TEXAS STATE UNIVERSITY

The rising STAR *of Texas*

E 1.13 - Toad Phone-Power Management and Recording

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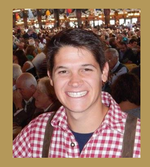
Sponsors: Dr. Shawn McCracken and Dr. Michael Forstner

TEXAS STATE BIOLOGY

Team Members





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Primary Goal

Create an efficient device capable of recording, storing and transmitting the mating call and environmental conditions of the endangered Houston Toad.

Boundary Conditions

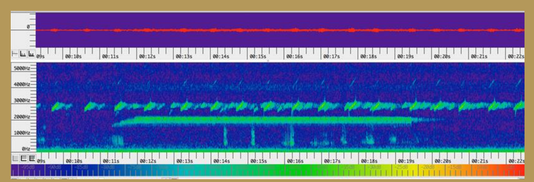
- Outdoor use
- Heat, Cold, Sunlight (High and Low), Wind, Moisture, Rain, Dust, Dirt, and Debris
- Use on private property
- Voltage: 4.75-5.25V
- Amperage: 1.0-2.5A

Condition	Expected Extremes	Detrimental Effect
High Heat	Up to 120° F	Electronic damage, weakened plastic
Extreme Cold	Down to -20° F	Less effective battery, electronic damage, cracked plastic
Intense Sunlight	<120,000 lux	Solar Panel output overload
Strong Winds	40 to 50 mph	Toppling device, added debris
High Moisture	100% Humidity	Condensation resulting in electronics short circuiting
Heavy Rain	2.0 inches rainfall/hour	Electronics short circuiting, dust and debris after evaporation
Dust, Dirt, and Debris	Anything landing on solar panel	Solar Panel producing dramatically less power
Cloudiness	1000-2000 lux	Solar Panel producing dramatically less power

Constraints

- Priced below $300
- Light and Portable
- Field life minimum of 60 days between service

Toad Call



Example frequency range of the Houston Toad call.

Overview

Problem:

The Houston Toad is an endangered amphibian found in central Texas. In order to aid in the protection and propagation of the species, biologist need to locate them so that they can be studied. Due to their low numbers and the remote locations of their habitat, Houston Toads can be difficult to find. Researchers at Texas State University are currently utilizing sound recording systems to identify the distinct mating call of the Houston Toad. These systems have notable limitations and require a substantial time commitment to maintain. With over 80 ponds currently being monitored, a system is needed to improve efficiency and allow for an expansion of monitoring.

Solution:

Toad Phone will be able to record sound at specified intervals and save the data to local storage. It will also collect environmental information such as temperature, humidity and atmospheric pressure. Powered with a rechargeable battery and a solar panel it will operate for long durations without the need to change batteries. With the help of the compression and transmission team, the recordings will be compressed and transmitted to a cloud server accessible to researchers.

Existing Systems Toad Phone Will Replace:

Automatic Recording Devices (ARDs)

- Only allow local storage to SD cards
- Poor battery life
- Must be serviced frequently to change batteries , collect data and switch out SD cards

Android Mobile Device with Spyware, rechargeable battery and solar panel.

- Cost prohibitive
- Heavy
- Unnecessary features add cost

Hardware

Raspberry Pi 3


Blue Snowflake Mic


SoundPi


RAV Battery Pack


ACO Solar Panel


Garmin GPS

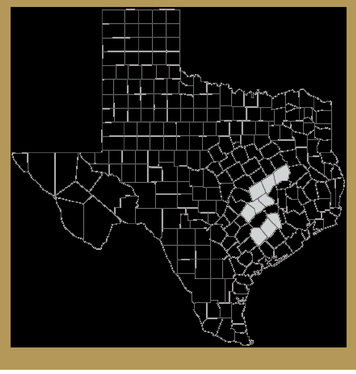

BME280 Sensors


Pelican Housing

Software

To control the various sensors and peripherals in Toad Phone, as well as to allow for the timing to be set, a control code will be written using the Python programming language. This control code will interface with the software embedded on the Raspberry Pi and the Raspbian operating system. A user interface will also be created.

Houston Toad Habitat



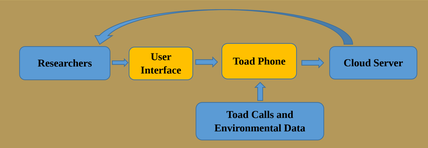
Expandability

The hardware incorporated into Toad Phone could be utilized to study more than the Houston Toad. The Houston Toad call is easily recognized between the sound frequencies of 1 kHz and 3.1 kHz, however the unit will be capable of picking up sound between 15Hz to 20kHz which would allow for the study of many other species. Another future feature of the Toad Phone will be the ability to analyze the sound it recorded and identify whether a Houston Toad (or other animal of interest) is present in the recording. It could then be programmed to only transmit a recording if it detected that sound.

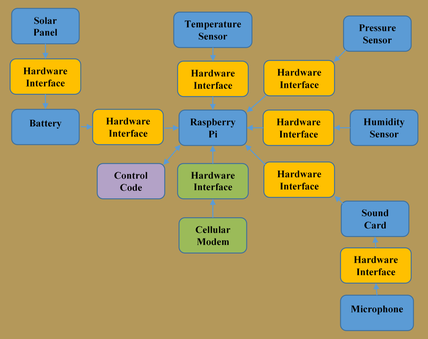
Future Tasks

- Assemble Raspberry Pi, Microphone, SoundPi, Battery, Solar Panel, GPS module, Sensors, and SD cards.
- Write python code to make the Raspberry Pi operate properly.
- Perform lab test of system.
- Perform field test of system.

Interfaces



Interface between users and Toad Phone.



Hardware and software Interfaces. Yellow boxes represents interfaces we will create. The purple box represents the control code we will create and its interface to the Raspberry Pi. The green boxes represent interfaces designed by the transmission and compression team.

Performance

Parameter	Test Conditions	Min	Max	Units	How to Test
Pi Voltage Requirements	Vin= 0V	4.75	5.25	Volts	Measure the output voltage of the battery with attached solar panel
Pi Current Requirements	Iin = 0A	1.0	2.5	Amps	Measure input current into the Pi
Solar Panel Output	Differing sun levels	8	20	Watts	Measure Output current and operating voltage under load
Microphone Bandwidth	Vin= 5V, Pi ON	35	20,000	Hz	Generate known sound and have the Pi listen
SD Card Storage		64		GB	Software on computer will detect exact size of SD Card
Pressure Sensors	Pi ON	870	1084	hPa	Take multiple readings at different times of day compared with meteorological data
Humidity Readings	% humidity	40	100	%	Heat water in oven at lowest setting and use humidity sensor to achieve 100% humidity
Temperature Readings	Pi ON	-20	120	F°	Take temperature measurements and compare with thermometer

Function	Description	How to Test
Record at designated times	The device will record for 10 minutes every hour	The device will be run and observed to see if it records at the correct times
Store Recordings	The recordings will be stored to SD Cards	The device will be run and the SD Cards played back to confirm storage
Standby Mode	The ability to set the device into standby with a button press	The button will be pressed and the recording will be checked, then pressed again to make sure no faults occur
Switch between SD Cards	Recordings will shift to the next SD Card once full	An SD Card will be filled with data and then confirm whether it shifts to the next card
Code Interface	A menu option will be provided in the code that will allow researchers to designate sampling rates, recording times, and data transmission options	Code will be subjected to multiple entry errors and invalid inputs
Software Accuracy	The software will correctly operate at given parameters for 60 days at a time	The code will receive multiple rounds of unit testing to ensure each module of the software is capable of accurately producing desired results
Error Detection	The software will reject invalid parameter entries and alert the user	Each user input option will be tested with a range of invalid entries

Acknowledgements

Instructor: Dr. C. Richard Compeau
Sponsor: Texas State Biology Department
Dr. Shawn McCracken and Dr. Michael Forstner
Faculty Advisors: Dr. George Koutitas and Dr. Harold Stern