# Remote modulation of awake, primate behavior

## Created by Taylor Webb

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This package of software contains a variety of code designed to drive the Verasonics system in different environments and to process data collected in those environments. The code is divided into folders based on the environment in which it is designed to be used.

The subfolders corresponding to the different environments are:

* **Aims**: Short for Acoustic Intensity Measurement System, AIMS is the former name of the Soniq measurement system. This folder contains code to run interface with the measurement tank for the characterization of transducers and other measurements performed in the water tank.
* **lib:** library files that I use regularly and that tend to be independent of the application
* **MonkeyTx:** Files relevant to driving the 256 element monkey transducer. This includes software for MR thermometry and sonication during awake behavior.
* **ProcessTask:** Analysis of behavioral and EEG data acquired during awake behavior.
* **SingleElement:** This software was designed to acquire pulse-echo data from a single element transducer in order to probe the possibility of using the received signal to estimate the acoustic properties of the skull. The code was later modified in other locations by Jan and others so I am uncertain of how fully it is currently functioning.

More detail on each of the above sections is found below. Feel free to reach out with questions.

# AIMS

These functions haven’t been used for a long time and are a little out of date. At one point, they were capable of fully characterizing a transducer – including scanning the hydrophone, changing the input power on the function generator, and measuring and creating a PDF readout of the response. As of October 2023, some of these PDFs were still hanging in the lab. It will take some work to get identify the correct files and get that fully functioning.

One very useful function for processing data acquired with the Soniq system is:

* readWaveform.m: returns the time and voltage vector of an individual waveform acquired using soniq. Originally written by Patrick Ye at Stanford.

# Lib

Below is a description of the most useful functions

* p2I\_brain and I2p\_brain take convert between pressure and intensity using IT’IS values for acoustic velocity and density in the brain. Note that all values are standard scientific even where the convention in US may be different. E.g. intensity is in w/m^2 not w/cm^2
* makeFigureBig is a function I wrote to make MATLAB figures more pretty
* shadedErrorBar is a MATLAB exchange function with an open license that creates line plots with standard deviation/standard error.

# MonkeyTx

This folder houses all of the Verasonics code that runs during behavioral tasks, thermometry sessions, or LSTIM sessions. Detailed descriptions of the most important code are below.

## Thermometry

Thermometry functions are a bit more scattered than others. They are found in lib, lib/mrLib, and lib/placementVerification.

lib/mrLib/runMrCode.m is the main script for thermometry. This script will add the necessary paths and call all the necessary helper functions to sonicate during a thermometry acquisition and plot the results. The script is well commented and serves as the best map of other relevant functions.

## LSTIM

Run\_lStim2.m is the best road map for the LSTIM capabilities. The LSTIM code is designed to allow flexible delivery of sonication two 2 targets both inside and outside the bore. It provides code to set function generators and triggers to synchronize the sonications with EEG recordings.

Scripts to analyze these results are also found in this folder. They should, in the future, be moved to the ProcessTask section but since they aren’t there currently I list them here.

plotGamm\_lstim and plotUeps are the primary functions for measuring changes in rhythms as a result of LSTIM. The script analyzeResults.m loads the data and puts it into the format required by these functions.

## Task

lib/taskLib contains the functions that enable the Verasonics to communicate with the psychtoolbox code used to run visual tasks. These scripts both drive the ultrasound and provide communication to ensure synchronization.

firstTarget.m is the primary code run during direct ultrasound tests (both durable and transient tests).

drugDeliver.m manages tasks in which an injection is given part way through the task

# Process Task

This contains all the analysis scripts I have built up over the years to analyze behavioral and EEG data resulting from LSTIM and behavior experiments. The most important scripts are listed below.

* genericDurable.m (directly within processTask). This function allows the user to specify directories containing data acquired during either durable ultrasound sessions (measures the effect of a single sonication delivered after a baseline period) or drug delivery session.
  + sortSessions.m: genericDurable.m returns a struct called tData with one entry for every session. sortSessions traverses this struct and organizes each session by its acoustic parameters. Other functions useful for sorting data are selectByFocus.m and getSessionIdx.m