Upper Arm Length Prediction

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I. Introduction

Wearable medical devices are revolutionizing medical care. However, the accuracy of these measurements can be compromised by body movements, particularly when the device is mounted on the arm. While the upper arm when compared to the lower arm is less susceptible to known covariates; depending on the orientation of the upper arm, these artifacts may still affect biomedical data acquisition, necessitating a method to account and negate these effects.

To address this issue, it is important to determine the distance of device placement from the patient's shoulder for an upper arm based device. By co-localizing a motion sensing device with where the measurement is taken, we can gather motion data to assist in this compensation. This study proposes an algorithm based on classical mechanics to estimate this distance by using the acceleration data, thereby enhancing the reliability of biomedical measurements in various arm orientations.

II. Method

To calibrate the upper arm length prediction algorithm, an individual would perform a specific sequence of arm movement(s) corresponding to known analytical relationships. Pre-processing via filtering is performed to reduce noise.

After filtering, stationary periods are identified, and a re-orientation of inertial frames is performed. For the procedure that follows, many intervals of data are collected to be used to develop these methods.

Five approaches were experimentally tested for estimating the upper arm length The accuracy of the algorithm is tested by comparing the estimated arm length with the actual measured length for each interval.

III. Result

The predicted upper arm length is first compared to the true upper arm length as a ratio, with comparative results across different methods shown in Figure 1.

A computed z-score gives a notion of the difference between the mean and the real value, normalized against the standard deviation. Thus, a z-score tells us how many standard deviations a data point is from the mean of the distribution. The closer the z-score is to zero, the better the estimation. Based on two separate analytical assessments, method 3 yields the smallest z-score, indicating the most accurate prediction. These results are highlighted in Table 1 below.

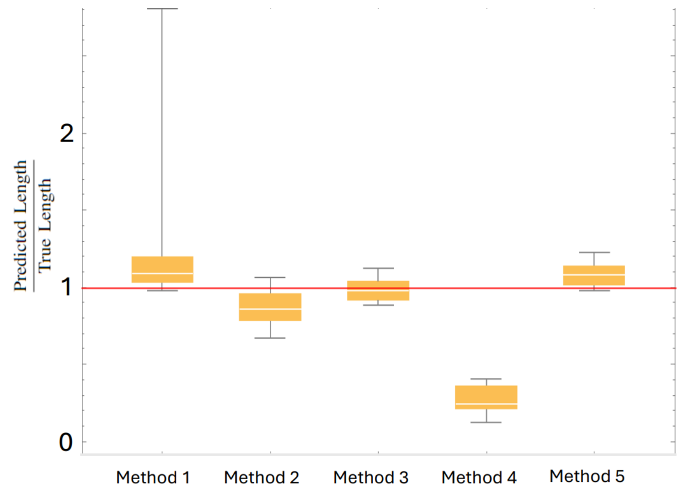

Fig. 1. Comparison of the range of predicted upper arm length values normalized against real value for various methods. The red line denotes a ratio of 1, where the estimation equals the real value.

Z_1	Z_2	Z_3	Z_4	Z_5
1.330	-1.325	-0.164	-7.508	1.379

TABLE I
VALUES OF Z_i.

IV. Conclusion

The host of algorithms evaluated here each show a relatively accurate approach for estimating upper arm length. Across these various methods, method 3 ultimately performs best in predicting upper arm length relative to true arm length.

Future Work

Future work will focus on reducing constraints to enable automatic upper arm length prediction. Also machine learning options will be explored.