(1) Stopwatch

This project programs a stopwatch. Initially, use the 7 segment displays to display 00 for minutes and 00 for seconds. Use the LCD to ask the user to enter 4 digits using the keypad; two for minutes and two for seconds. Use one pushbutton to start the stopwatch. Once this button is pressed, display the 4 digits entered by the user by the 7-segment displays and start counting down. Use another push button for pausing and resuming the stopwatch. Once the 7-segment displays show 0000, run the buzzer for a few minutes. You may need SysTick for time multiplexing needed for the 7 segment displays.

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(2) Calculator

Use the keypad to get numbers and an operation from the user – use the LCD to ask the user to enter the numbers and operation and then display the result when the user hits a key in the keypad.

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(3) Marks and Grades Project

This project uses a processor to allow for user input of class grades to determine the letter grade and overall GPA for all classes.

Interface:

• One DIP switch is used to disable the LEDs. The "on" position allows the LEDs to turn on as specified below.

• Four pushbuttons are used to initiate and complete grade entry. One button allows for the Math grade, another button is for Science, a third button is for social studies and the last one is for English.

• Keypad allows for grade entry. The grade is a number between 0 and 100.

• Four LEDs are used for indicating the grade after it is input. One LED comes on when the grade is an A, another LED is on for a B, a third LED is on for a C, the fourth LED is on for a D, and none on for an F.

• The left 7 segment digit shows the grade input from the keypad after it is submitted displayed as a letter grade. 100-90 is an A, 89-80 is a B, 79-70 is a C, 69-60 is a D, and below 60 is an F. The digit should be displayed only after grade submission.

• LCD displays prompts for guiding the user, using either one or two lines as necessary. The LCD also displays the calculated GPA.

• The system state begins with the LCD displaying "GPA = #.#" on the first line and "Select a course" on the second line (# represents a decimal number). This is also referred to as the idle state. Each course should be initialized with a grade of 0. Thus, the initial GPA will be 0.0.

- Starting grade entry: during the idle state, the pushbuttons may be used to initiate entering the grade for each respective course. Once the pushbutton is pressed, the LCD should display "Enter _____ grade", where _____ represents the course selected (Math or science).
- The keypad is sampled continuously for each part of the decimal grade (for 94, 9 is entered first and 4 is entered last). Digits can be continuously added until the pushbutton for that course is pressed.
- If the grade is valid (meaning it is in the range of 0-100), the letter grade should be shown on the left 7 segment and the LEDs should display accordingly.
- If the grade is invalid, the LCD should display "Grade not valid" for 2 seconds, and prompt for re-entry of the grade.
- GPA calculations should be done after the grade is inputted for the course. Each course is weighted the same and is on the normal 4.0 scale. Again, each course is initialized with a grade of 0. There are only four courses.

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(4) A digital lock

Use the keypad to take a PIN number (4 digits) from the user and if the numbers are valid display a message on the LCD and turn LED0 on for 10 seconds. LED0 emulates the latch used to open the door. If the PIN is not true, display a message and use the buzzer to make a beep sound for 10 seconds. There should be a special PIN for the system administrator. When this PIN is entered, the administrator should be able (1) see all the PINs that can open the lock, (2) delete some PINs (3) delete all PINs (4) Add new PINs.

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(5) Digital Clock

This project programs a digital clock. Use two 7-segment displays for hours and use two for minutes.

You may need SysTick for updating the time and use the main program for time multiplexing of the 7-segment displays and also to check a DIP switch. If the switch is connected, that means the user wants to set the time. In this case use the LCD to ask the user to input the time and use the keypad to input the time. Run the clock starting from this time when the DIP switch is disconnected.

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(6) Temperature controller

Write a program to control a room's temperature by turning an air conditioner on or off. The room's temperature is measured by a digital sensor emulated by three dip switches. The sensor's measurements are digital. They can take values from 000 to 111 based on the status of the switches. The air condition can be turned on by outputting one to PA12 (LED0 pin) and turned off by outputting zero at the same pin. If the LED is on, that indicates that the air conditioner is on. Use another DIP switch for on/off of the system. If the switch is on, the LCD should display

"System is on" in the first line and the current room temperature measured by the sensor. You need to continuously update the displayed temperature. If the switch is off, the temperature controller should not work. This means the LED and the air conditioner are off and the LCD shows "System is off". Turn the air condition off when the room temperature is less than the set point and turn it on when the temperature is more than the set point. Use three DIP switches to allow user to input the setpoint in binary. Alternatively, you can use the keypad to input the set point.

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(7) Self Checkout at a Super Market

Aim: To model a self-checkout counter at a supermarket that is capable of:-
   • Scanning through the items and identifying it.
   • Deciding if it is vegetable/meat, thereby weigh it.
   • Compute and display the final total of the products.

Assumptions
   • A table of the different items, their prices and barcodes, is specified.
   • Each Message on the LCD screen should be on for 3 seconds before clearing off.

Procedure Details
   • Start with LCD screen "Scan the item"
   • Enter the two digit barcode of the item using the keypad in decimal.
   • If a Barcode that is not present in the given table is entered, the LCD screen should display "Wrong Code" and then go back to the message "Scan the item".
   • Display the item name on the LCD screen and the price or price per pound.
   • Check if the item falls into the category of either meat or vegetables.
   • In case of meat or vegetables scanned
         o LCD Screen should display "Weigh the item".
         o Enter the weights through the keypad and display it on LCD, in integer pounds in decimal. The acceptable range of weight is 0-9 pounds. Any weight that is entered outside this range should display a message "Error" on the LCD screen and then go back to the message "Weigh the item".
         o The total price for that particular item is calculated and displayed on the LCD.
   • After scanning the item displaying its name and price, place the item in the bag.

• The Total in dollars (the sum of all the prices of various items scanned till that point) is displayed as "Total Amt= XX" on the LCD screen for 3 seconds and the message "Scan the item" should come up.

Table of Prices and Bar codes

Bar Code	Name of the Item	Price (Per pound in case of meat or vegetables)
11	Pen	$ 1.00
12	Table Lamp	$14.00
13	Travel Bag	$56.00
14	Tennis Racket	$22.00
15	Radio	$25.00
16	Box	$11.00
17	Shoes	$37.00
18	Shirt	$18.00
19	Camera	$89.00
20	Potato	$3.00
21	Carrot	$2.00
23	Chicken	$5.00
24	Beef	$4.00
25	Fish	$6.00

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(8) Distance Meter

Use an ultrasound transmitter and receiver to measure the distance to the nearest object and display the measurement by the 7 segment or the LCD. The measurement should be continuous. To program this project, you need to the learn the input capture functionality that is explained in chapter 5.

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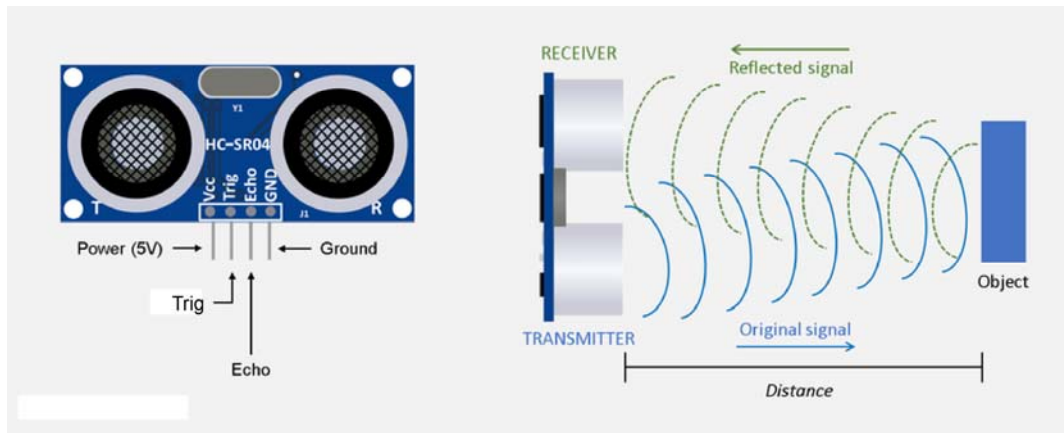
(9) Playing Songs

Allow the user to scroll a list of songs on the LCD by pressing a pushbutton. Use another pushbutton to confirm the selection of a song. Play the song and then wait for a press on either button. There are many online sources explaining how to generate different tones using the buzzer. Examples

https://energia.nu/guide/tutorials/other/sidekick/sidekick_piezobuzzer/

https://www.programming-electronics-diy.xyz/2021/02/playing-music-and-tones-using-piezo.html

https://dragaosemchama.com/en/2019/02/songs-for-arduino/

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(10) Microwave Oven Controller Project

Aim: This project simulates the embedded controller in a microwave oven.

Assumptions and Requirements:

• All cooking times are sped up to make debugging and demonstration times more reasonable.

• Input occurs via the keypad (0 - F).

• Displays on LCD and 4 7-segment displays.

• The entered and remaining cooking time counts down and is displayed on the four seven segment digits as minutes and seconds. For example: 27:11.

Procedure Details:

Use the LCD to ask the user to use the keypad to select what he wants to cook.

• If A is pushed on the keypad (for popcorn), the LCD should show "Popcorn" and then cook for 1 minute while the remaining cook time counts down on the digits, then clear the LCD after cooking completes.

• If B (for Beef) or C (for chicken) is pushed on the keypad, the words "Beef weight?" or "Chicken weight?" (respectively) should appear on the LCD. After that, the user must enter an integer

value between 1 and 9 on the keypad to indicate how many pounds are there to be defrosted. Note that only whole pound values are to be entered. After a valid number is entered, clear the LCD display and show the value of the weight on the seven segment digits for 2 seconds, and then start cooking while the remaining cook time counts down on the digits.

- o Beef is defrosted at a rate of 0.5 minutes per pound.

- o Chicken is defrosted at a rate of 0.2 minutes per pound.

- o If an illegal number is entered, then the LCD should show "Err" for 2 seconds, then show previous message.

• If D is pushed on the keypad, the words "Cooking Time?" should appear on the LCD. After that the user can enter a value between 1 and 30:00 to indicate the cooking time required in minutes and seconds. This value is displayed on the seven segment digits as it is entered, right to left. For example, pressing 1 displays 00:01, then pressing 2 displays 00:12, then pressing 4 displays 01:24, then pressing 5 displays 12:45.

After cooking is done

• When the microwave completes its function and timer has counted down to zero (regular timed cooking or defrosting), the speaker should produce an audible tone during this 3 second time period.