

Integrated Shower Water Management

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وزارة التربية والتعليم



Abstract

The Human actions are free but such actions may harm our world. From these actions is the unwise usage of water resources such as wasting it. This increases the problem of water which is accelerating from the last decade as 1 of 9 people in the world doesn't have access to water resources. Reducing the consumption of water is one of the crucial challenges that Egypt wants to overcome such as the developing of arid areas, increasing the industrial base, decreasing pollution and maintaining public health. Our project is focusing on the domestic use of water especially during showering as showering consumes 17.2 gallons in 8.2 minutes. Also, much water is wasted during adjusting of desired temperature before showering. In our solution, we rely on using microcontrollers such as Arduino in order for user to choose the desired temperature from 25: 40 degrees Celsius and the water falls with chosen temperature after about 30 seconds and using water used in showering itself to be used in the flushing. We determined the design requirements for our prototype. First, the falling water should be exactly at desired temperature. Second, the water doesn't flow unless water reaches the desired temperature within 30 seconds. We use Arduino UNO that controls 3 solenoid valves which controls the flow of hot water, cold water and the water having the desired temperature through giving instructions to Arduino to close hot water and open the final output when water reaches final temperature in addition to utilizing water used in showering to be used in flushing. We did the test plan and the results stated that it was successful as water reached desired temperature. We concluded that our device conserves 2.1 gallons of water for each session of showering as with normal flow of water there are about 2.1 gallons are fallen per minute and the user takes about a minute to adjust temperature.



Introduction

Egypt is suffering from a very crucial problem which is the overconsumption of water resources through whether bad behaviors of users or the increase of the demand on water in industrial, Agricultural and domestic usage. This problem is one of the main challenges that faces Egypt such as the unutilized arid areas, the lack of alternative energy sources, the lack of heedfulness of using modern technology in industry and the degeneration of public health. Many solutions are fulfilled to solve such problem such as dams where the government built the High Dam to stop the effect of the flood. As it is a huge waste of fresh water as well as it stores water in the room behind the dam to benefit from it in domestic purposes. Another solution is using CO₂ in cleaning the machines in factories instead of water where much water is used for such purposes. These solutions were very helpful especially the High Dam as it protected Egypt from the danger of flood and preserved a lot of water and cleaning machines using CO₂ saved a lot of water used in industry. Our project is focusing on the personal use of water especially in showering and adjusting temperature before showering. we rely on using microcontrollers such as Arduino in order for user to choose the desired temperature from 25: 40 degrees Celsius and the water falls with chosen temperature after about 30 seconds and using water used in showering itself to be used in the flushing. We determined the design requirements for our prototype. First, the falling water should be exactly at desired temperature. Second, the water doesn't flow unless water reaches the desired temperature within 30 seconds. Our idea is supported by many scientific laws as our solution applies the continuity equation and Bernoulli's equation in adjusting the flow rate of hot water and cold water. We used (L.O 2.0) in computer science to help us in the coding of the project in addition to benefiting from (L.O 2.0) in geology to help us address the problem.



Materials:

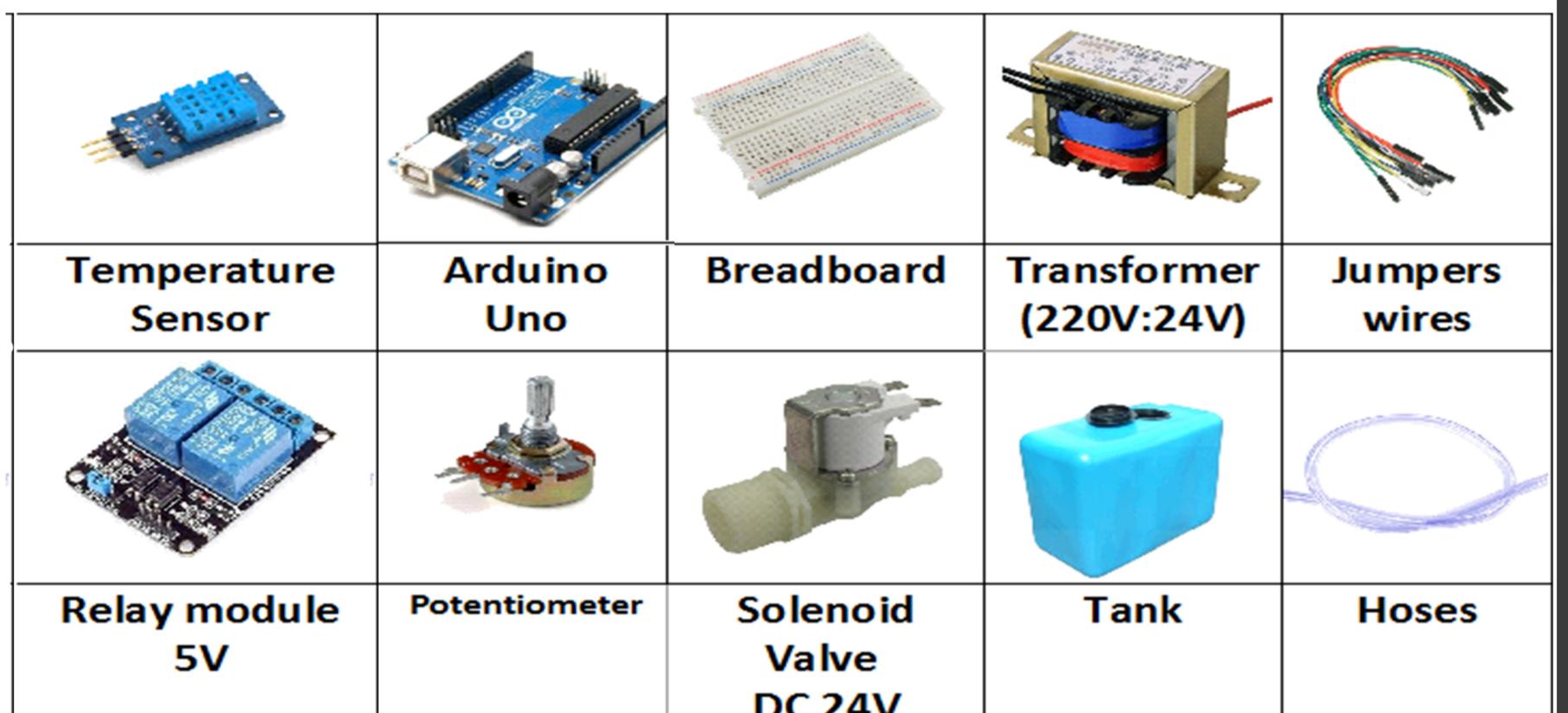


Fig. (1)

Methods:

- We connected our Arduino with the breadboard.
- We started connecting our DHT22 sensor and the potentiometer with Arduino.
- We connected the solenoid valve with the transformer and the relay then we connected the relay with the Arduino.
- We wrote the code using Arduino C language and gave instructions to our sensors and valves.
- After writing the code we made the connections by connecting the input of solenoid with the hose containing hot water then collecting the water coming from cold hose and the water coming from solenoid using collective.
- We settled the temperature sensor at the top of the tank.

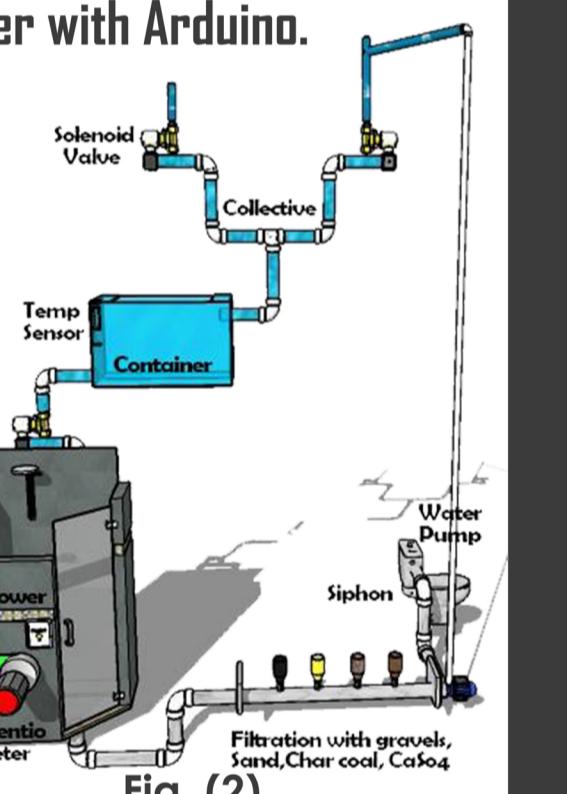


Fig. (3)

Test Plan:

- ☒ Test (1)
1. We executed the code on the Arduino IDE then we turned the power on in order for the solenoid valve to work.
2. After cold water and hot water are mixed together and the solenoid valve turned off, we started measuring the temperature of the water using thermometer as shown in figure (3).
- ☒ Test(2)
1. We calculated the time demanded at which hot water and cold water are mixed together using timer.



Results

First Test Results:

We chose the desired temperature 30°C we got the following results as shown in figure (4):

Trials	Desired temperature
1	29.1 °C
2	31.3 °C
3	30.5 °C

Fig. (4)

Second Test Results:

We measured the time taken for water to reach desired temperature using timer and we gathered data as shown in figure (5):

Temperature	Time taken
26 °C	34.2 seconds
28 °C	36.45 seconds
30 °C	38.1 seconds

Fig. (5)

We found that by increasing temperature with 2°C the time needed increase with an average of 2 seconds as shown in figure (6).



Fig. (6)



Analysis

Our Solution Has a Great Effect:

Our solution solves the problem of consuming plenty of water during showering in addition to adjusting temperature before showering. Our solution has a controlling system relies on Arduino that controls the flow of hot and cold water and the final output passing through pipes by giving instructions to three solenoid valves and when the water, after mixing, reaches the desired temperature chosen by the user, a (DHT22) temperature sensor detects that and gives instruction to Arduino to close solenoid valve on hot water and open the one at the final output so the water falls with the desired temperature. After water falls and user takes shower, water used in showering will pass through treatment process to be used in flushing.

Sensors and Actuators Controlling:

Our solution depends on Arduino to give instructions to actuators and get information from Sensors. This is achieved through coding using Arduino C language on Arduino IDE. We followed a sequence of steps in writing the code which is illustrated in the following diagram (7)&(8).

```
#include<DHT.h>
DHT dht;
int Value_out = 32;
int Value_in = 42;
int DHT11_PIN = 2;
void setup() {
  Serial.begin(9600);
  dht.begin(DHT11_PIN);
}
void loop() {
  float temperature = dht.readTemperature();
  if (temperature > 25) {
    digitalWrite(3, HIGH);
    digitalWrite(4, LOW);
  }
}
```

Fig. (8)

Water Purification and Usage in the Flushing:

- 1-Water is passed through filtration process in the pipe using (Charcoal, sand and gravel).
- 2-Water is then purified using boiler then it will pass through cooling process Water is ready to be used in flushing.

Interfering with Scientific Laws:

Why Solenoid Valve Worked?

The solenoid valve applies Faraday's law which states that if a wire moves rotationally between two poles of a magnet, an electric current is generated as the solenoid valve features a solenoid, which is an electric coil with a movable ferromagnetic core in its center. This core is called the plunger. In rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts a force on the plunger. As a result, the plunger is pulled toward the center of the coil so that the orifice opens.

Why Water Flowed Through pipes?

Water is a fluid and the fluids follow the continuity equation which states that the area of the tube is inversely proportional with the velocity of moving fluid ($A_1 V_1 = A_2 V_2$) so the two pipes had to be equal in order for the flow to be equal.

How Water Reached Desired Temperature?

When the code is executed and the power is on the water passes through the two pipes then they are aggregated in a tank after passing through connectivity in order for water to be mixed. This happened due to the law of conservation of energy as the energy amount going out of the warm water is equal to the energy amount going into the cool water.

Why Activated Charcoal is Used in Filtration?

Activated Charcoal has small, low-volume pores that increase the surface area so it has the ability to capture organic materials and other materials like soap from water and other chemicals.

Interfering with Curriculum

- 1-L.O (2.0) in Computer science as it states the principles of C programming which we used in writing our code.
- 2-L.O (2.0) in Geology to know more about water resources.



Conclusion&Recommendation

Conclusion:

- 1- Our project has a great implementation on user's life as it saves effort and time.
- 2- The device doesn't depend on weather conditions as we get hot water from the heater.

Test results proved different aspects for our solution

- 1- Our device has achieved the desirable design requirements with an error in the range of ± 2 %.
- 2- With normal flow of water during showering (2.1 gpm) and the user takes about a minute to adjust temperature so our device conserves 2.1 gallons of water for each session of showering.

Recommendation

- 1- Increasing the interactivity and accessibility of the device through connecting it with an IoT environment through making an android application.
- 2- Using a more accurate sensor that reads the temperature in decimals.



Literature Cited

- Water crisis. Retrieved October 2017 ,7, from <http://www.ecomena.org/egypt-water/>
- Prior solution. Retrieved October 2017 ,13, from https://www.pbs.org/wgbh/buildingbig/wonder/structure/aswan_high.html
- Arduino Basics. Retrieved October 2017 ,21, from <https://www.arduino.cc/>
- Electronic components. Retrieved October 2017 ,30, from <https://www.electronicshub.org/>
- Water Purification. (2017, November 8). Retrieved from <http://www.randwater.co.za/waterandinfrastructuremanagement/pages/waterpurification.aspx>



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