runlinc Intermediate Project 4:
Fluid Level Sensor (STEMSEL Version)

Contents

Introduction

Problem

Water is a very precious resource and we want a way to keep track on the water level in tanks, troughs or river levels. Not keeping track of water can lead to water mismanagement which can have dire consequences. Such as flooding and drought. But for now, lets help create a simple water level sensor system for farmers to help farmers know their water tank's water level.

Background

For this project, we will use a characteristic of water which is that water can conduct electricity. Generally, if two conductors are not connected and have a gap between them the circuit of the conductors has no current. Therefore, knowing that water can conduct electricity, we can connect the two conductors within the water. So, using the principle that if the circuit is closed, conductors connected, then we know that at that level where we place the conductor there still have water.

However, because electricity can ignite or cause reaction with some fluids, and additionally, many liquids do not conduct electricity like water; therefore, using fluids as a conductor is generally not implemented, but the principle behind this idea is used.

Ideas

What do we have that can be used to indicate the level of a tank? Let's say the tank only has three levels; full, low or empty. How could we distinguish between these levels? What do we have that could be used to indicate for the farmer what level the tank is currently at?

Plan

Main:

To represent a tank, use any container or a cup that can be easily modified, but we highly recommend the use of a cardboard cup. For this project, we will assume you will use a cardboard cup.

On the cup, mark a line about halfway up the cup. Poke a hole (as small as possible) to the marked area then thread a short length of wire, with some length of coating removed, through it (the length of the threaded wire through the hole should be less than the radius of the marked area). Plug any open spaces with play dough, blue tack, or tape. Do the same for another wire but below the marked area, ideally the bottom of the cup. The marked wire is the receiver, while the wire below the marked area is the transmitter.

With this setup, which can be visualized in Figure 1, we can slowly pour water into the cup. When the water is above or on the mark, the Green LED will be turned on while the Red LED is off to indicate that the tank has a fluid level above the mark. If the fluid is below the mark, the Green LED will be turned off while the Red LED will be turned on to indicate that the tank has a fluid level below the mark.

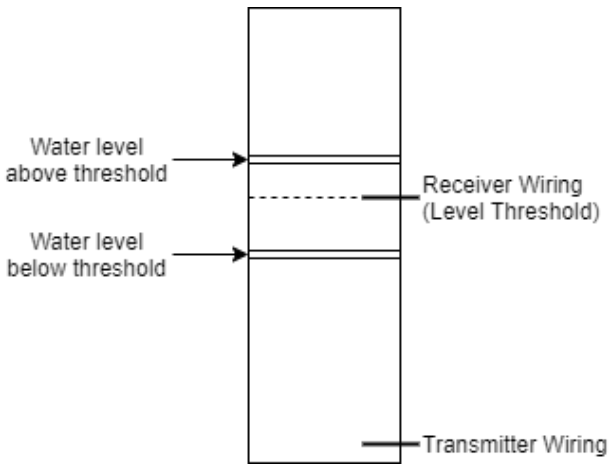


Figure 1 Visualization of Main Setup

Extension:

For the extension, we will need a new cup. This time we will need 4 receivers. We will implement the following water level indicators using its respective margin range for this project as followed in the table below:

Level Indicator	% Margin Range	Condition	LED
Full	95%~100%	Above or Equal Top Receiver	Green
Nearing Full	80%~95%	Above or Equal Lower Top Receiver	Green Yellow
Adequate	20%~80%	Above or Equal Upper Bottom Receiver	Yellow
Nearing Empty	5%~20%	Above or Equal Bottom Receiver	Yellow Red
Empty	0%~5%	Below Bottom Receiver	Red

Use the same method in the previous setup to install the wires to the cup. The level to install the wire from the base to the top is roughly 5% (bottom receiver), 20% (upper bottom receiver), 80% (lower top receiver), 95% (top receiver). For example, if your cup is 5cm tall, then install the bottom receiver at roughly 0.25cm away from the base, then install the upper bottom receiver at roughly 1cm away from the base, and same applies to the top receivers. Then install the transmitter below the bottom receiver. You can visualize the setup in the following Figure.

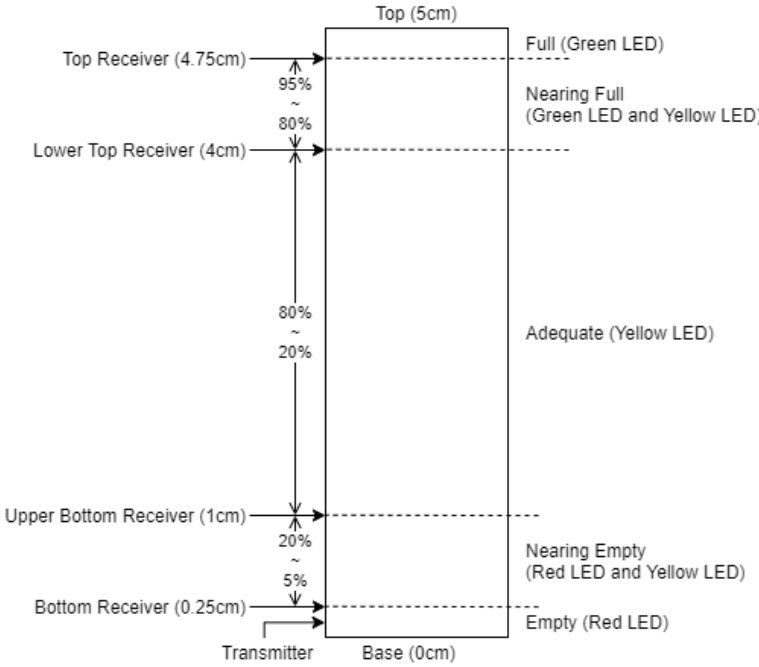


Figure 2 Visualization of Extension Setup for 5cm cup

runlinc Background

Runlinc is a web page inside a Wi-Fi chip. The programming is done in the browser and sent to the chip over Wi-Fi. The runlinc web page inside the Wi-Fi chip will command the microchips to do sensing, control, data logging Internet of Things (IoT). It can predict and command.

Part A: Design the Circuit on runlinc

Note: Refer to runlinc Wi-Fi Setup Guide document to connect to runlinc
Use the left side of the runlinc web page to construct an input/output (I/O).

In our circuit design,

- C7 -> ANALOG_IN: Receiver
- C3 -> DIGITAL_OUT: Yellow
- C4 -> DIGITAL_OUT: Transmitter
- C5 -> DIGITAL_OUT: Red
- C6 -> DIGITAL_OUT: Green

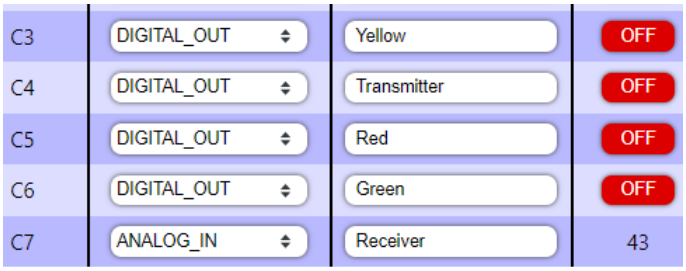


Figure 3 Expected I/O Configuration.

Part B: Build the Circuit

Use the runlinc I/O to connect the hardware. Remember that turning the screws clockwise will close the clamps and turning the screws anticlockwise will open them. All black wires should go in the negative (-) terminal, red wires go in the positive (+) terminal, and white wires go in the terminal we designated in the runlinc web page port.

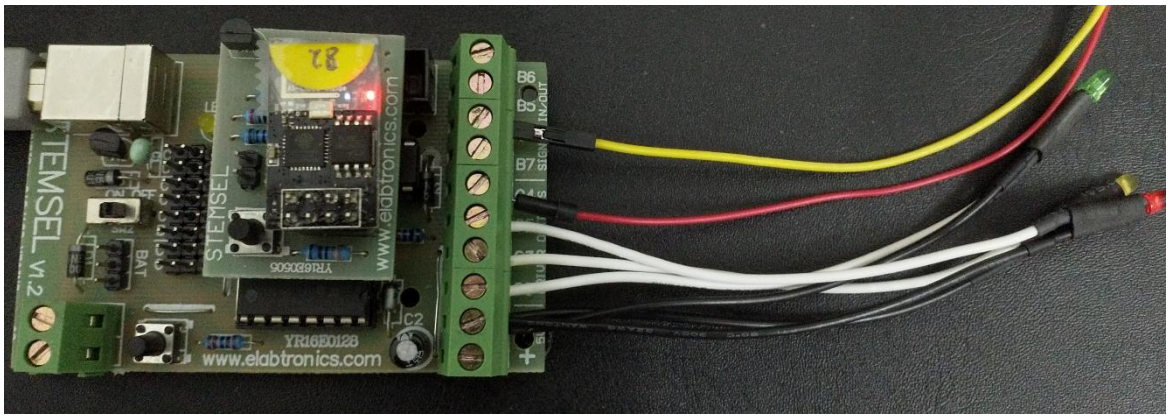


Figure 4 Circuit connection on STEMSEL.

Wiring Instructions

- Connect All White Wires to their Respective Pins
  - Green LED -> C6
  - Yellow LED -> C3
  - Red LED -> C5
- Connect All Black Wires to negative (-) terminal.
- Connect Wires on Respective Pins:
  - Receiver -> C7
  - Transmitter -> C4

Yellow LED will not be used in Main Section of the project, it'll be used in the Extension.

Part C: Program the Circuit

HTML

We will first set up our HTML page to receive information about the fluid level.

Let's set up the page to have text aligned to the centre with a title: We will add a status text after <h1></h1> that will have their equivalent LED shine.

```
<div style="text-align:center">
  <h1>Fluid Sensor Dashboard by runlinc</h1>
  <br>
  <br>
  Current Status: <font id="Status">Water Level Sensor is loading...</font>
</div>
```

JavaScript

We will do some basic setup on the JavaScript block.

1. We will initiate the threshold voltage. This threshold voltage is used to determine if the receiver has formed a closed circuit with the transmitter by comparing its voltage to its minimum threshold voltage. Since runlinc input use 0-255 range for 0-5V range then we use 51 times 4V for the threshold voltage. And turn on the transmitter.

```
var thresholdVoltage = 4 * 51;
turnOn( Transmitter );
```

JavaScript Loop

Now we will implement the measuring and analyzing functions for the sensors.

1. Within the JavaScript Loop block, let's code the receiver's value.

```
receiverValue = analogIn( Receiver );
```

2. Now we will compare the value to the threshold. If it is bigger or equal to the threshold, then turn on the Green LED and turn off the Red LED and announce the change to the status that the fluid is over the threshold. On the contrary, if it is below the threshold, add some delay to prevent overloading of the chip.

```
if(receiverValue >= thresholdVoltage){
   turnOn( Green );
   turnOff( Red );
   document.getElementById("Status").innerHTML = "The water level is above the
marked level.";
}else{
   turnOn( Red );
   turnOff( Green );
   document.getElementById("Status").innerHTML = " The water level is below  the
marked level.";
}
await mSec(500);
```

Now you can test out the sensor system. You can play around the system by moving the threshold level around by changing the level where you place the receiver.

Expected runlinc code and web page:

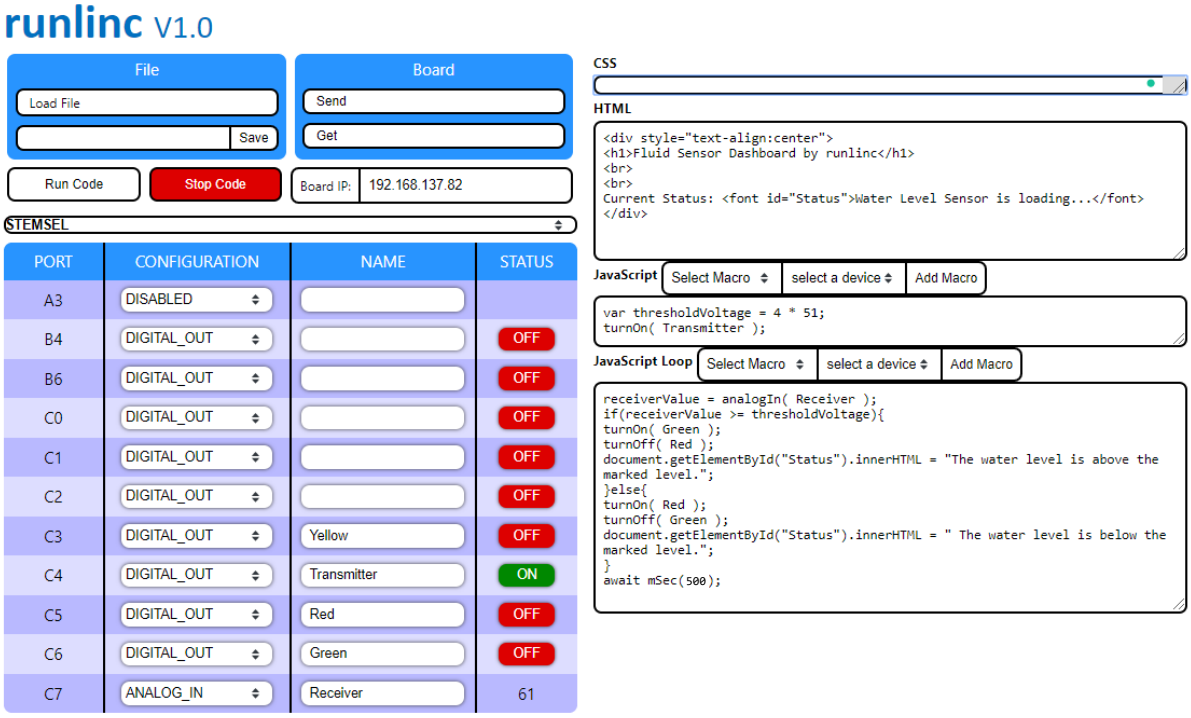
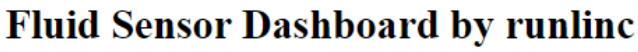


Figure 5 Expected runlinc



Current Status: Water Level Sensor is loading...

Figure 6 Expected website.

Extension

You may continue to the extension portion. For this extension, we will add another receiver to the runlinc STEMSEL board. You will see that the runlinc does not have analog input pins on the screw terminals except for C7. Therefore, you will have to use a wire that has a pin connector to connect to the pin section near the USB/Power source area. Find C1, C2, B4 and their respective row, plug the connector to the pin nearest to the microchip or in other words, furthest from the label. Like Figure 7.

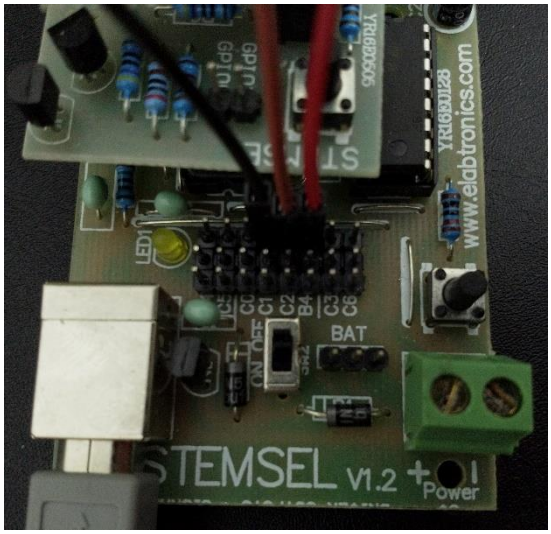


Figure 7 Extension Circuit Connection.

Changes to the I/O on runlinc:

- Reconfigure C7 -> ANALOG_IN: BottomReceiver.
- Configure C1 -> ANALOG_IN: TopReceiver.
- Configure C2 -> ANALOG_IN: LowerTopReceiver
- Configure B4 -> ANALOG_IN: UpperBottomReceiver

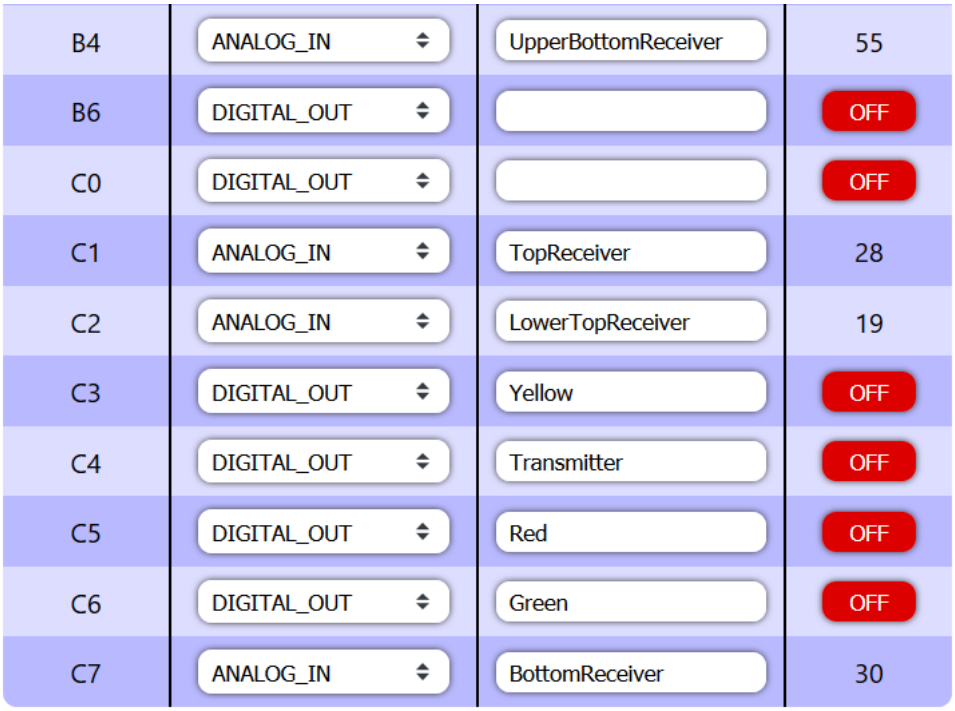


Figure 8 Extension New I/O Configuration

JavaScript Loop Changes

We will re-code the block.

1. Instead of one analogIn like in the main portion, we'll need 4 distinct analogIns.

```
receiverTValue = analogIn( TopReceiver );
receiverLTValue = analogIn( LowerTopReceiver );
receiverUBValue = analogIn( UpperBottomReceiver );
receiverBValue = analogIn( BottomReceiver );
```

2. We will now start checking the fluid level of the cup. First, check if the cup is full. If it is full, light up Red LED and change status. Continue to next step if not full.

```
//Checking Threshold from Top to Base
//Check if full
if( receiverTValue >= thresholdVoltage ){
  turnOn( Red );
  document.getElementById("Status").innerHTML = "The tank is CRITICALLY FULL.";
}else{
}
```

3. Now inside of the else bracket from the end of step 2, check if the cup is near full. If it is full, light up Red LED and Yellow LED and change status. Continue to the next step if it is not near full.

```
//Check if near full
if( receiverLTValue >= thresholdVoltage ){
   turnOn( Red );
   turnOn( Yellow );
   document.getElementById("Status").innerHTML = "The tank is NEAR FULL.";
}else{
}
```

4. Inside the else bracket of near full, check if the cup is at adequate levels. If it is adequate, light up Yellow LED and change status. Continue to the next step if it is not at adequate levels.

```
//Check if adequate level
if( receiverUBValue >= thresholdVoltage ){
   turnOn( Yellow);
   document.getElementById("Status").innerHTML = "The tank is at acceptable
levels.";
}else{
}
```

5. Within the final else bracket of adequate level, check if the cup is at near empty levels. If it is near empty, light up Yellow LED and Green LED and change status. At this step, if it is not near empty, then it is empty, light up Green LED and change status.

```
//Check if near empty
turnOn( Yellow );
turnOn( Green );
document.getElementById("Status").innerHTML = "The tank is NEAR EMPTY.";
}else{
   turnOn( Green );
   document.getElementById("Status").innerHTML = "The tank is FULLY EMPTY.";
}
```

6. Now outside of the if-else statement block and back to the main portion of the JavaScript Loop, we will need to add some delay and then turnOff all of the LEDs.

```
await mSec( 500 );
turnOff( Red );
turnOff( Yellow );
turnOff( Green );
```

Expected runlinc page and code for extension:

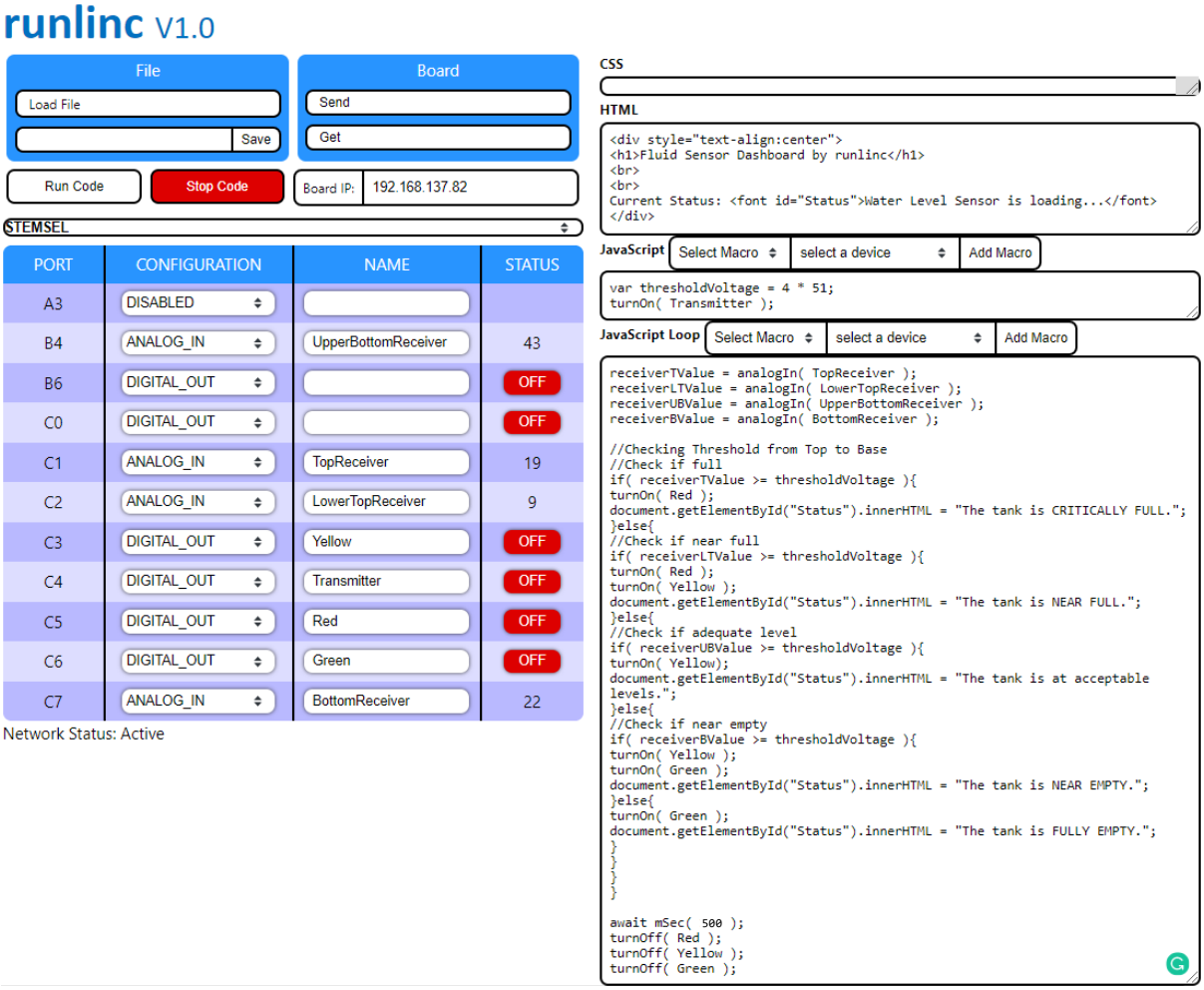


Figure 9 runlinc page and code.

There is no change to the website.

Challenge

Although warning lights are good to notify someone if their tank is running low, they might not always see them with all the other lights and notifications on a dashboard. What other notifications are there? Add either code or hardware that would give the farmer another form of feedback besides visual to warn them their tank level.

Summary

By using some wires, LED's and a microchip, we were able to measure the level of fluid in a cup. During this project, we learned how can we use the microchip to compare the voltage of wires in a liquid. Although this project only used a small cup, the principles can be applied to a fluid tank. This is a connection of STEMSEL. A small project that teaches how to turn some LED's on and off and program a microchip can be applied to real-world applications to improve the industry and improve the lives of people around the world.