Nadi Diagnosis Techniques

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Abstract: **Ayurveda and Traditional Chinese Medicine approach uses pulse signals obtained from radial artery as a means for diagnosis of diseases. These conventional techniques are nowadays been replaced by devices using various sensors for detecting pulse signal from radial artery at wrist position. This paper gives a brief review on such diagnosing techniques developed till now for diagnosis of various diseases using the concepts of Nadi Vigyan. The use of different sensors and their results will also be discussed in this paper.**

Keywords: Pulse Diagnosis, Nadi, Ayurveda, Vata, Pitta, Kapha

I.   INTRODUCTION

In the ancient times, pulse diagnosis using the signals obtained from the three precise locations on the wrist at the radial artery, viz. vata, pitta and kapha, played an important role in the Traditional Chinese Medicine and Ayurveda. The signals obtained from these locations are not only due to the contraction and relaxation of blood vessel but also a result of movement of blood through the artery and change in their diameter [2].

The science of Ayurveda is based on these three pulse signals, namely vata, pitta and kapha. In Traditional Chinese Medicine these pulses are named as cun, guan and chi respectively. But the basic science behind both these systems is same. The Nadi Vidwans using their experience and skill feel this signal on the patient's wrist. Any change in the nature of signal felt is a means of diagnosis of disease.

The different waveforms obtained from vata, pitta and kapha pulses have shape similar to that of movement of cobra, frog and swan respectively as shown in Fig. 1 [1] below.
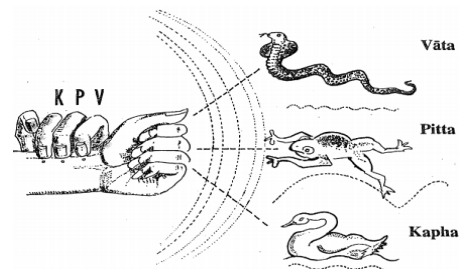

Fig. 1 Shapes of waveform of vata, pitta and kapha pulses [1]

These pulses are felt at specific positions on the wrist of the patient: vata on the index finger, pitta on the middle finger and kapha on the ring finger. The Nadi Vidwans feel them by placing their hand in a specific orientation on the patient's wrist, as shown in Fig. 2 [1].
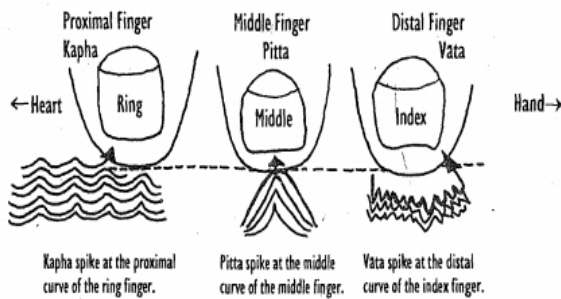

Fig. 2 Location of fingers on wrist to feel vata, pitta and kapha pulses [1]

Also, it is said that analysis of hollow organs and semi-solid organs is done by feeling the nature of pulse at the deep and superficial layers of the wrist radial artery by applying proper external pressure. The location of organ pulses on both the hands is shown in Fig. 3 [1].
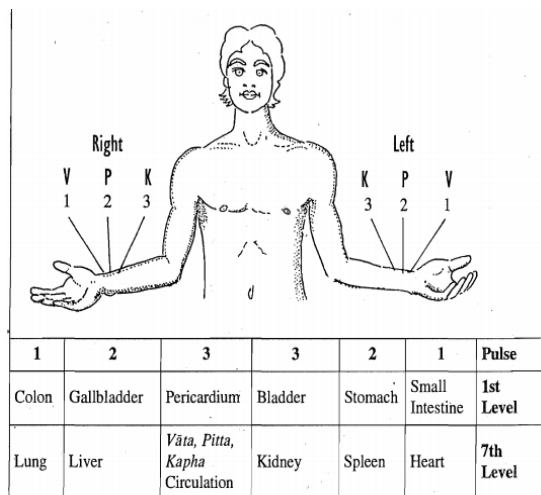

1	2	3	3	2	1	Pulse
Colon	Gallbladder	Pericardium	Bladder	Stomach	Small Intestine	1st Level
Lung	Liver	Vāta, Pitta, Kapha Circulation	Kidney	Spleen	Heart	7th Level

Fig. 3 Location of organ pulses [1]

But this technique of arterial pulse analysis requires years of experience and knowledge and can vary from person to person. Thus the recent trend follows to replicate this system in terms of a device which will be smart enough to diagnose diseases by capturing the signals from wrist using various types of sensor, depending on the disease to be diagnosed. This paper focuses on such techniques already available in the market.

The following sections will comprise of a brief review on techniques developed by various researchers to diagnose diseases using the concept of Ayurveda and Traditional Chinese Medicine, followed by conclusion and references.

II. TECHNIQUES AVAILABLE FOR PULSE DIAGNOSIS TO DETECT VARIOUS DISEASES

This section will give a brief overview on the available techniques developed by various researchers, across the globe, to diagnose any particular disease using the concept of Ayurveda and Traditional Chinese Medicine.

A Comparison of Three Types of Pulse Signals: Physical Meaning and Diagnosis Performance
In this paper, a comparative study was done on various kinds of sensor (photoelectric, piezoelectric and ultrasonic) mostly used in devices capturing the radial arterial signals. It has been observed by the researchers that pressure sensors imitate the procedure of Traditional Chinese Medicine, photoelectric sensors are easier to make and ultrasound sensors are robust in nature. Also according to the working principle of each sensor it is observed that pressure sensors are used in applications where pulse waveform classification is done and measurement of trans mural pressure variance of blood vessel is required and in diagnosis of diseases such as Cholecystitis, nephrotic syndrome and diabetes; photoelectric sensors are used in application involving measurement of systemic

18

vascular resistance and where volume information of blood in the vessel is required; and ultrasonic sensors are preferred in applications requiring blood volume information such as for diagnosis of diseases such as arteriosclerosis, pancreatitis, duodenal bulb ulcer, nephritis and Cholecystitis. In order to compare diagnosis performance of the three sensors, patients were diagnosed for diabetes problem. The result obtained using these sensors on a healthy patient is shown below in Fig. 4 [2].
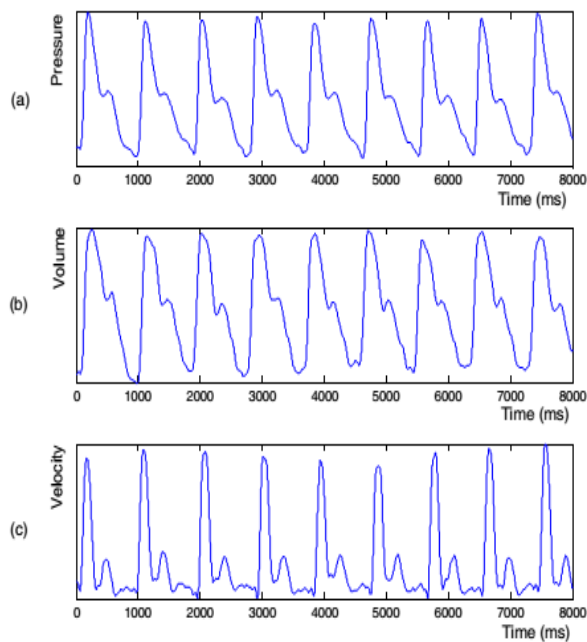

Fig. 4 Output using different sensors [2]

It can be observed from the graphs, that ultrasonic sensors show better performance compared to other two sensors. As diabetes is reported to have connection with blood viscosity [2], it is proved that diseases related to blood viscosity can be diagnosed better with ultrasonic sensors. Also, the performance of the system can be improved if all these three sensors are integrated together.

Comparative Study of Pulse-diagnosis Signals between 2 Kinds of Liver Disease Patients based on the Combination of Unsupervised Learning and Supervised Learning

In order to compare the signal obtained in two different types of liver disease namely, Fatty Liver Disease and Cirrhosis, a comparative study was done using unsupervised and supervised learning methods for identification of pulse signals. In this study, pulse signal were collected using the concepts of Traditional Chinese Medicine and were then pre-treatment and parameter extraction was done on the basis of harmonic fitting [3]. The parameters were extracted by database administration and analysis system for pulse diagnosis using the concept of Traditional Chinese Medicine and 193 parameters were obtained from each patient. The data was further analyzed using three analysis methods-unsupervised learning (Principle Component Analysis), supervised learning (LS) and Lasso [3]. It was concluded that there is a significant difference between pulse signals of patients having different types of liver disease, which can be diagnosed by the Traditional Chinese Medicine concept and can be mimicked by use of proper sensors and analytical methods.

Approximate Entropy Based Ayurvedic Pulse Diagnosis for Diabetics - A Case Study

This system focused on comparing the signal obtained from normal healthy patients and diabetic patients by use of a suitable pressure sensor and a statistical tool for analysis of the data. The signals from radial artery were acquired sequentially using MLT1010 piezoelectric pressure sensor by AD Instrument. This signal was captured in PC by directly connecting the output to Power Lab 16/30 data acquisition system by AD Instruments [4]. This signal was de-noised using Daubechies 9 wavelet transformation method, inspired by Nadi Yantra analysis method [7]. The vata pulse captured by the system is shown in Fig. 5 [4].
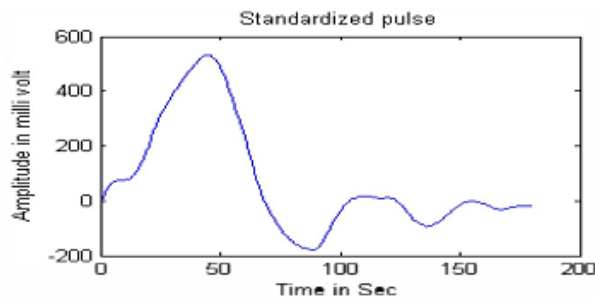
19

Fig. 5 Vata pulse obtained for analysis [4]

Approximate Entropy (ApEn), a statistical tool was used for analysis of the signal. It was observed that the value of ApEn for diabetic patients is generally below 0.1771 and that of normal healthy patients is above 0.25, as shown in Fig. 6 [4].

Mean Values	ApEn		
	vata	pitha	Kapha
Normal Patients	0.2651	0.2517	0.2849
Diabetic Patients	0.1771	0.1731	0.1751

Fig. 6 ApEn Values obtained for the two groups os subjects

Thus it was concluded that ApEn can be used as a tool for diagnosis of Diabetes.

Doppler Blood Flow Signal Analysis Meets Traditional Chinese Pulse Diagnosis

This method tries to reduce the gap between Traditional Chinese Pulse Diagnosis and Doppler Blood Flow Signal (DBFS) by capturing the Doppler sonogram of wrist radial arterial signals of healthy patients, patients having Gastrititis and patients having Cholecystitis. The DBFS signal was then smoothened using soft threshold wavelet packet filtering. Five Doppler parameters, SBI (Spectrum Broadening Index), STI (Stenosis Index), PI (Pulsalitity Index), RI (Resistance Index) and S/D (ratio of Systolic velocity by Diastolic velocity, were computed for clinical diagnosis [5]. Wave energy and wavelet packet energy were also calculated using the concept of multi resolution analysis and N-scale wavelet decomposition method respectively for calculating energy in all the frequency bands of the arterial signal [5]. Piecewise Axially Integrated Bispectra [5] is used as retains the amplitude phase information in the signal and is robust to additive

Gaussian noise. The distinctions between healthy persons and both groups of patients lie in where the Bispectra $|Bx(f1,f2)|$ culminates [5]. Wavelet decomposition and wavelet packet decomposition was done using sym8 and db10 methods respectively [5]. Samples were taken from either of the hands and from both hands to distinguish between the three groups. In the wavelet-based experiments, wavelet energy and wavelet packet energy were used for distinguishing healthy patients (H) from patients having Gastritis (G) [5]. Wavelet energy and Doppler parameters were used for differentiating between healthy patients and patients suffering from Cholecystitis (C) [5]. Wavelet energy and Wavelet packet energy were also used in classification between Group G and Group C patients [5].

Objective Study for Pulse Diagnosis of Traditional Chinese Medicine: Pulse Signal Analysis of Patients with Coronary Heart Disease

This system concentrated on distinguishing patients having Coronary Heart Disease (CHD), cardiovascular disease patients having non- CHD and healthy patients using the concepts of Traditional Chinese Medicine. The signal from radial artery, Guan pulse wave on left hand was acquired using a pressure sensor, ZBOX-I Digital Pulse Analysis System, designed by Shanghai University of TCM, China [6] which extracted using ZBOX-I system. 18 important parameters were analyzed, h1-amplitude of the main peak, h3- amplitude of the tidal wave, h3/h1, h4-amplitude of the incisura wave, h4/h1, h5-amplitude of the dicrotic wave, h5/h1, t1- duration between the onset and the peak, t4- duration between the onset and the incisura wave, t5- duration between the incisura wave and the end, t- duration of the pulse wave, w- width of the main peak, A_s- area of the systole period, w/t, pulse rate, maximum power level and A_d- area of the diastole period [6]. Butterworth filter was used to remove base line wandering and low frequency interferences and Chebysheve II filer was used to remove power line interference [6]. The data was then transformed into spectrum data using Fast Fourier Transform tool, which was further used to calculate pulse rate and maximum power value [6]. It was observed that certain sets of the parameters selected for analysis showed significant difference between the three groups of subjects.

20

Nadi Tarangini: A Pulse Based Diagnostic System

This system basically contains a 'Millivolt Output Medium Pressure Sensor' with tiny diaphragm at the center, and having '0–4 inch H2O' pressure range as a sensor, 16-bit multifunction data acquisition card NI USB-6210) to digitize the electrical signal obtained proportional to the pulse waveform and the data acquisition software LabVIEW, which controls the digitization as well. The set-up of this system is shown in Fig. 7 [9].

Fig. 7 Set-up of Nadi Tarangini [9]

Pulse waveforms obtained using this system for patients with various disorders is shown in the figure below Fig. 8 [9].
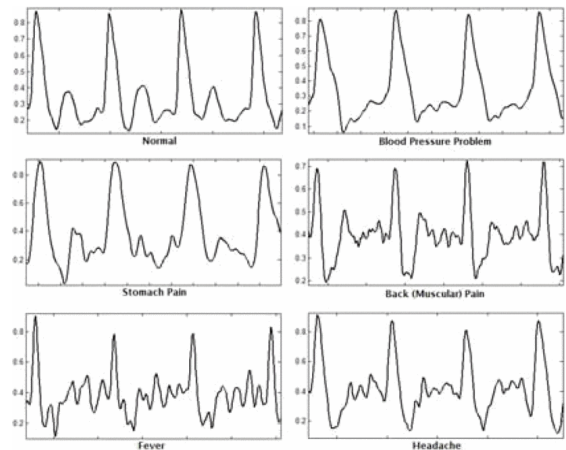

Fig. 8 Diagnosis done using Nadi Tarangini [9]

The main drawback which we feel in this system is that there is no mechanism to generate external pressure on the radial artery, as done by *Nadi Vigyans* to study different organs.

Clinico-Pathological Study on Nadi-Pariksha in Context to Tridosha with Special Reference to Ekanga Vata, Kamla & Atisthaulya

In this instrument, the basic mechanism used serves the purpose of converting mechanical wave, generated due to the movement of blood stream in radial artery, into electrical wave. The main sensors used in this system were: Microphone, to pick up mechanical vibrations and Optical sensor to obtain the pulse waveform. The room taken for examination was sound proof to avoid any artifacts due to noise signals in microphone output. The experiment was mainly conducted to detect jaundice in the subjects.

Table 1: Diseases Diagnosed in the papers discussed above

Sr. No.	Paper Title	Disease Diagnosed
1.	A Comparison of Three Types of Pulse Signals: Physical Meaning and Diagnosis Performance	Diabetes

2.	Comparative Study Of Pulse Diagnosis Signals Between 2 Kinds Of Liver Disease Patients Based On The Combination Of Unsupervised Learning And Supervised Learning	Fatty Liver Disease and Cirrhosis
3.	Approximate Entropy Based Ayurvedic Pulse Diagnosis for Diabetics - A Case Study	Diabetes
4.	Doppler Blood Flow Signal Analysis Meets Traditional Chinese Pulse Diagnosis	Gastrititis and Cholecystitis
5.	Objective Study for Pulse Diagnosis of Traditional Chinese Medicine: Pulse Signal Analysis of Patients with Coronary Heart Disease	Coronary Heart Disease
6.	Nadi Tarangini: A Pulse Based Diagnostic System	Blood Pressure, Headache, Fever, Back pain (muscular), Stomach pain
7.	Clinico-Pathological Study on Nadi-Pariksha in Context to Tridosha with Special Reference to Ekanga Vata, Kamla & Atisthaulya	Jaundice

III. CONCLUSION

Thus it can be concluded that diagnosis of most of the diseases can be done using a suitable sensor based system which works on the principle of Ayurveda and Traditional Chinese Medicine. Also, as shown in 'A Comparison of Three Types of Pulse Signals: Physical Meaning & Diagnosis Performance' [2] the diagnosis of a disease depends on certain specific parameters like blood viscosity, blood volume, etc. can be analyzed better by a specific kind of sensor rather than any sensor. Though by combination of all the three sensors, the system accuracy can be increased but it may make the system more complex in terms of its design. Also, according to the concept of Ayurveda each organ is related with the pulse signals obtained in the superficial and deep layer of artery on both the hands as shown earlier. Thus to analyze a disease related to a specific organ only one or two pulses can be analyzed instead of analyzing all the three pulses: vata, pitta and kapha.

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