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Intelligent Rainwater Monitoring System

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ABSTRACT :*This document presents an intelligent monitoring system to measure the level of rainwater of a cistern that is located within the Superior Technological Institute of the Sierra Norte de Puebla, controls the level of liquid, in order to know the cost of the cubic meters spent, and the savings for the organization of having a rainwater collection system, the system is monitored in real time. It has the following features: an application for mobile devices developed in App Inventor 2, under Android operating system, version 4.0 to 9; The methodology used to develop the application is by component; To keep control of the water supply in the cistern, a 2560 host is occupied, in charge of controlling the different sensors, it has a Bluetooth module to perform remote communication tests and an ultrasonic sensor, responsible for taking the quantity measurement of water stored in the cistern; Once the measurements are obtained, the necessary operations are carried out to inform the amount of water saved, this research is carried out by the academic body of engineering sciences of this Institution.*

KEYWORDS –*Intelligent System, Monitoring, Rainwater*

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I. INTRODUCTION

Water is a vital resource, which is not always within everyone's reach; The human being is responsible for taking advantage of the available water resources, including rainwater. According to the Water System of Mexico City, the recommended personal consumption per day is less than 100 liters; each Mexican consumes 360 liters a day; the use of water is used in 76.6% for agricultural activities, generally in crop irrigation, 14.5%, in public supply, delivery to domestic users, 4.9% is dedicated to the generation of electrical energy, through thermoelectric plants and the 4% to the self-supplied industry in products and services.

In the Superior Technological Institute of the Sierra Norte de Puebla, a rainwater collection system has been implemented, the personnel in charge of verifying the supply to the different buildings work in a schedule from 9 to 18 hours, from Monday to Friday, the institution has activities from 7:00 a.m. to 8:00 p.m., and including Saturdays, so it is necessary and constant the supply of the water tanks that provide the liquid to the "A" building, it is worth mentioning that during the days holidays and vacations this activity is not attended, but there are personnel on duty who are in the organization, on many occasions the spill of the liquid or shortage occurs in the tinacos and toilets. The objective of this study is to implement a computer system that allows monitoring the rainwater collection of building A; Its importance lies in benefiting the population made up of students, teachers and administrative staff.It is possible to remotely monitor the cistern for filling and distributing the water in building A by implementing an intelligent system in the organization.

Matthew and William are studied in 2010; Because they monitored three rainwater tanks in North Carolina, they use a computer model to simulate system performance, by evaluating a water balance using historical rainfall and anticipated use data, illustrating the improved performance of large systems while providing an indication of decreasing yields for greater tank capacity. Dumit and Girard are consulted in 2017; for his study on the economic viability when implementing a system of collection, treatment and distribution of rainwater for residential use. Xiaoyu, et al, in 2017. They carried out a rainwater collection to complement the supply of drinking water to ensure the water supply, they occupy a point of use (POU) treatment device.

Notaro, et al, in 2016; They propose the collection of rainwater as an effective supply solution to water scarcity. The use of water is for the supply of the toilet, from a house in Sicily, Italy. They analyzed historical data on water consumption to obtain a pattern of water demand. They performed a water balance simulation of the storage tank, and used a spill algorithm to measure the performance of the liquid. They identified the size of the optimal rainwater tank. Toshiyuki, et al, in 2016; they used a 5.6 ton rainwater tank, equipped with water level sensors.

II. METHODOLOGY

The methodology used is by components under the following phases: requirements determination, design, programming and testing of the prototype.The material used is a 2560 encoder, two 5 to 110 volts relays, an ultrasonic sensor, a Bluetooth, a 10 x 10 cm phenolic plate, utp cable, soldering iron, solder paste, fine welding. The software used is App inventor, fritzing, PCB Wizard 3.50 ProUnlimited, Star UML, among others. It has a cistern with a capacity of 66.17 m^3, its measures are: 5.90 m. in length, 5.03 m wide and 2.23 m deep, as shown in figure 1.

Figure 1. Cistern for rainwater collection of building A, of the ITSSNP

Water is collected during the rainy season during the months of June, July, August and September. Once the proper functioning of the tank has been verified, the sensors are tested and then the System design is elaborated as shown in figure 2.

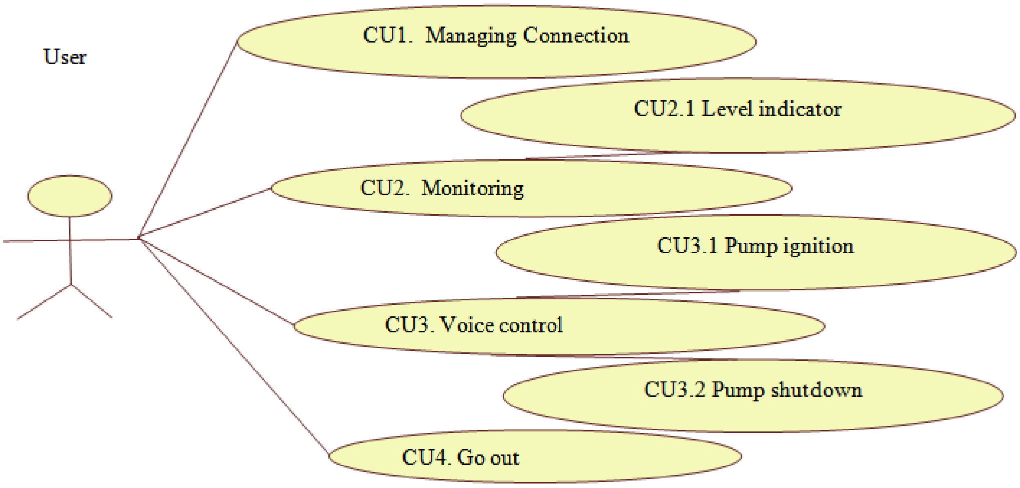


Figure 2. Design of the rainwater monitoring system

The software used for programming the microcontroller is Java Processing Wiring.

```
const int Echo = 5;
const int Trigger = 6;
int motor= 13;
double distancia;
long tiempo;
void setup ()
{
 Serial.begin (9600);
 pinMode (Trigger, OUTPUT);
 pinMode (Echo, INPUT);
 pinMode(motor,OUTPUT);
}
void loop ()
{
 digitalWrite (Trigger, LOW);
 delayMicroseconds (5);
 digitalWrite (Trigger, HIGH);
```

```
 delayMicroseconds (10);
 tiempo = (pulseIn(Echo, HIGH) / 2);
 distancia = (tiempo * 0.0343);
 Serial.println (distancia);
 delay (250);
 char dato = Serial.read();
 if (dato == 'A')
{
 digitalWrite(motor,HIGH);
}
 else if (dato == 'B'){
  digitalWrite(motor,LOW);
 }
}
```

Block programming in App Inventor for the mobile device is occupied as shown in Figures 3 - 6.

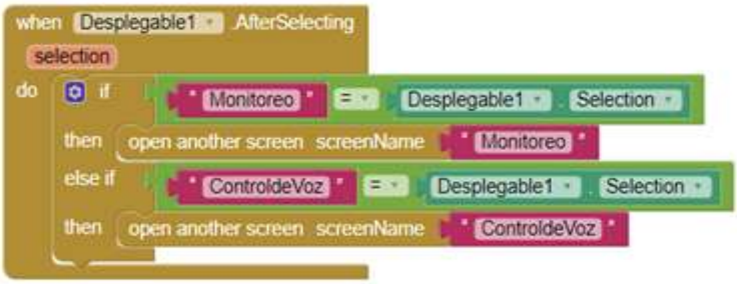
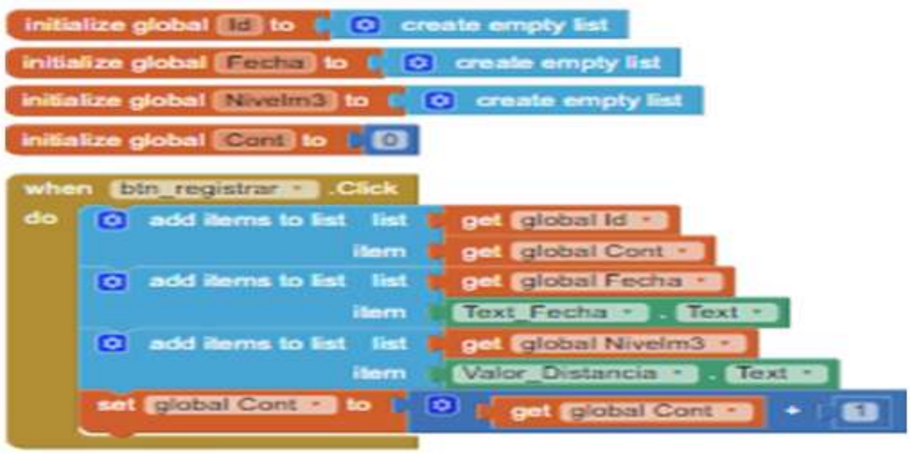


Figure 3. Voice controlled interface programming

Figure 4. Programming for remote data launch



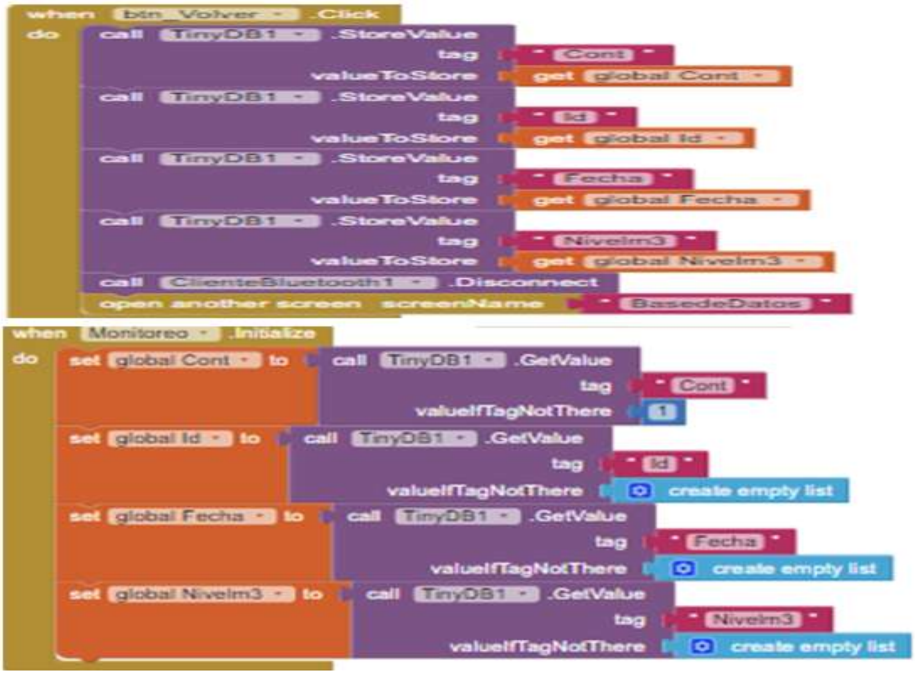


Figure 5. Programming the database.

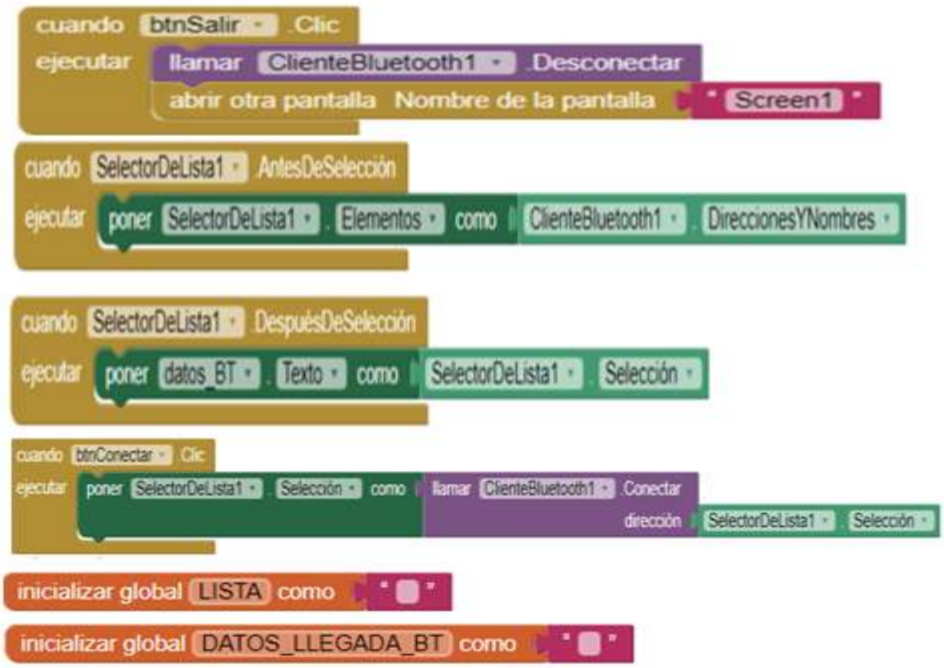


Figure 6. Programming the exit button.

III. RESULTS

The interface has been designed, encrypted and installed on a mobile device. The application runs from a cell phone; upon entering, the system is welcomed as shown in figure 7.

Figure 7. System startup screen

If, upon entering the application, the monitoring option is selected, the interface shown in Figure 8 is displayed.

Figure 8. Interface that shows the cubic meters and the savings generated with the Rainwater Collection System.

During the rainy season a control of the water captured in the cistern is kept, the data is recorded in a database of the Monitoring System as illustrated in Figure 9.

Figure 9. Daily log of the water collected.

With the installation of the Monitoring System, rainwater storage was monitored during the rainy season, the data that can be consulted in Figure 10.

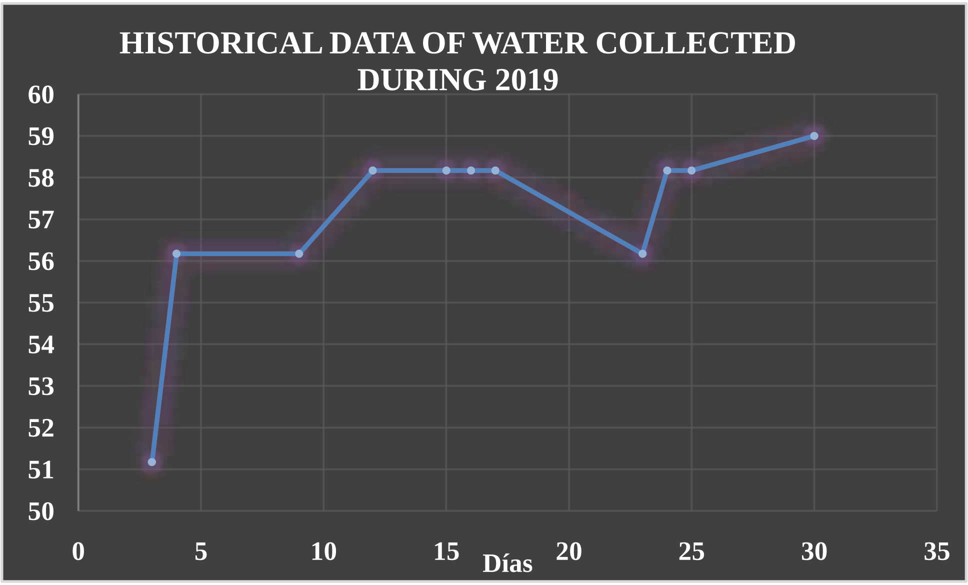


Figure 10. Tracking the rainwater collected.

IV. Conclusion

With the intelligent system it was possible to carry out the remote monitoring of the cistern for the collection and distribution of rainwater, with the application and historical monitoring it is possible to determine that the water saving can be up to 100%, depending of rainfall during the rainy season and it is confirmed that a rainwater harvesting system is viable for organizations where water consumption is high.

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