Proto-Zoöp

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Our Vision

We are currently facing the biggest environmental crisis in the 21st century. From deforestation, air pollution, and global warming, to massive biodiversity loss, humankind has threatened our natural environment, and it's only getting worse. The trend towards disruption will be inevitable if changes aren't made, from a microscopic to macroscopic level. While the majority of today's climate crisis is due to anthropogenic activities, we can actually extenuate environmental degradation through arguably, humanity's greatest invention: technology. Technological advancements can be a key factor in environmental conservation. Cutting edge innovations in this discipline have already been proven useful tools in transforming the way we deal with this catastrophe. We have established your proto-zoöp on Purdue's campus to provide suggestions on how to integrate technology into Purdue's urban environment in order to foster and improve interactions between humans and nonhumans. Further, our team presents possible intersections with other functioning proto-zoöp's such as Law, Ecology, and Economics to better propose a better, more well-rounded recommendation.

What's New On Campus? (Our Proposal)

One of the newer developments on campus is *The Lorax Initiative*: a series of interactive art exhibits around campus that focus on the visualization and sonification of plant data so that students and on-campus visitors can help ensure that they are healthy. In total, the Lorax initiative consists of three parts: the interactive art exhibits around campus, a central "bank" to help fund nonhuman needs, and a student group that advocates with the newly-formed Council for Nonhuman Affairs.

The art exhibits contain several kinds of plants: mushrooms, small flowers, succulents, small trees, and other small shrubs. There are two kinds of sensors used to draw data out for visualization: JXCT Soil NPK Sensors (1), which are high-quality sensors used to measure the level of nitrogen, phosphorus, and potassium in the soil, and KeeYees Soil Moisture Sensor Modules (2), which have high sensitivity and provide data on when to water plants. To make the exhibit artistic, the initiative combines these two basic sensors through an Arduino microcontroller to LEDs that are set up around the ceiling and under the display's tables or plant-housing structures. The lower LEDs apply to the NPK sensor outputs, which range from 0-1999 mg/kg (1). Because there are three outputs, each N, P, and K sensor output is codified to red, green, and blue light, respectively, and emitted on the LEDs. An ideal sensor output makes the LEDs white, but an imbalance will draw the visualized color in directions according to plant nutrition needs. The upper, more visible lights will visualize soil moisture content for the section of plants below, where the Arduino will codify the output of the moisture sensor modules and change the color of the LEDs above each section from white to red accordingly, where red means that the plants below are in dire need of water, and white means that they have plenty of water. Because the LEDs indicate to the visitors of the exhibit which nutrients or moisture deficiencies the plants have, visitors can help out by following posted instructions for each area of plants on how to properly water them and how to properly add NPK additives like blood meal or rock phosphate to the soil. We deem one NPK sensor and two moisture sensors per "table" as sufficient. Further, status information is relayed through a LoRa mesh network to a centralized aggregation point, allowing for the creation of campus-wide health checks. These health checks enable visitors to identify areas in need of help and enable rewards to be given out per the systems operated by the Lorax Initiative Student Group. In deploying the LEDs and the mesh, humans become part of the machine and a feedback loop of communication occurs between nonhumans and humans.

One of the largest draws to the exhibit, however, is data sonification of resistivity in different mushrooms, as based on MycoLyco's construction. The mushrooms are used as resistors to a 555 timer, in an oscillator circuit (3). They're hooked up to two clips that measure resistance to different parts of the same mushroom and then the change in mushroom resistance when a current flows through will change the speed of the oscillator in the circuit. This change in speed is read by a chip and transformed into four voltages and four gates, based upon activity in the mushroom. This data can be sent to a single modular synthesizer, which can sonify the resistance and play it on speakers in the exhibit. The clip sensors can also take the resistance values across multiple mushrooms and treat them as a "state" value, which is then compared to those in the nearby vicinity utilizing the LoRa (long range) network. Distance for the is calculated using Dijkstra's algorithm, utilizing the RSSI value for each LoRa node as the cost of each link. The aggregate value is then utilized to calculate the frequency for audible tones in each grouping of individual mushrooms, which are played using miniaturized speakers. Amplitude of the audio played will be determined by a static value (representing the size of each grouping), the severity of the state value (good or bad), and the relative state of each nearby grouping. To any observer capable of witnessing the aggregation of these tones, the tones will represent a song of the mushrooms, both assisting with the creation of the previously discussed feedback loop and creating a constantly evolving work of art.

These exhibits also have a monetary component: to enter, one must pay a small admittance fee of $3, and humans in the exhibit can buy select plants from the exhibit as well. These collected funds go toward a central account run by the Lorax Initiative Student Group, an on-campus student organization dedicated to the maintenance of the exhibits and to the assistance of nonhumans in West Lafayette. The Lorax Initiative Student Group also takes advice from the recently created Council for Nonhuman Affairs, which advocates for legal change to help nonhumans, in order to figure out how best to redirect their raised funds to help local projects and areas that need more support for nonhumans.

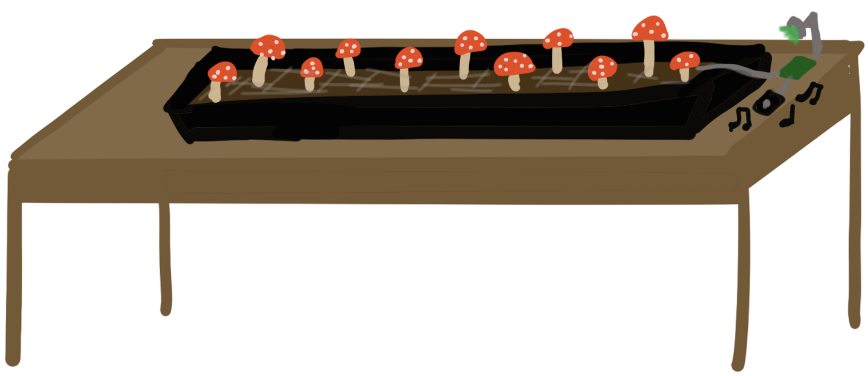

Figure 1 (Above): Simple example diagram for one table of mushroom sonification.

Figure 2 (Above): Scale for one table of the mushroom display. A full exhibit would have many of these tables.

How can you get involved?

While our proposal concerns various technological endeavors, it is important to keep students informed and engaged in class settings. As part of the proto-zoöp, Purdue has included a variety of classes and student-led organizations to promote biodiversity conservation on campus. The biggest addition is the introduction of a new major called “Zoonomic Cooperation Studies” within the College of Science, which entails the study of, and leads to a career in, the fast growing field of non-human representation in society. Outside of the major, Purdue also now also offers classes such as Environmental Technology & Management, and Sensors & The Ecosystem. These classes are meant to teach students how to better foster a relationship with the surrounding natural environment and educate them on sensor technology. Students will be required to take at least one of these classes during their academic career at Purdue as an effort to encourage relationships between humans and plants. Student-led organizations are also being formed in various academic divisions. The College of Engineering has just announced a new Learning Community that focuses on advancing sensor technology within the Honors College and prototyping new devices to integrate into the various art exhibits around campus. The College of Science and the Polytechnic Institute, are also featuring a program that collects data via drone technology to analyze plant health around campus. The data collected through this program helps students both interact with Purdue’s ecosystem while strengthening their knowledge of collecting data in a novel way. Finally, the College of Science is partnering with students at the Krannert School of Management, by sending this data to monitor finances and distribute funds to ecosystem conservation efforts.

Sources

(1) http://www.jxctiot.com/product1/product195.html

(2) https://www.amazon.com/KeeYees-Sensitivity-Moisture-Watering-Manager/dp/B07QXZC8TQ/ref=asc_df_B07QXZC8TQ/?tag=hyprod-20&linkCode=df0&hvadid=343238573411&hvpos=&hvnetw=g&hvrand=12273301141481126538&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9016722&hvtargid=pla-757549749596&psc=1&tag=&ref=&adgrpid=71762478951&hvpone=&hvptwo=&hvadid=343238573411&hvpos=&hvnetw=g&hvrand=12273301141481126538&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9016722&hvtargid=pla-757549749596

(3) https://www.youtube.com/watch?v=SKUNk8AQ-54&t=200s