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Touchless Sink with Adjustable Temperature

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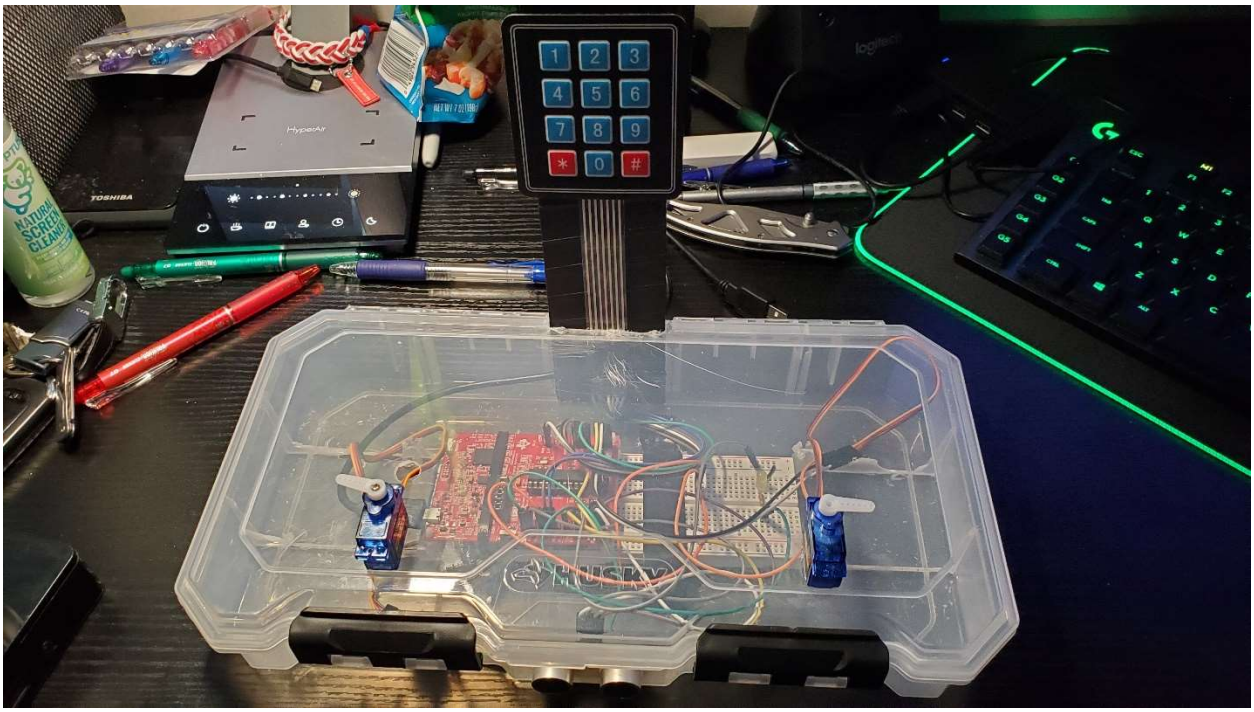
Touchless sink proof of concept design using a sonic distance sensor to allow for three distance thresholds. Uses a keypad for digital temperature adjustment, adjusting servo angles. Designed and implemented for use with the MSP430 microcontroller using Code Composer Studio.



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1 Introduction

1.1 Problem Description

Public sinks can be a breeding ground for germs and contact infection. This is especially important during the current covid-19 pandemic. Changing temperature also requires that a valve be manipulated and requires time and maintenance

1.2 Significance of the Problem

Allowing for a more sanitary option when washing one's hands in public restrooms, can help reduce spread of viruses and bacteria. Using a keypad or a digital mechanism such as a keypad to change temperature could eliminate the need to manually manipulate a valve to adjust the temperature of suck a sink. The public benefits from a far more sanitary option of washing in a public location. The facility itself can also benefit from having an easier way to adjust temperature, that could reduce work time and allow for a better evaluation for costs of heating and water usage. While touchless sinks are widely available, one issue that they do present is that in order to adjust temperature a valve would have to be manipulated in a secondary location, which could possibly not indicate the degree in change of water temperature and requires tools and time.

1.3 Overview of the Solution

The goal of this project is to improve upon the design of touchless sinks by giving the public a sanitary option and by giving facilities that would use such a device a way to adjust temperature in a more precise way.

1.4 Goals and Objectives

Design goals are to experiment with a sonic distance sensor to replace IR sensors commonly used in touchless sinks to allow for the use of varying distances to add function to a touchless sink, such as a soap or towel dispenser to be attached, as well as using a keypad to digitally alter temperature by closing and opening valves by 10% from numbers 1 -9, and with 0 representing 10.

The specific objectives are:

- Design and implement a touchless sink prototype using a distance sensor and two servos representing valves. 1 for cold water and 1 for hot water respectfully
- Interface a 3x4 keypad to provide a digital way to remotely adjust valves

1.5 Related Research

Using sinks designers like KOHLER as reference, the design suggested in this report is somewhat of a departure from the average design of most common touchless sinks. KOHLER offers a voice activation feature on top of their touchless design. Most sinks use IR sensors as

the primary motion sensor solution. Since IR has a source and a sensor, it can only allow for one distance to be detected. And while voice commands could also be a solution, this could be a very expensive option, and not something that would be practical in a public setting. According to Hunker.com, another problem arises when it comes to changing temperature of the water flowing from the sink. A valve must be adjusted to adjust temperature, and with adjusting a valve there us not way of knowing the actual temperature change without expensive sensors. While the site also lists a few other problems with touchless sinks, these are all focused on plumbing issues rather than those related to the sink's microprocessor. The design offered in this report could be solutions to both the IR sensor issue and the temperature adjustment issue. There are patents for sinks that are like the design presented here. Sinks that use a proximity sensor to initiate the device as well as giving options for multiple distances such a patent number US5868311A. However, in this design the flow of water is controlled by the distance sensor rather than using an external module for temperature change. Allow customers to change temperature of the water, may be uneconomical and costly.

2 System Design

2.1 Project Requirements

Design ideas were developed by reviewing patents online and look at features many manufacturers were developing for their touchless sinks, such as KOHLER. No interviews were done, and MSP430 architecture was researched through the "Programmable Microcontrollers" textbook. Based on the features that this prototype seeks to implement

2.1.1 This unit shall have three distance thresholds for off, on, and soap
2.1.2 This unit shall change temperature based on input from keypad
2.1.3 This unit shall have two opposing servos that are manipulated by the keypad

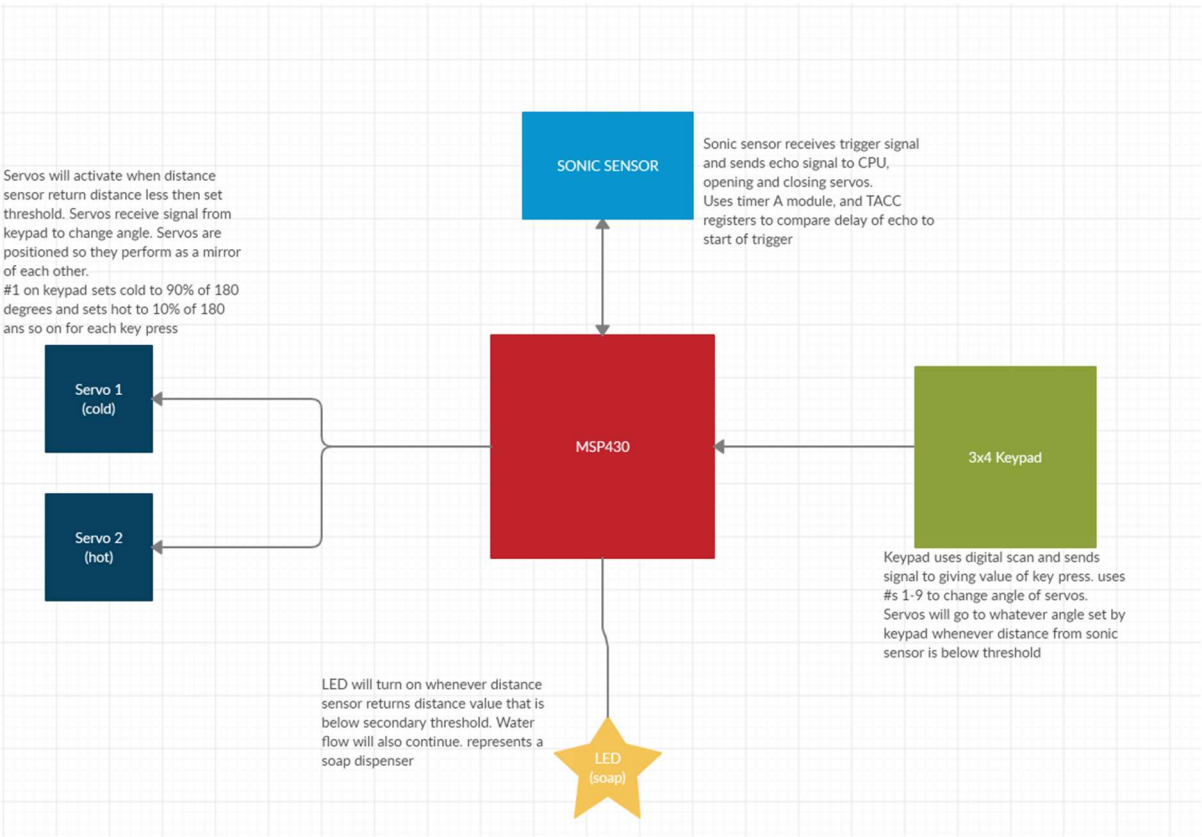
2.2 Project Requirements Not Met

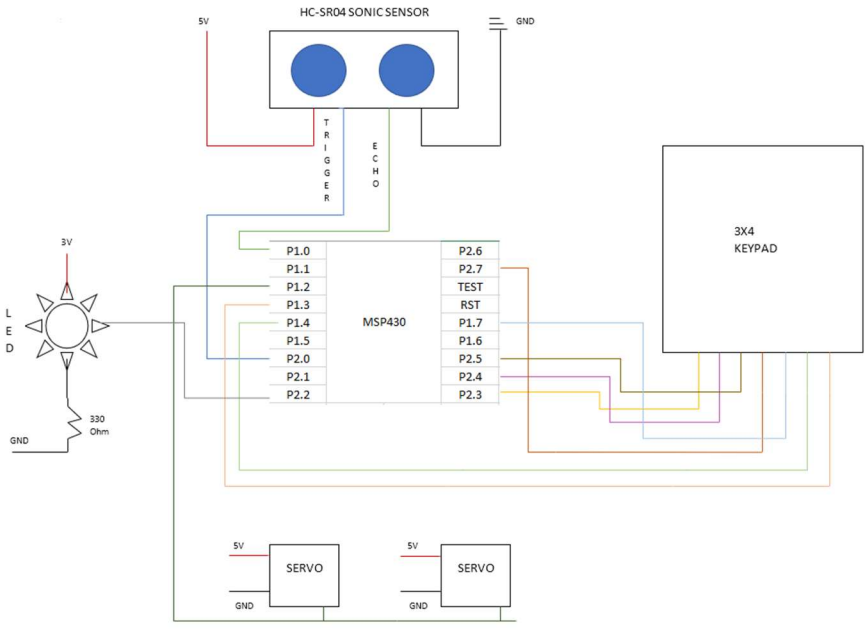
In the initial proposal, an LCD was going to serve as GUI for manipulation on the keypad and show water temperature, however do to the limitations of the MSP430, it would have required two microcontrollers to be used in unison through as UART connection, and due to time constraints and malfunctions with one of the microcontrollers the LCD was implemented.

2.3 Project Requirements Added

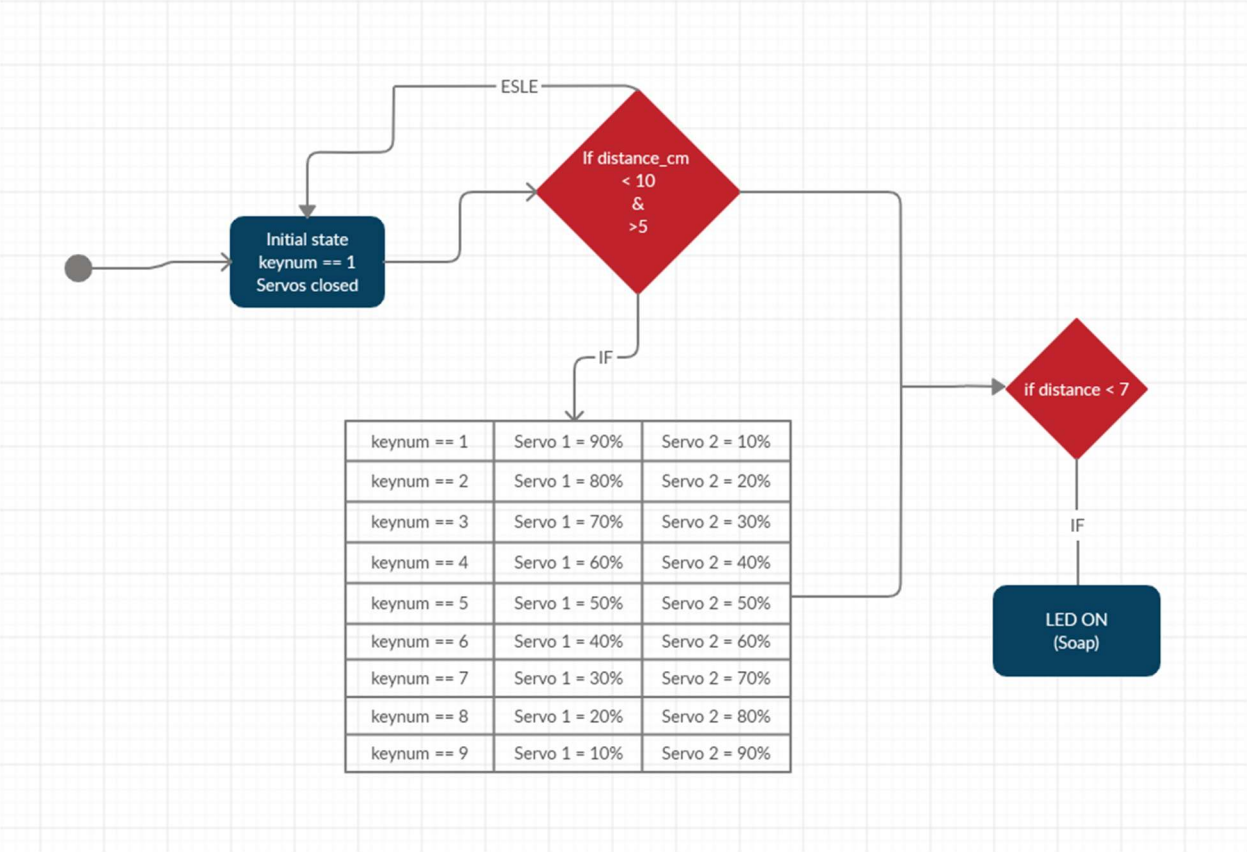
No requirements were added since the proposal.

2.4 System Diagram





2.5 State Diagram



keynum == 1	Servo 1 = 90%	Servo 2 = 10%
keynum == 2	Servo 1 = 80%	Servo 2 = 20%
keynum == 3	Servo 1 = 70%	Servo 2 = 30%
keynum == 4	Servo 1 = 60%	Servo 2 = 40%
keynum == 5	Servo 1 = 50%	Servo 2 = 50%
keynum == 6	Servo 1 = 40%	Servo 2 = 60%
keynum == 7	Servo 1 = 30%	Servo 2 = 70%
keynum == 8	Servo 1 = 20%	Servo 2 = 80%
keynum == 9	Servo 1 = 10%	Servo 2 = 90%

3 System Implementation

3.1 Hardware

- MSP430
  - Microcontroller used to interface each component
  - Pretested and calibrated by manufacturer
  - Provided by FAU engineering department
- HC-SR04 Sonic Distance sensor
  - Used to measure distance, three separate thresholds used
  - Integrated by direct connect to ports on msp430
  - Uses integrated resistors of MSP430
  - Used timer A module 1 for distance calculation
  - Tested and Calibrated using source code on code composer studio
  - Tested, Calibrated, and integrated by Dominic Robbins
- Micro Servo SG90
  - Used to represent valves
  - 2 in total

    - Manipulated by keypad and sonic sensor
    - Uses timer A module 0 for changes in servo angle.
    - Uses integrated resistors of MSP430
    - Tested and Calibrated using source code provided by instructor
    - Tested, calibrated, and implemented by Ricardo Salinas
- 3x4 keypad
    - Digital keypad used to manipulate servos for change in temperature
    - Tested and calibrated using source code provided by instructor
    - Tested, calibrated, and integrated by Ricardo Salinas
    - !! possible issue with 3x4 keypad, does not always work correctly!!

3.2 Software

All software, source code, and header files were developed on Code Composer Studio and were designed for use with the TI Msp430 microcontroller. The source code written was developed by both members of the team and some source code is inspired or repurposed code form code provided by the instructor, and by the “Programmable Microcontrollers” textbook. The msp340.h header file was provided by Code Composer Studio natively. All source code was written in the C programming language. All timers A values used for servo angles were found through trial and error.

3.3 User interface

The sonic sensor module will act as an interfacing module for common ever day usage. Through its three distance thresholds a user will be able to turn the device on or off, as well as dispense soap. The keypad provides and interface for temperature adjustment by changing the angle of the servos.

The device is initially configured for servo 1 (cold water) to be at a full 180 degree (100%) opening. The keypad will allow this to be changed by adjusting each servos angle. 10% for each number 0 – 10. At one cold water will be at 90% open and warm water would be at 10% open, etc.

3.4 Data Communication

The only data that will be stored in the last number entered on the keypad, and that will be store in a primitive which will be stored on a register of the microcontroller. As long as the microcontroller has power and isn’t reset the primitive value should hold. There is no outside communication.

4 Testing and Evaluation

4.1 Performance Assessment

Since the system was designed as a proof of concept, it was not tested with a real-world application. However, we still followed some metrics used for touchless sinks, such as responsiveness and ease of use. The procedure for testing was very simple: The tester would approach the unit as they would any other sink and pantomime washing their hands.

Through repeated testing, we found that the motion sensor to be very susceptible to movement and possible outside interference. It appeared to not work as well in a noisy environment then an environment that was quieter. This may be because of destructive interference of the sound waves produced and read by the sonic sensor. However, the sensor did work in a quiet environment quite well and was responsive to an object placed in front on it.

The servos also responded well to the signals from the keypad and moved smoothly and quickly to the programmed positions.

The 3x4 keypad was unfortunately a big area of unresponsiveness. After keypresses, the system would seem to get stuck and would only respond after repeated presses to force its response. The faulty keypad was a known issue by the professor. However, when the keypad does work the response by the system is smooth and speedy.

5 Budget

component	number	price	misc.
MSP-EXP430G2ET	1	24.99	Provided by FAU engineering department
Micro Servo SG90	2	2.50	Purchased from Amazon.com
HC-SR04 Sonic Sensor	1	1.99	Provided by FAU engineering department
Plastic enclosure	1	5.49	Purchased at Home Depot
3x4 Keypad	1	1.74	Provided by FAU engineering department

6 Project Management and Workload Distribution

Both Team members developed and debugged the source used in the final product. Team member Dominic Robbins was responsible for the final report and all that was required. Team member Ricardo Salinas ensured as components were connected correctly and was responsible for the completed construction of the final unit. Both team members worked on repurposing the plastic enclosure for the final product.

Team Member	effort
Dominic Robbins	50%
Ricardo Salinas	50%
total	100%

7 References

Google Patents, https://patents.google.com/patent/US8418993B2/en

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Ünsalan Cem, et al. *Programmable Microcontrollers: Applications on the MSP430 LaunchPad*. McGraw-Hill Education., 2014.