Simulation Pipeline Of STANCE Simulator

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Introduction

- This is a brief instruction for the pipeline of simulations, for more details of usage of functions and demos, please go to the user guide.

- Note: The resource of phantom subjects, anatomical brain and activation data should be saved in the corresponding file under root directory '…/Resource'

1. Initialization

◆**Functions:** STANCE_initialize_STANCE.m;

◆**Utility:** Initializes STANCE.mat including simulator working levels and affine transform matrices from MNI152 brain to native subject space, and other global resources, such as many of file locations, the provided 20 subject brains and their file names.

Name

- activations
- canonical
- MNI
- subjects
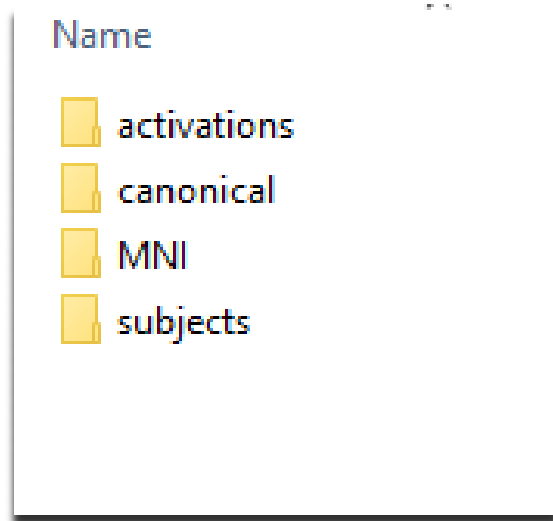
2. Registration

◆**Functions:** STANCE_register_MNI.m;

◆**Utility:** Loads, registers and transforms the isotropic MNI152 -w brain to the isotropic -w brain image of interest after setting its the voxel-to-world mapping.
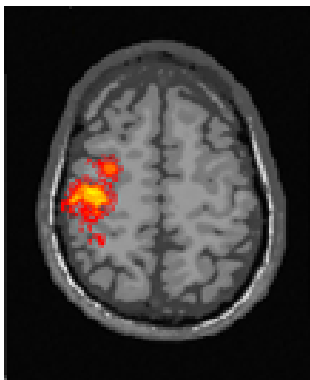

MNI152   Native
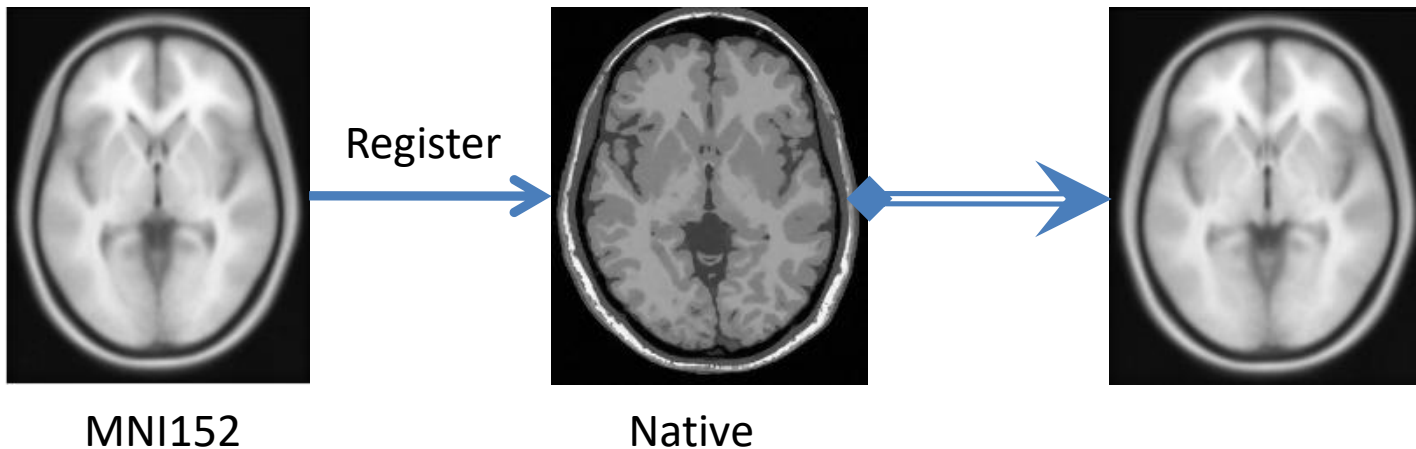
3. Define modeled neuronal activation maps

◆ **Functions:** STANCE_make_activation_map.m; STANCE_load_map.m; STANCE_register_activation.m; etc.

◆ **Utility:** Make activation maps by modelling reported results or load existing activation maps and register activation maps onto subject's volume.

◆ Note: The key structure array **'task'** contains fields describing activation regions. See details in **'The task structure'** under master directory **'Key structure arrays used by STANCE functions'**

4. Reslice the volumes to a functional space

◆**Functions:** STANCE_reslice_tissue.m; STANCE_reslice_volume.m; STANCE_make_parameter_map.m; STANCE_GM_mask.m; STANCE_add_activation.m;

◆**Utility:** Generates the tissue fuzzy memberships, creates T2* Baseline Volumes and projects activation maps in functional space masked with gray matter mask and then add activation maps on baseline volume.
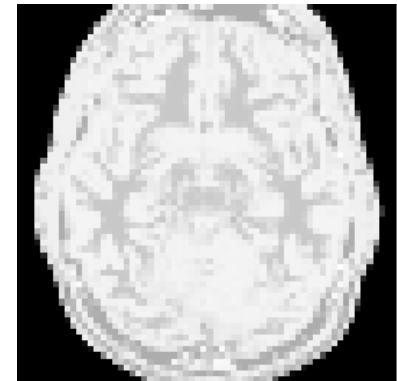

T2* Baseline

◆**Note:** The key parameter is array 'scan', which contains parameters of fMRI scan protocol, such as voxel size, tilt angle, TR, TE, etc. See more details in **'The scan structure**'.

5. Design 4D BOLD time series

◆**Functions:** STANCE_design_timeseries.m; STANCE_event_design.m;

STANCE_blocked_design.m;

STANCE_apply_response_function.m;

◆**Utility:** Specifies the experimental time-series, constructs the HRF

maps to model HRF variability in

subject and convolve both of them

to yield the BOLD response. Then

generates T2* Baseline Volumes with

data we simulated above.
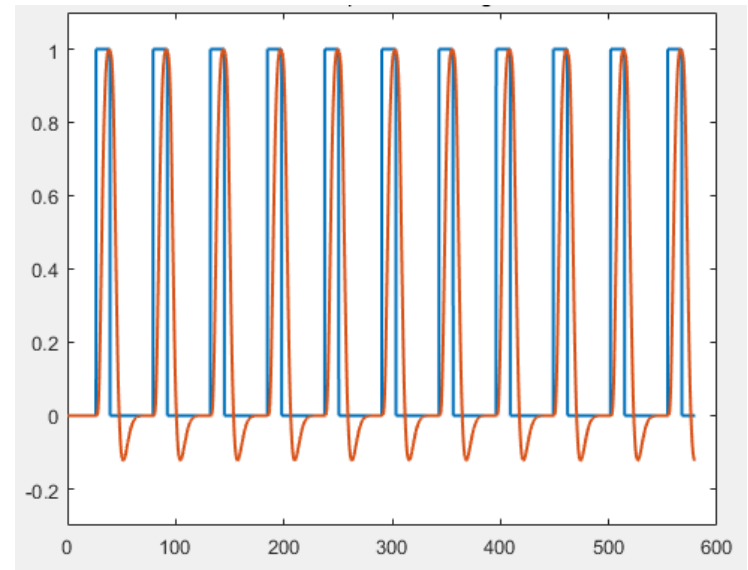
Block design and BOLD Response

Cont...

◆**Note:** The varying HRF map should be defined with certain response function and corresponding parameters (map). See more details in '**STANCE_apply_response_function.m**' in user guide and demo 'demo_4D_simblock.m'.
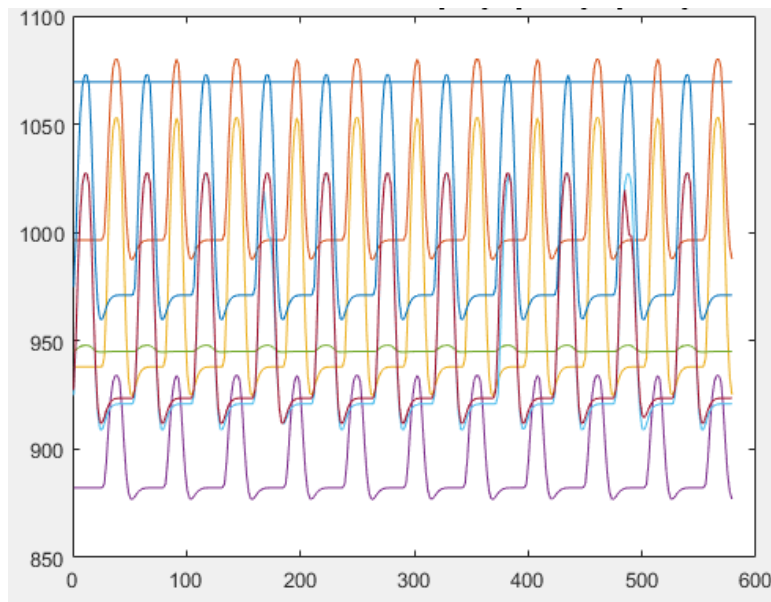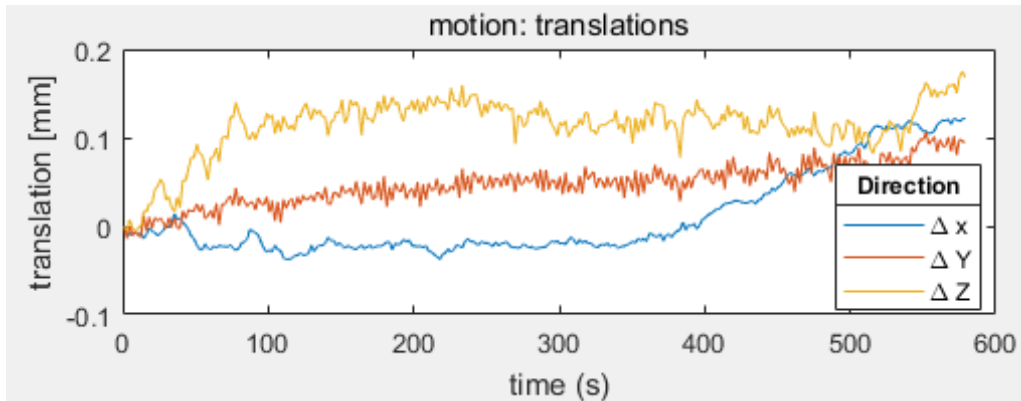

T2* time series

6. Add Noise, Attenuation and Motion

◆**Functions:** STANCE_make_noise_map.m; STANCE_estimate_RTI.m;

STANCE_physio_4D.m;

◆**Utility:** Generates spatially varying system noise and a physiological

noise times-series with the 6 main sources of respiratory and cardiac noiseSee more details in paper ' Hilla, Jason E., et al. "A Task-related and Resting State Realistic fMRI Simulator for fMRI Data Validation." Proc. of SPIE Vol. Vol. 10133. 2017.' and user guide.

Cont…

◆Note: The crucial physiological noise parameter 'physio' should be defined by the rule of **'The physio structure'** specified in the user guide.
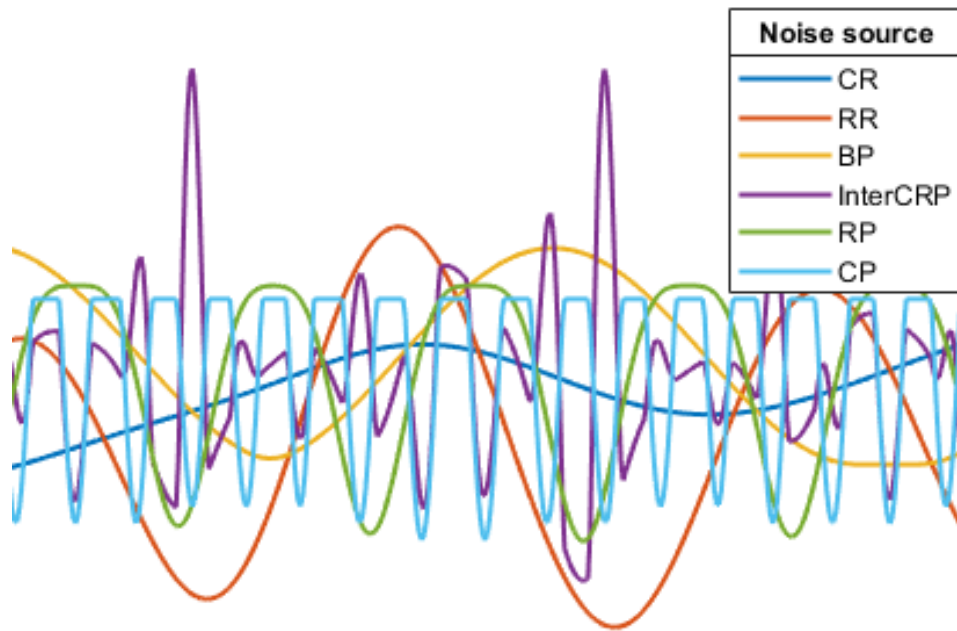
7. Solve fMRI signal by Bloch Equation

◆**Functions:** STANCE_EPI_signal.m;

◆**Utility:** Utility: From the fMRI scan protocol, pulse sequence, and the PD, T1, and BOLD-like T2* parameter maps in functional space, the Bloch equation, a simple model of tissue magnetization vector behavior, can be solved for every voxel and time.