TI Kits

In-Class Activity: TI Kits – Taum Sauk Part 2

PURDUE UNIVERSITY | School of Engineering Education

In-Class Activity: Overview

Design a simple early-warning system to help prevent a Taum Sauk–style incident. You'll complete two TI Kit mini-activities that build toward the final system:

1. **Buzzer + Selection Structures**
   - use `if/else` structure to create alert patterns
2. **Ultrasonic Ranging**
   - measure distance using ultrasonic range sensor and read the distance from 4-digit display
   - integrate ultrasonic ranging and selection structure to trigger the buzzer when objects get too close
   - test system accuracy by examining the % error and SSE

Before we start

Download the following files from here

- Download Taum Sauk – Part2 Sketchbook
- Download .xlsx and .docx files

Objective

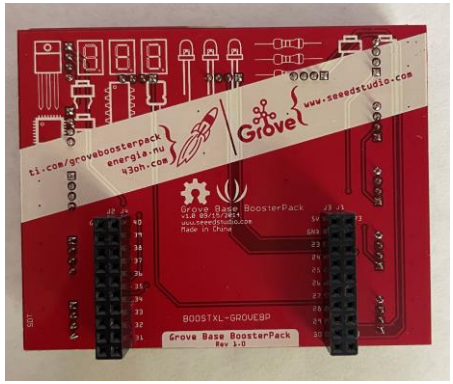
Our goal is to **design an early warning system** for Taum Sauk Reservoir.

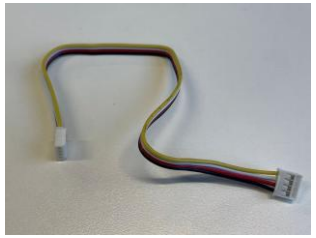
Therefore, in this activity…

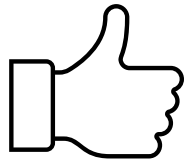
1. You will see how distance is measured using ultrasonic sensor and how it is read from the 4-digit display.
2. Then, you will integrate ultrasonic ranger with buzzer warning to make an early warning system.
3. Finally, you will test the system's fidelity by conducting some error analyses.

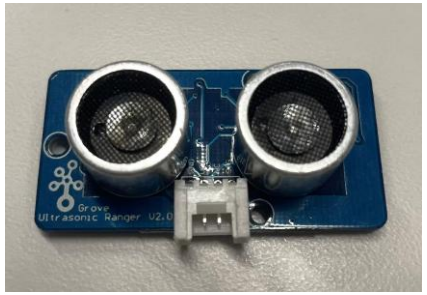
What you will need in this activity

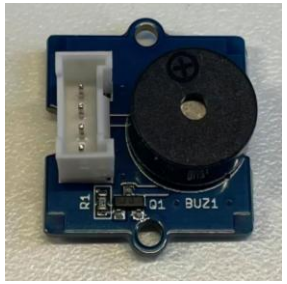
- TI MSP430 Board
- Grove Base BoosterPack
- 4-Pin Wire x 3
- Buzzer
- Ultrasonic Sensor
- 4-Digit Display
- Micro B Cable
- Ruler
- Index Card
- Energia
- Download Class 5A Sketchbook

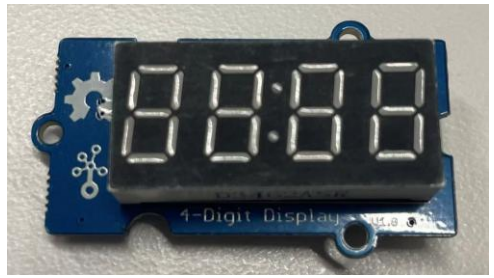












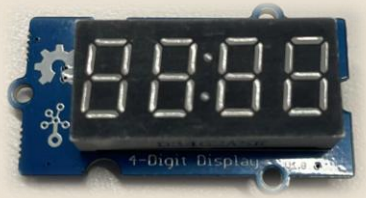
Introducing our new sensors

Ultrasonic ranger is a sensor that measures distance using sound waves:

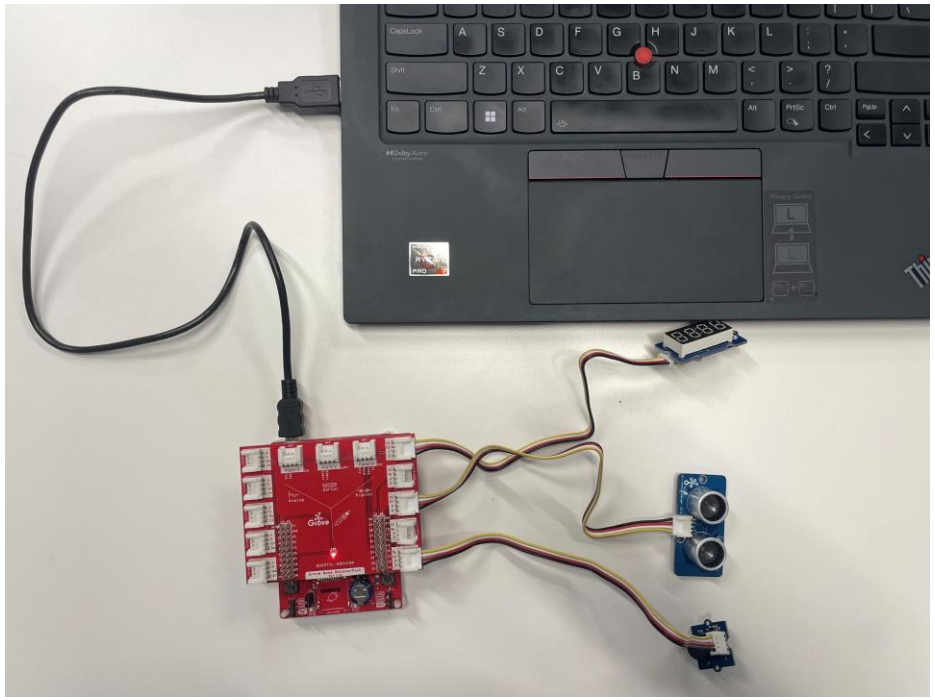
similar to how bats navigate in the dark. It sends out an ultrasonic “ping” (a sound too high for humans to hear), waits for the echo to bounce back from an object, and then calculates the distance based on the time it takes for the sound to travel.

4-Digit Display is a simple screen made of four connected seven-segment LEDs:

the same kind you see on alarm clocks or microwave timers. Each digit can show numbers (0–9) and some letters by turning specific LED segments on or off.



Early Warning System: Preparation

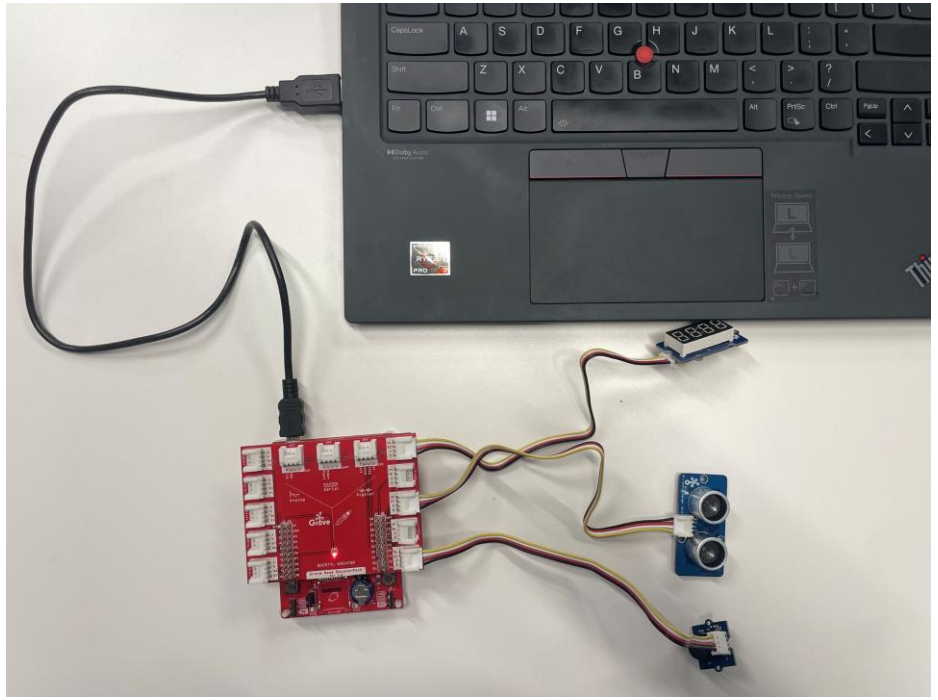


Task 1: Draw (by hand or via a computer) a block diagram of the microcontroller set up shown in the picture.

Task 2: Draft the pseudocode needed for a warning system to sound a buzzer when something gets closer than a given distance in your answer document.

Early Warning System: Sanity Check

- **Step 1**: Connect the everything as shown on the right.
- **Step 2**: In Energia,
  - Navigate to sketchbook → Class 5A → `warning_system`
  - Run the code to see if
    1. 4-Digit Display lights up,
    2. The number shown on 4-Digit Display changes as you move your hand up and down above the ultrasonic ranger.



Early Warning System: Integration

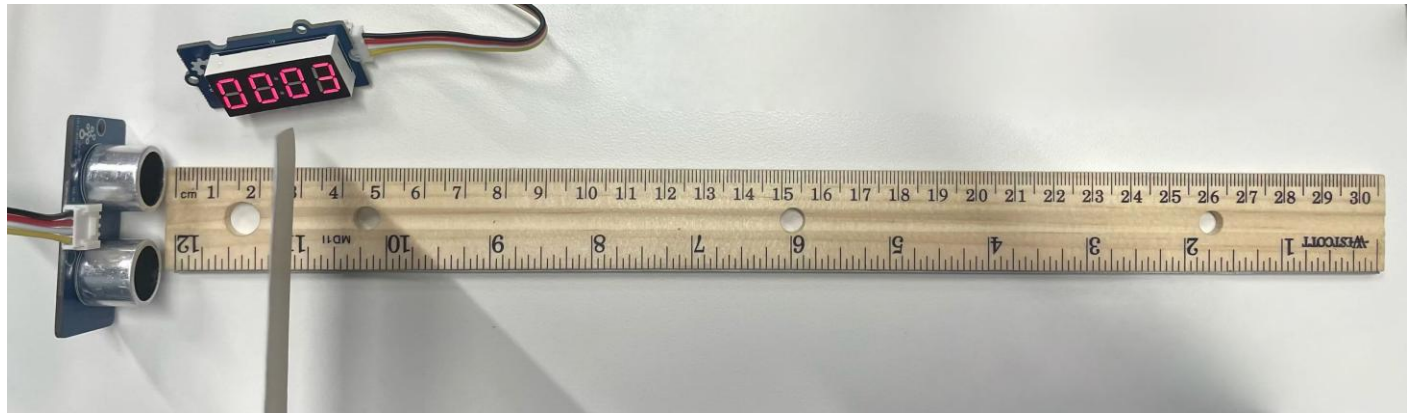
- **Step 3**: In `warning_system` file,
  - Task 3: In where it is indicated (3 places), modify the code and add a selection structure (if-else statement) that makes sound when an object gets too close.

    Hint: define a reasonable threshold, turn on buzzer when distance is below the threshold, vice versa.

Early Warning System: Fidelity Test

- **Step 4**: Collect data

1. Place a ruler on the table with your Ultrasonic Range Sensor sideways as shown below.
2. Place an index card at the end of the ruler and slowly move it towards Ultrasonic Range Sensor, when the buzzer goes off, stop moving your hand and measure how far from the sensor it is. Repeat this measurement 10 times.



Task 4: Record the data to the excel file and complete the error analysis.

Error Analyses

Task 5: Comment on your results.

Collect 10 data points and calculate the percent error and Sum of Squared Error for each point.

a) Record each measurement for when the buzzer sounds.

b) Calculate the percent error for each measurement using the following formula:

$$\%\ Error = \frac{Measured\ Value - Theoretical\ Value}{Theoretical\ Value}$$

c) Calculate the Sum of Square Error (SSE) using the following formula:

$$SSE = \sum_{i=1}^{n} (Theoretical\ Value - Measured\ Value)^2$$

Submission Instructions

Download the following files from here

- **ENGR131_ICA_YourName.pdf** *(Background and Instructions – do not submit)*
- **ENGR131_ICA_YourName.xlsx** *(For Calculation– do not submit)*
- **ENGR131_ICA_YourName.docx** *(Answer Sheet – to complete & submit)*

- Complete the **.docx** file with your answers.
- Submit **only the .docx file** on **Brightspace > Content > In-Class Activity Drop Box.**