

Multi-functional Water Dispenser

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[devpost link](https://devpost.com/software/multi-functional-water-dispenser): <https://devpost.com/software/multi-functional-water-dispenser>



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Abstract

To help people develop the habit of drinking water and live a healthier lifestyle, a multi-functional water dispenser will be designed in this project. The basic function of this device is to detect a cup and then dispense water. To allow us to form drinking habit, the dispenser reminds hourly and warns when our daily fluid intake is under the required level. Additionally, a display clearly shows the information of water amount of both that has been taken and that is still needed. Real time information is also expected to be shown, which let the gadget serve as an electronic clock and can be placed on our study desk for convenience.

Motivation

It is significant to have plenty of drinks since staying hydrated is a daily necessity. Unfortunately, as Harvard Health Publishing states, many of us aren't getting enough to drink, especially older adults.¹ "Older people don't sense thirst as much as they did when they were younger. And that could be a problem if they're on a medication that may cause fluid loss, such as a diuretic," says Dr. Julian Seifter, a kidney specialist and associate professor of medicine at Harvard Medical School.¹

Not only for old adults, as figure 1 shows, the Quench study found that more than three-quarters (77%) of surveyed people did not think they consumed enough water on a daily basis to meet their health needs.² However, water serves as an important role in our daily life. "Think of water as a nutrient your body needs that is present in liquids, plain water, and foods. All of these are essential daily to replace the large amounts of water lost each day," says Joan Koelemay, RD, dietitian for the Beverage Institute, an industry group.³ Kaiser Permanente nephrologist Steven Guest, MD, agrees: "Fluid losses occur continuously, from skin evaporation, breathing, urine, and stool, and these losses must be replaced daily for good health," he says.³

Based on the current situation and the significance of being hydrated, we decide to design a multi-functional water dispenser. It should be a small device placed on the desk. Once this gadget reminds users to drink liquid, we can have water immediately. We do not need to be bothered putting brakes on our work and getting up to drink water. Additionally, it is able to record our drinking amount and let us know when we still need liquid. We believe that this multi-functional water dispenser can help people to live in a healthier lifestyle.

During the typical workday, how often do you think you drink enough water to meet your health needs?

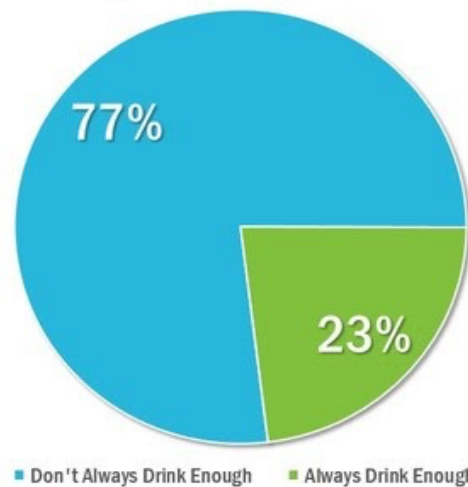


Fig 1 During the typical workday, how often do you think you drink enough water to meet your health needs?²

Goals

The goal of this project is to design a multi-functional water dispenser, with the basic function of dispensing water automatically when the cup is near to the dispenser. To add more functions which can benefit the user's normal life, a buzzer, which can be used to give reminders to users of drinking water and an LCD, which can be used to display the information of the amount of water can be added to the dispenser.

A. Milestone 1

For the first 3 weeks, the goals are achieving the following functions of water dispenser:

1. Dispenses water when the cup is under the water outlet.
2. Gives warnings by buzzer every 1 hour to remind the user of drinking water.

B. Final Demo

For the following 2 weeks, the goals are achieving the following functions of water dispenser:

1. Sets daily drinking water goals, and sets a time to remind the user of achieving goals.
2. Gives warnings at a set time by buzzer if the user does not achieve the daily drinking water goal.
3. Displays information about the time, the amount of water dispensing this time and the amount of water that the user has already drunk in the day.

Methodology

To realize the basic function-dispense water, the infrared sensor is used to measure distance between the water dispenser and the cup. The infrared sensor can send an analog voltage to the Arduino, and the Arduino can calculate the distance based on the voltage. Therefore, this sensor should be connected to an ADC pin of Arduino. In the normal situation, there are no obstacles in front of the water dispenser, the infrared sensor always sends a large distance. When the infrared sensor measures a distance smaller than about 5cm, the cup is almost under the water outlet and it is the time to dispense water. The interrupts will happen every time when the ADC finishes the conversion. In the interrupt service routine, when the measured distance is smaller than the set threshold, the Arduino will send the signal to the actuator to dispense water. For the actuator part, the water pump needs to work in the voltage domain of 9V -12V. Therefore, batteries are needed to charge the pump. To control whether the pump is working or not, between the battery and the pump, a relay needs to be added to control the connection and the disconnection of the circuit. When the distance is small, Arduino sends signals to the relay to build the connection between battery and pump, and the pump begins to transfer water from the water container to the cup. When the distance is large, Arduino sends signals to the relay to disconnect the circuit, and the pump stops working.

To realize the functions of giving warnings every hour and giving warnings at set time if the daily drinking water goal is not achieved, the real time circuit is needed, since Arduino can only measure the relative time. Here, the communication between the real time circuit and Arduino is I2C protocol, which needs 4 connection wires: SDA, SCL, VCC and GND. Arduino can receive the data from the real time circuit.

When the real time is reached, the buzzer should ring hourly to give warnings and at the set time the buzzer should also ring if the daily drinking water goal is not achieved. To distinguish the two warnings, the buzzer should play different short music. The interrupts always happen to generate a PWM wave with specific frequency and duty cycle to control the passive buzzer. In the interrupt service routine, when the buzzer does not need to ring, Arduino generates a PWM wave with frequency lower than 20Hz, which can not be heard by humans. When the Arduino reads a real time of hours, the Arduino generates a PWM wave with specific frequency and duty cycle that can play a short music. Only if the user puts the cup under the water outlet, will the buzzer stop ringing. And similarly, when the

Arduino reads a real time of the set time and the daily drinking water goal is not satisfied, the Arduino generates a PWM wave that can play another short music. And the buzzer will stop after the music is over.

To measure the amount of water, the Arduino internal timer can be used. The pump has a constant speed to transfer water, if the transfer time can be measured, the amount of water can be calculated. Here, when the relay builds the connection, Arduino records TCNT and times of overflows until the relay disconnects the circuit. The time period can be calculated based on the recorded number. And the amount of water can be calculated by the time period multiplying transfer speed.

The last part of this multi-functional water dispenser is an LCD. It can help the user get necessary information such as the time, the amount of water dispensing this time and the amount of water that the user has already drunk in the day. In this part, the connection between LCD and Arduino is SPI bus, and our task is to write functions that can be used to display the information above. And then, the real time can be obtained from a real time circuit, the amount of water dispensing this time can be calculated by Arduino, and the amount of water that the user has already drunk in the day is the sum of every amount.

Components

To achieve the goals, the following components are needed:

1. Arduino Uno: the microcontroller of the whole project, all the peripherals are connected to the Arduino Uno. It is used to collect the information from sensors and send operations to actuators.
2. Infrared Sensor (GP2Y0A21YKIR): this sensor is used to measure the distance between the water dispenser and the cup. From the measured distance, Arduino can judge whether the cup is under the water outlet.
3. Real Time Circuit (DS3231): this integrated circuit is used to send real time to Arduino. It can work independently, even if the Arduino shuts down, the real time circuit can still be timed normally.
4. Pump (AE1207): the actuator that is used to transfer water from the water container to the cup.
5. Battery: the battery is used to charge the pump.
6. Relay (2-1415899-6): the actuator that is used to control the status of the pump.
7. Buzzer (PS1440P02BT): the actuator that is used to give warnings.
8. LCD (ST7735R): the actuator that is used to display the needed information.

Evaluation

The evaluation is specific for each function that is expected to be realized and is based on the user experience. For the cup detecting and water dispensing features, the response duration between detecting the cup and dispensing water is no larger than 1 second, preventing the situation when the water is still dispensed even if the cup is already removed. Additionally, a reasonable maximum dispensing time duration should be set to ensure the water not to spill from the cup.

For the reminding function, the hourly music will only be played once so that the user will not be annoyed. This is because it is used as a reminder, regardless of whether the user drinks water during the corresponding time period or not. But for the warning feature, it acts based on the recorded fluid intake level. Only if the amount is lower than the required level, the water dispenser will ring and blink in a noisier way until the user take enough drinks.

For the LCD display, the time information is refreshed to keep the same as the real time. But the water amount is updated every time the user takes drinks with this water dispenser. There will not be a real-time water volume change when user is still collecting water because it is not necessary and asks for extra resources to reach a high screen refresh rate.

Timeline

This section is to help guide your progress over the next few weeks. Feel free to adjust and edit the table below to something that would be useful to you. Really think about what you want to accomplish by the first milestone.

Week	Task	Assigned To
Week 1: 11/09 - 11/15	Purchase components	Xiyue
	Measure distance by infrared sensor	Shuyi
Week 2: 11/16 - 11/22	Build I2C communication between real time circuit	Xiyue

	and Arduino	
	Use relay control the connection and disconnection of circuit	Shuyi
Week 3: 11/23 - 11/29	Build SPI bus between LCD and Arduino	Xiyue
	Control the pump by relay	Shuyi
Week 4: 11/30 - 12/06	Write functions which can make buzzer play short music	Xiyue
	Write functions of set time and daily drinking water goals	Shuyi
Week 5: 12/07 - 12/10	Use LCD to display the needed information	Xiyue
	Use buzzer to warn the user	Shuyi

Proposal Presentation

The presentation slides is shown in Google slides:

[Proposal Slides Link](#)

References

1. <https://www.health.harvard.edu/staying-healthy/how-much-water-should-you-drink>
2. <https://www.prnewswire.com/news-releases/nearly-80-percent-of-working-americans-say-they-dont-drink-enough-water-quench-survey-300668537.html>
3. <https://www.webmd.com/diet/features/6-reasons-to-drink-water#1>