

Investigation of EEG and PPG Data for Subjects with Visual Height Intolerance

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Introduction

Acrophobia is an extreme or irrational fear or phobia of heights, especially when one is not particularly high up. Our experiment focuses on exploring the neural and physiological correlations of acrophobia.

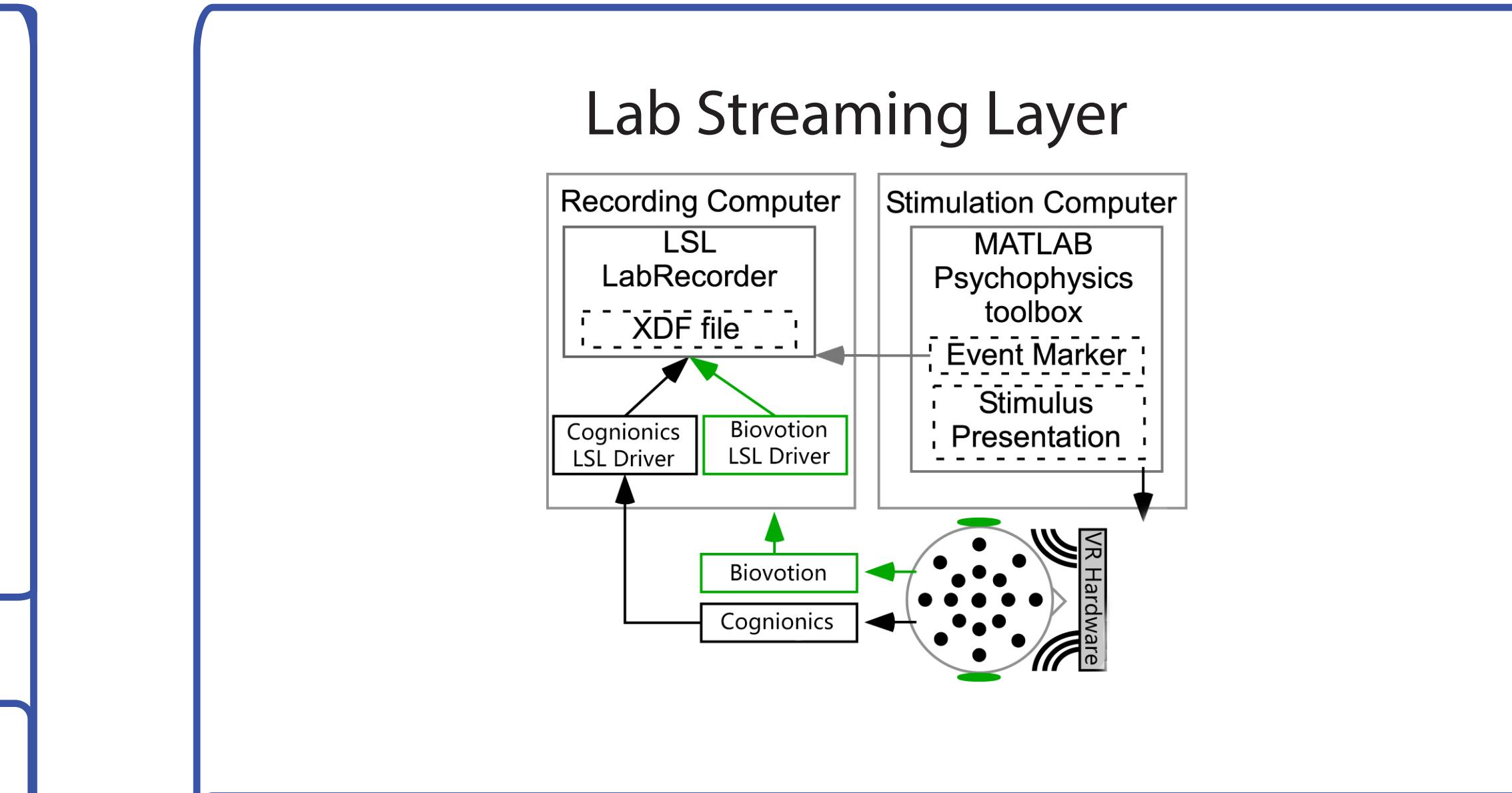
Abstract

This study explores the neural and physiological correlates of acrophobia. We are mainly considering the heart rate and heart-rate variability extracting from the non-invasive PPG signals. Before the experiment, subjects fill up a questionnaire that evaluates their level of height intolerance. During the experiment, HTC Vive VR headset will be used to present stimulus, Cognionics Quick-30 headset will be used to collect EEG data and BioVotion armband will be used to collect PPG data. In the past few months, we have designed and developed the VR contents for this study. We have also developed methods to collect, analyze and synchronize the multi-modal data streams from the EEG headset and the BioVotion armband. We plan to collect and analyze the multi-modal data across 10 subjects within the VR environment in the next three months.

Cognionics Quick-30 EEG Headset and Sensors



Biovotion Armband



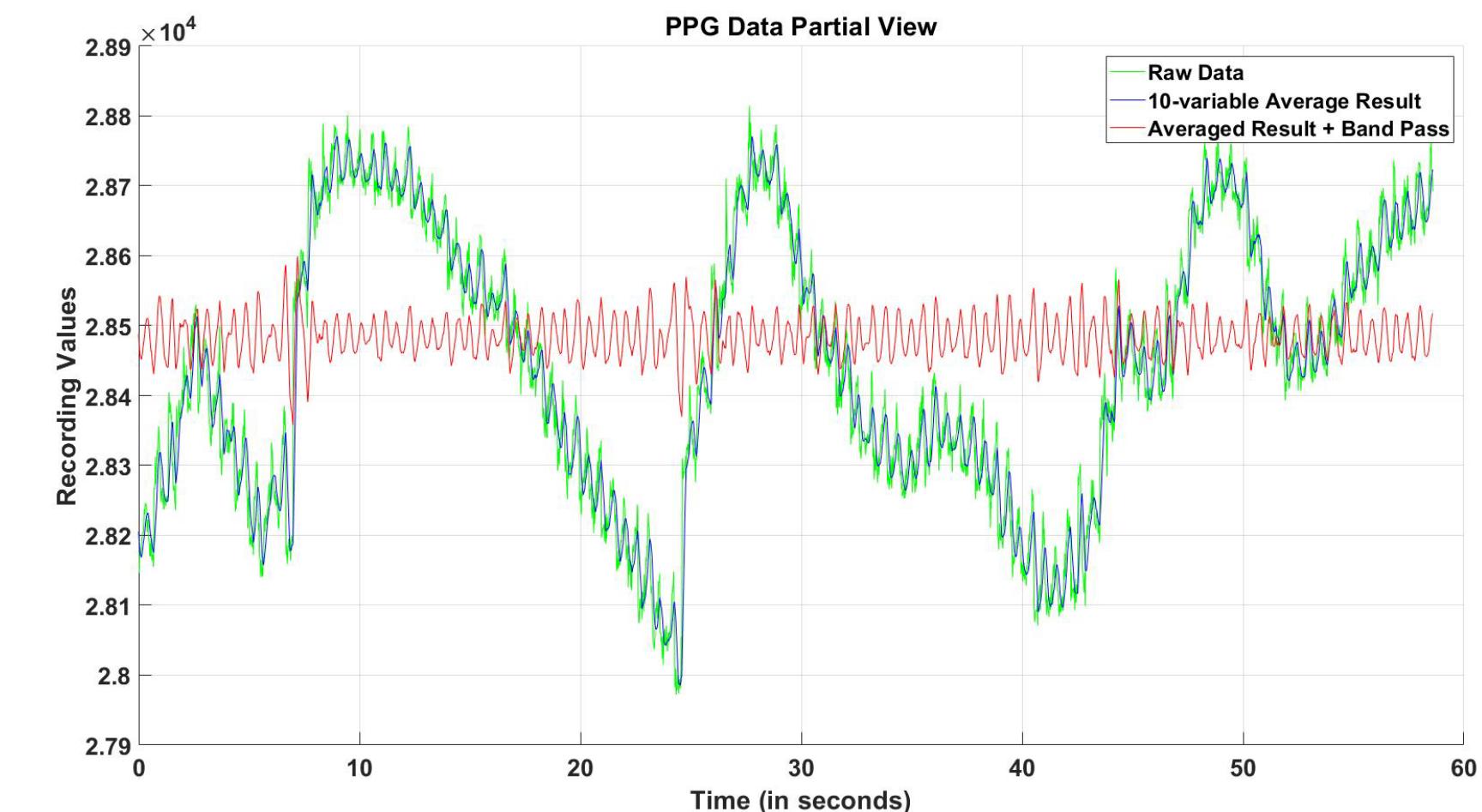
Methods

Questionnaire:

The questionnaire will be provided before the subject starts the experiment. The questionnaire is constructed mainly based on Visual Height Intolerance Severity Scale (vHIS) ⁽¹⁾ and a questionnaire from "Cognitive processing and acrophobia: Validating the Heights Interpretation Questionnaire" ⁽²⁾. We mainly ask subjects three types of questions.

1. How are subjects' daily-life actions affected by acrophobia, and how severe are they being affected.
2. How afraid do subjects feel when they imagine they are exposed to heights
3. How will subjects' acrophobia symptoms be induced.

Biovotion PPG Data - Green Channel



Experiment Scene Examples

Experiment Scene



Control Scene

VR Environment:

The VR Environment is built up by Unity. The videos shown were taken by Samsung Gear360. Subjects will watch these videos in a VR Headset (HTC Vive) while standing, and will be asked to turn around during each scene. There will be a total of 20 scenes, with 3 control scenes and 17 experiment scenes. Control scenes are taken on athletic fields, and experiment scenes are taken on cliffs and building edges. All scenes are 60 seconds long, containing a 10 second blank period, a 10 second base period, and a 40 second experiment period.

Cognionics EEG Headset:

The Cognionics Quick-30 EEG headset is a dry-EEG headset. This headset uses flex sensors to pick up signals from skins under the hair and drypad sensors to pick up signals from bare skins.

Biovotion Armband:

Biovotion armband is a multi-sensor wearable monitoring platform for physiological signals. We extract the raw PPG signals from BioVotion and obtain the heart rate and heart rate variability data.

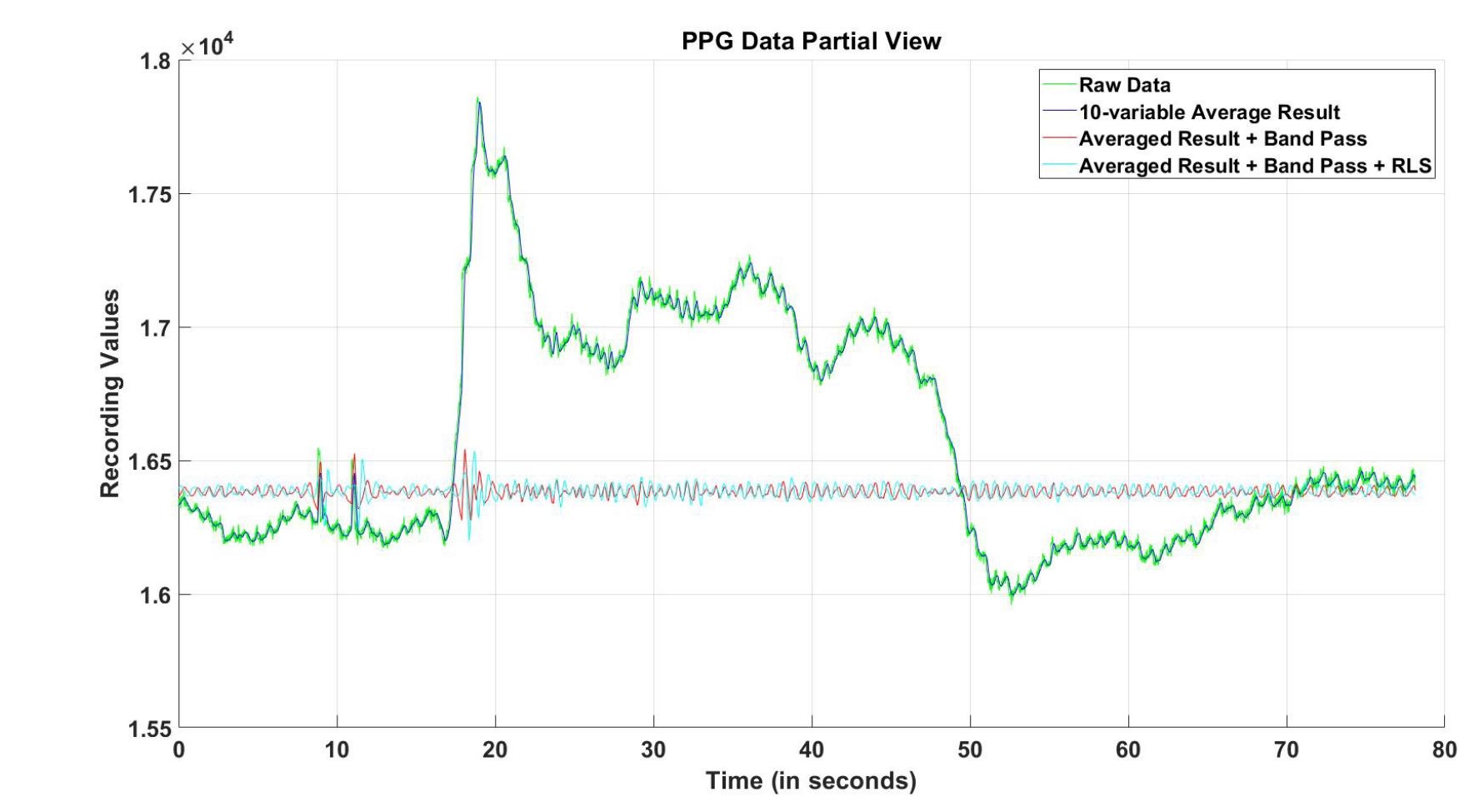
* : More introductions on insight.ucsd.edu

Data Analysis

RLS (Recursive Least Squares) Adaptive Filter:

While moving, subjects will generate a lot of motion noise. In order to minimize the effects of motion noises, we decided to use a combination of filters. Currently the best result is generated by the combination of Moving Average Filter + Band Pass Filter + RLS Adaptive filter.

RLS is excellent in removing the motion noises, when sometimes subjects intensively move their arms, causing a huge gap or peak on the graph.



(1): Huppert, Doreen, Eva Grill, and Thomas Brandt. "A new questionnaire for estimating the severity of visual height intolerance and acrophobia by a metric interval scale." *Frontiers in neurology* 8 (2017): 211.

(2): Steinman, Shari A., and Bethany A. Teachman. "Cognitive processing and acrophobia: Validating the heights interpretation questionnaire." *Journal of anxiety disorders* 25.7 (2011): 896-902.