



Polytechnic University of Puerto Rico San Juan Campus

ELECTRICAL AND COMPUTER ENGINEERING FACULTY

MICROPROCESSOR INTERFACING LABORATORY

LABORATORY 7: ANALOG TO DIGITAL CONVERSION

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1 Objective

For this laboratory it is required to find the distance, in centimeters, between a photosensor and a flash light. It is important to mention that Arduino cannot understand wavelength(light) as such, it needs to be translated into an electrical value and that electrical value needs to be translated into numbers that can be processed with the arduino. In order to do that we need to translate the Digital values (LOW, HIGH) into voltage values between 0v and 5v (0.50v, 3.4v, etc...).

The table 2 shows how to connect the photosensor to the arduino and a resistor. Figure 1 shows how the connection was implemented on a Bread-Board with the 10K resistor and a photosensor.

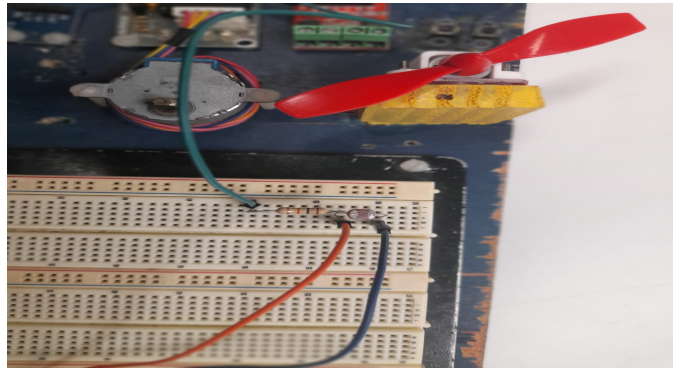


Figure 1: Circuit Design

In order to make this laboratory possible, make sure to have the following materials,

1. Arduino Mega ADK
2. Potentiometer (about 10K ohms)
3. Analog Sensor
4. BreadBoard and wires

2 Procedures

This laboratory consists of two parts, the first 2.1 part where the program asks you to take 10 measurements to get the equation of the line and the

second ?? part where the program takes 50 measurements. In order to run between parts, a boolean variable (testEnable) is used, where if it is true then the program asks you to take the measurements and when is false, the program for 50 measurements. In figure 2 it can be seen a series of questions, with the help of the Serial Monitor, that runs until all inputs have been satisfied. The table 2 shows how to implement the circuit design for this laboratory.

```
void loop() {
  static bool answered = false;
  static bool testEnable = false;
  static String unit = "";
  if(answered == false){
    Serial.println("What will be the unit of distance measurement?");
    do{
      if(Serial.available() > 0){
        unit = Serial.readStringUntil('\n');
        Serial.flush();
        break;
      }
    }while(1);
    Serial.println(unit);
    Serial.println("Will preliminary tests be undertaken? (yes / no)");
    do{
      if(Serial.available() > 0){
        String tmp = Serial.readStringUntil('\n');
        if(tmp.equals("yes")){
          testEnable = true;
          Serial.println(tmp);
          Serial.flush();
          break;
        }
        else if(tmp.equals("no")){
          Serial.println(tmp);
          Serial.flush();
          break;
        }
        Serial.println("Wrong input! Try again!");
      }
    }while(1);
  }
}
```

Figure 2: Loop Menu

Table 1: Arduino Pinout

Arduino Mega	Breadboard
5V	photosensor (positive)
GND	10K resistor
A13	photosensor

2.1 First part

This part is done, when the variable "testEnable" is set to TRUE, where the user will take 10 measurements(cm).

1. The program will ask for ten (10) different measurements related to the position of the light source, where the output of this step is used to create a data table. See image ??.
2. User proceeds to take 10 examples of measurements, see figures below.

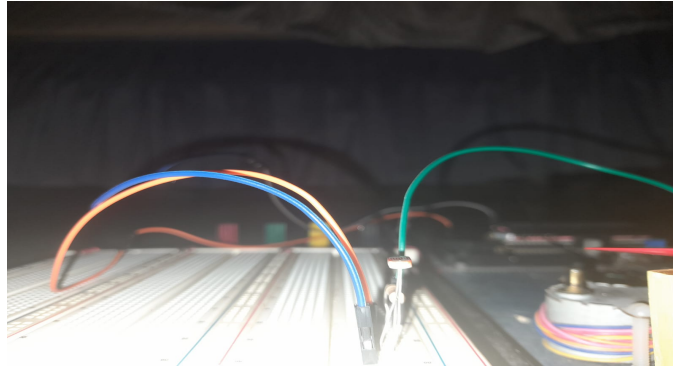


Figure 3: 10cm distance

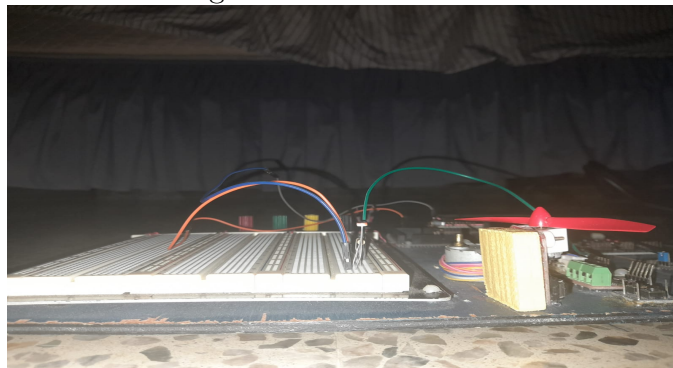


Figure 4: 20cm distance

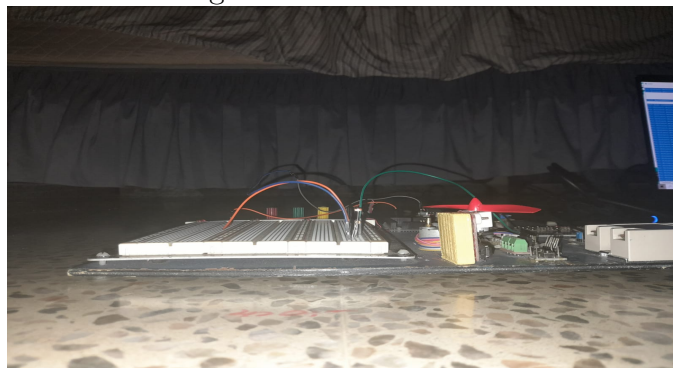


Figure 5: 30cm distance

3. Once the data has been printed, excel or google sheets is used to create a table with the given magnitudes and distances and to create a graphic

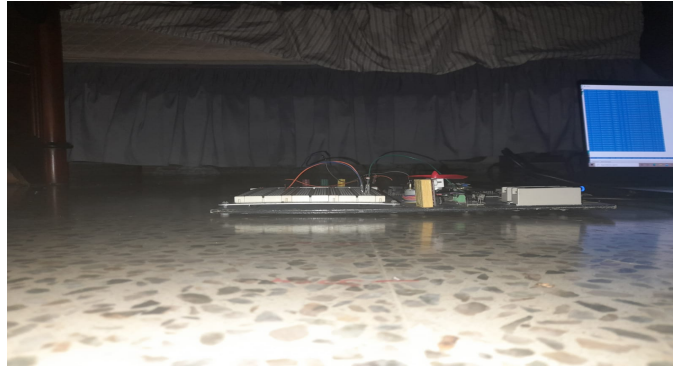


Figure 6: 40cm distance

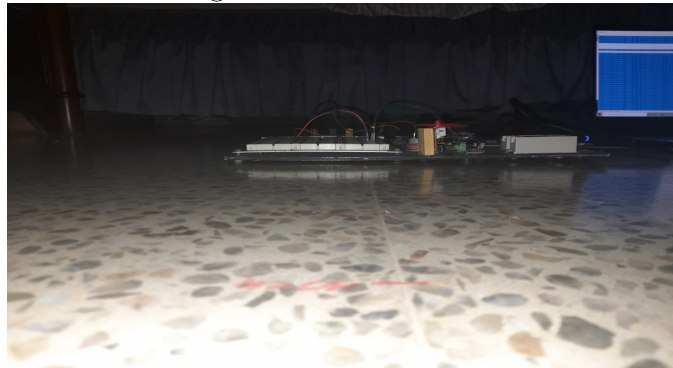


Figure 7: 50cm distance

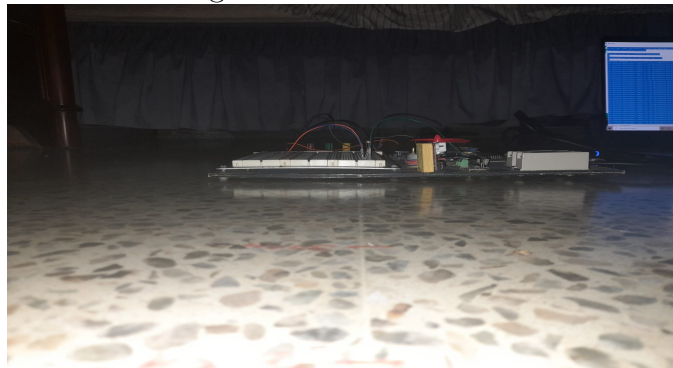


Figure 8: 60cm distance

using the equation of the line. For examples, refer to section 3.2.

2.2 Second Part

In this second part the program will calculate the position of a light source in intervals of fifty (50) measurements, divided from one another with a delay of 10 seconds.

1. The program will print on the Serial Monitor a message telling the user to move the light source around to calculate the distant.
2. The user proceeds to move the light source away from the photosensor in order for the arduino to calculate the distance. See video found in section 3.3.

It is important to notice that this second part runs continuously, although it only takes 50 measurements and then stops for a few seconds, it continues to run.

It should be noted that the descriptions of all the steps provided in this section were obtained with the laboratory's documentation [1].

3 Results

This section documents the various results of the **Laboratory 7: Analog to Digital** experiment.

3.1 The Developed C Embedded Program

The following **Photo-resistor Program** was developed for the realization of the already described experiment.

```
Photo-resistor Program
1  #define pinA A13
2
3  const int nIterations = 1136;
4  const int nTests = 10;
5
6
7
8  //const double L = 500;
9  //const double k = 0.00000005670;
10 //const double R = 10000;
```



```

11
12 void setup() {
13     Serial.begin(9600);
14     Serial.println("PHOTORESISTOR - DISTANCE PROGRAM");
15     Serial.println("This program will try to approximate the
        distance a light source with a photoresistor.\n");
16     Serial.println("USAGE: In order to properly use this program
        the user must first decide on the units of measurements
        ");
17     Serial.println("for the distance of the light source and
        enable the TEST MODE of itself. After these two steps
        have ");
18     Serial.println("been accomplished, the user will then aid
        the program on acquiring certain measurements of which he
        ");
19     Serial.println("or she must then use to create a
        spline-related equation. Lastly, the user will input this
        equation ");
20     Serial.println("in the code, reset the Arduino, disable the
        TEST MODE state of the program and verify if it detects
        ");
21     Serial.print("the correct approximated distance.\n\n");
22 }
23 /*
24  * Function which serves as the 'main' of this porgram, it
        will ask the user two (2) questions with the aid of the
        Serial Monitor. The
25  * first one is associate with the unit of length
        meassurement, and the other to that of the undertaking of
        the tests to obtain the values
26  * for the construction of the equation of the line.
27  */
28 void loop() {
29     static bool answered = false;
30     static bool testEnable = false;
31     static String unit = "";
32     if(answered == false){
33         Serial.println("What will be the unit of distance
            measurement?");
34         do{

```

```

35     if (Serial.available() > 0){
36         unit = Serial.readStringUntil('\n');
37         Serial.flush();
38         break;
39     }
40 }while(1);
41 Serial.println(unit);
42 Serial.println("Will preliminary tests be undertaken? (yes
    / no)");
43 do{
44     if (Serial.available() > 0){
45         String tmp = Serial.readStringUntil('\n');
46         if (tmp.equals("yes")){
47             testEnable = true;
48             Serial.println(tmp);
49             Serial.flush();
50             break;
51         }
52         else if (tmp.equals("no")){
53             Serial.println(tmp);
54             Serial.flush();
55             break;
56         }
57         Serial.println("Wrong input! Try again!");
58     }
59 }while(1);
60 }
61 answered = true;
62 doTests(unit, testEnable);
63 }
64 /*
65  * Function to accomplish the brunt of functionality that is
    tasked throughout this experiment. As such, it serves two
    (2) purposes:
66  * 1. If testEnable equals true, then the program will ask for
    ten (10) different measurements related to the position of
    the light source, all of which will be outputted on the
    screen
67  * for the user to compile into a graph and its associated
    equation of the line. It should be noted that the program

```

```

    will go into the
68 * power sleep mode state. In other words, the Arduino must be
    reset.
69 * 2. If testEnable equals false, the program will calculate
    the position of a light source in intervals of fifty (50)
    measurements, divided from one another with a delay of 10
    seconds.
70 * In this case, the program will run indefinitely.
71 */
72 void doTests(String unit, bool testEnable){
73     if(testEnable == true){
74         double analogInputAvgs[nTests];
75         Serial.println("TEST MODE ENABLED: The Arduino will take
            ten (10) samples for the magnitude of the average of
            the input obtained from analogRead(...).\n");
76         for(int i = 0; i < nTests; i++){
77             Serial.print("SAMPLE ");
78             Serial.print(i+1);
79             Serial.print(" IN 20 SECONDS! POSITION THE LIGHT SOURCE
                AT ");
80             Serial.print(10*(i+1));
81             Serial.print(" ");
82             Serial.print(unit);
83             Serial.println(" DISTANCE FROM THE PHOTORESISTOR...");
84             delay(20000);
85             Serial.print("TEST HAS STARTED!... ");
86             analogInputAvgs[i] = getAnalogInputAvg();
87             Serial.println("TEST HAS COMPLETED!");
88         }
89         Serial.println("\nTESTS COMPLETED! PLEASE MAKE A NOTE OF
            THE OBTAINED VALUES SO AS TO CALCULATE THE EQUATION OF
            THE GRAPH!The results are as follows: ");
90         for(int i = 0; i < nTests; i++){
91             Serial.print(i+1);
92             Serial.print(". ");
93             Serial.println(analogInputAvgs[i]);
94         }
95         Serial.print("\n\nARDUINO WILL GO TO POWER DOWN SLEEP
            MODE! IF WANT TO START THE PROGRAM AGAIN, RESET THE
            DEVICE.");

```

```

96     powerDownSleep();
97 }
98 else{
99     static unsigned long int i = 0;
100    if( i == 0){
101        Serial.println("TEST MODE DISABLED: The Arduino will try
            to approximate the distance of the light source from
            the photoresistor.");
102    }
103    Serial.print("For distance measurement number ");
104    Serial.print(i+1);
105    Serial.print(", the aproximated distance is ");
106    Serial.print(getAproxDistance((double)analogRead(pinA)));
107    Serial.print(" ");
108    Serial.println(unit);
109    i++;
110    if(i % 50 == 0){
111        Serial.println("\n\nFIFTY MEASUREMENTS HAVE BEEN
            COMPLETED! ARDUINO WILL RESTART TAKING THEM IN 10
            SECONDS!\n");
112        delay(10000);
113        i = 0;
114    }
115 }
116 }
117 /*
118  * The getAnalogInputAvg() calculates the average of the sum
            of the analogReads of pin A13. This value is to be
            associated
119  * with the approximated distance.
120  */
121 double getAnalogInputAvg(){
122     long int sum = 0;
123     for(int i = 0; i < nIterations; i++){
124         sum = sum + analogRead(pinA);
125     }
126     return ((double)sum)/((double)nIterations);
127 }
128 /*
129  * The function getAproxDistance(...) tackles with the

```

```

        equation of the graph that is used to approximate the
        various
130    * distances of the light source. Furthermore, as a parameter,
        it has aRead which is the same as the value obtained
131    * from pin A13.
132    */
133    double getAproxDistance(double aRead){
134        return 709*pow(aRead,-0.665);
135    }
136    /*
137    * The following function, when called, makes the program
        enter some form of power down sleep sate.
138    */
139    void powerDownSleep(){
140        while(1){};
141    }
142
143    /*
144    void loop(){
145        for(int i = 0; i < nIterations; i++){
146            double voltageA13 = analogRead(A13)*(5.0/1024);
147            double a13Temp = (900/5)*(voltageA13-0.5);
148            double lux = k*pow(a13Temp,4);
149            //double lux = 500*(5.0/voltageA13 - 1)/R;
150            double distance = sqrt(L/(4*PI*lux))*100;
151            sumDistances = sumDistances + distance;
152        }
153        Serial.println(sumDistances/((double)nIterations));
154        delay(5000);
155    }
156    */

```

3.2 Outputs of the Developed C Embedded Program

Given the manner in which the developed program shown in the previous subsection operates, the following lines of text represent its output depending in the value chosen for *testEnable*:

Output For Case When *testEnable* Is *True*

1 PHOTORESISTOR - DISTANCE PROGRAM

```

2 This program will try to approximate the distance a light
  source with a photoresistor.
3
4 USAGE: In order to properly use this program the user must
  first decide on the units of measurements
5 for the distance of the light source and enable the TEST MODE
  of itself. After these two steps have
6 been accomplished, the user will then aid the program on
  acquiring certain measurements of which he
7 or she must then use to create a spline-related equation.
  Lastly, the user will input this equation
8 in the code, reset the Arduino, disable the TEST MODE state of
  the program and verify if it detects
9 the correct approximated distance.
10
11 What will be the unit of distance measurement?
12 cm
13 Will preliminary tests be undertaken? (yes / no)
14 yes
15 TEST MODE ENABLED: The Arduino will take ten (10) samples for
  the magnitude of the average of the input obtained from
  analogRead(...).
16
17 SAMPLE 1 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 10 cm
  DISTANCE FROM THE PHOTORESISTOR...
18 TEST HAS STARTED!... TEST HAS COMPLETED!
19 SAMPLE 2 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 20 cm
  DISTANCE FROM THE PHOTORESISTOR...
20 TEST HAS STARTED!... TEST HAS COMPLETED!
21 SAMPLE 3 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 30 cm
  DISTANCE FROM THE PHOTORESISTOR...
22 TEST HAS STARTED!... TEST HAS COMPLETED!
23 SAMPLE 4 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 40 cm
  DISTANCE FROM THE PHOTORESISTOR...
24 TEST HAS STARTED!... TEST HAS COMPLETED!
25 SAMPLE 5 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 50 cm
  DISTANCE FROM THE PHOTORESISTOR...
26 TEST HAS STARTED!... TEST HAS COMPLETED!
27 SAMPLE 6 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 60 cm
  DISTANCE FROM THE PHOTORESISTOR...

```

28 TEST HAS STARTED!... TEST HAS COMPLETED!
29 SAMPLE 7 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 70 cm
DISTANCE FROM THE PHOTORESISTOR...
30 TEST HAS STARTED!... TEST HAS COMPLETED!
31 SAMPLE 8 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 80 cm
DISTANCE FROM THE PHOTORESISTOR...
32 TEST HAS STARTED!... TEST HAS COMPLETED!
33 SAMPLE 9 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 90 cm
DISTANCE FROM THE PHOTORESISTOR...
34 TEST HAS STARTED!... TEST HAS COMPLETED!
35 SAMPLE 10 IN 20 SECONDS! POSITION THE LIGHT SOURCE AT 100 cm
DISTANCE FROM THE PHOTORESISTOR...
36 TEST HAS STARTED!... TEST HAS COMPLETED!
37
38 TESTS COMPLETED! PLEASE MAKE A NOTE OF THE OBTAINED VALUES SO
AS TO CALCULATE THE EQUATION OF THE GRAPH!The results are
as follows:
39 1. 515.58
40 2. 235.65
41 3. 126.13
42 4. 82.43
43 5. 55.49
44 6. 40.59
45 7. 32.26
46 8. 25.89
47 9. 21.74
48 10. 17.88
49
50
51
52 ARDUINO WILL GO TO POWER DOWN SLEEP MODE! IF WANT TO START THE
PROGRAM AGAIN, RESET THE DEVICE.

With the previous case-related outputs, the following table **9** and graph **10** figures were created, as shown below:

Analog Pin In. (Bits)	Distance (cm)
515.58	10
235.65	20
126.13	30
82.43	40
55.49	50
40.59	60
32.26	70
25.89	80
21.74	90
17.88	100

Figure 9:

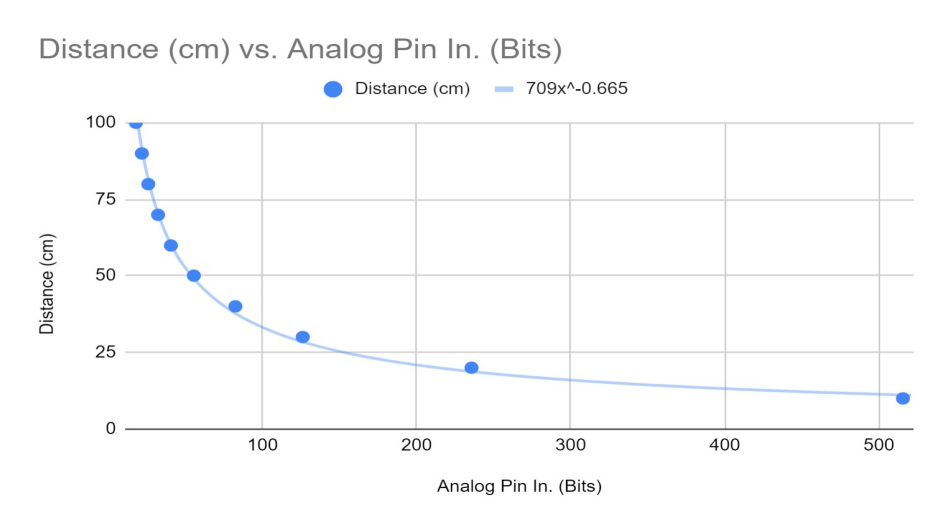


Figure 10:

Output For Case When *testEnable* Is *False*

```
1 PHOTORESISTOR - DISTANCE PROGRAM
2 This program will try to approximate the distance a light
  source with a photoresistor.
3
4 USAGE: In order to properly use this program the user must
  first decide on the units of measurements
5 for the distance of the light source and enable the TEST MODE
  of itself. After these two steps have
6 been accomplished, the user will then aid the program on
  acquiring certain measurements of which he
7 or she must then use to create a spline-related equation.
  Lastly, the user will input this equation
8 in the code, reset the Arduino, disable the TEST MODE state of
  the program and verify if it detects
9 the correct approximated distance.
10
11 What will be the unit of distance measurement?
12 cm
13 Will preliminary tests be undertaken? (yes / no)
14 no
15 TEST MODE DISABLED: The Arduino will try to approximate the
  distance of the light source from the photoresistor.
16 For distance measurement number 1, the aproximated distance is
  21.49 cm
17 For distance measurement number 2, the aproximated distance is
  21.49 cm
18 For distance measurement number 3, the aproximated distance is
  21.42 cm
19 For distance measurement number 4, the aproximated distance is
  21.49 cm
20 For distance measurement number 5, the aproximated distance is
  21.42 cm
21 For distance measurement number 6, the aproximated distance is
  21.42 cm
22 For distance measurement number 7, the aproximated distance is
  21.42 cm
23 For distance measurement number 8, the aproximated distance is
  21.49 cm
24 For distance measurement number 9, the aproximated distance is
```

21.49 cm

- 25 For distance measurement number 10, the aproximated distance is 21.49 cm
- 26 For distance measurement number 11, the aproximated distance is 21.42 cm
- 27 For distance measurement number 12, the aproximated distance is 21.42 cm
- 28 For distance measurement number 13, the aproximated distance is 21.49 cm
- 29 For distance measurement number 14, the aproximated distance is 21.42 cm
- 30 For distance measurement number 15, the aproximated distance is 21.49 cm
- 31 For distance measurement number 16, the aproximated distance is 21.49 cm
- 32 For distance measurement number 17, the aproximated distance is 21.42 cm
- 33 For distance measurement number 18, the aproximated distance is 21.42 cm
- 34 For distance measurement number 19, the aproximated distance is 21.42 cm
- 35 For distance measurement number 20, the aproximated distance is 21.49 cm
- 36 For distance measurement number 21, the aproximated distance is 21.49 cm
- 37 For distance measurement number 22, the aproximated distance is 21.49 cm
- 38 For distance measurement number 23, the aproximated distance is 21.34 cm
- 39 For distance measurement number 24, the aproximated distance is 21.42 cm
- 40 For distance measurement number 25, the aproximated distance is 21.42 cm
- 41 For distance measurement number 26, the aproximated distance is 21.42 cm
- 42 For distance measurement number 27, the aproximated distance is 21.42 cm
- 43 For distance measurement number 28, the aproximated distance is 21.42 cm
- 44 For distance measurement number 29, the aproximated distance

is 21.49 cm

45 For distance measurement number 30, the aproximated distance
is 21.42 cm

46 For distance measurement number 31, the aproximated distance
is 21.42 cm

47 For distance measurement number 32, the aproximated distance
is 21.42 cm

48 For distance measurement number 33, the aproximated distance
is 21.34 cm

49 For distance measurement number 34, the aproximated distance
is 21.34 cm

50 For distance measurement number 35, the aproximated distance
is 21.42 cm

51 For distance measurement number 36, the aproximated distance
is 21.49 cm

52 For distance measurement number 37, the aproximated distance
is 21.34 cm

53 For distance measurement number 38, the aproximated distance
is 21.42 cm

54 For distance measurement number 39, the aproximated distance
is 21.42 cm

55 For distance measurement number 40, the aproximated distance
is 21.42 cm

56 For distance measurement number 41, the aproximated distance
is 21.34 cm

57 For distance measurement number 42, the aproximated distance
is 21.42 cm

58 For distance measurement number 43, the aproximated distance
is 21.42 cm

59 For distance measurement number 44, the aproximated distance
is 21.49 cm

60 For distance measurement number 45, the aproximated distance
is 21.42 cm

61 For distance measurement number 46, the aproximated distance
is 21.49 cm

62 For distance measurement number 47, the aproximated distance
is 21.49 cm

63 For distance measurement number 48, the aproximated distance
is 21.42 cm

64 For distance measurement number 49, the aproximated distance

is 21.49 cm

65 For distance measurement number 50, the aproximated distance
is 21.42 cm

66

67

68

69 FIFTY MEASUREMENTS HAVE BEEN COMPLETED! ARDUINO WILL RESTART
TAKING THEM IN 10 SECONDS!

70

71 TEST MODE DISABLED: The Arduino will try to approximate the
distance of the light source from the photoresistor.

72 For distance measurement number 1, the aproximated distance is
12.42 cm

73 For distance measurement number 2, the aproximated distance is
12.38 cm

74 For distance measurement number 3, the aproximated distance is
12.38 cm

75 For distance measurement number 4, the aproximated distance is
12.33 cm

76 For distance measurement number 5, the aproximated distance is
12.16 cm

77 For distance measurement number 6, the aproximated distance is
12.00 cm

78 For distance measurement number 7, the aproximated distance is
11.95 cm

79 For distance measurement number 8, the aproximated distance is
11.93 cm

80 For distance measurement number 9, the aproximated distance is
11.95 cm

81 For distance measurement number 10, the aproximated distance
is 11.93 cm

82 For distance measurement number 11, the aproximated distance
is 11.90 cm

83 For distance measurement number 12, the aproximated distance
is 11.90 cm

84 For distance measurement number 13, the aproximated distance
is 11.88 cm

85 For distance measurement number 14, the aproximated distance
is 11.90 cm

86 For distance measurement number 15, the aproximated distance

is 11.88 cm

87 For distance measurement number 16, the aproximated distance
is 11.90 cm

88 For distance measurement number 17, the aproximated distance
is 11.90 cm

89 For distance measurement number 18, the aproximated distance
is 11.90 cm

90 For distance measurement number 19, the aproximated distance
is 11.88 cm

91 For distance measurement number 20, the aproximated distance
is 11.88 cm

92 For distance measurement number 21, the aproximated distance
is 11.88 cm

93 For distance measurement number 22, the aproximated distance
is 11.87 cm

94 For distance measurement number 23, the aproximated distance
is 11.88 cm

95 For distance measurement number 24, the aproximated distance
is 11.88 cm

96 For distance measurement number 25, the aproximated distance
is 11.87 cm

97 For distance measurement number 26, the aproximated distance
is 11.88 cm

98 For distance measurement number 27, the aproximated distance
is 11.87 cm

99 For distance measurement number 28, the aproximated distance
is 11.88 cm

100 For distance measurement number 29, the aproximated distance
is 11.85 cm

101 For distance measurement number 30, the aproximated distance
is 11.87 cm

102 For distance measurement number 31, the aproximated distance
is 11.83 cm

103 For distance measurement number 32, the aproximated distance
is 11.85 cm

104 For distance measurement number 33, the aproximated distance
is 11.85 cm

105 For distance measurement number 34, the aproximated distance
is 11.85 cm

106 For distance measurement number 35, the aproximated distance

```

    is 11.87 cm
107 For distance measurement number 36, the aproximated distance
    is 11.85 cm
108 For distance measurement number 37, the aproximated distance
    is 11.85 cm
109 For distance measurement number 38, the aproximated distance
    is 11.83 cm
110 For distance measurement number 39, the aproximated distance
    is 11.83 cm
111 For distance measurement number 40, the aproximated distance
    is 11.83 cm
112 For distance measurement number 41, the aproximated distance
    is 11.82 cm
113 For distance measurement number 42, the aproximated distance
    is 11.83 cm
114 For distance measurement number 43, the aproximated distance
    is 11.82 cm
115 For distance measurement number 44, the aproximated distance
    is 11.83 cm
116 For distance measurement number 45, the aproximated distance
    is 11.82 cm
117 For distance measurement number 46, the aproximated distance
    is 11.83 cm
118 For distance measurement number 47, the aproximated distance
    is 11.83 cm
119 For distance measurement number 48, the aproximated distance
    is 11.82 cm
120 For distance measurement number 49, the aproximated distance
    is 11.82 cm
121 For distance measurement number 50, the aproximated distance
    is 11.82 cm
122
123
124
125 FIFTY MEASUREMENTS HAVE BEEN COMPLETED! ARDUINO WILL RESTART
    TAKING THEM IN 10 SECONDS!
126
127 TEST MODE DISABLED: The Arduino will try to approximate the
    distance of the light source from the photoresistor.
128 For distance measurement number 1, the aproximated distance is
```

11.83 cm

129 For distance measurement number 2, the aproximated distance is
11.82 cm

130 For distance measurement number 3, the aproximated distance is
11.83 cm

131 For distance measurement number 4, the aproximated distance is
11.82 cm

132 For distance measurement number 5, the aproximated distance is
11.82 cm

133 For distance measurement number 6, the aproximated distance is
11.83 cm

134 For distance measurement number 7, the aproximated distance is
11.82 cm

135 For distance measurement number 8, the aproximated distance is
11.82 cm

136 For distance measurement number 9, the aproximated distance is
11.82 cm

137 For distance measurement number 10, the aproximated distance
is 11.82 cm

138 For distance measurement number 11, the aproximated distance
is 11.82 cm

139 For distance measurement number 12, the aproximated distance
is 11.82 cm

140 For distance measurement number 13, the aproximated distance
is 11.82 cm

141 For distance measurement number 14, the aproximated distance
is 11.82 cm

142 For distance measurement number 15, the aproximated distance
is 11.82 cm

143 For distance measurement number 16, the aproximated distance
is 11.82 cm

144 For distance measurement number 17, the aproximated distance
is 11.82 cm

145 For distance measurement number 18, the aproximated distance
is 11.82 cm

146 For distance measurement number 19, the aproximated distance
is 11.82 cm

147 For distance measurement number 20, the aproximated distance
is 11.83 cm

148 For distance measurement number 21, the aproximated distance

is 11.82 cm

149 For distance measurement number 22, the aproximated distance
is 11.83 cm

150 For distance measurement number 23, the aproximated distance
is 11.83 cm

151 For distance measurement number 24, the aproximated distance
is 11.83 cm

152 For distance measurement number 25, the aproximated distance
is 11.82 cm

153 For distance measurement number 26, the aproximated distance
is 11.82 cm

154 For distance measurement number 27, the aproximated distance
is 11.82 cm

155 For distance measurement number 28, the aproximated distance
is 11.83 cm

156 For distance measurement number 29, the aproximated distance
is 11.83 cm

157 For distance measurement number 30, the aproximated distance
is 11.83 cm

158 For distance measurement number 31, the aproximated distance
is 11.83 cm

159 For distance measurement number 32, the aproximated distance
is 11.83 cm

160 For distance measurement number 33, the aproximated distance
is 11.83 cm

161 For distance measurement number 34, the aproximated distance
is 11.82 cm

162 For distance measurement number 35, the aproximated distance
is 11.82 cm

163 For distance measurement number 36, the aproximated distance
is 11.83 cm

164 For distance measurement number 37, the aproximated distance
is 11.85 cm

165 For distance measurement number 38, the aproximated distance
is 11.85 cm

166 For distance measurement number 39, the aproximated distance
is 11.85 cm

167 For distance measurement number 40, the aproximated distance
is 11.83 cm

168 For distance measurement number 41, the aproximated distance

is 11.83 cm

169 For distance measurement number 42, the aproximated distance
is 11.85 cm

170 For distance measurement number 43, the aproximated distance
is 11.83 cm

171 For distance measurement number 44, the aproximated distance
is 11.85 cm

172 For distance measurement number 45, the aproximated distance
is 11.85 cm

173 For distance measurement number 46, the aproximated distance
is 11.85 cm

174 For distance measurement number 47, the aproximated distance
is 11.85 cm

175 For distance measurement number 48, the aproximated distance
is 11.85 cm

176 For distance measurement number 49, the aproximated distance
is 11.85 cm

177 For distance measurement number 50, the aproximated distance
is 11.82 cm

178

179

180

181 FIFTY MEASUREMENTS HAVE BEEN COMPLETED! ARDUINO WILL RESTART
TAKING THEM IN 10 SECONDS!

182

183 TEST MODE DISABLED: The Arduino will try to approximate the
distance of the light source from the photoresistor.

184 For distance measurement number 1, the aproximated distance is
16.37 cm

185 For distance measurement number 2, the aproximated distance is
16.34 cm

186 For distance measurement number 3, the aproximated distance is
16.34 cm

187 For distance measurement number 4, the aproximated distance is
16.30 cm

188 For distance measurement number 5, the aproximated distance is
16.34 cm

189 For distance measurement number 6, the aproximated distance is
16.34 cm

190 For distance measurement number 7, the aproximated distance is

16.34 cm

191 For distance measurement number 8, the aproximated distance is
16.37 cm

192 For distance measurement number 9, the aproximated distance is
16.37 cm

193 For distance measurement number 10, the aproximated distance
is 16.34 cm

194 For distance measurement number 11, the aproximated distance
is 16.34 cm

195 For distance measurement number 12, the aproximated distance
is 16.34 cm

196 For distance measurement number 13, the aproximated distance
is 16.34 cm

197 For distance measurement number 14, the aproximated distance
is 16.34 cm

198 For distance measurement number 15, the aproximated distance
is 16.34 cm

199 For distance measurement number 16, the aproximated distance
is 16.34 cm

200 For distance measurement number 17, the aproximated distance
is 16.34 cm

201 For distance measurement number 18, the aproximated distance
is 16.34 cm

202 For distance measurement number 19, the aproximated distance
is 16.34 cm

203 For distance measurement number 20, the aproximated distance
is 16.34 cm

204 For distance measurement number 21, the aproximated distance
is 16.30 cm

205 For distance measurement number 22, the aproximated distance
is 16.37 cm

206 For distance measurement number 23, the aproximated distance
is 16.34 cm

207 For distance measurement number 24, the aproximated distance
is 16.34 cm

208 For distance measurement number 25, the aproximated distance
is 16.34 cm

209 For distance measurement number 26, the aproximated distance
is 16.34 cm

210 For distance measurement number 27, the aproximated distance

is 16.34 cm

211 For distance measurement number 28, the aproximated distance
is 16.34 cm

212 For distance measurement number 29, the aproximated distance
is 16.34 cm

213 For distance measurement number 30, the aproximated distance
is 16.37 cm

214 For distance measurement number 31, the aproximated distance
is 16.34 cm

215 For distance measurement number 32, the aproximated distance
is 16.34 cm

216 For distance measurement number 33, the aproximated distance
is 16.30 cm

217 For distance measurement number 34, the aproximated distance
is 16.26 cm

218 For distance measurement number 35, the aproximated distance
is 16.22 cm

219 For distance measurement number 36, the aproximated distance
is 16.22 cm

220 For distance measurement number 37, the aproximated distance
is 16.22 cm

221 For distance measurement number 38, the aproximated distance
is 16.19 cm

222 For distance measurement number 39, the aproximated distance
is 16.19 cm

223 For distance measurement number 40, the aproximated distance
is 16.19 cm

224 For distance measurement number 41, the aproximated distance
is 16.15 cm

225 For distance measurement number 42, the aproximated distance
is 16.15 cm

226 For distance measurement number 43, the aproximated distance
is 16.19 cm

227 For distance measurement number 44, the aproximated distance
is 16.19 cm

228 For distance measurement number 45, the aproximated distance
is 16.19 cm

229 For distance measurement number 46, the aproximated distance
is 16.15 cm

230 For distance measurement number 47, the aproximated distance

is 16.15 cm

231 For distance measurement number 48, the aproximated distance
is 16.15 cm

232 For distance measurement number 49, the aproximated distance
is 16.19 cm

233 For distance measurement number 50, the aproximated distance
is 16.15 cm

234

235

236

237 FIFTY MEASUREMENTS HAVE BEEN COMPLETED! ARDUINO WILL RESTART
TAKING THEM IN 10 SECONDS!

238

239 TEST MODE DISABLED: The Arduino will try to approximate the
distance of the light source from the photoresistor.

240 For distance measurement number 1, the aproximated distance is
32.94 cm

241 For distance measurement number 2, the aproximated distance is
33.38 cm

242 For distance measurement number 3, the aproximated distance is
33.38 cm

243 For distance measurement number 4, the aproximated distance is
33.38 cm

244 For distance measurement number 5, the aproximated distance is
33.38 cm

245 For distance measurement number 6, the aproximated distance is
33.61 cm

246 For distance measurement number 7, the aproximated distance is
33.61 cm

247 For distance measurement number 8, the aproximated distance is
33.38 cm

248 For distance measurement number 9, the aproximated distance is
33.38 cm

249 For distance measurement number 10, the aproximated distance
is 33.61 cm

250 For distance measurement number 11, the aproximated distance
is 33.38 cm

251 For distance measurement number 12, the aproximated distance
is 33.38 cm

252 For distance measurement number 13, the aproximated distance

is 33.38 cm

253 For distance measurement number 14, the aproximated distance
is 33.38 cm

254 For distance measurement number 15, the aproximated distance
is 33.38 cm

255 For distance measurement number 16, the aproximated distance
is 33.16 cm

256 For distance measurement number 17, the aproximated distance
is 33.61 cm

257 For distance measurement number 18, the aproximated distance
is 33.38 cm

258 For distance measurement number 19, the aproximated distance
is 33.16 cm

259 For distance measurement number 20, the aproximated distance
is 33.38 cm

260 For distance measurement number 21, the aproximated distance
is 33.16 cm

261 For distance measurement number 22, the aproximated distance
is 33.16 cm

262 For distance measurement number 23, the aproximated distance
is 33.16 cm

263 For distance measurement number 24, the aproximated distance
is 33.38 cm

264 For distance measurement number 25, the aproximated distance
is 33.16 cm

265 For distance measurement number 26, the aproximated distance
is 33.16 cm

266 For distance measurement number 27, the aproximated distance
is 33.16 cm

267 For distance measurement number 28, the aproximated distance
is 33.16 cm

268 For distance measurement number 29, the aproximated distance
is 33.16 cm

269 For distance measurement number 30, the aproximated distance
is 33.16 cm

270 For distance measurement number 31, the aproximated distance
is 33.38 cm

271 For distance measurement number 32, the aproximated distance
is 33.16 cm

272 For distance measurement number 33, the aproximated distance

is 33.16 cm

273 For distance measurement number 34, the aproximated distance
is 33.16 cm

274 For distance measurement number 35, the aproximated distance
is 32.94 cm

275 For distance measurement number 36, the aproximated distance
is 32.94 cm

276 For distance measurement number 37, the aproximated distance
is 32.94 cm

277 For distance measurement number 38, the aproximated distance
is 32.94 cm

278 For distance measurement number 39, the aproximated distance
is 32.94 cm

279 For distance measurement number 40, the aproximated distance
is 32.94 cm

280 For distance measurement number 41, the aproximated distance
is 32.94 cm

281 For distance measurement number 42, the aproximated distance
is 33.16 cm

282 For distance measurement number 43, the aproximated distance
is 32.94 cm

283 For distance measurement number 44, the aproximated distance
is 32.94 cm

284 For distance measurement number 45, the aproximated distance
is 32.73 cm

285 For distance measurement number 46, the aproximated distance
is 32.94 cm

286 For distance measurement number 47, the aproximated distance
is 32.94 cm

287 For distance measurement number 48, the aproximated distance
is 33.16 cm

288 For distance measurement number 49, the aproximated distance
is 33.16 cm

289 For distance measurement number 50, the aproximated distance
is 32.73 cm

290

291

292

293 FIFTY MEASUREMENTS HAVE BEEN COMPLETED! ARDUINO WILL RESTART
TAKING THEM IN 10 SECONDS!

294
295 TEST MODE DISABLED: The Arduino will try to approximate the
distance of the light source from the photoresistor.
296 For distance measurement number 1, the aproximated distance is
26.77 cm
297 For distance measurement number 2, the aproximated distance is
26.64 cm
298 For distance measurement number 3, the aproximated distance is
26.51 cm
299 For distance measurement number 4, the aproximated distance is
26.64 cm
300 For distance measurement number 5, the aproximated distance is
26.64 cm
301 For distance measurement number 6, the aproximated distance is
26.51 cm
302 For distance measurement number 7, the aproximated distance is
26.64 cm
303 For distance measurement number 8, the aproximated distance is
26.64 cm
304 For distance measurement number 9, the aproximated distance is
26.51 cm
305 For distance measurement number 10, the aproximated distance
is 26.77 cm
306 For distance measurement number 11, the aproximated distance
is 26.64 cm
307 For distance measurement number 12, the aproximated distance
is 26.64 cm
308 For distance measurement number 13, the aproximated distance
is 26.77 cm
309 For distance measurement number 14, the aproximated distance
is 26.77 cm
310 For distance measurement number 15, the aproximated distance
is 26.64 cm
311 For distance measurement number 16, the aproximated distance
is 26.64 cm
312 For distance measurement number 17, the aproximated distance
is 26.77 cm
313 For distance measurement number 18, the aproximated distance
is 26.64 cm
314 For distance measurement number 19, the aproximated distance

is 26.77 cm

315 For distance measurement number 20, the aproximated distance
is 26.77 cm

316 For distance measurement number 21, the aproximated distance
is 26.64 cm

317 For distance measurement number 22, the aproximated distance
is 26.64 cm

318 For distance measurement number 23, the aproximated distance
is 26.64 cm

319 For distance measurement number 24, the aproximated distance
is 26.77 cm

320 For distance measurement number 25, the aproximated distance
is 26.77 cm

321 For distance measurement number 26, the aproximated distance
is 26.39 cm

322 For distance measurement number 27, the aproximated distance
is 26.64 cm

323 For distance measurement number 28, the aproximated distance
is 26.64 cm

324 For distance measurement number 29, the aproximated distance
is 26.64 cm

325 For distance measurement number 30, the aproximated distance
is 26.77 cm

326 For distance measurement number 31, the aproximated distance
is 26.77 cm

327 For distance measurement number 32, the aproximated distance
is 26.77 cm

328 For distance measurement number 33, the aproximated distance
is 26.64 cm

329 For distance measurement number 34, the aproximated distance
is 26.77 cm

330 For distance measurement number 35, the aproximated distance
is 26.64 cm

331 For distance measurement number 36, the aproximated distance
is 26.64 cm

332 For distance measurement number 37, the aproximated distance
is 26.64 cm

333 For distance measurement number 38, the aproximated distance
is 26.77 cm

334 For distance measurement number 39, the aproximated distance


```

        is 26.77 cm
335 For distance measurement number 40, the aproximated distance
        is 26.51 cm
336 For distance measurement number 41, the aproximated distance
        is 26.77 cm
337 For distance measurement number 42, the aproximated distance
        is 26.64 cm
338 For distance measurement number 43, the aproximated distance
        is 26.77 cm
339 For distance measurement number 44, the aproximated distance
        is 26.64 cm
340 For distance measurement number 45, the aproximated distance
        is 26.90 cm
341 For distance measurement number 46, the aproximated distance
        is 26.77 cm
342 For distance measurement number 47, the aproximated distance
        is 26.77 cm
343 For distance measurement number 48, the aproximated distance
        is 26.77 cm
344 For distance measurement number 49, the aproximated distance
        is 26.64 cm
345 For distance measurement number 50, the aproximated distance
        is 26.64 cm
346
347
348
349 FIFTY MEASUREMENTS HAVE BEEN COMPLETED! ARDUINO WILL RESTART
        TAKING THEM IN 10 SECONDS!

```

It should be noted that the outputs related with the case whenever *testEnable* equals *true* are associated with the video described in the following **The Videos of the Results** subsection.

3.3 The Videos of the Results

The following table **3.3**, illustrates the names of the video files related with the already illustrated *C Embedded* program:

Table 2: Video Names of Laboratory Results

Video Names of Laboratory Results
Photoresistor_1

4 Analysis of Results

Albeit somewhat complicated given the various different pieces of information that were found, it was possible to identify certain caveats related with this experiment, i.e.:

- Given the intensity of the light source, the resistance of a photo-resistor inversely varies. For instance, if the intensity of a light source is high, the resistance of a photo-resistor will be low. If the opposite occurs, of course, the opposite will be true.
- Given the information that was found about photo-resistors, the accuracy of such components seem to be 50 percent (%).
- It is possible to relate distance with the intensity of a light source by experimenting and procedures.

5 Conclusion

In conclusion, it was possible to construct a *Photo-resistor Circuit* for the acquisition of approximated distances of a light source with the aid of a *C Embedded* program and mathematical interpolation.

References

The following *References* related with this document are in the IEEE Format, as shown below:

- [1] Roman Lopez, Phd., "Laboratory 7: Analog To Digital". Mega. 2022. [PDF]