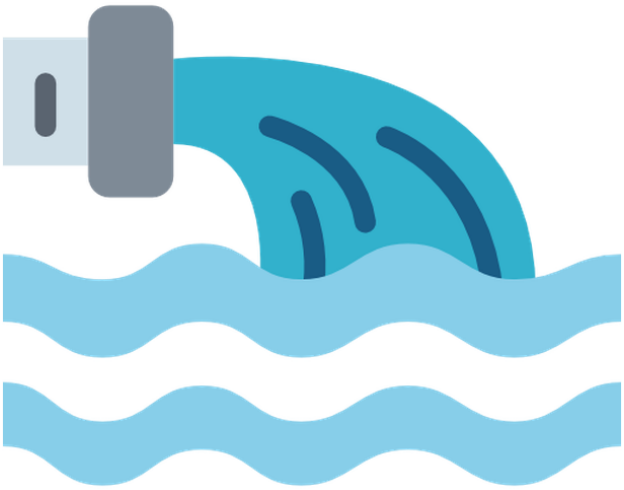


Water Waste Monitor

Akarsh Singhal
18/01/2020

Introduction

State what kind of system is being designed and built and who could use it

The type of system that is going to be built and designed is a water waste monitoring system. A water waste monitoring system is a system that detects the amount of water being used, consumed, or wasted. It will notify the user if they are using excessive amounts of water and tell them to stop. People who spend too much time in the shower, leave the tap on while brushing their teeth, forget to close the tap, etc, will need this device in order to save water.

Summarize what the system does including any planned enhancements

This system basically takes in the sound of water as the input, and outputs a message on a screen if the user is draining excessive amounts of water. A planned enhancement for this project is to add an ultrasonic sensor to detect any disturbance to the system. The ultrasonic sensor will detect if an object is placed on the system and tell the user, this will be important because if someone places an object on the system by accident, the mic that is taking in the input may get blocked off and not be able to detect the sound of running water. Consequently, the system will not function properly.

Research and Requirements Definition

Identify the main Social and/or Business needs satisfied by the system

The social need satisfied by this system is the reduction of wasted water on the planet. Water wastage is a major issue in our world. If we do not start limiting the amount of water we use, soon we will run out of it and humanity may become extinct. This system will monitor how much water is being used by the user and will notify them if the recommended amount has exceeded. This system will contribute to stopping water from being wasted because it helps tell the user to stop using water when the system thinks that he/she is using too much water. Another issue that this system solves is flooding. When excess water is being run, the buzzer will sound and the user who has forgotten to close the source of water, will close it and prevent a flood from occurring. Thus, the main social need this system satisfies is the saving of water, which is essential to human life.

Identify and describe subproblems and related details that are also important

In our world, there are many problems related to the problem of wastage of water. Firstly, there is a huge problem with the wastage of food. People in homes, weddings, or other events throw away so much food that can feed enormous amounts of people. According to World Vision, thrown away food can feed approximately 2,000,000,000 people. Next, running of unattended taps, showers, etc causing flooding is a silly but common problem. People leave their taps running after washing their hands and go to sleep because they forget to close it. This can create a huge problem as running taps output lots of water and by the time the house owner wakes up, the house is flooded. This problem relates to the problem I am trying to solve and can be solved using the system I am creating. Finally, the quality of water is another issue in our world. Some parts of the world such as Africa and India have very poor drinking water due to the high levels of pollution and poor treatment of water. According to the United Nations, 115 people in Africa die every hour from diseases linked to poor sanitation, poor hygiene, and contaminated water. There are many problems in our world that require new inventions and ideas to solve, we must create the best technology to fix them.

Research and summarize similar problems with solutions done by others

There are multiple environmental problems connected to water in this world, consequently, we have people who have created amazing inventions to solve those problems. There is an invention called the Quick Water Dam. They are sandless bags that absorb water. They can absorb up to four gallons and are placed right outside properties. They also divert water. These sandbags will help to keep floods from coming from an outside source, whereas, my system will prevent a flood from an inside source and notify about excess water use. Another solution that is in the market is the Water Inflated Property Protector (WIPP). This barrier is filled with water and it is put outside of properties to divert water.

Identify & describe system environmental, economic & social *sustainability* needs

The water waste management system fills environmental and economic needs. Firstly, this system will monitor how much water is being used by the user and will notify them if the recommended amount has exceeded. This system will contribute to stopping water from being wasted because it helps tell the user to stop using water when the system thinks that he/she is using too much water. Another issue that this system solves is flooding. When excess water is being run, the buzzer will sound and the user who has forgotten to close the source of water, will close it and prevent a flood from occurring. Flooding of a house leaves people with lots of debt if they do not have house insurance. However, if many people's houses start to flood and they have house insurance, insurance companies will drown leaving a significant impact on the economy. The water waste management system will prevent these floods from happening and save the economy.

State the design *functional requirements* (What it will do and how well)

This system will function very well and update the user with live information unless any changes or damages are made to the system. This system basically takes in the sound of water as the input and outputs a message on a screen if the user is draining excessive amounts of water. This system will monitor how much water is being used by the user and will notify them if the recommended amount has exceeded. It will take accurate readings of water sound, however, if secondary noise such as someone talking is detected, the system will take it as an input and the system will malfunction. Therefore, the system will work perfectly unless other noises other than the noise of the water is present.

State all *constraints* (restrictions or limitations) including SAFETY and CPSA

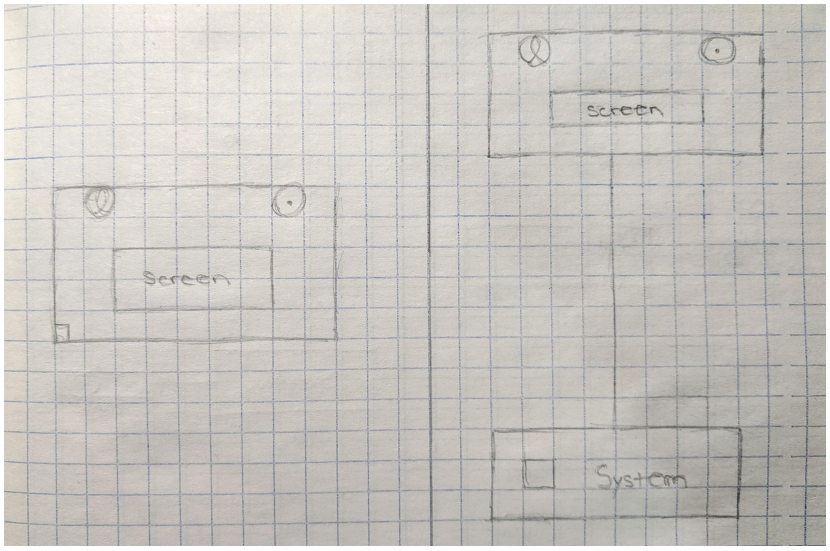
There are only a few constraints for the water waste management system. Firstly, if secondary noise such as someone whistling is detected, the system will take it as an input and the system will malfunction. The system will work perfectly unless other noises other than the noise of the water is present. There is another constraint, damages/changes to the system. In order to help eliminate the problem of the system not working if the mic is blocked or damage is about to be done, I have decided to add an ultrasonic sensor to detect any disturbance to the system. The ultrasonic sensor will detect if an object is placed on the system and sound the buzzer, this will be important because if someone places an object on the system by accident, the mic that is taking in the input may get blocked off and not be able to detect the sound of running water. Also, the system will not electrocute anyone as an enclosure will be on it and no water will be able to enter the circuit. There may be a risk of the system turning into a sharp object. If the system is broken using force, sharp metals may form and cut the user. Therefore, a plastic enclosure will be used to reduce the risk of the system turning sharp.

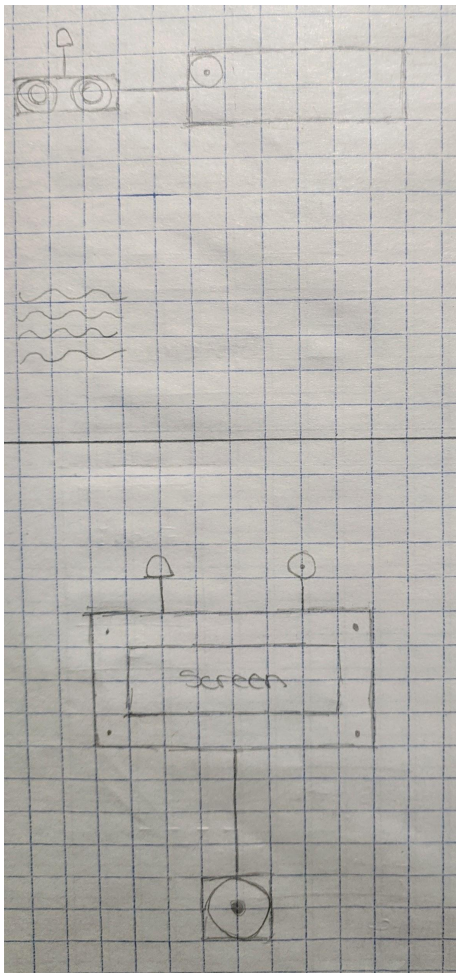
Rank all requirements as must haves and desirable

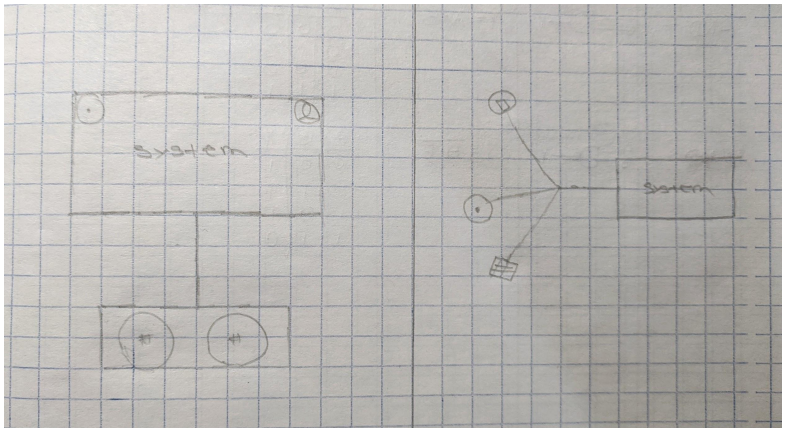
1. Arduino UNO & breadboard to upload the code in order for system to run
2. Sound sensor to detect water running
3. LCD screen to output message
4. Ultrasonic sensor to prevent any changes/damages to system

Preliminary Designs

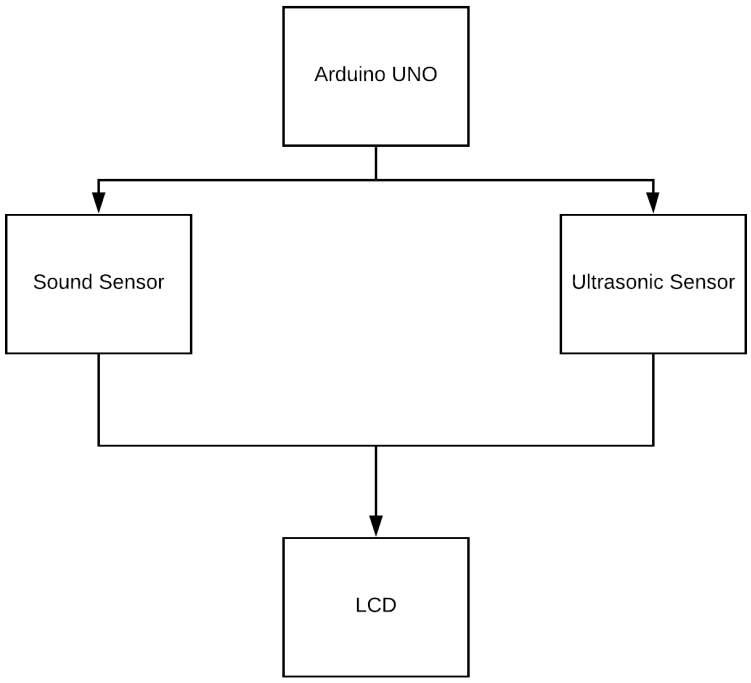
Brainstorm rough sketches at least 2 different designs



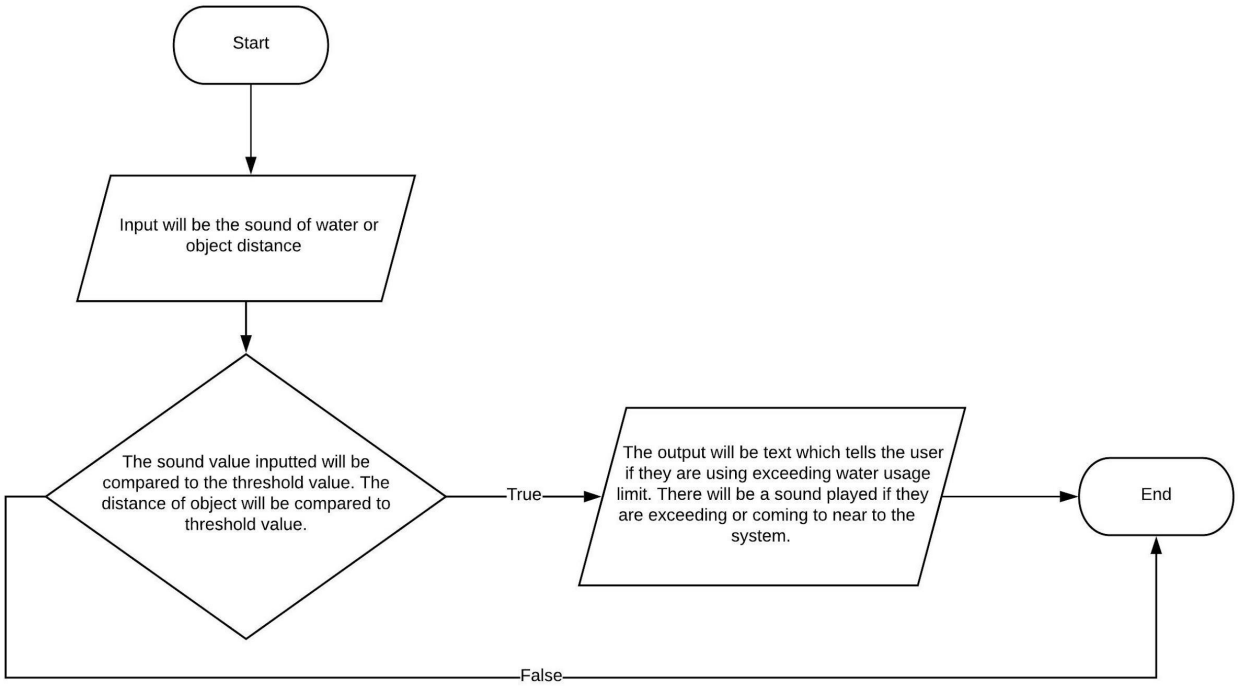




Create a *block diagram* of all control system components



Create an outline of the software (see *pseudo code* & *flow chart* examples)

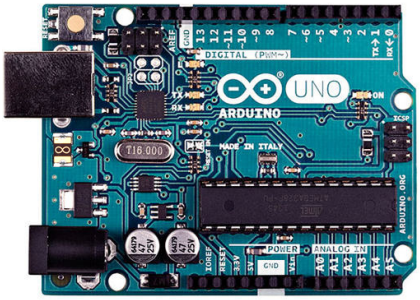


Final Design Plan

Write a *Theory of Operation* - explain each subsystem in detail plus drawings below

Arduino UNO:

- The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output pins that may be interfaced with various expansion boards and other circuits. This subsystem will be used to upload the code onto and send it to the Shield Base which will be connected to it.



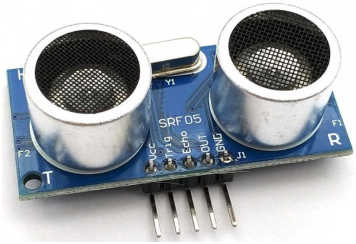
Sound Sensor:

- A sound sensor is a generally small system that detects sound waves. Generally, this module is used to detect the intensity of sound. The applications of this module mainly include switch, security, as well as monitoring. The accuracy of this sensor can be changed for ease of usage. In the Water Waste System, the sound sensor will be used to detect the sound of running water.

Ultrasonic Sensor:

- An ultrasonic sensor is a sensor that detects the distance of an object. For that reason, it is also called a distance sensor. Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to hear. They then wait for the sound to be reflected back, calculating distance based on the time required. This is similar to how radar measures the time it takes a radio wave to return after hitting an object. This sensor will be used in the water waste system to detect the distance of any objects intentionally or unintentionally

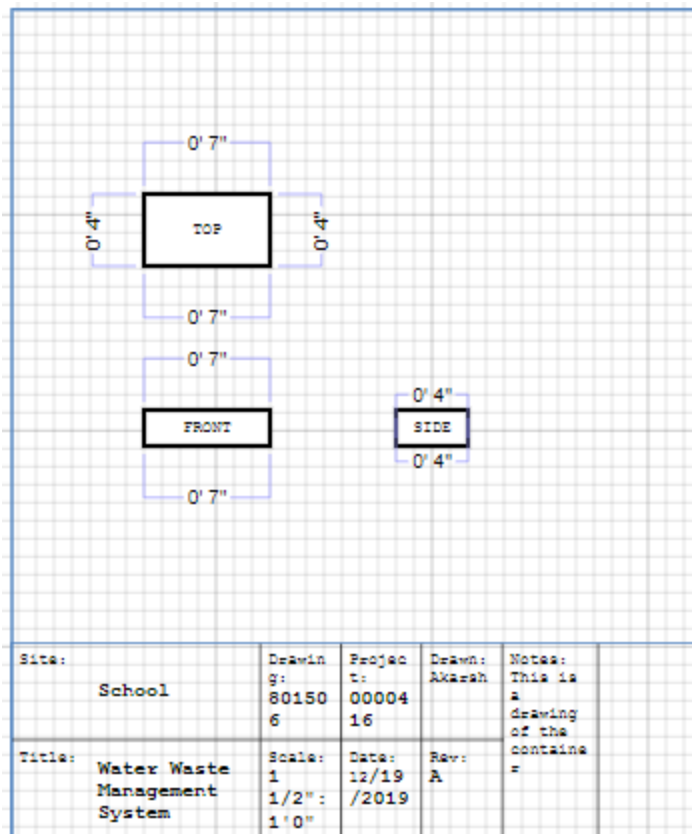
attempting to damage the system. If the sensor detects any object at a certain distance, it will trigger a buzzer.



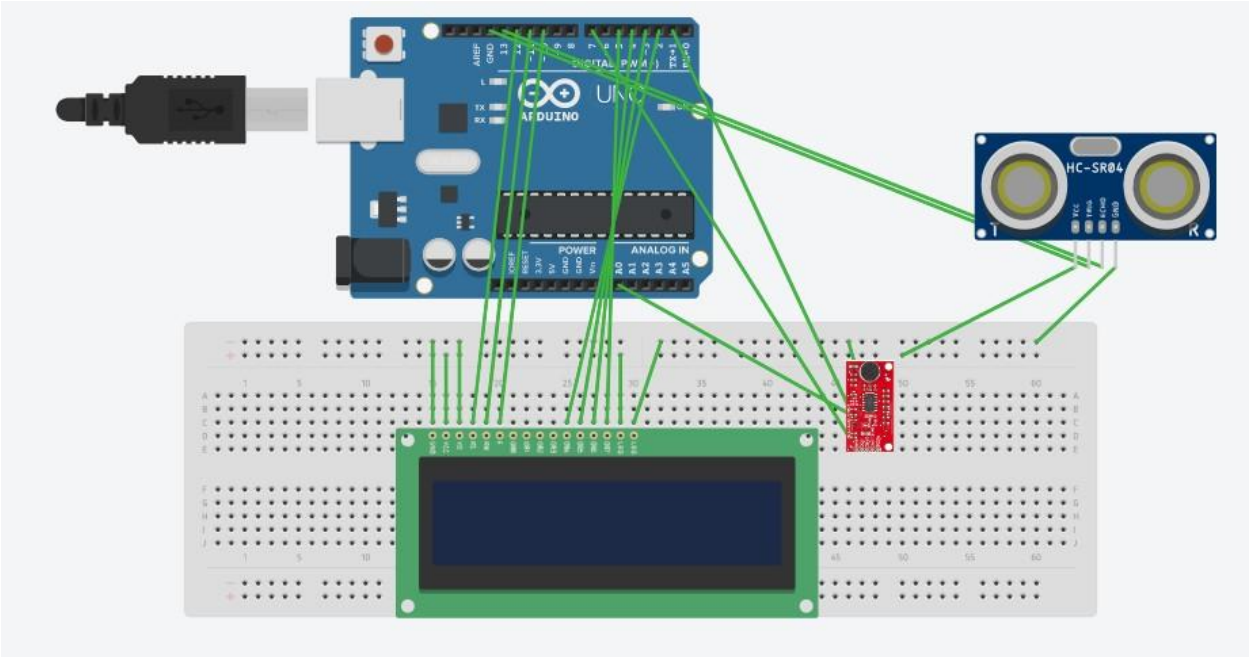
Liquid Crystal Display:

- A liquid crystal display is basically a screen that outputs something. It is a combination of two states of matter, the solid and the liquid. LCD uses a liquid crystal to produce a visible image. Liquid crystal displays are super-thin technology display screens that is generally used in laptop computer screens, TVs, cell phones and portable video games. Liquid crystal display is composed of several layers which include two polarized panel filters and electrodes. LCD technology is used for displaying the image in a notebook or some other electronic devices like mini computers. Light is projected from a lens on a layer of liquid crystal. This combination of colored light with the grayscale image of the crystal (formed as electric current flows through the crystal) forms the colored image.

Make *fully dimensioned mechanical drawings* (Autodesk Inventor preferred)



Create a labelled *circuit schematic diagram* with all control system elements



Create a *Bill of Material* (BOM) listing all the parts of your subsystem, model #, description, URL reference, quantities prices, total.

Part	Model #	Description	URL	Quantities Price	Total
Arduino Uno	A000066	Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller.	https://store.arduino.cc/usa/arduino-uno-rev3	$22.00/1	$22.00
Sound Sensor	BOB-12758	This small breakout board couples an Electret microphone (100Hz–10kHz) with a 60x mic preamplifier to amplify the sounds of voice, claps, door knocks or any sounds loud enough to be picked up by a microcontroller's analog-to-digital converter. Each breakout comes fully assembled and works from 2.7V up to 5.5V.	https://abra-electronics.com/electromechanical/audible-devices/microphone-elements/bob-12758-sparkfun-electret-microphone-breakout.html	$9.73/1	$9.73
LCD I2C	I2C	Typically this unit has 16 pinouts that requires a breadboard to interface with any microcontroller and a 10k potentiometer to adjust the contrast value to reduce the backlight and view the text.	https://www.gearbest.com/other-accessories/pp_216639.html?wid=21	$4.26/1	$4.26
Ultrasonic Sensor	EL-SM-001	Device that can measure the distance to an object by using sound waves. It measures	https://www.amazon.ca/HC-S	$11.99/1	$11.99

		distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.	R04-Ultrasonic-Distance-Arduino-MEGA2560/dp/B01COSN7O6		
Corrugated Plastic	BCP04W-18X24	The most economic friendly and versatile signage product out there. Practical, durable, cost-effective, and multitude of usages. These sheets make great screen printing products as well as vinyl adhesives.	https://www.canadiandisplay.ca/18-x-24-Blank-Corrugated-Plastic-Sheets-White-p/bcp04w-18x24.htm	$2.99/1 piece/24” x 18”	$2.99
Jumper Wires	JW-75	Each set contains 65 male to male breadboard jumper wires in a mix of colors (red, orange, yellow, green, blue, black, white).	https://abra-electronics.com/?subcats=Y&pcode_from_q=Y&pshort=Y&pfull=Y&pname=Y&pkeywords=Y&search_performed=Y&q=jumper+wire&dispatch=products.search	$4.98/65	$4.98
Breadboard	n/a	a board for making an experimental model of an electric circuit.	https://www.amazon.ca/Solderless-Bread	$5.99/1	$5.99

			board-Bread-Points-Contacts/dp/B00CGVFQ0U		

Describe the build and *assembly procedures* in sequence

1. Gather all of the material which are Arduino Uno, breadboard, sound sensor, ultrasonic sensor, wiring, LCD, resistor, transistor.
2. Connect LCD, sound sensor and ultrasonic sensor to breadboard.
3. Connect LCD, sound sensor and ultrasonic sensor to Arduino.
4. Verify and upload the code for the system on to the Arduino Uno board.
5. Run the code and check if the system is functioning.
6. Build the box for the system out of corrugated plastic, make sure the sensors, LCD are sticking out slightly so they work at their best.
7. Add decorations to the box to make it look appealing.
8. The box is ready to be used.

This is a general procedure of building this system, there may be more steps involved once building the actual system

Create *fully documented software code* for your system

```
//Name: Akarsh
//Date: 2020/01/11
//Purpose: create program to run final project

#include <LiquidCrystal.h> //Load Liquid Crystal Library
LiquidCrystal LCD(11,10,9,2,3,4,5);  //Create Liquid Crystal Object called LCD

#define trigPin 13 //Sensor Echo pin connected to Arduino pin 13
#define echoPin 12 //Sensor Trip pin connected to Arduino pin 12
int soundSensor=7; // Digital Pin 7 on the Arduino is where the "DO" of the Sound Sensor is connected.
int sensorValue = analogRead(A0); //This is where the "AO" of the Sound Sensor is connected.
int threshold = 1;
int waterUseAllowedDuration = 15000;

//Simple program just for testing the HC-SR04 Ultrasonic Sensor with LCD dispaly
//URL:

void setup()
{
```

```
  Serial.begin(9600);
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);

  LCD.begin(16,2); //Tell Arduino to start your 16 column 2 row LCD
  LCD.setCursor(0,0);  //Set LCD cursor to upper left corner, column 0, row 0
  LCD.print("Water Waste:");  //Print Message on First Row

  pinMode(soundSensor,INPUT);
  pinMode(sensorValue, OUTPUT);
}

void loop() {
  int sensorValue=analogRead(sensorValue);
  Serial.println(sensorValue);
  Serial.println("analog");
  int SensorData=digitalRead(soundSensor);
  Serial.println(SensorData);
  Serial.println("digital");

  Serial.print(sensorValue);
  LCD.setCursor(0,1);  //Set cursor to first column of second row
  LCD.print("               "); //Print blanks to clear the row
  LCD.setCursor(0,1);   //Set Cursor again to first column of second row
  LCD.print("Water Off");  //Print your units.
  delay(3000);

  if(SensorData=1){
    if(sensorValue>621){
    LCD.setCursor(0,1);  //Set cursor to first column of second row
    LCD.print("               "); //Print blanks to clear the row
    LCD.setCursor(0,1);   //Set Cursor again to first column of second row
    LCD.print("Water On");  //Print your units.
    delay(waterUseAllowedDuration);
    LCD.setCursor(0,1);  //Set cursor to first column of second row
    LCD.print("               "); //Print blanks to clear the row
    LCD.setCursor(0,1);   //Set Cursor again to first column of second row
    LCD.print("Turn Off Water");  //Print your units.
    delay(7000);
    }
  }

  //For the ultrasonic sensor to work
  long duration, distance;
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
```

```
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance = (duration/2) / 29.1;

  if(distance<15){
  LCD.setCursor(0,1);  //Set cursor to first column of second row
  LCD.print("               "); //Print blanks to clear the row
  LCD.setCursor(0,1);   //Set Cursor again to first column of second row
  //LCD.print(distance); //Print measured distance
  LCD.print("Don't Harm");  //Print your units.
  delay(2500); //pause to let things settle
}
}
```

Build & Test

Describe each test planned to verify the requirements and constraints

In order for my system to work, there had to be multiple tests ran. The first test was done in the morning on January 15, 2020, and it was done to test if all of the components were functioning. Since this was the first test, I was just looking for signs of the sensors and actuators working. The next test was run in the afternoon on January 15, 2020, and it was done to test if the code is working correctly and reading accurate measurements. This test was used to see if the code is correct and if it is working with the component and wiring combination. Another test was run in the morning on January 16, 2020, and this test was done to see if the whole system is functioning properly. The final test was done in the afternoon on January 16, 2020, and this test was done after all edits and final thresholds were set. This test was to see if the overall system is functioning properly.

Document each test date, the resulting observations and measurements taken and
Determine and document all resulting corrective actions and improvements needed

Test Date	Observations	Measurements & Action Taken
January 15, 2020 (9:52 am)	• LCD was working and displaying message but message not changing • Ultrasonic sensor working	• Code was changed so it could display ultrasonic readings • Sound sensor wiring was changed

	• Sound sensor not working	
January 15, 2020 (3:33 pm)	• Ultrasonic reading were showing on LCD • Sound sensor still not working	• Sound sensor code was changed to work
January 16, 2020 (9:31 am)	• LCD, sound sensor, and ultrasonic sensor working • Sound sensor was getting triggered all the time keeping it always on	• Thresholds and sensitivity values changed
January 16, 2020 (3:40 pm)	• Everything working as planned • All reading correct	• Packaging built and finished

Document each re-test date and the results of redesigns and/or improvements made

Re-test Date	Results	Improvements
January 15, 2020 (3:33 pm)	• Ultrasonic reading were showing on LCD • Sound sensor still not working	• Wiring of LCD was done again to make it look clean
January 16, 2020 (9:31 am)	• Sound sensor was getting triggered all the time keeping it always on	• Better sound sensor used instead of small one
January 16, 2020 (3:40 pm)	• Everything working as planned • All reading correct	• Packaging built and finished so the product looks clean

Conclusions

State how well the system and each subsystem met or did not design requirements

The Water Waste Monitor I built had met most of the design requirements I was planning to fulfill. Firstly, I wanted to add an LCD to my system so it could display messages to the user. This idea had worked out very well as all of the messages such as “don’t harm” displayed on the screen when I wanted it to. Next, I wanted to add an ultrasonic sensor so that the screen outputs a message saying “don’t harm” when someone comes near the system. This idea worked because whenever someone came within a range of 15 cm, the system would say “don’t harm”. Also, I wanted to add a sound sensor to detect sound and whenever it detected sound, the screen would output “water is running, stop using it”. This idea worked because whenever I made a sound similar to the sound of water in the sound sensor, it would start the water running part of my program. The whole idea of the system was to detect the sound of water and say “stop using it “ after a certain limit of time. However, I wanted to add a buzzer to beep when any sensor was triggered but that idea was not good for the system. A buzzer has a very small sound, against the sound of water it would be nothing, that is why I removed it. Overall, my system worked out as planned and I hope to make a more advanced version in the future.

Describe any remaining issues and ideas for modifications and/or enhancements

The Water Waste Monitor worked out pretty well however there is always room for improvement. Firstly, an on/off switch can be added on the system for it to be more easy for the user to turn on and off. Currently, if the user wants to turn off the system, they must unplug the cable from the power source. By taking steps to add a switch, the system will become easier to turn on/off and there will be less of a risk of an electric shock. Next, a speaker which plays a nice tune can be added to the system. The speaker will play a sound when the user uses too much water. The speaker will make the system usable for people with low vision and add a better effect to the system making it better. Last but not least, a movable mopping system can be added to the system. The mopping system will activate when it detects water on the surface it is on and will start to clean the water off of the surface. This feature is advanced but it will make the system usable for more than one thing. There are endless amounts of enhancements that can be added to the Water Waste Monitor, however, it is more important to do the main task first.

Reflect on your general learnings effects on your education and career plans

I believe the Water Waste Monitor has really helped me understand the importance of water and building it has enhanced the skills I will need to be a computer scientist. While researching my topic which is water waste, I came across lots of information that helped me realize why we should not waste water. Water is a vital source for surviving, unfortunately, there is a limited amount of freshwater available on Earth. According to National Geographic, 2.5% of our water is fresh and out of that only 1 percent is accessible to us. If we keep wasting water, the water will become depleted and we will have to drink the same water which is filtered over 100 times. Also, the circuitry, coding, and testing that was involved in making this product will greatly help me in the future. As a computer scientist, I will need to make lots of code for the company I will work in. This project has helped me get a great understanding and further developed my skills in coding. Also, this project has helped me learn how to make a project from scratch. There are many steps in making a project and I will use these steps if I want to create a big product in the future. The making of the Water Waste Monitor educated me on water waste, developed my skills in coding, circuitry, and product making.

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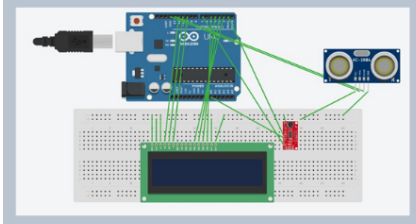
Summary Sheet

WATER WASTE MONITOR

Simple device that saves water.

DESCRIPTION

A Water Waste Monitor is a system that detects the amount of water being used, consumed, or wasted. It will will notify the user if they are using excessive amounts of water and tell them to stop. People who spend too much time in the shower, leave the tap on while brushing their teeth, forget to close the tap, etc, will need this device in order to save water.



DIAGRAMS

This is a schematic diagram of the Water Waste Monitor. It includes all of the components the system uses. If you open the system, you will see this layout.

OPERATION

This system basically takes in the sound of water as the input, outputs a message on a screen if the user is draining excessive amounts of water. The ultrasonic sensor will detect if an object is placed on the system and tell the user.

MAINTAINANCE

To maintain this product don't move it around too much, don't place object in front of it, don't leave it on if you are going on vacation, and don't place heavy loads on it..

"THIS PRODUCT WILL HELP YOU SAVE WATER"

BUILT BY AKARSH SINGHAL

A product by Akarsh Industries.