International Journal of Engineering Applied Sciences and Technology, 2016
Vol. 1, Issue 5, ISSN No. 2455-2143, Pages 87-90
Published Online March – April 2016 in IJEAST (http://www.ijeast.com)

IDENTIFICATION AND VALIDATION OF WRIST PULSE SIGNAL PLATFORM FOR AN OBJECTIVE STUDY

Nidhi Garg
Department of ECE
UIET, Panjab University, Chandigarh, India

Abstract— **In the Ayurveda, wrist pulse signals are used for understanding the status of human health. It is non-invasive method and subjective in nature. The computerized pulse acquisition system is one of the initial requirements for an objective study. The wrist pulse signal of individual is different from other till the health status is different. In this paper, we are investigating the suitability and repeatability of experimental setup by comparing the signals of same subjects and different subjects. Significant results were obtained. More than 95 % correlation exist if comparing wrist signals of same subjects and for different subjects correlation found less. Hence, the pulse taking platform would be useful for further data acquisition and analysis.**

Keywords— **Wrist Pulse Signals, Data Acquisition, Digital Signal Processing, Validation**

I. INTRODUCTION

Wrist Pulse diagnosis is a technique used in Traditional Asian Systems of Medicine including Traditional Chinese Medicine and Traditional Indian Medicine (Ayurveda) [1-5]. It is used to diagnose disease or medical conditions of humans. It is described as a skill that is very difficult to master. It requires subtle pulse readings in many locations and in multiple combinations. The basis of wrist pulse diagnosis lies in three radial pulses which are known as vata, pitta and kapha. They exhibit different characteristics in terms of their amplitude, frequency, regularity, etc. The features related to the wrist pulse signals are important from diagnostic point of view. Practitioners of these systems of medicine check the pulse for strength, speed, and other qualities. They believe that certain pulse qualities indicate energy imbalances in specific organs or areas of the body. The computerized pulse signal analysis has shown promises to the modernization of traditional pulse diagnosis, such as the pulse pattern recognition and the pulse series analysis.If the health condition of the subject is different from other one, the wrist pulse signals obtained would not be the same. Although, if they exhibit same characteristics then it indicate subjects suffers from same type of disease. This indicates that if the comparison between the acquired signals would be done we could come to the conclusion which type of disease the subject is suffering from. It is always desirable that the system which we are using to acquire wrist signals is able to reproduce the wrist signals from the same subject. However, wrist signals are varying within individuals during a day itself. Therefore, signals from same subjects have been acquired with a gap of 10 minutes only.

In this paper, the investigation is carried out to find whether the wrist pulse signals acquired from different subjects are related to other or not and to find the suitability of experimental setup in order to reproduce the wrist pulse signals from same subjects.

The rest of the paper is organized as follows. Section II explains data acquisition and pre-processing, section III highlights the evaluation parameters and describes the results. Section IV gives the conclusion.

II. DATA ACQUISTION AND PRE-PROCESSING

The experimental setup has been created to acquire the wrist pulse signals. The main objective is to build a general system to obtain data from an external device to achieve a desired output. The pressure sensor physical phenomenon is converted into electrical signal with the help of amplifiers and filters. The wrist pulse signal has low voltage level so need to be amplified. With help of hardware signal is taken from wrist location. Further, the process of the overall system is divided in three stages, shown in Fig. 1. These three stages are acquisition, pre-processing and feature analysis.

International Journal of Engineering Applied Sciences and Technology, 2016
Vol. 1, Issue 5, ISSN No. 2455-2143, Pages 87-90
Published Online March – April 2016 in IJEAST (http://www.ijeast.com)

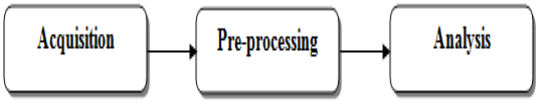

Fig. 1 Block diagram representing overview of system

The data during the acquisition, pre- processing and analysis must be displayed and stored on a computer in the form of a waveform pulse series. Here, LabVIEW software is used to perform all the functions. Dataset has been created of two subjects with same age group. For one minute duration data was acquired from the all the subjects. To check the reproducibility of the system wrist pulse signals were acquired twice a time from all the subjects with a minimum gap of 10 minutes under same settings and environmental conditions. Wrist pulse waveforms for the duration of 60 seconds had been acquired from two subjects named A and B. Two signals were acquired from each subject with the time gap of 10 minutes. Further, signals were processed to obtain average pulse waveforms for each of the 4 signals. These average pulses were used to extract spatial features to verify reproducibility capability of hardware using evaluation parameters.
Preprocessing is required prior feature extraction and analysis. It is the one of the most significant step. The number of steps needs to be followed and single period averaged signal was obtained [5-7]. The steps and the function performed are represented in the Fig. 2.

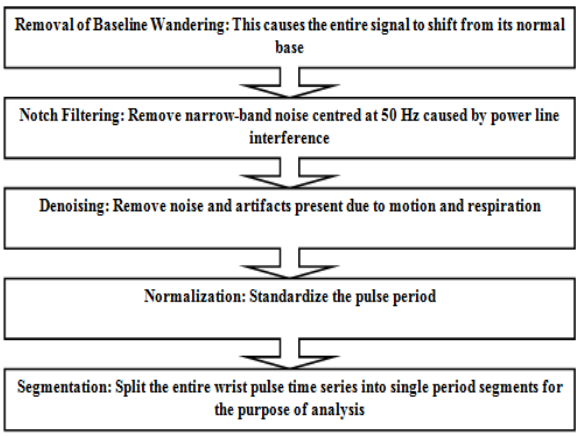

Fig. 2. Flowchart for Pre-Processing

III. EVALUATION PARAMETERS AND RESULT:

The parameters Cross-covariance, Correlation(r) have been derived to obtain the numerical measures of the strength of a relation between the wrist pulse signals. These are explained as follows:
Cross-covariance: It describes the degree to which two random variables or sets of random variables tend to deviate from their expected values in similar ways. Specifically, covariance measures the degree to which two variables are linearly associated. If X & Y are two random variables

Cross-covariance: $\sigma_{XY} = E[(X - E[X])(Y - E[Y])]$
Where, E is the expected value operator.

Correlation: It is the scaled version of covariance that takes on values in [-1, +1] with a correlation of ±1 indicating perfect linear association and 0 indicating no linear relationship.
If X & Y are two random variables
Correlation: $\rho_{XY} = E[(X - E[X])(Y - E[Y])] / (\sigma_X \sigma_Y)$
Where, σ is standard deviation.
All the evaluation parameters were used to relate the signals obtained from same or different subject. Moreover, overlapping of wrist pulse signal waveforms has been performed to validate the experimental setup.

Pattern analysis has been carried out by analyzing derived average wrist pulse signals to check the degree of resemblance between same subject wrist pulses and different subject wrist pulses. Signals acquired from subject A were named as A1 and A2 and signals acquired from subject B were named as B1 and B2. Overall four average wrist pulse signals were under analysis. These pulse patterns were overlapped on one another as shown in Fig. 3-8 to examine the degree of resemblance.

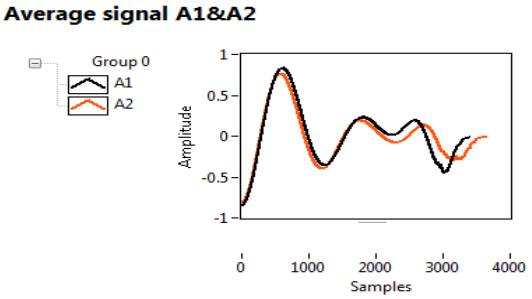

Fig. 3. Representation of comparison of average signal pulses of same subject (subject A with gap of 10 min)

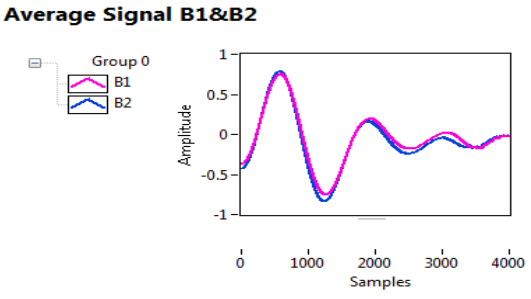

Fig. 4. Representation of comparison of average signal pulses of same subject (subject B with gap of 10 min)

International Journal of Engineering Applied Sciences and Technology, 2016
Vol. 1, Issue 5, ISSN No. 2455-2143, Pages 87-90
Published Online March – April 2016 in IJEAST (http://www.ijeast.com)

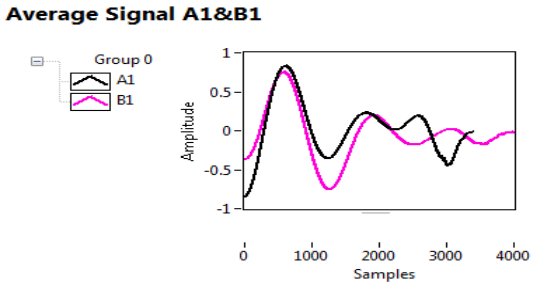

Fig. 5. Representation of comparison of average signal pulses of subject A and B (signal A1 and signal B1)

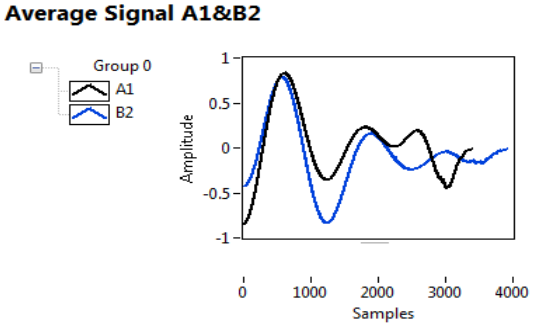

Fig. 6. Representation of comparison of average signal pulses of subject A and B (signal A1 and signal B2)

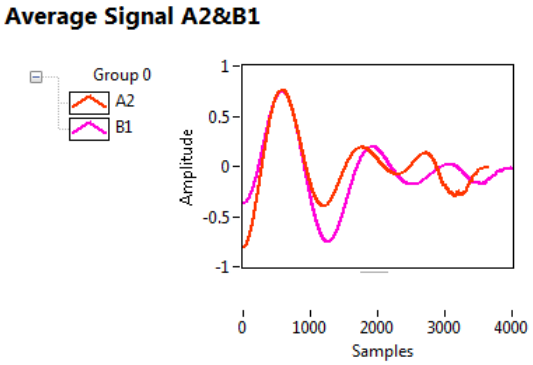

Fig. 7. Representation of comparison of average signal pulses of subject A and B (signal A2 and signal B1)

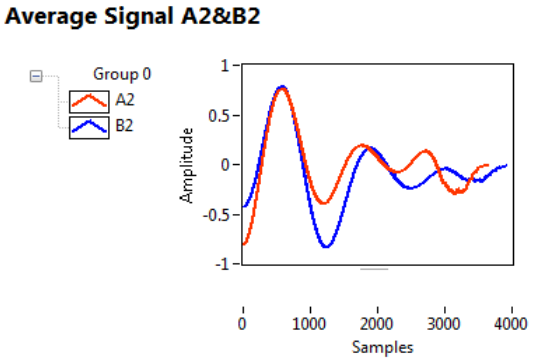

Fig. 8. Representation of comparison of average signal pulses of subject A and B (signal A2 and signal B2)

The degree of resemblance was examined and it justify the fact that the average signal pulses from same subjects were analogous and their patterns were closely related to each other as compared to pulses from different subjects. In Fig. 3 and 4, waveform graphs represents the comparison of two average signal pulses from same subject and Fig. 5-7 waveform graphs represents the comparison of two average signal pulses from different subjects.

The pattern analysis results were validated using evaluation parameters. These parameters were Covariance and Correlation (r). Table -1, represents the extracted values for the mentioned parameters. Here, using bar graph correlation parameter is represented to display the different cases.

Table -1 Result obtained from Average Signals

	Covariance	Correlation (r)
Signal A1&A2	0.105517	0.953872
Signal B1&B2	0.115925	0.995361
Signal A1&B1	0.083372	0.761581
Signal A2&B2	0.090108	0.825918
Signal A1&B2	0.091746	0.767793
Signal A2&B1	0.080943	0.809258

International Journal of Engineering Applied Sciences and Technology, 2016
Vol. 1, Issue 5, ISSN No. 2455-2143, Pages 87-90
Published Online March – April 2016 in IJEAST (http://www.ijeast.com)

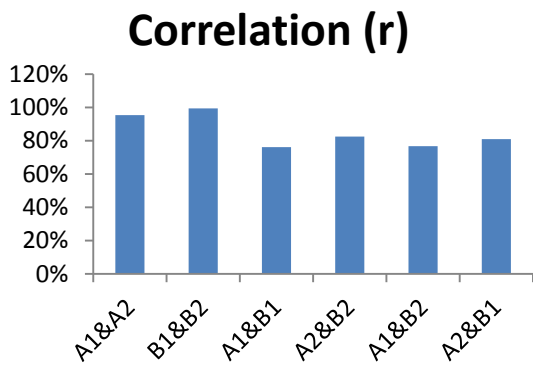

Fig. 9. Bar graph representing correlation between all signals

From the table and bar graph, we can conclude that the correlation between two pulses acquired from same subject is greater than 95%. Therefore, these two cases (i.e A1&A2 and B1&B2) show significant resemblance whereas the other four cases (i.e A1&B1, A2&B2, A1&B2 and A2&B1) show significant differences. It also reveals the repeatability of the pulse taking platform.

IV. CONCLUSION

The Experimental setup used to acquire the wrist pulse signals is capable to mimic the operation carried out by ayurvedic physicians. It also proves the theory of the Traditional Indian Medicine that wrist pulse signals of individuals is different having different physiological conditions. It also validates the repeatability of the pulse taking platform.

V. REFERENCE

[1] Lad, V.D.: Secrets of the Pulse: The ancient art of Ayurvedic pulse diagnosis. Motilal Banarsidass, Delhi (2005).

[2] S. Upadhyay, *Nadi vijnana (Ancient pulse science)*. Chaukhambha Sanskrit Pratishthan, Delhi, 1986.

[3] Shiva Ayyadurari, V.A. (2014)'The control systems engineering foundation of traditional Indian medicine: the Rosetta Stone for Siddha and Ayurveda', *Int. J. System of Systems Engineering*, Vol. 5, No. 2, pp. 125-149. DOI:10.1504/IJSSE.2014.064836.

[4] X.F. Hu, H.X. Li, Taking a look at the characteristics of the diagnostic methods of Traditional Chinese Medicine (TCM) from the periodical literature in the Republican period of China, Zhonghua Yi Shi Za Zhi 39 (2009) 218–221.

[5] L.S. Xu, K.Q. Wang, D. Zhang, Modern research on Traditional Chinese pulse diagnosis, Eur. J. Orient. Med. 4 (2004) 46–54.

[6] Chopra, M., Kaur, R., Garg, N. (2015), 'Study and Evaluation of Denoising and Baseline wandering of Computerized wrist pulse signal using Virtual Instrument', *International IEEE Conference on Next Generation Computing Technologies (NGCT),* Vol. 208, No. 2, pp. 181–189.

[7] Xia, C., Li, Y., Yan, J., Wang, Y., Yan, H., Guo, R., Li, F. (2008), 'A Practical Approach to Wrist Pulse Segmentation and Single-period Average Waveform Estimation', *IEEE International Conference on BioMedical Engineering and Informatics*, pp. 334-338. DOI: ieeecomputersociety.org/10.1109/BMEI.2008.140