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Research Article

NADI PARIKSHA: WRIST PULSE ANALYSIS WITH TRADITIONAL AND MODERN INTERPRETATION

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ABSTRACT

Nadi Pariksha (Pulse diagnosis) is considered the most important assessment in Traditional Medicine System (TMS) for health monitoring. Traditional pulse analysis is subjective and hard to quantify. It is difficult for a Ayurvedic doctor to understand the pulse by his own perception due to its arbitrariness. To realize due recognition of TMS, standard techniques and standard instruments are urgently to be developed. In view of the increasing popularity of traditional and alternative medicine worldwide, researchers have explored pulse sensing and analysis, but due to the conflict of research goals, methodologies and statistical tools applied, the outcome of studies till date is not focused in one direction. This study explores current status of pulse signal interpretation by researchers using latest electronic signal processing techniques in recent years. The aim of research is towards development of pulse sensing and analyzing techniques using latest technology to assist or help Ayurvedic doctors, in a way to promote our country's traditional pulse sensing. Since no sensor is benchmarked as a standard in wrist pulse sensing till date, various sensors were explored to sense wrist pulse and the results were correlated with the recent research. Optical sensor HOA 709 in reflective mode, exhibited best results, it captured the minute details and was used to acquire pulse signal of healthy subjects at Pita point on radial artery. The sensor was explored further to record pre-meal and post-meal data of two subjects and significant variation in signal contour was noticed. It can further be explored to extract more parameters with the help of Ayurvedic doctors to make it useful in health care.

KEYWORDS: TMS (Traditional Medicine System), MAS (Modern Allopathic System), wrist pulse sensing and interpretation.

INTRODUCTION

Ayurveda (Traditional Medicine System) (TMS) can be classified into three main groups codified medical systems, folk medicine and associated practices of health knowledge[1]. Codified medical systems include Siddha, Ayurveda and Unani in the India, China, Korea and Japan with a history of around 5000 years. TMS is staging a comeback. In the developed countries, 50% of the population prefers a natural approach to health care using traditional medical therapies as well as the products and many governments have incorporated traditional medicine practices to meet their basic health care needs and their usage is, Canada 70%, France 49%; Australia 48%; United States 42% and in many developing countries, it is being used extensively (India 70%; Chile 71%; China 40%; Colombia 40% and up to 80% in African countries)[1,4]. Worldwide the interest in TMS has increased due to its easy accessibility, it is based upon pulse sensing which is nonintrusive, convenient, inexpensive, no consumables are required, it is bloodless, painless and has no side effects. Pulse sensing is one of the most important parts for physiological information acquisition. Health condition of a person or a particular organ can be predicted through pulse palpation at three locations, i.e. VPK (*Vata Pita* and *Kapha*) on both wrists illustrated in Figure 1.

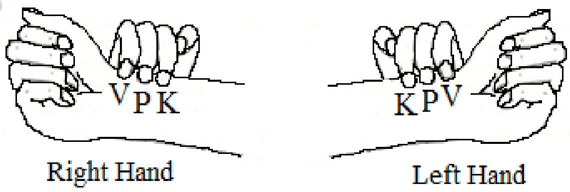


Fig. 1 VPK (*Vata Pita* and *Kapha*) positions on both wrists

A health practitioner combines clinical data collected from pulse assessment and other clinical assessments to prescribe treatments to his patient and to monitor his prognosis. He examines the pulse applying pressure until the pulse is maximal and then varies pressure while concentrating on the phases of the pulse. Various policy measures have been and are being applied to the use of TMS, in order to increase its acceptability, safety, and usefulness[2,3]. Researchers have worked extensively on the present status of research on TMS with constraints, problems and possible solutions[3,4]. Considerable increased use of complementary and alternative medicine therapies, needs measures to regulate these practices for safety and authenticity. The mandate of National Center for Complimentary and Alternative Medicine (NCCAM) at the National Institutes of Health is to explore complementary and alternative healing practices in the context of rigorous science to educate and train researchers [5]. It is need of the hour for adequate scientific base and standardization of techniques. Safety, usefulness, quality and rational use of TMS are major policy challenges[6]. In the present research different types of microphone and optical sensors were explored, best results were achieved using optical sensor. Since flexibility, repeatability and off line parallel processing are main advantages of DSP (Digital Signal Processing) over analog signal processing, after preamplifier, using DSP is better option for signal processing and analysis. [7]

Normal Wrist Pulse Characteristics described in Ayurveda TMS

Ayurveda the traditional Indian medicine system believes that universe comprises of five basic elements air, water, earth, fire and space. Human life is considered as an accumulation of seven *Dhatus* (tissues), three *Doshas* (elements) *(Vata, Pitta and Kapha)* and three *Malas* (wastes). According to ancient literature, any ailment in the body changes the constitution of *Vata, Pitta* and *Kapha*. Variations are sensed by the fingers of a pulse examiner. Ayurvedic practitioners carefully examine pulse at different depths, each connected with a specific part of the body and believed to register even the slightest physiological based changes. *Vatta*, *Pitta* and *Kapha* move in the whole body producing good or bad effects upon the entire system according to their normal or abnormal states. Normal state is *Prakruti* (Balance) and the abnormal state is *Vikruti* (imbalance). Three *Doshas* are assessed generally under the index, middle and ring fingers, their subtle qualities are felt under specific areas of each fingertip, at the distal, middle and proximal curvatures [8]. The pressure to be applied at radial pulse point can be divided into seven levels, from the superficial layer to the innermost layer. Superficial level can be called the first level and at the deepest level, after which the pulse is abolished is the seventh level. *Prakruti* and *Vikruti* are assessed by feeling and comparing the pulse at the first level and at the seventh level. Variations in real time can be recorded and analyzed according to *Ayurvedic* principles[9]. *Prakruti* and *Vikruti* are referred to in several ways; levels seven and one, deep and superficial levels, the levels of balance and imbalance. *Prakruti* has *a* very important role in the diagnosis of disease and it is also possible to predict the possible clinical features of each *Prakruti* type [10]. Abnormal pulse patterns can be identified with their correlation to abnormal status. Pulse morphologies for healthy subjects are formally known in the research literature with moderate, taut and slippery pulse [11].

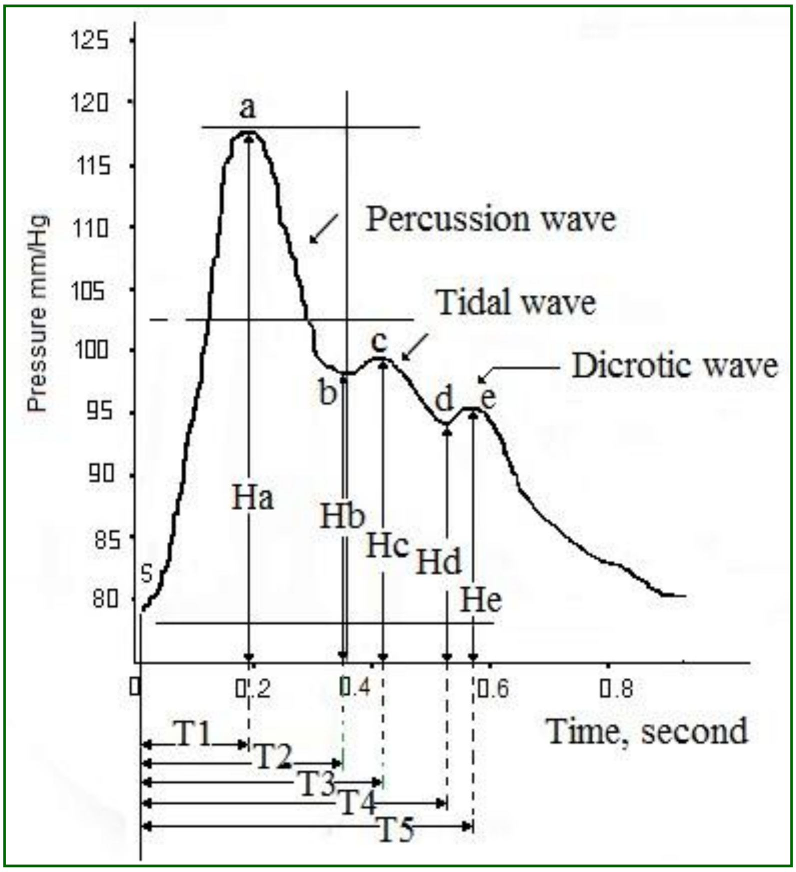


Fig. 2a Pulse signal of a healthy subject

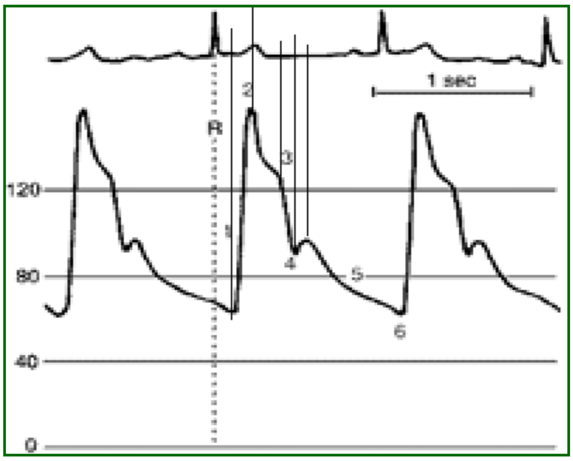


Fig. 2b ECG and Radial Arterial Pulse monitoring in Modern Clinical Practice(MCP)

Normal Pulse Interpretation

Five most important physiological feature points of human wrist-pulse waveform are peak point of the pulse marked as *a*, the trough point of the pulse marked as *b*, the peak point of before the dicrotic notch marked as *c* it is seen rarely but is considered normal, the peak point of the dicrotic pulse marked as *e*, the trough point of the dicrotic pulse marked as *d* in a pulse cycle represented as in figure 2a. Various segments of normal arterial blood pressure waveform (1) systolic upstroke, (2) systolic peak pressure, (3) systolic decline, (4) dicrotic notch, (5) diastolic runoff and (6) end-diastolic pressure are correlated with electrocardiographic R wave in the time sequence in Figure 2b. At the end of systole phase of heart, when aortic valve closes, a rebound action of the arterial blood results in a small dicrotic notch and the diastole phase of the heart starts.

Radial Arterial Signal Analysis in Different Medical Conditions

A noninvasive continuous blood pressure measuring system was developed by analyzing radial artery pulse from the wrist which suggested a more stable and accurate controlling mechanism for the placement and tightening of the transducer [12].

Respiratory and cardiac rhythm disorders were detected by measuring pressure variations with a lightly inflated cuff wrapped around the wrist, related to changes in the blood arterial pressure. Systolic reflective index was derived from the ratio of the second peak over the first peak of the systolic part of the radial arterial wave [13].

The accuracy of the pulse transit time method was evaluated for determining diastolic blood pressure using intra-arterial blood pressure as a reference. Diastolic pressure was determined by the point when the transit time started to increase. Diastolic pressure errors are not strongly dependent on arm circumference and body mass index [14].

MATERIAL AND METHODS

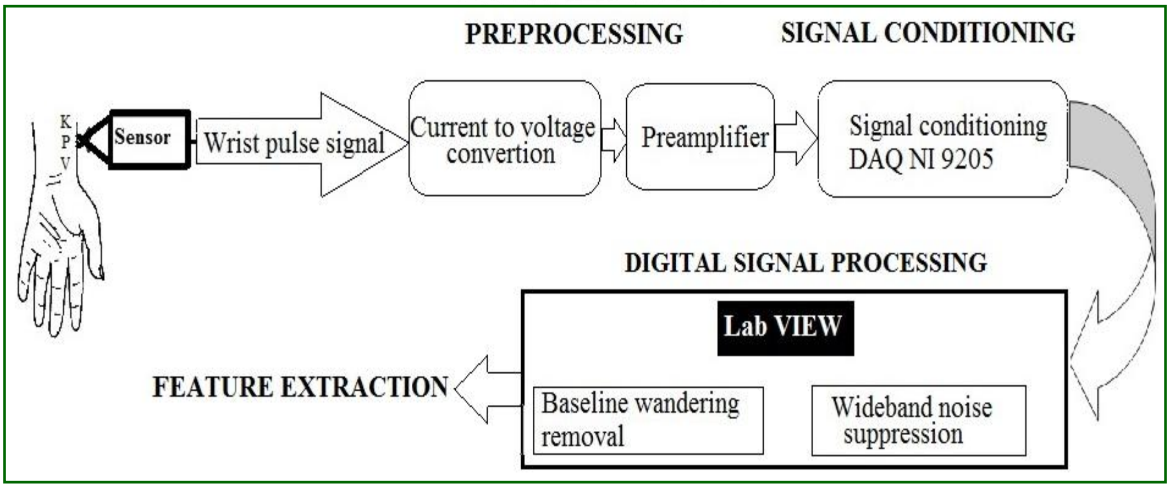


Fig. 3 System Block Diagram

To acquire wrist pulse signal, system set up illustrated in figure 3 was set up. It consists of five stages, sensing, pre-amplification, signal conditioning, digital signal processing and feature extraction. Different types of microphone and reflective type optical sensors were explored at sensing stage. Each sensor requires a dedicated signal pre-amplification. Sensor in each set, exhibiting best performance was explored further for signal analysis. 9.5mm diameter, 40db microphone sensor unidirectional with noise cancellation in the set of microphone sensors was used for pulse sensing at single point. HOA 709 exhibited best results in optical sensors and was used to acquire pulse signal of a healthy subjects at *Pita* point on radial artery, using NI input module 9205 and the analyses was done in LabVIEW software.

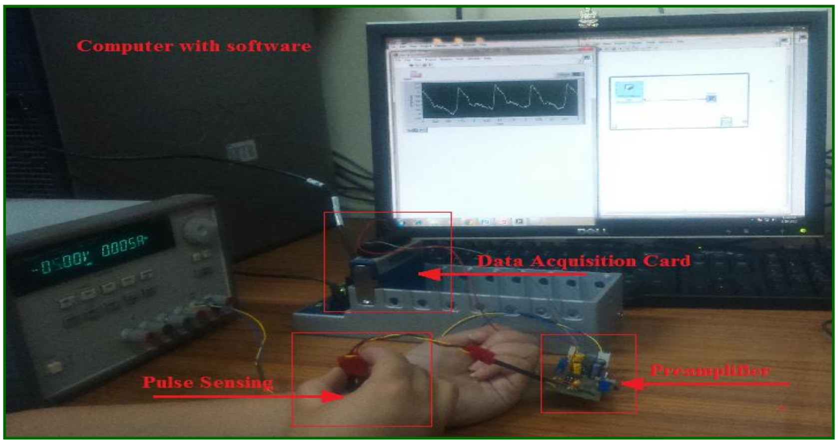
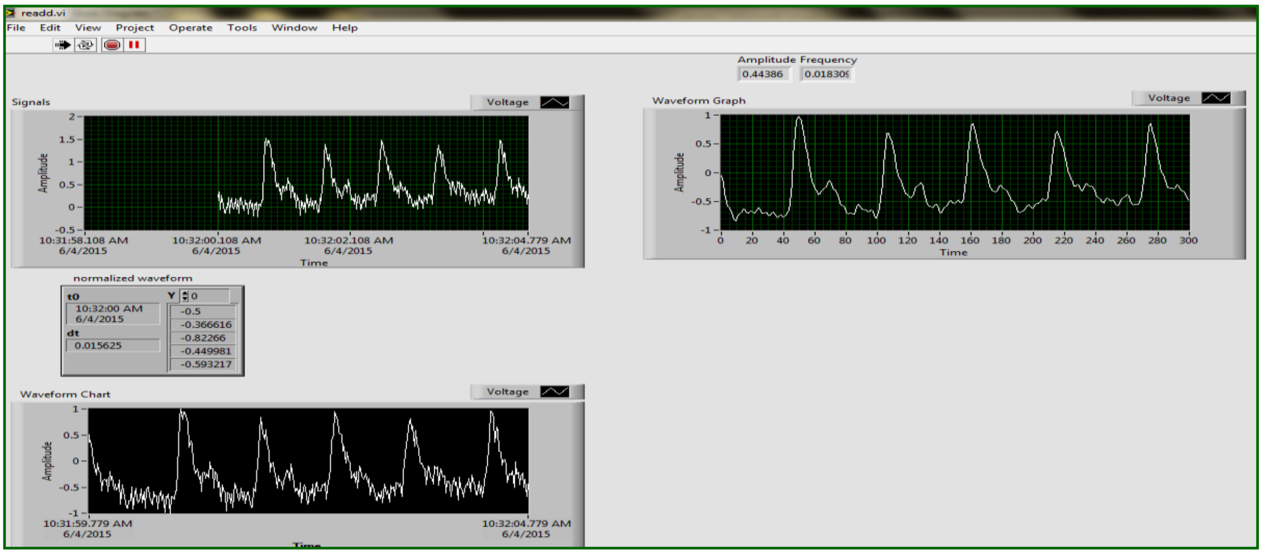


Fig. 4. (a), Wrist Pulse Signal Acquisition



(b) Processed and raw wrist pulse signal

A customized pulse acquisition setup shown in figure 4 a was setup to acquire and record wrist pulse signals. It consists of DC Power supply, pre amplifier circuit, DAQ card 9205 and computer with LabVIEW software. The experiment was carried out at CSIR-CSIO Chandigarh in Biomedical Instruments Division. Four healthy young volunteers agreed upon to participate in the study. Sensing stage is the most critical stage affecting overall performance of analog signal conditioning, information lost at this stage can never be retrieved later on in the next stages. The optical sensor was capable to sense the wrist pulse palpation and produced an output low in amplitude. Precision operational amplifier with high speed and fast settling time was used in preamplifier to truly capture the minute variations. Processed and raw wrist pulse signals are shown in figure 4 b.

RESULTS

We got comparatively better and informative results with optical sensor than with microphone sensor. Pulse signal contour is different for different types of sensors. Pulse shape described in figure 2a is relevant to optical sensor which also resembles standard PPG (Photoplethysmogram) waveform. The pulse signal of normal subjects was acquired and recorded during the normal rest condition. The sensors were able to detect the changes in the signal, which confirms changes in body condition captured at *Pita* point on the wrist. The results obtained from optical and microphone sensor of four subjects are shown in figure 5 (a) and (b). It is very clear that signal from optical sensor has more information and signal to noise ratio is also better in the signal using optical sensor.

Wrist pulse signal of four healthy volunteers was acquired from left hand at *Pita* point using both optical and microphone sensors. Data of all subjects was different and repeatable. Acquired data was also recorded in Excel sheet for further data analysis. Data of 4 subjects is shown in figure 5(a) and figure 5(b). Details of four volunteers who participated in the experiment is tabulated in table1.

Table1 Details of volunteers

Volunteer	Male/Female	Age in years	Height	Body Type	Health Condition
Subject 1	Male	27	5'7"	Average	Normal
Subject 2	Male	23	5'9"	Athetic	Normal
Subject 3	Female	21	5'2"	Average	Normal
Subject 4	Female	23	5'	Average	Normal

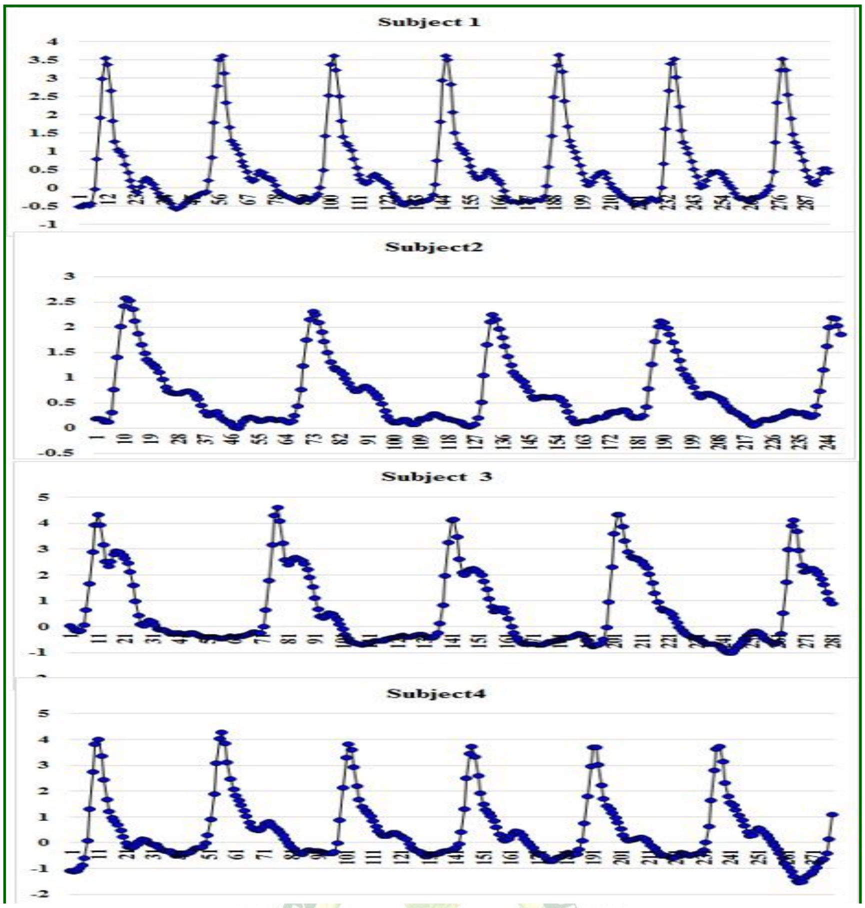


Fig.5(a) Wrist pulse signal of four subjects using

Fig.5(b) Wrist pulse signal of four subjects using microphone sensor

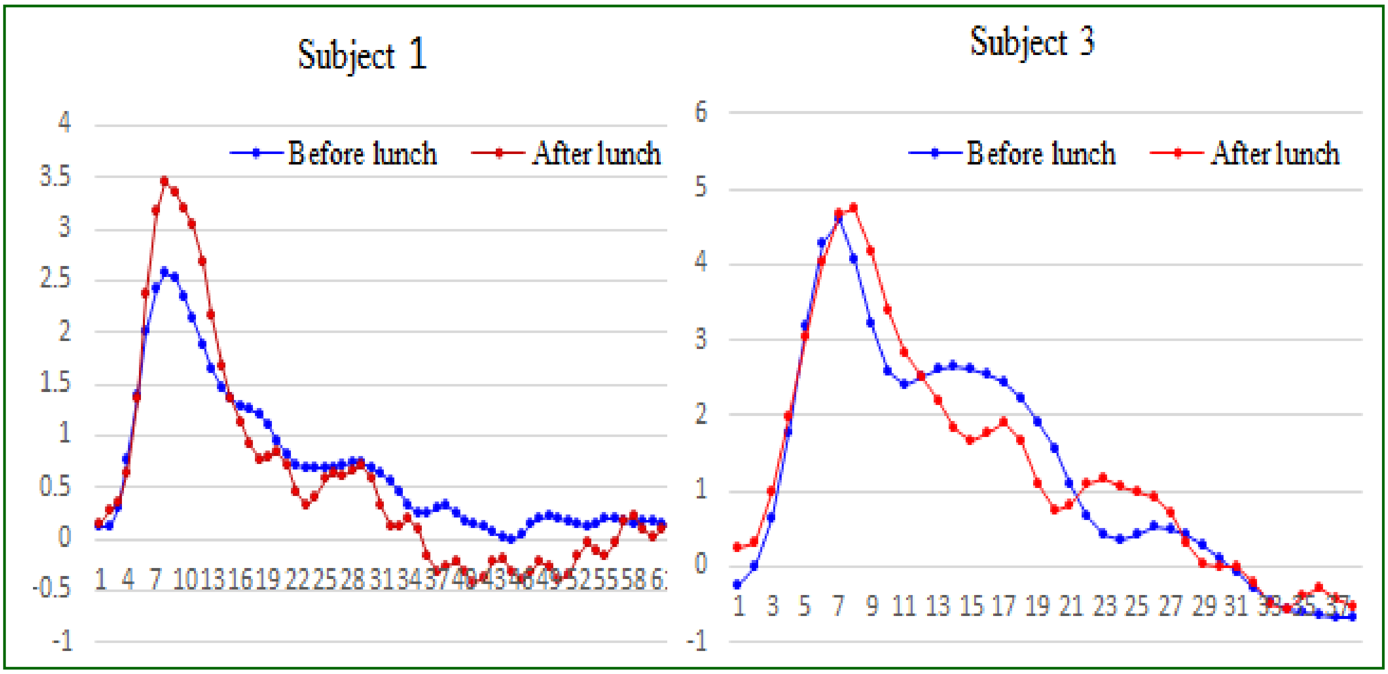


Fig.6 Pre-meal and post-meal wrist pulse signal of two subjects using optical sensor

Pre-meal and post-meal wrist pulse signal of two subjects using optical sensor is shown in figure 6. Data shows a significant variation between the stated two conditions of both the subjects which is indication of resolving capability of sensor and its electronics. We can find out relative variation mathematically but the domain knowledge from Ayurvedic doctors is required to find out, what this variation actually means as per subject's health.

CONCLUSION

As per literature survey for cardiac output (CO) monitoring in surgery and intensive care patients by mathematical analysis of an arterial blood pressure (ABP) waveform is performed with a radial artery catheter which is an invasive technique in MAS (Modern Allopathic System). A number of such "pulse contour analysis" techniques have been proposed by the researchers of MAS. Pulse contour of wrist pulse signal acquired using optical sensor resembles with the signal achieved with a radial artery catheter by the clinical researchers, hence advanced signal processing algorithm can also be implemented for extracting various features from pressure varying wave morphology of a radial arterial pulse pressure wave acquired from human wrist noninvasively. It is concluded that optical sensor signal acquired at Pita point has significant information that can be used for diagnosis and can be explored further for feature extraction. Various clinical parameters like arterial stiffness index, reflection index, depth of pulse, total pulse duration can also be estimated from the pulse signal, which further can be explored for health care as per.

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