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Prototype of monitoring and irrigation system of a hydroponic crop with the PIC16F15244

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Abstract - Hydroponic cultivation is carried out through the use of humidity, temperature and level sensors who control its stability. In addition, a high-level language is implemented which is C together with pic16f15244 allowing us to make use of electronic components such as LCD screens. https://github.com/camilalopez16/CULTIVO-HIDROPINICO-/tree/main

Keywords: sensor, culture, language c, pic.

General Objective

- Develop a prototype for monitoring and irrigation of a hydroponic crop

Specific objectives

- Design the prototype in its mechanical layers; electronics and software.
- Implement algorithms for system operation based on PIC16F15244
- Experimentally validate the operation of the system.

I. INTRODUCCION

This report will develop the analysis of a hydroponic crop based on the advantages it may have for different types of applications. Whether urban or rural and agricultural applications or for private uses. Mainly, a detailed justification for the use of this type of crop is developed. The physical assembly of the proposed hydroponic culture for assembly is then explained. Based solely on recyclable materials that are easy to obtain. Finally, the electronic needs that the project should have are addressed in order to ensure that the crop has sufficient autonomy for a good functioning and also provide the user with a one-way communication to make the system variables known to the user.

II. METHODOLOGY

The assembly to be carried out is intended to present a prototype of a solution alternative, showing a hydroponic crop which has relevant advantages compared to other models of traditional agriculture, it can be clarified in the first place that although the fundamental basis of hydroponic crops is water, it will be allowed by the technology implemented an efficient use of the resource , in addition, the physical assembly of the crop will solve a disadvantage that traditional crops possess which is the possibility of growing under limited environmental and physical conditions. To finish the exposure of its advantages it is important to highlight how this prototype will be viable to obtain high quality crops by more accurately controlling the amount of water and consequently the amount of nutrients that the crop will receive.

The crop itself will monitor two important variables in the crop, it will be temperature and humidity the magnitudes that will allow decisions to be made in the care of the crop, based on the specific conditions required by the type of plant to be sown, in addition the assembly will have a level sensor in its water supply tank which will give knowledge of the status of the remaining water level in the system , in addition to providing safety and the motor pump that will feed the crop.

All variables that will be read by the sensors in addition to providing information necessary to allow the proper functioning of the project, also the signals provided by the sensors will be displayed on an LCD which allows the user to monitor the status of the same variables.

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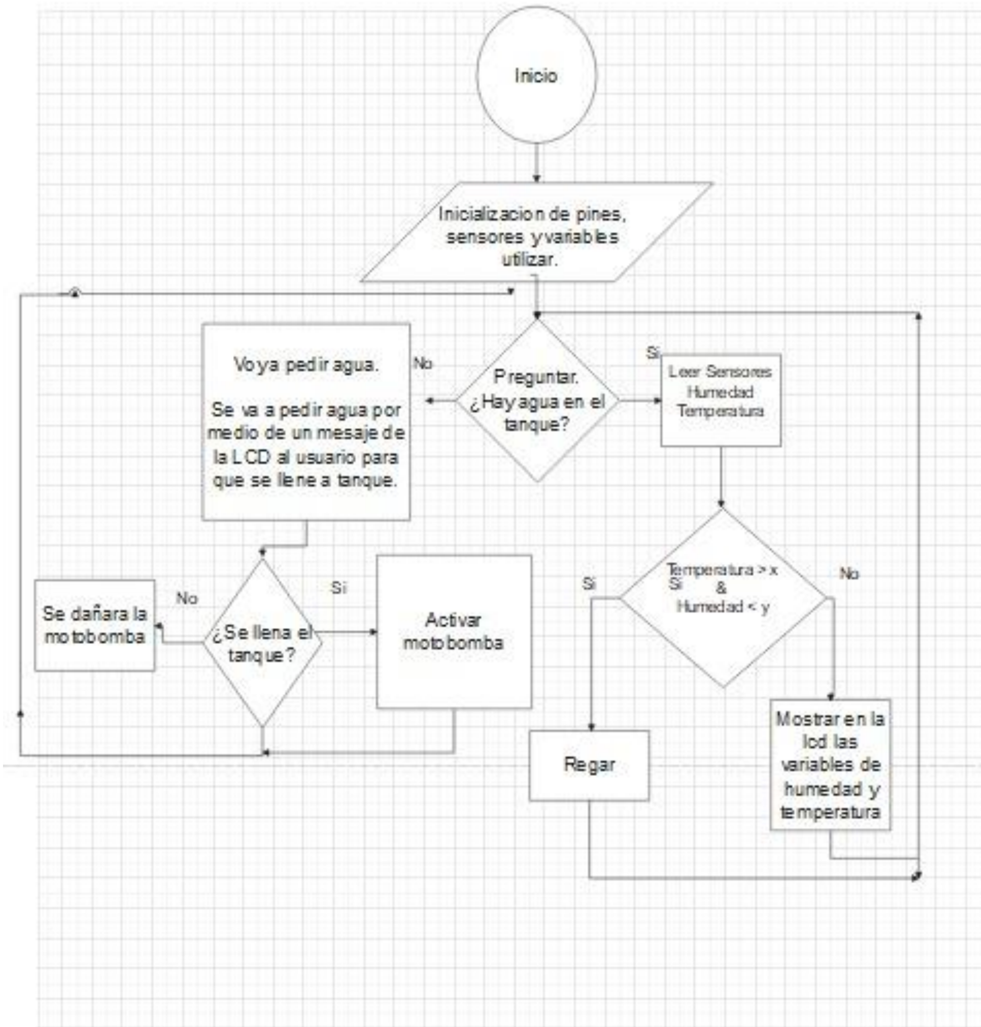

III. DEVELOPMENT

1. Step by step to assemble the project

Mainly we resorted to finding each of the materials necessary for the formation of the hydroponic culture, for the physical part we have PVC pipes, soil, bucket with water, etc. Already for the electronic part we use passive elements such as utpcable, resistors, relay and temperature sensor (PT100 3 wires) and active elements such as transistor and humidity sensors (FC-28), an integrated circuit as set of operational amplifiers and the PIC16f15244. Already when obtaining these materials, we proceed to the electronic assembly connections, that is, what goes in the Protoboard. Before we start we put as a parameter in placing all the lands together so as not to have connection problems, it is ideal to define a bottom line of the protoboard for ground and any connection is made to it as shown in Fig. 1.

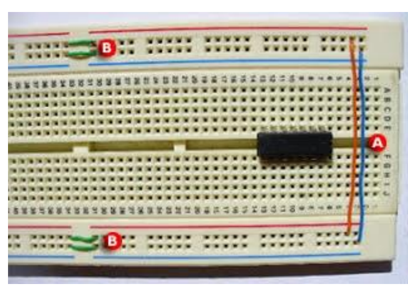

Fig. 1. Theupper and lower rows are enabled as food and as ground to make more organized connections in the Protoboard.

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This same connection procedure was developed with all the protoboards that were required for the implementation of the full assembly.

Then we continue with the water level sensor, where an adaptation of the sensor is made with a bucket of water where the motor pump will be. In the protoboard the respective connection is made with a relay, a resistor, a transistor and the pic which will be the same for one of the sensor terminals. In addition, it should be noted that, this must have the system of a Pull Up [Fig. 2.] , that is, this must be kept short for the sensor to keep running. On the other hand, it should be noted that the motor pump must always be in the water so that it will not suffer any affectation or damage.

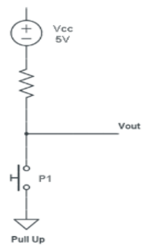

Fig. 2. Circuito Pull Down.

As for the Hygrometers FC-28 [Fig. 3.] Also called as a humidity sensor is a two-part sensor where the horseshoe is the sensor and the device that is called a transducer or integrated circuit that it brings with it. That circuit translates the signal it receives into digital signal.

Fig. 3. FC-28 hygrometer is a sensor that measures soil moisture. They are widely used in automatic irrigation systems to detect when the pumping system needs to be activated.

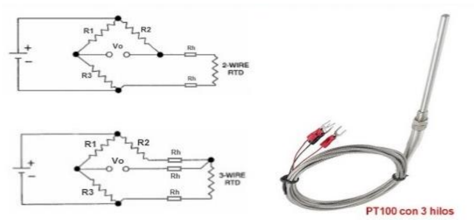

Fig. 4. Wheatstone Bridge adapted to the 3-wire pt100

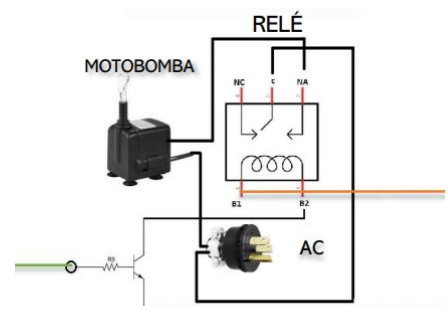

Fig. 5. relay circuit

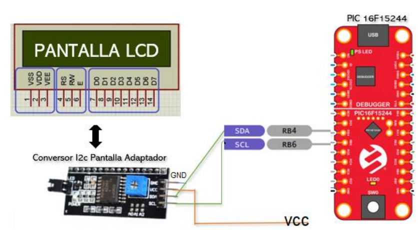

Fig. 6. LCD circuit.

1. materials

HYDROPORIC CULTURE IMPLEMENT COST TABLES

ELECTRONIC IMPLEMENTS	*quantity*	*price*
PT100 3 wires of 2 meters	*1*	*32,700*
Higrómetro FC-28	*2*	*14,00*
Vertical water leveler	*1*	*13,000*
LCD 16 x 2	*1*	*7,000*
Resistances	*1*	*4,000*
IC2 LCD adapter	*1*	*7,000*
INA122	*1*	*30,000*

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Pump	*1*	*22,000*
Capacitor of 0.1 uF	*1*	*200*
Capacitor 10 uF	*1*	*200*
Relay 12v	*1*	*3,000*
LM7805	*1*	*1,500*
Total		*134,600*

Origin: Cost database for hydroponic cultivation, author.

PHYSICAL IMPLEMENTS	*quantity*	*price*
Pvc tube	*1 metro*	
Pvc elbows	*3*	
Pvc tube cover	*1*	
Wooden Legs	*-*	
Wooden base	*-*	*V.*
Hose for the motor pump	*4 metros*	*7.000*
Materas	*4*	*16.000*
earth	*1 kilo*	*5.000*
supplements	*4 types*	*20.000*
Total		

Origin: Cost database for hydroponic cultivation, author.

A. plants

- In the annexes of the plants are found on land because, mainly they were had in water, but it attracted a lot of stilt, then while the relationship of the physical part of the crop was made, these were placed on land but when repositioned in water, that is, already work in the crop will have no affectation.

- ONION

onions can be grown directly from the seed stage or you can plant bulbs first, in this case it was, mainly caught a small bulb and put in a container with water and cotton to help with your subsistence by letting it grow to a certain extent. It was then slightly inserted into the hydroponic configuration. In addition, it should be emphasized that this requires at least 12 hours of light for your well-being.

Fig. 7. Onion growth stage.

- TOMATO

Tomatoes are quite resistant plants that respond very well to hydroponic growing methods. In addition, tomatoes are vulnerable to a lot of different bacteria, viruses, fungi and pests on the other hand, the seeds germinated in the outdoor soil could be contaminated by pests and germs then that's why they were grounded at first, to protect them from this.

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Fig. 8. Tomato growth stage

➢ CUCUMBER

Apart from the fact that cucumbers are quite delicate and require special treatment even in hydroponic systems; it was one of the easiest to grow. Well, mainly their seeds were extracted from a well-functioning cucumber, then they were put on a napkin so that it manages to have a natural drying, and at the same time proceeded to be placed in water and cotton, where its seeds began to grow over 4 days.

Fig. 9. Cucumber growth stage.

1. CILANTRO

Para el cilantro principalmente se mantuvo en tierra durante 28 días para que la planta debe capaz de sostener el sustrato sin desprenderse de la raíz. De una altura de 10 a 12 cm y al menos unas 6 a 8 hojas.

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Fig. 10 Cilantro growth stage.

ADVANTAGES

- Permite disminuir costos de producción
- Se produce con poca agua (solo el 10% de lo que se consume en un cultivo tradicional)
- Alimentos de alto valor nutricional
- Alimentos libres de pesticidas
- Permite producir cosechas fuera de estación
- No se usa maquinaria agrícola
- Mayor limpieza e higiene en el producto terminado
- Cultivos con control mucho mayor de plagas (bacterias, hongos, virus)
- Se obtiene uniformidad en los cultivos
- Da solución a los problemas de cultivos en tierras frías o calientes
- No es necesario nivelar el cultivo
- Ahorro significativo de agua

DISADVANTAGES

1. High initial investment
2. Lack of technical knowledge

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1. IV. RESULTS

Wheatstone Bridge Calculations

Tem = 0° → 100 Ω

Tem = 100° → 157.32Ω

Ecuaciones

$$Va = \frac{Vcc * Rx}{R2 + Rx}$$

$$Vb = \frac{Vcc * R3}{R1 + R3}$$

Calculo con 0°

$$Va - Vb = 0{,}05769 - 0{,}05769 = 0v$$

Calculo con 100°

$$Va - Vb = 0{,}08977 - 0{,}05769 = 0.03208v$$

equation to find profit

G= ganancia

$G = \frac{3.3}{0.03208} = 102.86$

profit equation of an instrumental

$$Vo = (Va - Vb)(1 + 2\left(\frac{R1}{RG}\right))(\frac{R3}{R4})$$

R3 = R4 = R1 = 33K

$$Vo = (Va - Vb)(1 + 2\left(\frac{R1}{RG}\right))$$

$$Rg = \frac{2R1}{102.86 - 1}$$

Gain resistance

$$Rg = 640\Omega$$

Motobomba.

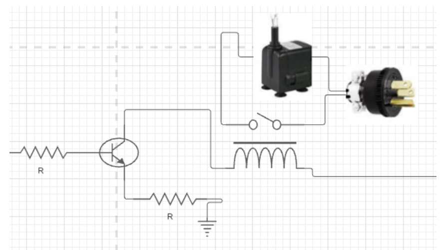

Fig. 11. Motor pump circuit.

$$IC: 25\ mA - - - - hfe: 10$$

$$0 = -V1 + RbIc + 0{,}7 + RcIc$$

$$\frac{1v}{25mA}: 40 - - - 47$$

$$\frac{v1 - 0{,}7 - (25mA)(47)}{25mA/10}$$

$$El\ v1\ se\ remplaza\ por\ 3{,}3\ v$$

$$\frac{3{,}3 - 0{,}7 - (25mA)(47)}{25mA/10} = 570$$

Cuantificación

$$M = \frac{100 - 0}{1{,}6 - 0{,}25} = 74{,}074$$

$$y - 0 = 74{,}074(x - 0{,}25)$$

$$y = -18{,}5185$$

$$y = -18{,}5185$$

ecuación final de conversión

$$y = 74 * pin - 18.51$$

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ANALYSIS OF THE PROTOTYPE.

Call

for the connection of the relay for the activation of the motor pump was done in a protoboard, to check the operation where the result was positive. It was then placed based on the pic where the same error was presented as in the rest of the functions. With code and this circuit you want to get that, when the system is without water, the water level sensor will send a signal to the pic. And this one will write a signal on a transistor that will activate the relay. This will be activated to give way to the motor pump to water the crop.

```c
void main(void)
{
    // Funcionamiento del Rele
      PIN_MANAGER_Initialize();
      OSCILLATOR_Initialize();
      TMR2_Initialize();
      PWM3_Initialize();
       while(1)
       {

           if(PORTCbits.RC2 == 0)
        {
           PORTBbits.RB7 = 1;
        }
         else
         {
           PORTBbits.RB7 = 0;
          }
           __delay_ms (200);

        }
}
```

2.

HIDROMETRO

For the hydrometer the code aims to read an analog value delivered by the sensor and be converted to a default value that gives the sensor to convert it to a percentage value.

That is, quantification and sampling shall be used to find the required value of relative humidity, with the maximum and minimum humidity limits for a given type of crop taken into account; which would work as a condition for making the decision wither to pump water. Finally, it should be noted that both humidity and temperature

they took the hand of their hand so we had 4 limits (Tmin, Tmax, Hmin, Hmax) to make a decision regarding cultivation.

```c
// Vo_A_TEMP.
// Conversion de Voltios a Temperatura
const float Vo_A_TEMP=100.0*5.0/1023.0;
// Vo_A_HUM.
//Conversion de Voltios a Humedad
const float Vo_A_HUM=1.0*5.0/1023.0;
```

Full tank

```c
void TanqueLLeno()
{
    while(Aviso==1)
    {
        if((PORTC & nivel)==0x0)
        {
            Aviso=0;
            PORTC|= Valvula;                                        // A
            LCD_Set_Cursor(2,8);
            LCD_Write_String("Tanq_lleno");
            __delay_ms(1000);
        }
    }
}
```

Empty tank

Full tank

```c
void TanqueLLeno()
{
    while(Aviso==1)
    {
        if((PORTC & nivel)==0x0)
        {
            Aviso=0;
            PORTC|= Valvula;                                        // A
            LCD_Set_Cursor(2,8);
            LCD_Write_String("Tanq_lleno");
            __delay_ms(1000);
        }
    }
}
```

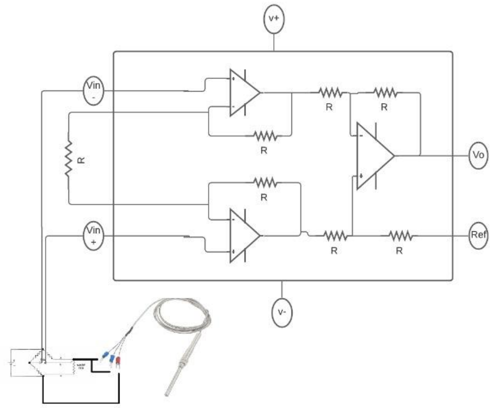
Empty tank

```
void TanqueVacio()
{
    PORTCbits.RC7=PORTCbits.RC2;
    PORTCbits.RC6=PORTCbits.RC3;
    if((PORTC & nivel)==0b00001100)
    {
        PORTC&=~Valvula;
        PORTC|=BOMBA;
        Aviso=1;
        LCD_Set_Cursor(2,8);
        LCD_Write_String("Llenando");
    }
}
//-----------------------------------------------------------------
```

3.

PT1000

Because, with the temperature sensor, that is, with the 3-wire PT100, minimum and maximum temperature standards were programmed, thus making the decision either to water or warn that the plant is in a non-acting temperature state for it, either high or very high or low. In addition, this fragment towards the requirement to make a conversion from analog to digital. That is, by converting the value that the sensor throws according to the temperature with sampling and quantification, where the required equation with the calculated se is found and an integer value is saved which would be the value shown on the LCD. At the quantization stage it was necessary to implement a conditioning circuit such as the Wheatstone Bridge and an amplifier stage capable of feeling the small temperature variations in the form of voltage. This amplifier stage was done with an assembly of an operational amplifier. To find the gain of the operational amplifier he realized that the maximum input voltage of the pic was to be 3.3V.



4.

LCD

Mainly to test the operation of the LCD 16x2 were found different libraries where with them we could use short and simple messages. On this LCD we used 8 pins of the pic, but it was something that did not suit since, it spent most pic pins. This lcd was intended to show the level of humidity that manages the system and the temperature level.

```
void main(void) {

    LCD_Set_Cursor(1, 1);
    LCD_Write_String("Prueba");
    __delay_ms(1000);
    LCD_Set_Cursor(1, 2);
    LCD_Write_String("De pantalla");
    __delay_ms(1000);
```

adding libraries for the use of I2C in order to be able to use the necessary pins in order to be able to connect the entire circuit in the pic, the actions, columns and rows where the default messages would be displayed according to the current condition that would be carried out.

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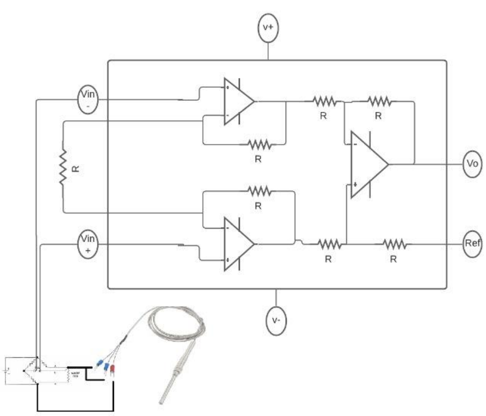

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V. CONCLUSIONS

1. The versatility presented by implementing a proposal or project such as a hydroponic crop means that there are many possibilities in its applications, which can range from vertical crops that maximize indoor space, to agricultural production crops in places where the possibility of conventional planting cannot be developed.
2. the need to develop the electronic part based on the proposed practical design was found during the project

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development. The number of elements and the types of sensors would be appropriate to implement in order to meet the basic needs of the operation of the project depended on this practical design.

3. In an approach to the project it was wished to make an I2C communication to allow monitoring on an LCD of the physical magnitudes provided by the sensors used in the crop but in the end it was decided to use port B of the pic (pic name) to send and allow communication with the LCD
4. The microcontroller option with which the project is developed is a good option for the practicality it brings to hydroponic cultivation. It is a microcontroller that does not take up much space and does not have the need to include additional elements outside of those already included in its printed circuit as could be the serial communication port that allows you to program the microcontroller or glass for the reference of its internal frequency. In addition to its size and practical way of use it also has as advantages the extensive functionalities that each of its pins have allowing analog and digital readings and writes. Using PWM. An internal LED and a pushbutton

1. VI. REFERENCES

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