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MATLAB Interface for Blood Pressure Determination from Oscillometric Data

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Abstract—**The accurate measurement of blood pressure is a fundamental aspect of healthcare, serving as a vital diagnostic tool for assessing an individual's cardiovascular health and overall well-being. Traditional methods of blood pressure measurement involve the use of cuff-based devices, such as sphygmomanometers, which rely on the auscultatory technique. While this method has been the gold standard for decades, recent advancements in technology have paved the way for more sophisticated and convenient approaches to blood pressure determination. Blood pressure determination involves several steps to extract meaningful information from the acquired signals. From the detected systolic and diastolic peaks, we calculated several key blood pressure-related parameters. This included determining the maximum value of the diastolic valleys and its associated time point, which provided essential information for calculating the Mean Arterial Pressure. Utilizing the computed thresholds and peak indices, we identified the cuff pressure values corresponding to the systolic and diastolic peaks. These values represented the Systolic Blood Pressure and Diastolic Blood Pressure, respectively.**

Keywords-blood pressure determination; sphygmomanometer; LabQuest Mini; MATLAB;

I. INTRODUCTION

The accurate measurement of blood pressure is a fundamental aspect of healthcare, serving as a vital diagnostic tool for assessing an individual's cardiovascular health and overall well-being. Traditional methods of blood pressure measurement involve the use of cuff-based devices, such as sphygmomanometers, which rely on the auscultatory technique. While this method has been the gold standard for decades, recent advancements in technology have paved the way for more sophisticated and convenient approaches to blood pressure determination.

One such innovative approach is the utilization of MATLAB, a powerful computational software environment widely employed in various scientific and engineering disciplines. In recent years, MATLAB has emerged as a versatile platform for processing and analyzing medical data, including the interpretation of oscillometric data for blood pressure estimation. This paper explores the development and implementation of a MATLAB interface tailored to blood pressure determination from oscillometric data, showcasing the potential for enhanced accuracy and efficiency.

The oscillometric method, which relies on the measurement of pressure fluctuations in an inflatable cuff, presents a non-invasive and user-friendly alternative to the traditional auscultatory technique. However, accurate blood pressure estimation from oscillometric data involves complex signal processing, calibration, and interpretation, often necessitating the use of specialized software tools. MATLAB's extensive computational capabilities, coupled with its user-friendly interface, make it an ideal candidate for creating an accessible and customizable solution for blood pressure determination.

This paper begins by providing a comprehensive overview of the oscillometric method, its principles, and we delve into the development of a MATLAB-based interface designed to process oscillometric data efficiently and accurately. The interface's functionality includes data acquisition, signal processing, calibration, and the generation of clinically relevant blood pressure readings.

Furthermore, this paper aims to demonstrate the potential applications and benefits of our MATLAB interface in both clinical and research settings. By facilitating the automation of blood pressure determination and improving the accuracy of results, this technology has the potential to enhance the quality of healthcare delivery and advance our understanding of cardiovascular health.

II. METHOD

The system consists of hardware and software, Fig. 1. The sensor is in fact Vernier Blood Pressure Sensor used to measure systemic arterial blood pressure (non-invasively). LabQuest Mini, manufactured by Vernier, was used for data logging. It is possible to use any newer LabQuest Mini data-collection interface.

The principal architecture of the system is shown in Fig. 1.

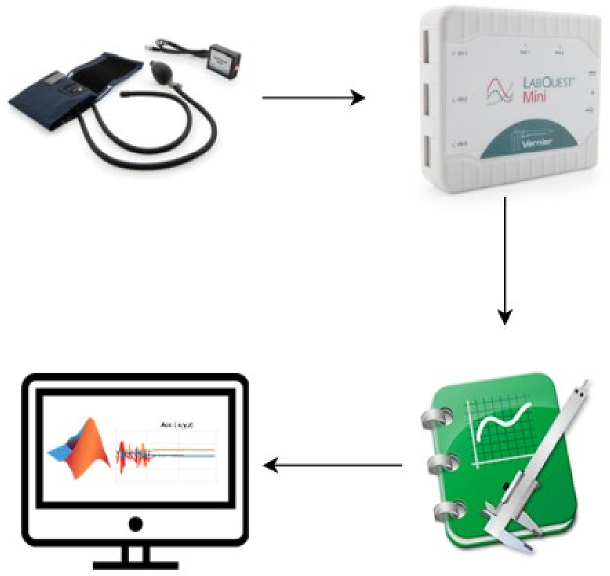

Figure 1. The principal architecture of Blood Pressure Measurement, based on Sphygmomanometer, LabQuest Mini sensor interface and MATLAB

A. *Blood pressure determination from accelerometric data*

Blood pressure determination from oscillometric data involves several steps to extract meaningful information from the acquired signals.

In the proposed algorithm, data acquisition and preprocessing starts with the importation of the raw data from a CSV file containing time values and cuff pressure measurements. These data were read into MATLAB.

To identify relevant features in the oscillometric cuff pressure signal, we employed peak detection algorithms. The primary objective was to locate the systolic and diastolic peaks within the signal. This involved finding points in the signal where the cuff pressure exhibited significant variations indicative of the cardiac cycle.

Initially, we detected the systolic peak, which corresponds to the maximum cuff pressure value during systole, representing the peak of the cardiac cycle. The exact time at which the systolic peak occurred was recorded.

Similarly, the end of the cardiac cycle was determined by finding the last recorded time point in the dataset. Subsequently, we calculated the indices within the dataset corresponding to the duration of a complete cardiac cycle. The cuff pressure values within this interval represented one full cardiac cycle.

To enhance the quality of the cuff pressure signal, we applied a high-pass Butterworth filter. This filtering process involved removing lower-frequency components, leaving only the relevant high-frequency variations.

Following the signal filtering step, we proceeded to detect both systolic and diastolic peaks within the positive filtered cuff pressure signal. Diastolic valleys, representing the lowest points in the cuff pressure signal during diastole, were detected by inverting the positive filtered signal and applying the same peak detection algorithm.

From the detected systolic and diastolic peaks, we calculated several key blood pressure-related parameters. This included determining the maximum value of the diastolic valleys and its associated time point, which provided essential information for calculating the Mean Arterial Pressure. Utilizing the computed thresholds and peak indices, we identified the cuff pressure values corresponding to the systolic and diastolic peaks. These values represented the Systolic Blood Pressure and Diastolic Blood Pressure, respectively.

The visual representation of the algorithm is shown in Fig. 2.

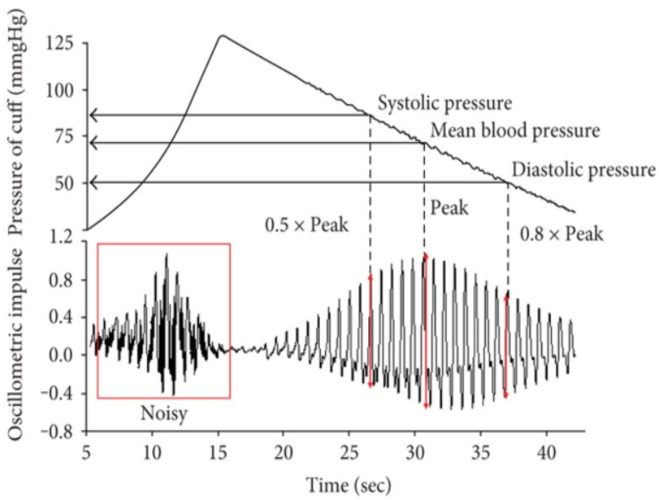

Figure 2. Cuff pressure waveform of oscillometric method [3]

III. EXPERIMENT AND RESULTS

To evaluate the effectiveness of the MATLAB-based interface for blood pressure determination from oscillometric data, we conducted experiments involving four individuals. The study aimed to assess the accuracy and reliability of the algorithm in estimating blood pressure parameters, including Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Mean Arterial Pressure (MAP). To validate the algorithm's performance, we will simultaneously compare the results with the ones obtained using Vernier Logger Lite software.

The algorithm successfully processed the oscillometric data and provided estimations of blood pressure parameters for each participant. To facilitate a comprehensive comparison, Table 1

below presents the algorithm's results alongside measurements obtained using the Vernier blood pressure measuring software:

Person	Blood pressure in mmHg					
	MAP-Vernier	MAP-Matlab	SBP-Vernier	SBP-Matlab	DBP-Vernier	DBP-Matlab
#1	98	97.83	124	128.74	71	76.75
#2	87	96.88	119	119.26	69	71.63
#3	79	97.76	110	111.68	66	74.77
#4	88	88.14	119	117	62	66.51

Table 1

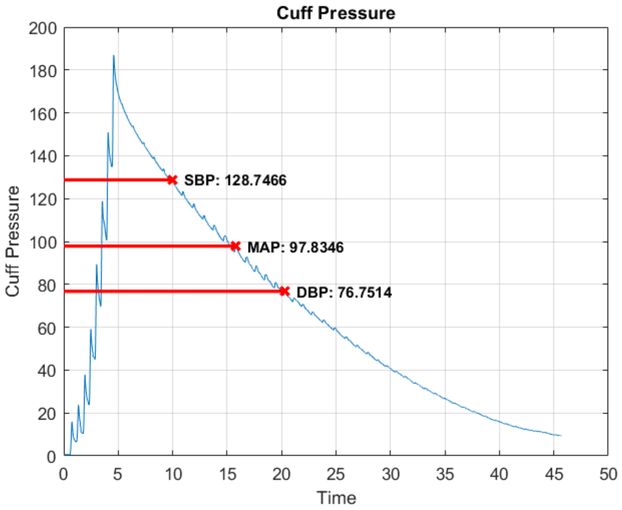

Figure 3

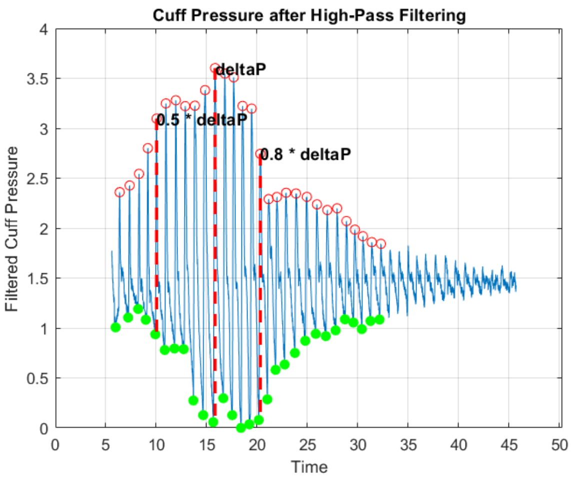

Figure 4

All the relevant information and graphs can be found in Fig. 2, which we obtained from MATLAB, and from there, we can read the relevant values.

IV. CONCLUSIONS

This paper presents an examination of the effectiveness of our MATLAB-based interface for blood pressure determination from oscillometric data. The noteworthy alignment between the algorithm's estimations and measurements obtained using the Vernier blood pressure measuring device serves as compelling evidence of its accuracy and reliability. Our interface emerges as a promising tool for blood pressure assessment in clinical and research contexts, offering the advantages of automation and efficiency while maintaining a high level of precision and consistency in blood pressure parameter estimation.

The complete MATLAB code, as well as the images used in the display, can be found at the following link:

https://github.com/UsernamekaLu/BPSAnalysis.git

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