Plantasia
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CART 360 - Tangible Media
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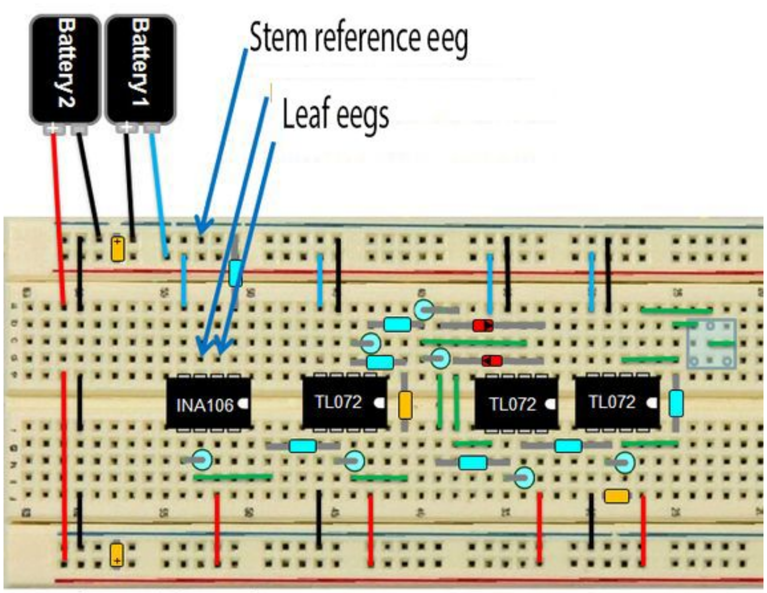
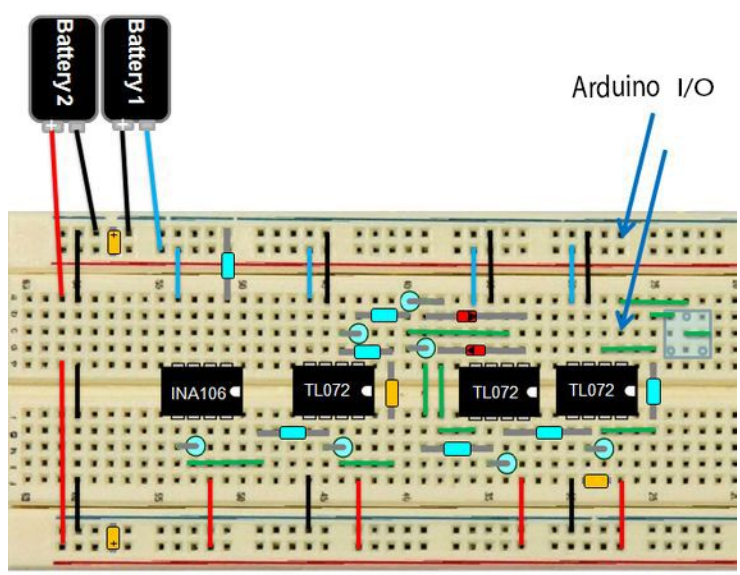
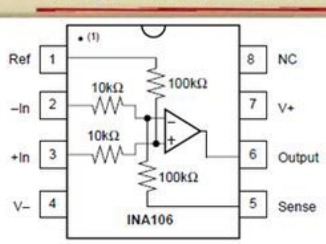
Project Basics

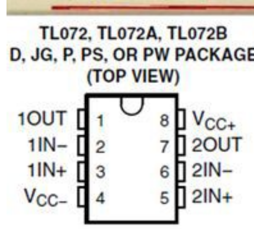
The goal of our sensor project is to read differential micro voltages from a live plant. To do this we will be using a non traditional analogue sensor that we ourselves have built on a breadboard. The part of this sensor will be the differential amplifier which takes two input voltages and outputs the difference between the two using a reference line connected to ground. The micro voltages will be read from the plant leaves while the reference will be on the stem of the plant using eeg biomedical pads. The pads sense voltage from the surface (although traditionally intended for skin) and connect to an alligator clip / through-hole into the breadboard. The differential op amp supplies the needed voltage to monitor the plant via the electrodes while the three additional op amps provide a series of signal smoothing.

Circuits









Design

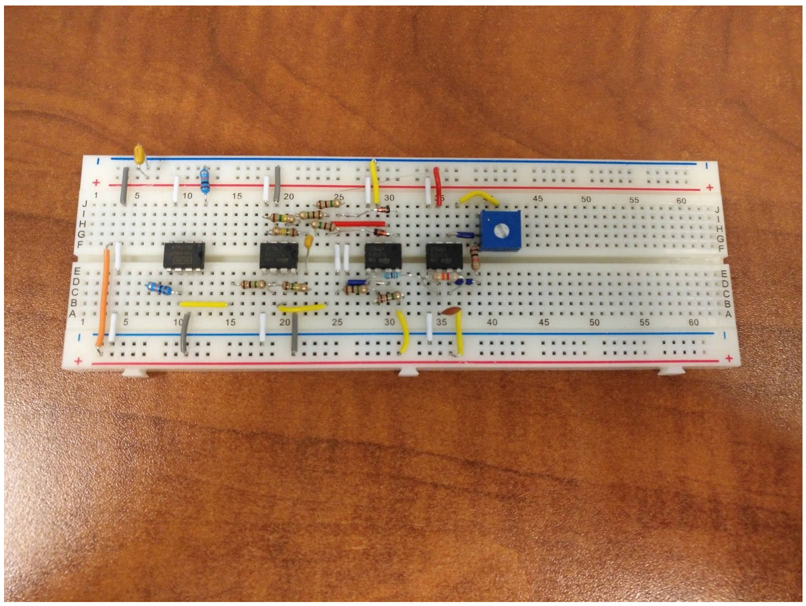
The plants I will be using come from my home houseplant collection. It has been cut, grown, and nourished from day one under my care so it can be easily ported harmlessly to this project as I know it well. The electrodes are non-invasive and do not harm the plant.

The sensor monitors voltage differences across the plant, but why is this important and how can it be given purpose? The design does not just exist for a simple signal reading off the plant, the circuit actually gives us live feedback on the plants health. The feedback will be patched into Max (more below) to create audible tones that vary with different conditions, including touch. Due to the versatility of sound the project can be taken in a few directions. For the purpose of this project I'll be investigating two. Firstly, the plants capability to give the gardener live feedback of their garden, secondly to perform. Attaching many plants to the circuits built in this project and routing them all to Max one can achieve a home "orchestra" of their garden providing a new way to interact with plants. For example, when light intensity changes, voltage changes. When ionic conditions in the water/soil change, voltage readings fluctuate. When the plant is injured, voltage may either drop or increase depending on the nature of the injury. In nature plants can communicate through hormones telling neighbouring plants if there's a threat - assuming one can get these hormones they could either stimulate this response or simple use this response in a garden setting (invasive pests). On the performance side all that changes is the nature of how one is interacting with their plants. The sensor gives a new voice to a traditionally non-communicative lifeform.

I can turn these voltage differences into music via serial communication in Max. The differences can control amplitude, modulate filters/envelopes, or change frequency speed of the designated oscillators (one per plant). Each plant would be assigned their own tone across a wide spectrum of octaves. Personally in concept I would assign lower tones to larger plants as a more bass/low sound for me signifies a larger size, while the smaller plants would be up in the higher octaves. All of these differences would reflect the state of the plant - lower voltages (symbolic of injury or low light conditions) would lower the frequency and create a darker, more melancholic sound. Depending on how many plants one has, the condition of their garden, or the state they want to monitor the serial values can be adjusted to control different settings to avoid confusion, by this I'm mainly referring to sound summation. Like an additive synthesizer, when many tones are summed together they can blend into one sound to the human ear dominated by the loudest tone (fundamental frequency). To avoid this one can assign the values to, for instance, detune a certain tone which will be perceived as a note falling out of the sonic blend. It may also be beneficial to have many speakers, one close to each plant to help the ears differentiate their tones.

Implementation

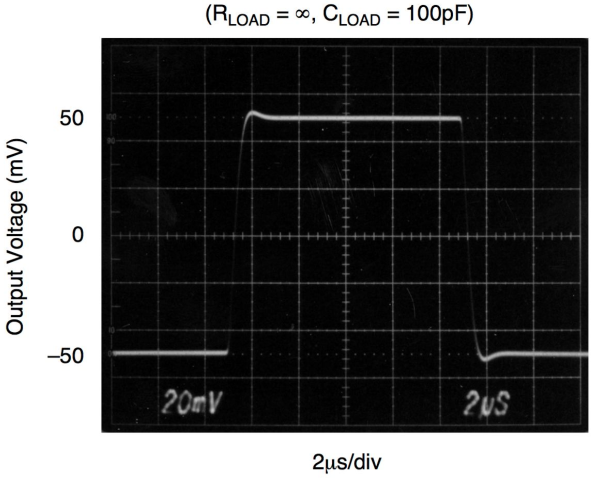
The circuit I have built is identical to the one seen on the fritzing diagram above and shown on the image below. Arduino usage in this context is fairly simple, the Arduino captures the analogin values and sends them to Max via serial communication (IC2). Most of the processing code is done in Max. A more detailed storyvoard can be seen in the project video here: https://vimeo.com/240433894

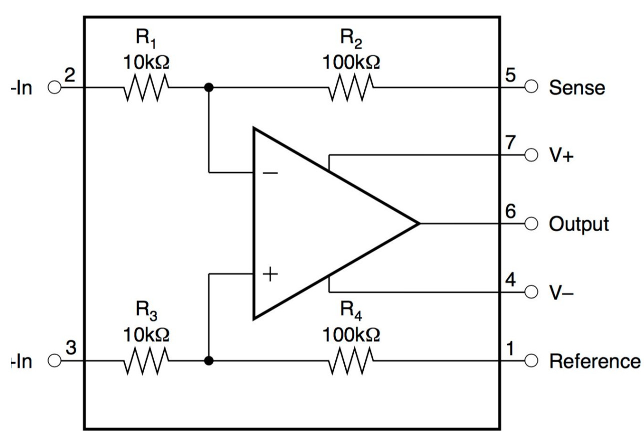


Sensor Research

1) INA102 Differential Amplifier:
    a) +- 18V power rating.
    b) Resistance (see right).
    c) Response (see left).

SMALL SIGNAL RESPONSE
($R_{LOAD} = \infty$, C_{LOAD} = 100pF)





2) Flora Accelerometer

a) 2.4 - 3.6V power rating.
b) Signal change depends on varying DC amplitude.
c) Signalling via SPI/IC2 interface
d) Signal range from 60-1700 mg (Force = mass*gravity)

3) 1375-ADA Touch Sensor

a) 1.8-5.5V power rating
b) Optimal resistance value is 100kOhms
c) Range of 20-220 kOhms with varying power