How PlantWave Works - in depth technical overview

PlantWave captures biorhythmic signals from the plant, a series of natural cycles and physiological processes and translates them into notes and control values, that over time, result in sound resembling music. Here’s how it’s done.

Sensor Input

PlantWave uses two electrodes attached to the surface of the leaves of plants. That allows for the measuring of electrical impedance measured by pulse width.

Measuring Electrical Impedance: By sending 3v of electricity through the plant (about the same as two AA batteries) the device measures changes in the plant's electrical impedance. Impedance can be thought of as resistance, or how much of that 3v of electricity makes it from one part of the plant to the other. This changes over time based on the amount of electrical connection between the two points in the plant. These changes can be influenced by internal factors such as water content and cellular activities or external stimuli like light and temperature.

Modulating Pulse Width: As the impedance fluctuates, it modulates the pulse width of a 555 timer. The 555 timer, a classic electronic component, is instrumental in this process. As the plant's electrical impedance changes, the timer adjusts the duration of its output pulses. In simple terms, the variations in the plant's impedance modulate pulse widths or time intervals. This modulation, driven by the plant's biorhythms, forms the basis for the musical notes and control signals generated by the system.

Data Analysis

Sensor input data is analyzed in order to get an understanding of the amount of changes in impedance of the plant.

Snapshots: The modulating pulse width is continuously measured in microseconds. Over time, the device takes snapshots of these modulated pulse widths, collecting them in groups of 10 for analysis. It’s important to note that the amount of time it takes to collect 10 samples varies based on the pulse width of the 555 timer, which is determined by the amount of change in impedance.

Average Pulse Duration: The device then calculates the mean duration of the pulses from a snapshot (collection of 10 samples) to determine a central tendency in the data. This mean serves as a representative value for the current state of the plant's biorhythmic signals.

Delta: Additionally, the device determines the delta, or the difference between the maximum and minimum pulse widths in the snapshots, to gauge the extent of variation in the impedance.

Mapping to MIDI

Analyzed data gets translated into MIDI. MIDI (Musical Instrument Digital Interface) is a protocol used to communicate musical information between devices. Each MIDI message consists of a series of numbers that represent various musical parameters like note pitch, velocity (how hard a note is played), and control signals.

Mapping to MIDI Notes: The device then translates the average pulse duration to a MIDI note between 0 and 127 using a mod128 function. A shorter average pulse duration, will result in a higher note. A longer average pulse duration will result in a lower note.

Mapping to MIDI CC: The device also translates the delta to a MIDI CC message using a mod128. MIDI CC can control anything from effect knobs, arpeggiation rate of notes, or even what instruments are played by those notes.

MIDI to Sound

Sending to the Sound Engine: The MIDI Note and MIDI CC messages are then sent to our sound engine, which has instruments we've designed for plants to play. This sound engine is highly configurable and allows us to scale MIDI to a key, route the data stream to multiple instruments at once, arpeggiate each instrument differently, select note ranges for each instrument and provide variability of each instrument's effects and expression based on the MIDI CC data.

Final Thoughts

It's important to note that while the device is capturing real data points, interpreting them in terms of specific physiological or environmental events requires more specialized knowledge and might not be deterministic. Essentially, plants are responding to much more than we can easily perceive and test for in an isolated environment. For that reason, PlantWave is not intended to be used for diagnosis of plant health.