

CPR For Dummies

Bathtub Drowning Prevention

James C. Young

Justin O. Young

April 26, 2006
Computer Engineering
Senior Project Proposal

Introduction

Over 200 children drown in bathtubs each year in the U.S. It's the second leading cause of death in toddlers. It seems like every month there's a story on the news about a child drowning in the bathtub, or being severely burned from hot water. Whether it's the parents fault or a younger brother or sister's fault, toddlers fall victim to carelessness and in most cases the results are fatal. The main goal of this project is to design and build a small device that will automatically drain the bathtub when it's not being used, or if the water temperature is hot enough to cause skin burns. This project will minimize the time window in which an accidental drowning/burning can occur.

Motivation

Recently we had a relative who had a child drowned in a bathtub due to water being left in the tub from older brothers. When children take a bath they sometimes forget to let the water out of the tub, and that makes it very dangerous for other small children in the house. If there would've been a fail safe way to make sure the bathtub was drained, then our cousin would still be alive. We feel this is a matter that can easily be solved using the knowledge of computer engineering and computer science. A family member applied for a patent for this project and we're still in the process of receiving the patent.

Functional Description

There will be three hardware components which will be installed in the bathroom. First, a small black plastic case with a red push button on it; it will be installed to the outside of the bathtub. Second, a special type of draining unit; it will replace the current draining unit in the bathtub. Third, a small audio speaker; it will be installed in one of the corners in the bathroom. The only user interface will be through the red push button on the small black plastic case. This button will allow the user to reset the system and start the timer over.

The system will have two primary functions. First, it will determine if the bathtub is empty (has water but no human). Second, it will determine if the water temperature is hot enough to cause skin burns. If either case is detected, it will then sound an alarm and wait for a response (red push button). If the "red push button" is pushed, it will reset the system. If it doesn't receive a response within ten seconds after sounding the alarm, it will then drain the bathtub.

To verify that our project works we will install it onto a portable bathtub. We'll fill the bathtub with water and let it sit for a while. Within a few minutes the system should sound the alarm, once this happens we'll push the reset button. We'll repeat this process without pushing the reset button. The system should then drain the bathtub and turn itself off. We'll then refill the bathtub with only hot

water and see if the system sounds the alarm. If so, we'll wait 15 seconds to allow the system to drain the bathtub and turn itself off.

Baseline Implementation

We plan on getting the following parts/functionality finished by demo day:

- Detect whether or not bathtub is empty (has water but no human).
- Detect whether or not water temperature is hot enough to cause skin burns.
- Sounds an alarm prior to draining the bathtub.
- Drains the bathtub and shuts itself off.

Project Extras

If we have extra time then we would like to jazz up our project with the following extra features/bells and whistles:

- Struggle detection – Will detect if someone is struggling in the bathtub.
- Wireless phone module – Once the system sounds the alarm it will also make a phone call to a pre-programmed number and play a pre-recorded audio alert message.
- Relay call – In the event that the phone line is already in use, it will use a different phone line to guarantee alert notification.

Design Description

We will use a small microphone attached to the outer-wall of the tub which will be accessible once installed. We will use this microphone for sound waveform detection. The microphone will act as our form of detecting whether or not the tub is in use.

We will use a micro-controller for converting from Analog to Digital. We will use some low pass filters for the filtering of noise waveforms and also to prevent wave aliasing. We will also use the micro-controller for the logic behind determining whether the tub has been empty for a long enough period to begin draining the tub.

If the logic has determined that the tub needs to be drained we will sound a small audible alarm for a short period of time prior to draining the tub. If at the end of that alarm the tub still hasn't detected anyone in the tub we will drain the tub and have the system turn itself off.

We are going to use a Crown Sound Grabber II PZM. Ideally we want a microphone that will be very small and able to interface easily with a micro-controller. This microphone seems to be able to work for what we need.



Figure 1 – Crown Sound Grabber II.

- Frequency response (typical): 50 Hz to 16 kHz.
- Polar pattern: Hemispherical (half-omni) on a large surface.
- Impedance: 1600 ohms, unbalanced.
- Sensitivity: 20mV/Pa (-54 fBV/Pa).
- Power sensitivity: -42 dBm.
- Cable: 10 foot with mini phone plug, ¼" phone plug and micro phone plug adapters.
- Power: One 1.5v AAA alkaline battery.

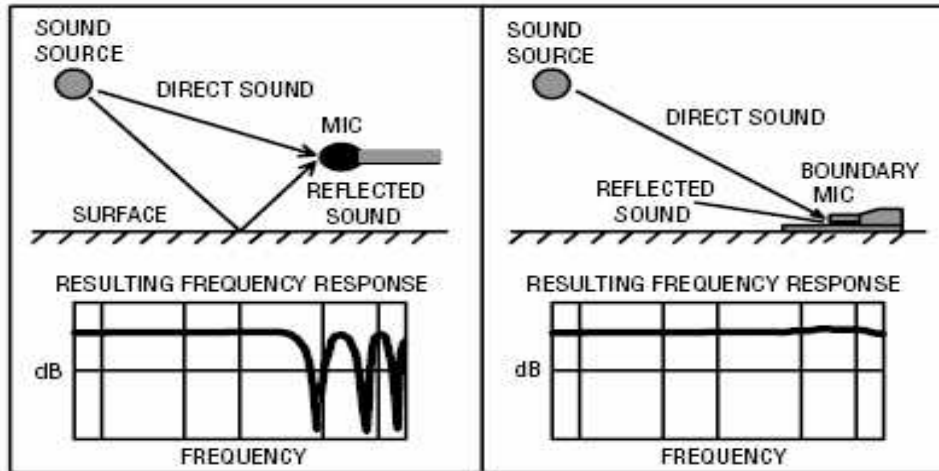


Figure 2 – Conventional mic vs. PZM mic.

A PZM microphone will help reduce noise as shown in the figure above. In order to reduce the amount of noise even further we're going to surround the unit in a sound absorbent casing, except on the side connected to the tub. We're also going to build a circuit that will filter and amplify the analog signal coming from the microphone going to the micro-controller. The internal amplification of the micro-controller may be sufficient; in that case we will only need to build a low-pass filter. We'll also build a circuit that will convert the digital signal coming from our micro-controller to an analog signal going to the speaker (DAC). Figure 3 shows a sample of what the analog signal coming from the microphone could look like.

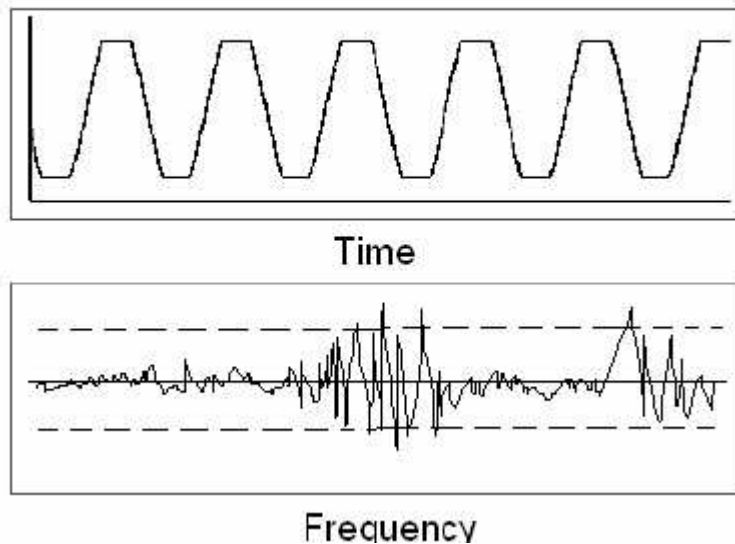


Figure 3 – Waveforms generated from microphone.

We are using a TEGAM 8662 thermistor sensor probe. This thermistor is small and has a wide enough range with plenty of accuracy.



Figure 4 – TEGAM 8662.

- 5-ft long wire probe.
- Stranded 22AWG Teflon-insulated wire.
- Connected to a YSI series 400, 1/4" phone jack.
- Sheath: 304 SS.
- Range: -40°C to +150°C
- Time constant: 6 seconds
- Accuracy: +-0.2°C from 0°C to 70°C

We're going to use a Motorola micro-controller in the M68HC08 family. This chip will allow us to get help from some of the SOC faculty or students that have worked with this chip. This chip also has freeware for programming the chip making the cost of the chip minimal. The M68HC08 software contains a compiler for C and assembly programming. It also contains a simulator which will greatly aid in debugging our project. It also has an internal ADC which will allow us to analyze the analog signal coming from the microphone.

We will need to build the drain mechanism. We will probably build a "pop-drain". One that will function like a push-pen, where you push it down to close the drain and push it down again to pop open the drain. We're going to use servos to operate the drain mechanism. The drain will also act as a switch; turning the system off while the drain is open or on while the drain is closed. This will allow for lower power consumption and in the event that we use battery power, longer battery-life.

We'll be using a small Sony audio speaker for the alarm system.

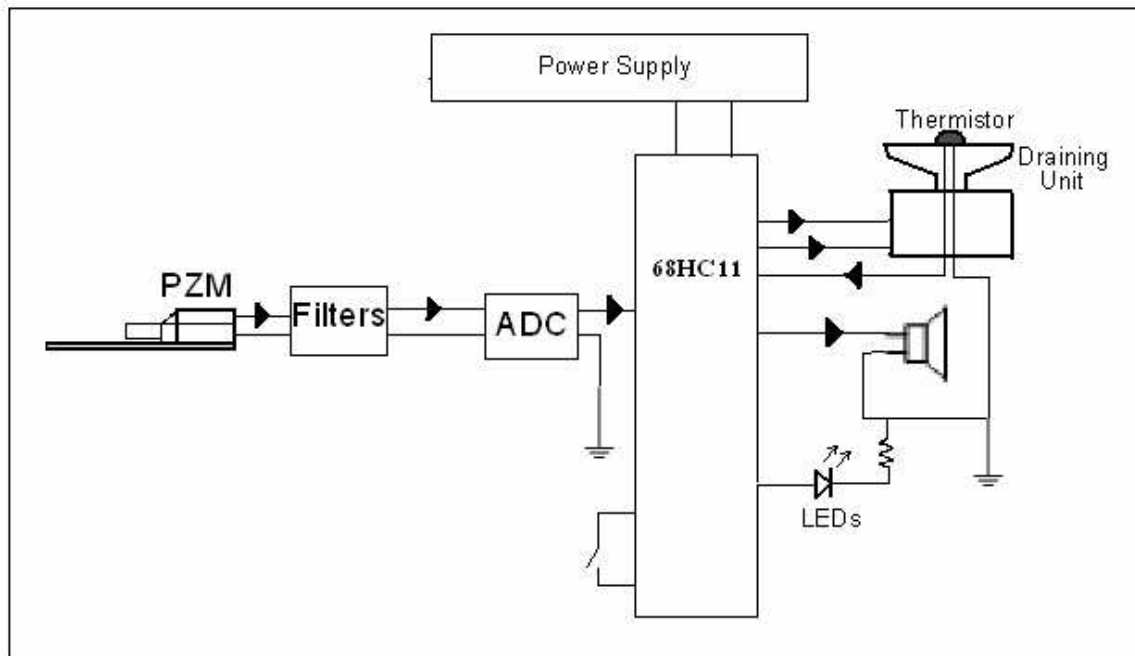


Figure 5 – Design Description (Block Diagram).

Interface Issues

We will have to interface a microphone, a micro-controller, a thermistor module, a speaker, and a draining mechanism. Because the micro-controller has an internal ADC, we'll be able to interface the microphone and thermistor with the micro-controller much easier.

Risks

High Risks:

- Micro-controller functionality (can it do what we need)
- Draining Mechanism (how to physically create)
- Power Supply (Battery or 120 VAC to 5 VDC converter)

Medium Risks

- Micro-phone (Low Power and Inter-faceable)
- Thermistor (Ease of interfacing)
- Telephone Module (don't know anything about creating one)

Low Risks

- Swamped by other class material
- Inability to recognize waveforms (unlikely)
- Inability to filter out noise from analog signal
- Parts not available

Schedule

Task	Start Date	Finish Date	Lead Person
Finalize Design	January 11, 2006	April 26, 2006	Both
Order & Receive Parts	April 26, 2006	June 4, 2006	Justin
Determine Waveforms	June 1, 2006	July 24, 2006	Justin
Interface Microphone	June 1, 2006	September 1, 2006	James
Interface Thermistor	July 1, 2006	September 21, 2006	James
Interface Speaker	July 1, 2006	October 1, 2006	Justin
Draining Unit	August 1, 2006	November 15, 2006	James
Debugging & Testing	June 1, 2006	November 25, 2006	Justin
Catch-up & Extras	November 20, 2006	December 5, 2006	Both

Milestones

PZM Microphone

- Analyze analog signal (wave form patterns).
- Build electrical circuitry.
- Mounting device.

Thermistor

- Power supply.
- Analyze analog signal.
- Mounting device (waterproof).

Draining Unit

- Build (servos).
- Power supply.
- Mounting device (waterproof).

Microcontroller

- Power supply.
- Mounting device.
- Interface PZM microphone (ADC).
- Interface thermistor (ADC).
- Interface speaker.
- Interface draining unit.

BOM

PARTS	PRICE	VENDOR	AVAILABILITY
IC Chip (68HC11)	\$20.00	Motorola	Already have 2
PZM Micro-phone	\$70.00	Crown	Widely available
Filter Parts	\$10.00	U of U	Widely available
ADC	Free	U of U	Limited
DAC	?	U of U	?
Draining Unit (Servos)	\$40.00	Radio Shack	Widely available
Speaker & Wire	Free	Sony	Already have

Conclusion

This product will help reduce the number of fatalities caused by bathtub drowning & burns. We don't want people to let there guard down thinking they don't have to drain the bathtub because this product will do it for them. Instead we want to provide this product as an additional safety feature that complements ones common knowledge to make sure the bathtub is drained properly. For example, just because you have seat belts in your car doesn't mean you can drive recklessly and expect to be 100% safe. Seat belts are a last resort safety feature, as is our product. Ask yourself how much your child's life is worth to you, if the answer is priceless then so is this product.