

IMPROVE THE CONTENT VALIDITY OF THE VIRTUAL-DRILLING SIMULATOR

Computer Integrated Surgery II

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Introduction

- Auditory feedback has great potential in surgical simulators that aim at training surgeons associated to the correct interpretation of anatomy of sounds (Hoffmann, Pablo Faundez et al. (2009)).
- This project involved collecting a data set with varying density phantoms and extract frequency and force information.
- The goal of this project was to improve the auditory feedback provided in FIVRS (Fully Immersive Virtual Reality System).

The Problem

- Validating the existing audio feedback in FIVRS allows us to improve and test the accuracy of the current implementation.

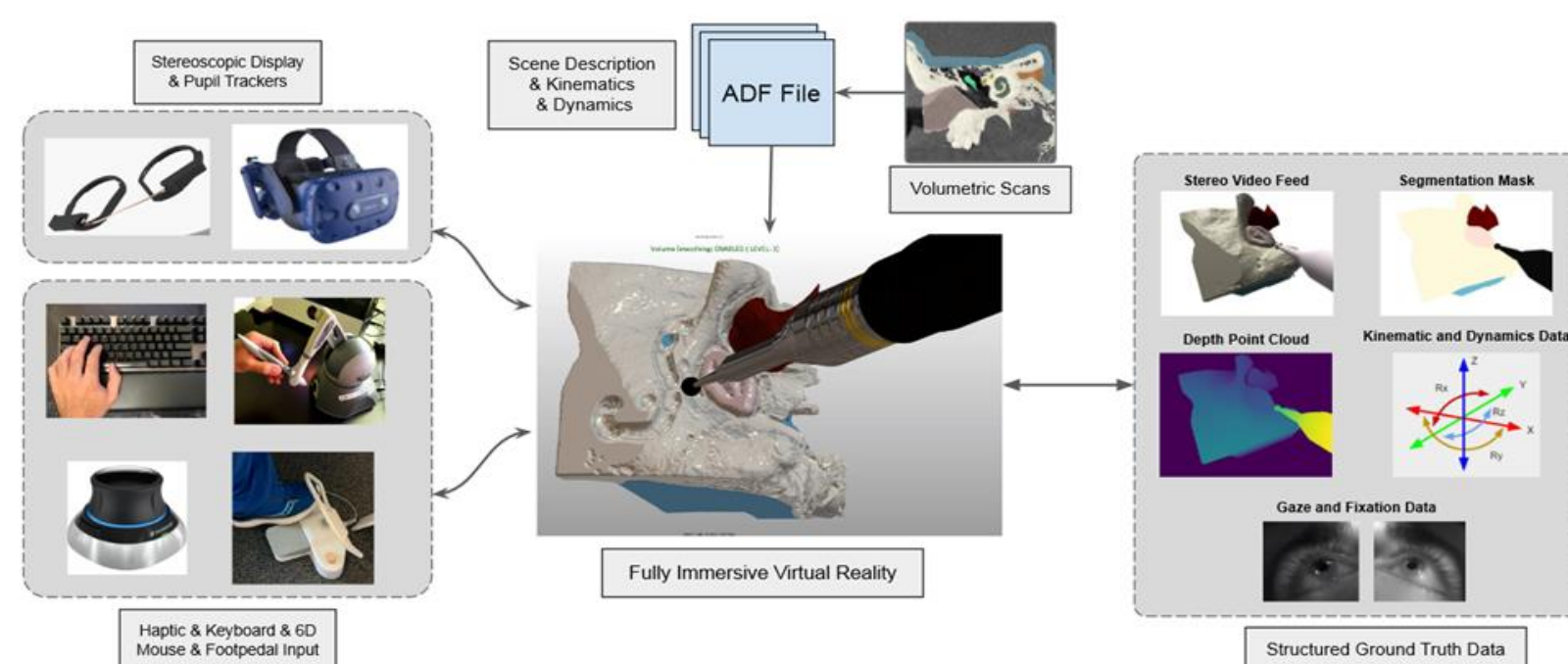


Fig 1: FIVRS Setup

The Solution

- Three phantoms were used during data collection. Modeling of the collected data was performed to study the relations between density of the phantom, force applied during drilling and frequency of the drill audio.

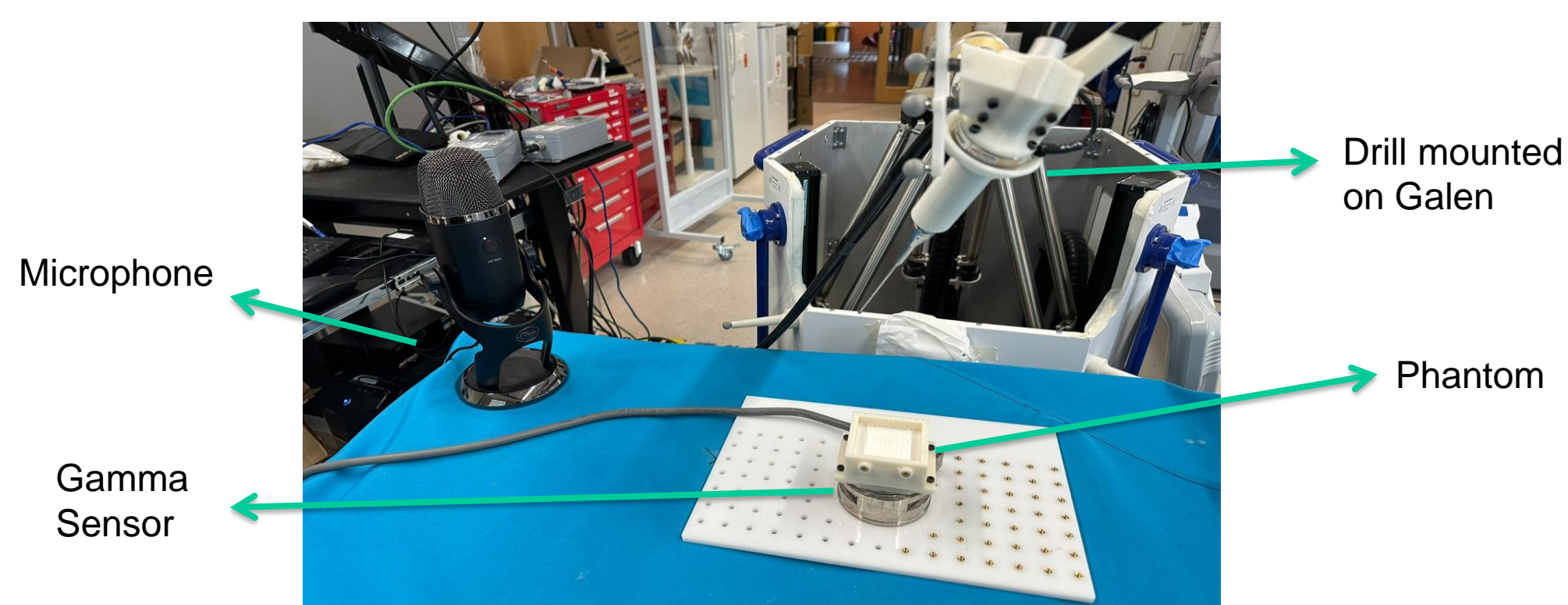


Figure 2: Data Collection Setup

Parameter	Details		
RPM of Drill	80000 revolutions per minute		
Density (in kg/m^3)	Phantom 1 (LL) 1084.065	Phantom 2 (AVG) 1630.6	Phantom 3 (UL) 2100.3
Orientation	Kept constant as the initial orientation. Angle of the drill with the phantom surface was kept below 90 degrees.		
Motion	Single stroke motion for every reading using the Galen robot.		

Table 1: Details about the experimental procedure

- The files were synched using manual taps. Audio wave files were passed through a highpass filter with the cutoff frequency set at 8000 Hz.
- The offset in the resultant of the wrench-force and torque were fixed by shifting the entire data by the minimum value of the clipped data.

Outcomes and Results

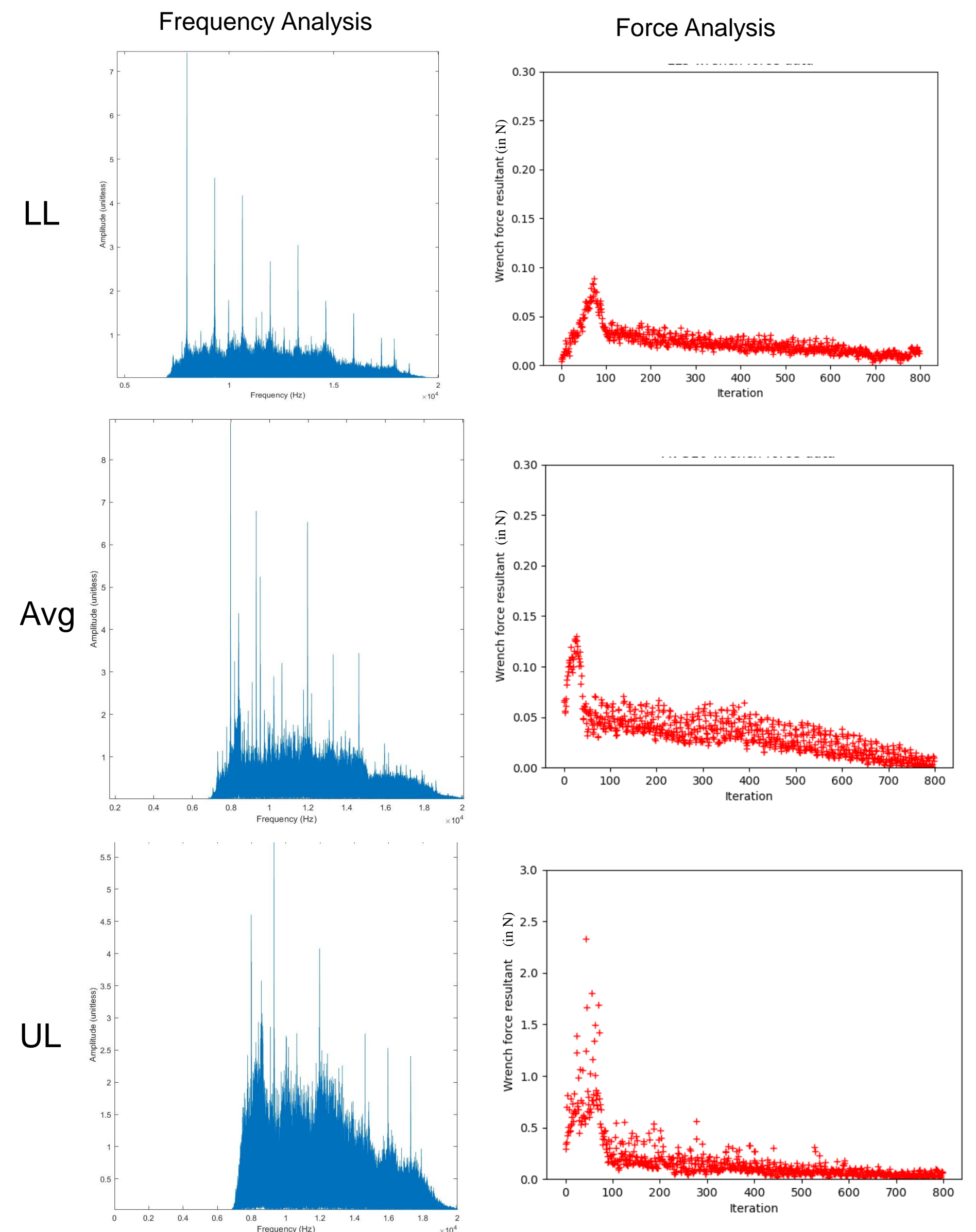


Figure 3: Single-sided amplitude spectrum plots and wrench-force plots

- With increase in density, mean wrench-force value increases from 0.062 N in LL to 0.1489 N for Avg and 1.698 N in UL. We also see the amplitude increase prominently in the 8000-16000 Hz range.

Issues Faced:

- Synchronization of some files couldn't be done accurately.
- Filtering of the sound when the drill was on but not drilling couldn't be done without loss of information.

Future Work

- Mathematically relation and implementation of these relations into the FIVRS.

Lessons Learned

- Workflow of research-oriented projects
- Audio processing using Librosa, SciPy and MATLAB
- Force collection and extraction using ROS

Support by and Acknowledgements

- Thank you to all my mentors for providing consistent and continuous support during the duration of this project.