2-D Waterfall

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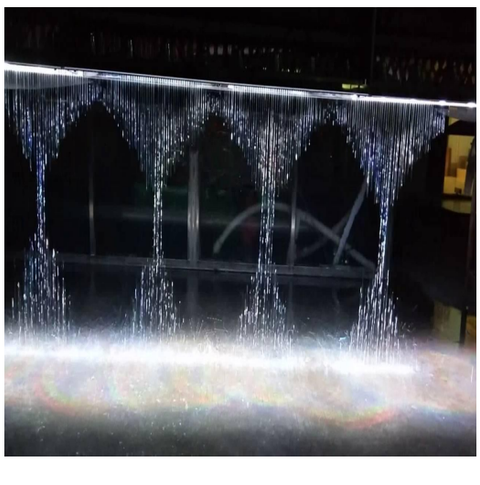


Introduction

This project is a design that experiments with different attractive patterns that can be generated using water droplets over a 2d plane, essentially creating a display of light effects using water. By controlling arrays of water outlets using pumps held by a specially designed structure, we are able to produce different patterns and moving images using droplets of water. Images and design patterns can be processed and converted into code which can then be uploaded to a circuit board which controls the pumps appropriately. Different light sources can be used to change or provide gradients of colours to the water droplets in the waterfall display. We would be using diaphragm pumps to control the flow of water through the outlets and these pumps would be controlled through an Arduino circuit board with help of relay modules and transistors.

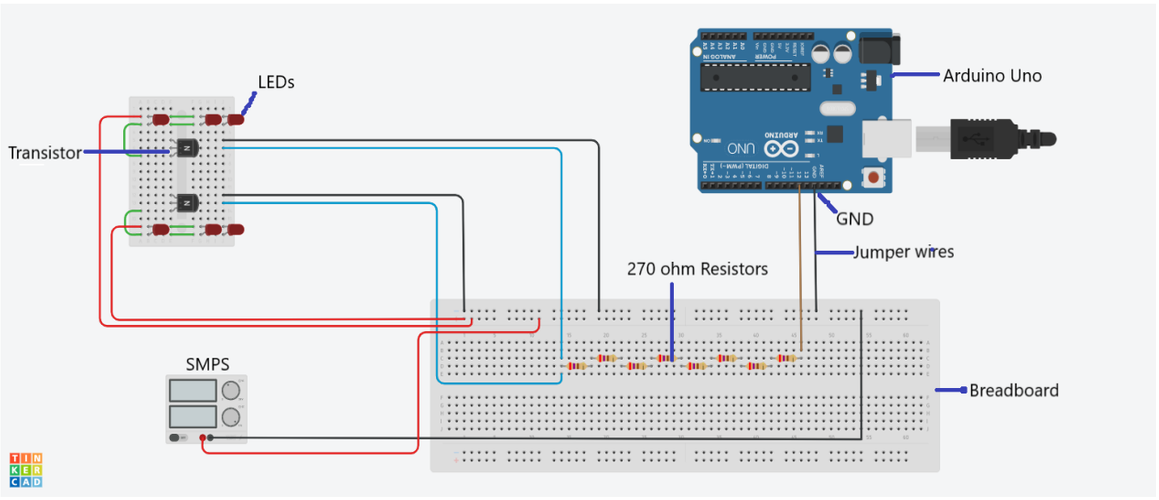
In addition, an illusion of Water Levitation can be achieved on a Digital Curtain by introducing a strobe light as the light source for the structure. This phenomenon is known as Stroboscopic effect and is achieved by syncing the frequency of the strobe light with that of the water droplets falling from each outlet. This effect can be enhanced to actually control the movement of the droplets(moving up or down with varying speed or levitating in a still position) by introducing a relative change between water droplet and light frequencies

PRINCIPLE

The stroboscopic effect is a visual phenomenon caused by aliasing that occurs when continuous rotational or other cyclic motion is represented by a series of short or instantaneous samples (as opposed to a continuous view) at a sampling rate close to the period of the motion.A strobe fountain, a stream of water droplets falling at regular intervals lit with a strobe light, is an example of the stroboscopic effect being applied to a cyclic motion that is not rotational. When viewed under normal light, this is a normal water fountain. When viewed under a strobe light with its frequency tuned to the rate at which the droplets fall, the droplets appear to be suspended in mid-air. Adjusting the strobe frequency can make the droplets seemingly move slowly up or down.

ELECTRONICS

1. Circuit for LEDs (Water Levitation):-



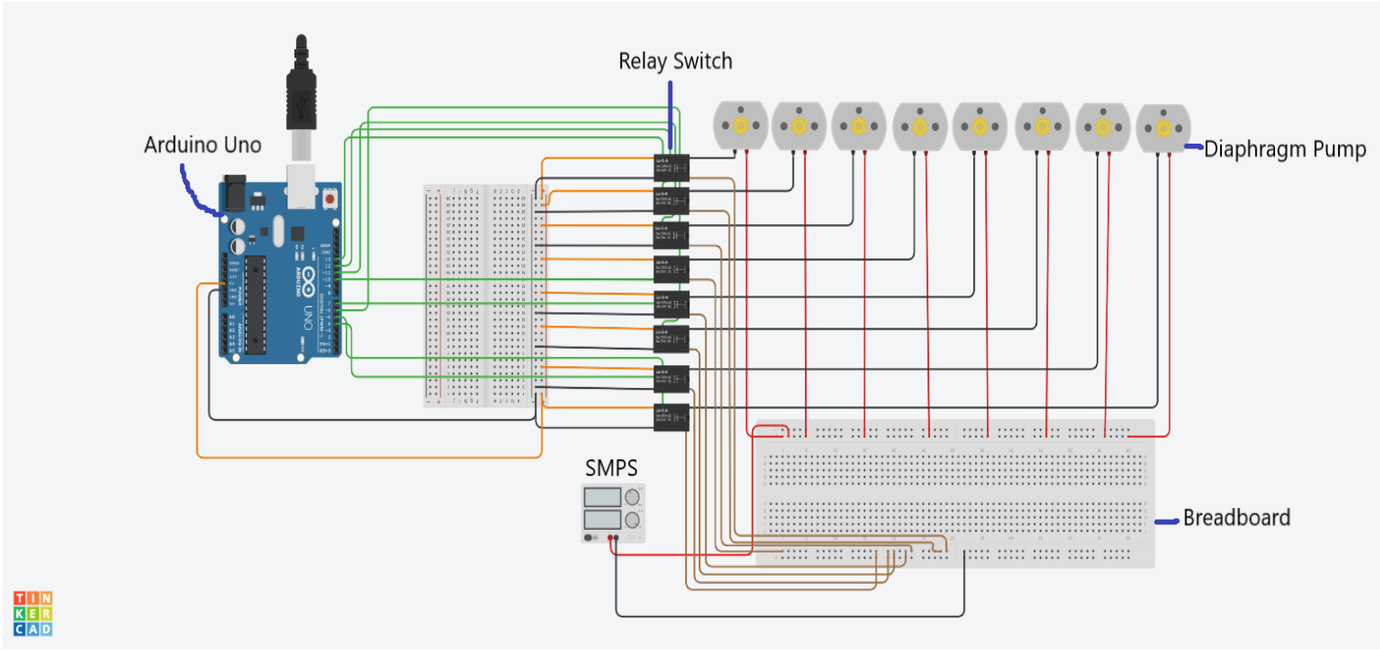
Components :-

- BreadBoard
- Arduino Uno
- Resistors (270 ohm)
- SMPS (Switched Mode Power Supply) 12V/5A
- NPN transistors (2N5298)
- High power Leds (5V)
- Jumper wires

We used a led board containing six leds in parallel connection as a source of strobe light. They were given instructions by a microcontroller (Arduino Uno), and 2N5298 type transistors were used as a switch which operated at given frequencies. Initially, we were using relay as a switch but we were not able to reach at a frequency suitable for stroboscopic effect and hence, we switched to transistors.
We used SMPS to convert and step down 220V AC main supply to 12V/5A DC. Due to unavailability of 2.2 kΩ resistors, eight resistors of 270Ω each were connected in series to maintain the current flow in the circuit. Proper current flow was essential to protect transistors from short-circuit but due to this, we have faced an issue regarding brightness of leds. Leds were not that bright as they should be and that's why, we were not able to cover all the water streams for water levitation.

Leds connected in parallel to led board

2. Circuit for Pumps :-



Components :-

- BreadBoard
- Arduino Uno
- Diaphragm Pumps (12 V)
- SMPS (Switched Mode Power Supply) 12V/5A
- SPDT Relays
- Jumper wires

The above circuit diagram shows the connection of diaphragm pumps with relay switches controlled by Arduino Uno. It seems to be a complex circuit but the connections were really simple. Positive ends of each diaphragm pump were connected directly to V+ of SMPS (used to convert and step down the Main supply), and negative end was connected to relay (one to each diaphragm pump) which are connected to V- of SMPS. Since there were a lot of wires used in the connections, we were not able to manage them properly and therefore, we faced several issues during debugging.

The three ends of the relay switch on the other side were connected to the arduino board. In particular, VCC was connected to 5V pin, GND is connected to ground of the arduino and IN of each relay is connected to different digital pins.

Digitals pins were actively used in creating different patterns during waterfall but during water levitation, all the pins were kept on high since we required continuous and steady flow of water.

Diaphragm pumps connected to wooden plank

MECHANICAL

Materials :-

- Wooden ply (6 mm)
- IV Infusion set
- Level pipe
- Black cloth
- Fevicol
- Nails and nut-bolts
- Water storage tank

Main Body :- It consisted of a support structure for the wooden plank containing diaphragm pumps and a black background for clear visibility of water droplets. The whole body was made up of wooden ply and fixed together using fevicol marine and nails. The bottom part of the structure was made in such a way that it can be used to store falling water (which is not shown in the above photo). One flat wooden ply was attached at the bottom to provide a wider base so that it will prevent any short of toppling. Initially, we planned to put led bulbs on both sides of the body but due to technical difficulties while operating bulbs at higher frequencies and limited amount of time, we switched to led board.

Plank :- Wooden plank was used to support all the diaphragm pumps. Pumps were attached to the plank using screws.

Water Storage Tank :- Behind the main body, we used a bathtub to store water. Diaphragm pumps were connected to tank with level pipes and water flow was controlled by using infusion sets. The main problem we faced during water levitation was the frequency and outflow of water through diaphragm pumps and hence, we came up with a temporary solution of using IV infusion sets.

Infusion sets connected to level pipe and tank

Infusion set

CODE

1. Code for 2D Waterfall

```
//waterfall presentation

//Pump Pins

const int p[] = { 2,7,4,5,6,3};
const int pcount = 6;

//Light source Pin

const int Led=10;
```

```
void setup() {

  for (int i=0; i<pcount;i++){
    pinMode(p[i],OUTPUT);
    digitalWrite(p[i],LOW);
  }
  pinMode(Led, OUTPUT);

  digitalWrite(10,HIGH);//Constant Light for Waterfall

}

void loop() {

 delay(3000);

  //Slope Start and slope Finish

  //R to L

  for (int i=0;i<pcount;i++){//slope lasting for 3 seconds)
    digitalWrite(p[i],HIGH);
    delay(375);
  }
  delay(3000);

  for (int i=0;i<pcount;i++){
    digitalWrite(p[i],LOW);
    delay(375);
  }
  delay(1000);

//L to R

  for (int i=pcount-1;i>=0;i--){
    digitalWrite(p[i],HIGH);
    delay(375);
  }
  delay(3000);
  for (int i=pcount-1;i>=0;i--){
    digitalWrite(p[i],LOW);
    delay(375);
  }
  delay(2000);

//V shape Entry and exit

  for (int i=0;i<pcount/2;i++){
    digitalWrite(p[i],HIGH);
    digitalWrite(p[pcount-i-1],HIGH);
    delay(375);
  }

  delay(3000);

  for (int i=0;i<pcount/2;i++){
    digitalWrite(p[i],LOW);
    digitalWrite(p[pcount-i-1],LOW);
    delay(375);
```

```
}

  delay(2000);


  //Alternate pumps on off


  for (int i=0;i<pcount;i+=2){
    digitalWrite(p[i],HIGH);
  }

  delay(2000);

  for (int i=0;i<pcount;i+=2){
    digitalWrite(p[i],LOW);
    digitalWrite(p[i+1],HIGH);
  }

    delay(2000);

  for (int i=0;i<pcount;i+=2){
    digitalWrite(p[i],HIGH);
    digitalWrite(p[i+1],LOW);
  }

  delay(2000);

  for (int i=0;i<pcount;i+=2){
    digitalWrite(p[i],LOW);
    digitalWrite(p[i+1],HIGH);
  }

  delay(2000);

  for (int i=0;i<pcount;i++){
    digitalWrite(p[i],LOW);
  }
  }
```

2. Code for Water Levitation

```
//For Diaphragm Pump Arduino


void setup() {

pinMode(2, OUTPUT);
pinMode(3, OUTPUT);
pinMode(4, OUTPUT);
pinMode(5, OUTPUT);
pinMode(6, OUTPUT);
```

```
pinMode(7, OUTPUT);
pinMode(8, OUTPUT);
pinMode(9, OUTPUT);

}

void loop() {

 digitalWrite(2, HIGH);
 digitalWrite(3, HIGH);
 digitalWrite(4, HIGH);
 digitalWrite(5, HIGH);
 digitalWrite(6, HIGH);
 digitalWrite(7, HIGH);
 digitalWrite(8, HIGH);
 digitalWrite(9, HIGH);

}

//Led Control Arduino

void setup() {

pinMode(10, OUTPUT);  // this is relay- switches

}

void loop() {

 digitalWrite(10, HIGH);
 delay(1);

 digitalWrite(10, LOW);
 delay(19);
```

Issues faced

- The initial choice of relay switch was not compatible with the project. Proper research onto switch modules would have prevented the issue
- Light ambience was insufficient to produce water levitation effect on all the water outlets
- Number of pumps were insufficient to produce a good waterfall effect due to the small scale of the project.
- Connection issues and improper water control caused 2 of the pumps and one arduino to stop working properly
- LEDs used as the light source were of bad quality and resulted in high amounts of heat being produced, and wastage in current.
- Limited light source due to less number of smps.

- Issues in water collection due to structure design and limited resources.

Improvements

- Connection issues could have been prevented to some extent by designing a pcb for the project
- The pumps could be placed more closer with more pumps to enhance the water curtain effect.
- Patterns can be generated with the water levitation concept by using more pumps and altering code appropriately.
- Light ambience could be made better with more light sources being placed at multiple angles. Multi-colored light can be used to beautifully illuminate the water curtain.