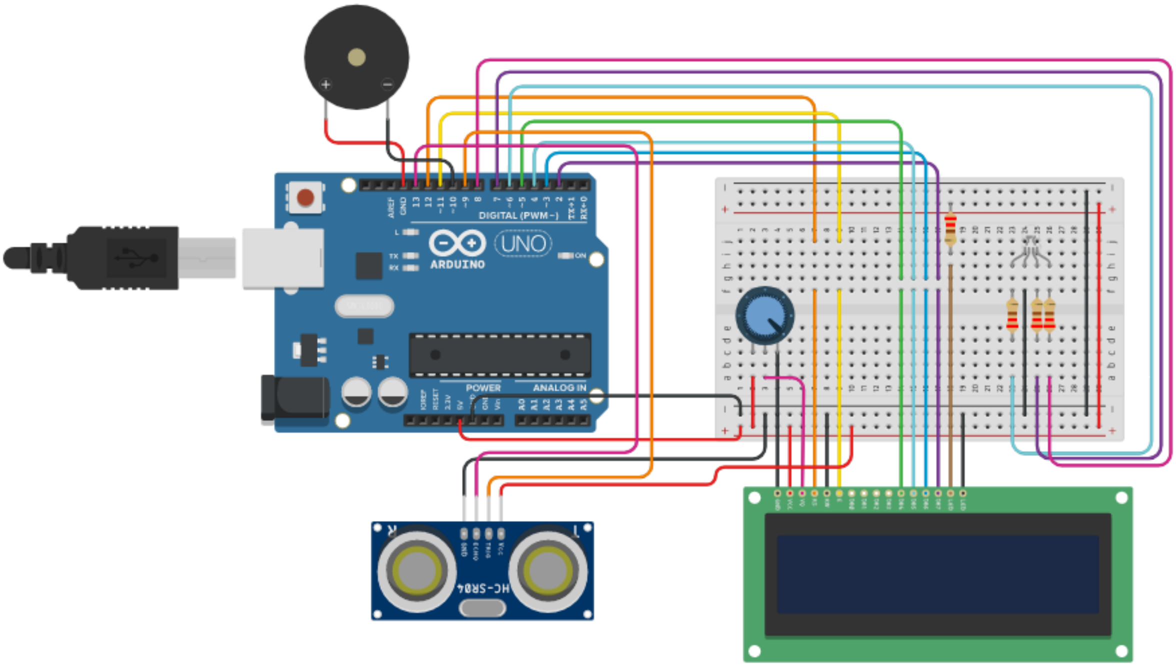

Fig. 15. Making the second mechatronic montage, by connecting and assembling specific components

The mode of operation of the application developed for the second mechatronic assembly is as follows:

- the ultrasonic sensor HC-SR04 transmits the measured distance up to an obstacle to the 16x2 LCD screen and, depending on the value of this measured distance, we have the following situations:
  – the LED lights up in green, if the distance ("Distance") is in the range of 400 cm to 50 cm;
  – the LED lights up in yellow, if the distance is in the range of 50 cm to 10 cm, and the buzzer emits a loud sound at a frequency of 500 Hz - to warn of danger!
  – the LED lights up in red, if the measured value is less than or equal to 10 cm, and the buzzer in this case emits a high sound at a frequency of 1000 Hz - to warn of high danger!

For example, the three situations listed above are shown in Figs. 16, made through the Simulation Module of the specialized software application TINKERCAD.

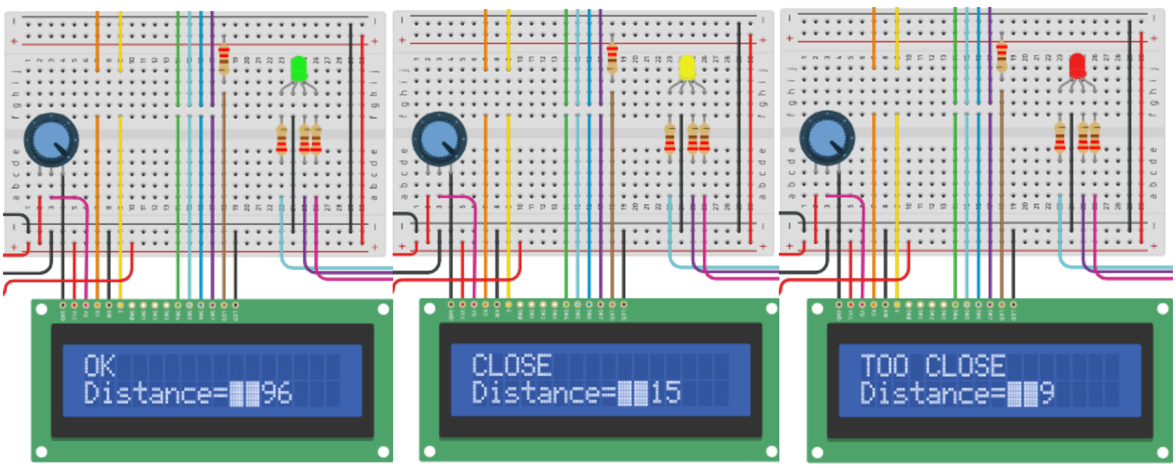

Fig. 16. Simulation of LED lighting and distinct messages displayed, depending on the distance measured, for the second mechatronic assembly made by modeling

In order for the LCD application for the second mechatronic assembly to work under the conditions presented above, the following developed programming code is required:

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
int red=6;
int blue=7;
int green=8;
const int trigger = 9;
const int echo = 13;
int buzzer = 10;
int distance;
long duration;

void setup()
{Serial.begin (9600);
 pinMode (trigger, OUTPUT);
 pinMode (echo, INPUT);
 pinMode (buzzer, OUTPUT);
 lcd.begin(16, 2);
 pinMode(red, OUTPUT);
 pinMode(green, OUTPUT);
 pinMode(blue, OUTPUT);}

void loop()
{digitalWrite (trigger, LOW);
  delayMicroseconds (2);
  digitalWrite (trigger, HIGH);
  delayMicroseconds (10);
  digitalWrite(trigger, LOW);
  duration = pulseIn(echo, HIGH);
  distance = duration*0.034/2;
if (distance <400 && distance >50)
{digitalWrite(blue, LOW);
  digitalWrite(red, LOW);
  digitalWrite(green, HIGH);
  digitalWrite(buzzer, LOW);
 noTone(buzzer);
 lcd.clear();
 lcd.setCursor(0,0);
 lcd.println ("Distance=");
 lcd.print (distance);
 delay (500);}
else
{if (distance <50 && distance >10)
{digitalWrite(blue, LOW);
  digitalWrite(red, HIGH);
  digitalWrite(green, HIGH);
  digitalWrite(buzzer, HIGH);
  tone(buzzer,500);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("CLOSE ");
  lcd.setCursor(0,1);
  lcd.println ("Distance=");
  lcd.print (distance);
  delay (500);}
else
{if (distance <=10)
{digitalWrite(blue, LOW);
  digitalWrite(red, HIGH);
  digitalWrite(green, LOW);
  digitalWrite(buzzer, HIGH);
  tone(buzzer,1000);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("TOO CLOSE ");
  lcd.setCursor(0,1);
  lcd.println ("Distance=");
  lcd.print (distance);
  delay (500);}}}}
```

3. Conclusions

The objective proposed at the beginning of the modeling and simulation study was fulfilled by the authors, by creating with the help of modeling in the virtual software application TINKERCAD the two mechatronic assemblies separately, and their operation was highlighted by simulating the behavior of this assembly in real operation. To achieve this goal, the authors went through the following steps: determining the components needed for the two assemblies, properly assembling all the electronic components needed for modeling, developing programming codes for LCD displays, and finally simulating how the assemblies work. in operating conditions similar to the real ones.

4. References

[1]. *** https://archive.curs.upb.ro/2020/course/view.php?id=1495

[2]. Ungureanu, L.M. and Alionte, C.G. (2021), *Simularea sistemelor de comandă şi control a dispozitivelor mecatronice*, Ed. PRINTECH, Bucuresti.

[3]. Marian, E., Mihaescu, I., Schmol Mircea and Syatmarz I. (1988), *Montaje electronice de vacanţă*, Ed. Albatros, Bucuresti.

[4]. *** https://www.tinkercad.com/things/6vS5wpp9rrj-ultrasonic-sensor-lcd

[5]. Hughes, J.M. (2016), *Arduino: A Technical Reference: A Handbook for Technicians, Engineers, and Makers*, Editura O'reilly Media.

[6]. Boxall, J. (2021), *Arduino Workshop, 2nd Edition: A Hands-On Introduction with 65 Projects*, Editura No Starch Press.

[7]. Antoch, S. (2010), *Experiments with Electric Circuits*, Editura Zap Studio.