Ayurvedic Pulse Diagnosis Techniques

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Abstract: Ayurveda and many other medical diagnosis techniques uses pulse diagnosis for detection of a disease or the organs at distress by feeling the palpations at precise locations on the human wrist. *Nadi Pariksha* is the science of observing this pulse from a perspective of diagnosis of the human body, active mind and the sub-conscious. Conventional techniques recognizes the vibratory frequency of the pulse at various levels on the radial artery using piezoelectric sensors placed at the three precise locations on the radial artery. The pulse, when examined, reveals both physical & mental features of the pulse. This is comprehended in the form of symptoms along with their prognosis which helps in understanding the cause. In this review paper we intend to focus on the underlining principles involved in the study of the ancient Ayurvedic lineage in terms of modern electronics, various methods used for diagnosis of disease in the already existing devices and further modifications possible to improve the accuracy of the device and thereby making it more generic.

Keywords: Nadi, Ayurveda, Pulse Diagnosis

I. INTRODUCTION

Ayurveda is the science of life which believes daily living in harmony with the laws of nature. The main aim of Ayurveda is to maintain the perfect health of a healthy person through prevention and to cure the disease process in an unhealthy person through appropriate diet, lifestyle, *panchakarma* and rejuvenation. This purpose is achieved by having a basic understanding of pulse which is known as ***Nadi Vijnanam***. ***Nadi*** means pulse and ***Vijnanam*** means understanding or specialized knowledge, thus Nadi Vijnanam means understanding and examining pulse to diagnose any disease.

Ayurvedic pulse opens up the doors of perception to explore the hidden secrets of life. Pulse is mainly a subtle expression of universal consciousness pulsating through a person's constitution. Which carries blood through the body along with the nutrients to the cellular level. This leads to a continuous flow of communication between cells and this flow of communication is intelligence.

In the non-invasive pulse examination system of Ayurveda it is believed that the function of entire human body is governed by three humors: *vata*, *pitta*, and *kapha*, called as *Tridosha*. These three forces within the body are detected using the standard method of feeling a pulse waveform obtained on a wrist with the index, middle & ring fingers respectively [1] as shown in Fig. 1.

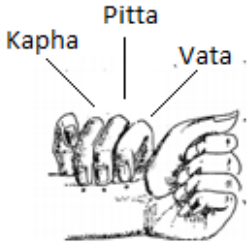

Fig. 1

The backbone of Ayurveda depends on the method of reading these three waveforms and discrepancies in them.

II. TECHNIQUES AVAILABLE FOR PULSE ANALYSIS

Some groups have already worked on development of devices that monitors pressure variations from the three precise points on the radial artery for pulse diagnosis, thereby eliminating subjective errors and

overcomes the constraint of the art of pulse diagnosis with experience.

The following section discusses a brief review of techniques used in this devices:

Fuzzy Theory in Traditional Chinese Pulse Diagnosis: In this system, the pulse phenomena are observed by an input equipment designed from two sensors, one using condenser microphone to acquire the pulse wave and other using pressure transducer to get pressure against the skin, when the microphone is pressed. This input waves are analyzed using a graphical expression and derivative method, and these subjective descriptions are interpreted into the fuzzy inferences, and diagnosis is proceeded using fuzzy theory concept. This system was used to check inflammation in kidney of a patient and worked effectively.

Intelligent Diagnosis of Human disorders based on Ayurveda: In this system, *Nadi* observations are the input to the system which includes speed of the "*Nadi*" represented as pulse rate which is calculated by the conventional way of placing hand on the radial artery position, hardness & softness can be observed by measuring blood pressure which is any conventional means, temperature is another input, and *Nadi* movement or *Gati* which is recognized due to its unique wave shape & thus represented using graphics as movement of a particular animal like Duck, Snake or Frog as analogous to the Ayurveda. These five input data are considered and the membership function for each of the variables are then plotted. Universe of discourse is specified first, then it is quantized in to three overlapping fuzzy sets which are low medium and high. Membership functions indicates the degree to which an item belongs to a fuzzy set. Initial information about patient like, Patient Name, Age, Sex, Weight and Time of observation is also needed. Drawback of this system is it depends on input data which is collected manually and may cause errors in the diagnosis.

A Preliminary Research on Analysis of Pulse Diagnosis: This system basically comprises of a device which instead of measuring the arterial pressure, measures the volume change of skin surface from the pulsation. A device was developed in this system which consisted of a simple structure composed of a transparent vessel with the upper tubular having a much smaller surface area than the bottom, with a liquid-impenetrable thin film contacted to the bottom, containing a liquid of low-viscosity in the vessel. If the radial artery is pushed to contact the film bottom, the pulsation produces a volume change in the skin and the change will be amplified and demonstrated by the height of the liquid surface. In this way, the pulse diagnosis sensed by finger touch is visually reflected as the change of liquid surface. The characters of the change of liquid surface due to different pulsation can then be used for disease diagnosis. The mechanical setup of the system is shown in terms of block diagram in Fig. 2 [8]. To measure quantitatively, a CCD linear sensor is used to record the change in liquid surface.

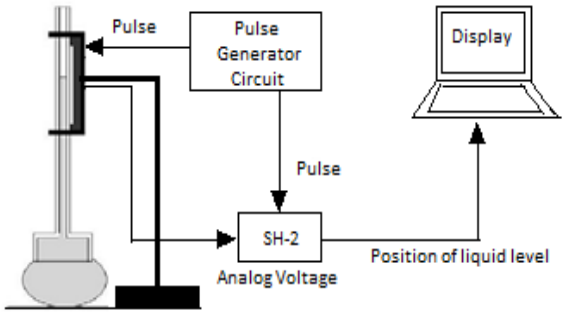

Fig. 2

The main drawback of this system is its repeatability and accuracy of diagnosis, which may be poor.

A quantitative system for pulse diagnosis in Traditional Chinese Medicine: This is a quantitative system for pulse diagnosis based on Bayesian networks (BNs) to build the mapping relationships between pulse waves and pulse types. In this system, the pulse transducer is pressure-adjusting and can regulate the pressure from 25~150g. Pulse wave was recorded when the amplitude reaches the maximum. The probabilistic reasoning module consisted of discovering dependency relationship module, parameter learning and reasoning module. A new hybrid leaning algorithm for dependency relationship discovery and parameter learning was used, named as GBPS algorithm. Given the parameterized model, the reasoning module was implemented via Clique Tree Propagation algorithm (CTP), which allowed computation sharing among multiple queries and can satisfy the requirement of pulse diagnosis.

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.

Nadi Tarangini: 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. 4 [5].

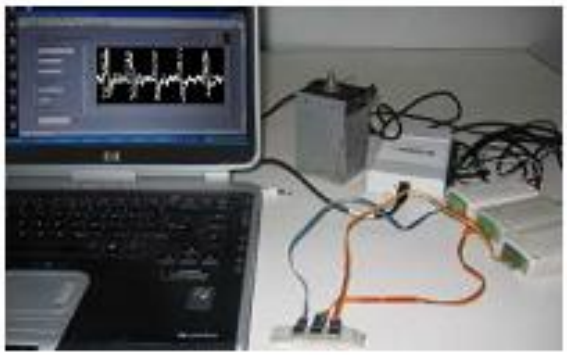

Fig. 4

Pulse waveforms obtained using this system for patients with various disorders is shown in the figure below Fig. 5 [5].

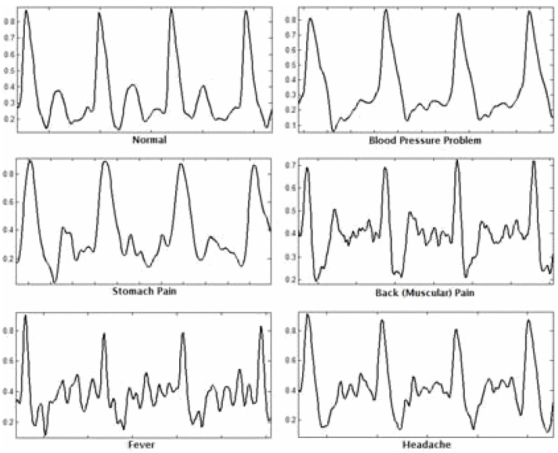

Fig.5

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.

Nadi Yantra: This system has an automated external pressure application mechanism on the three positions of the radial artery, thereby removing the potential for errors experienced when a person applies the external pressure. This system contains three identical piezo based sensors as pressure sensors, amplifier and filter circuit for signal conditioning, a mechanical set-up for exerting external pressure and a data acquisition system (BioPac-150 TM) to capture the signal from the three precise positions, where *vata, pitta* and *kapha* pulses can be obtained, of the radial artery.

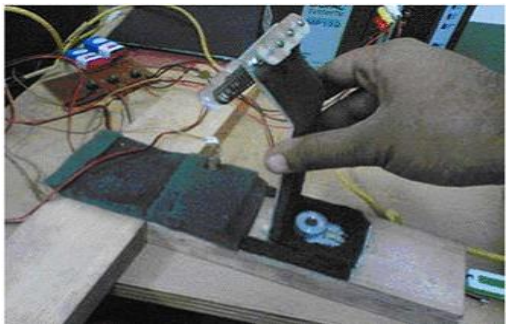

Fig .6

Nadi Yantra is flexible enough for proper positioning of three sensor tips to tune with Kapha pulse [1], Vata pulse [1] and Pitaa pulse [1] as shown in Fig 6 [6].

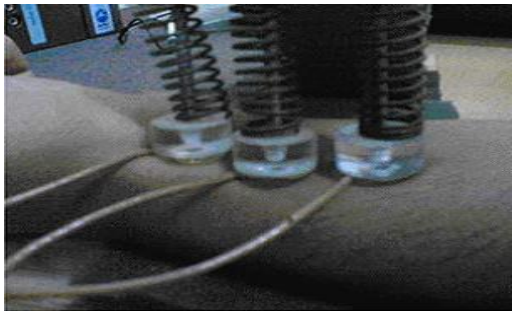

Fig. 7

Springs attached to the sensors, as shown in Fig 7 [6], are used in order to reduce damping, thus imitating natural damping present due to the muscles in the tip of Nadi Vidwan's finger. Signal processing included calculation of Fast Fourier Transform (FFT) of the three inputs and then, the calculation of Power Spectrum Density (PSD) is done by a Fourier Transform approach. The demo showing recording of pulse using Nadi Yantra [6] is shown in Fig.8 [6].

Fig. 8

This project was further extended to measure Heart Rate Variability (HRV) using Daubhechies wavelet function (D9) [9].

Pulse Type Classification by Varying Contact Pressure: This system is based on the three characteristics of the pulse: the degree of pulse floating, the degree of pulse size, and the degree of pulse strength. The degree of pulse floating is measured by the first contact pressure at which the maximum average amplitude of the pulse signal appears. The degree of pulse size is defined as the maximum average amplitude, and the degree of pulse strength is defined as the range of pressures where the average pulse amplitude is above 80% of the maximum value. The plots of average amplitude versus contact pressure were obtained for each subject which showed a common feature: the average amplitude first increases as the contact pressure increases, reaches a peak value at a certain pressure, and then decreases. The three main observations obtained were:

1. A low degree of pulse floating corresponds to a pulse that can be detected with minimum pressure exerted on the radial artery, and the large degree of pulse floating corresponds to the pulse that can be detected only under a large pressure. Traditionally, the pulse has been classified simply as floating or sinking, according to whether the force exerted to detect the pulse is small or large. The degree of the pulse floating provides a physical quantity measuring how much the pulse is floating or sinking, rather than the dichotomous classification. It was observed that female subjects generally showed a small degree of pulse floating in comparison with the male subjects, which is consistent with clinical experiences.

2. A large value of the degree of pulse size indicates that a strong pulse is detected, and a small degree of the pulse size indicates that a weak pulse is present. The results showed that there is a tendency for the male subjects to have larger values (stronger pulses) than the female subjects, again consistent with clinical practice.

3. A large value of degree of pulse strength indicates that the pulse can be detected over a broad range of the contact pressure. For a pulse with a low degree of pulse strength, the average amplitude decreases rapidly as the contact pressure increases, and it is important to find a suitable pressure range in order to obtain the correct pulse diagnosis. Here, too, the female pulse strength appears to be concentrated within a lower range of pressures than for males.

Thus it can be concluded that the degree of pulse strength is significant and it enables us to measure the strength of the pulse quantitatively, which has traditionally been classified simply as full or empty, accordingly as the pulsation is strong or weak with varied contact pressure.

Noi Kanippaan – Nadi Diagnosing System: Noi Kanippaan, meaning finding any disease using Nadi, proposed a system comprising of three pressure sensors to acquire signal from vata position, pitta position and kapha position which is transmitted for digitization using three transmitters cum amplifiers.

Fig. 9

The data obtained will be further processed using Noi Kanippaan learning algorithms and classified using Hierarchical Digital Modulation Classification. The classification will be done on the basis of types and sub-types of Nadi, Analyzing diseases and diagnosis of chronic diseases like Obesity, Asthma, Diabetes, Cancer and Hepatitis [11]. The system is divided in two phases as shown in Fig. 10 [12].

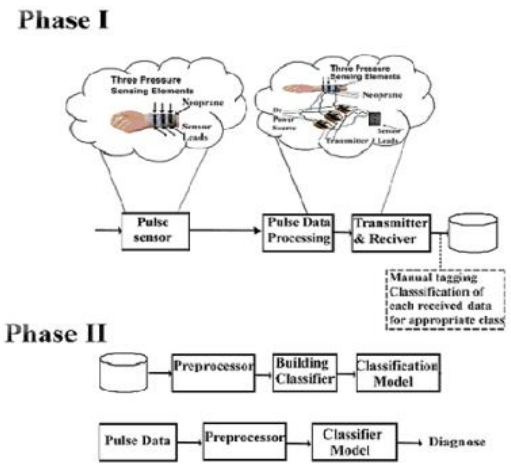

Fig. 10

Nadi Parikshan Yantra and Analysis of Radial Artery: This system was developed mainly to detect the dominant doshas among the three basic doshas in the body: vata, pitta and kapha using three pressure sensors operating on ultrasonic frequency. The system is portable and the radial arterial data was analyzed by calculating the relative amplitudes of the three waveforms obtained and applying certain frequency and time domain analyzing techniques. The snapshot of the system is shown in Fig. 11 [11].It was concluded that the time domain analyzing methods can be effectively used to detect the dominant doshas in the body.

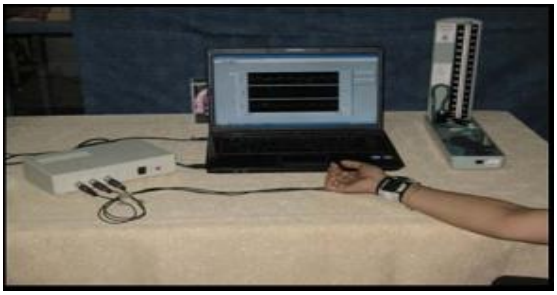

Fig. 11

Table 1 Summary of All Techniques Present till Date

Sr. No.	Title of Paper	Sensor Used	Analytical Technique Used for Diagnosis
1.	Fuzzy Theory in Traditional Chinese Pulse Diagnosis	Condenser Microphone and Pressure Transducer	Fuzzy Logic
2.	Intelligent Diagnosis of Human disorders based on Ayurveda	Blood Pressure Measuring Device and Temperature Sensor	Fuzzy Logic
3.	A Preliminary Research on Analysis of Pulse Diagnosis	Self- Designed Transducer	-
4.	A quantitative system for pulse diagnosis in Traditional Chinese Medicine	Pulse Transducer	Bayesian Networks
5.	Clinico-Pathological Study on Nadi-Pariksha in Context to Tridosha with Special Reference to Ekanga Vata, Kamla & Atisthaulya	Microphone and Optical Sensors	-
6.	Nadi Tarangini	Millivolt Output Medium Pressure Sensor	Signal processing & Analysis with LabVIEW
7.	Nadi Yantra	Piezo Based Sensors	Fast Fourier Transform, Wavelet Transform
8.	Pulse Type Classification by Varying Contact Pressure	Pressure-Adjusting Pulse Detector	-
9.	Noi Kanippaan: Nadi Diagnosing System	Pressure Sensors	Noi Kanippaan Learning Algorithm, Hierarchical Digital Modulation Classification
10.	Nadi Parikshan Yantra	Pressure sensors operating on ultrasonic frequency	LabVIEW

III. CONCLUSION

Ancient literature provides enough evidence that most of the diseases can be diagnosed by pulse examination. But, this technique requires years of experience and skill, which was in ancient days passed by guru to his disciples. But with the evolution of technology this technique can be easily replicated using modern electronics and artificial neural networks. Nadi expert acquires details about temperature, pressure variations, sound & vibrations simultaneously with the help of most advanced sensor i.e. human hand and analyses this data with brain on the basis of previous experiences and current variations in it. After a practice of many years they developed the art of accurate medical diagnosis. Design of such a device which can be used for accurate medical diagnosis purpose based on Nadi Vigyan is still in an earlier stage of development. More research should be done for integrating all the sensors which can provide maximum data for detailed analysis with proper wrist positioning without any motion artifacts into one portable unit.

Though in most of the techniques described above, pressure sensors are used as sensing devices, more detailed information can be extracted by using infrared sensors [10] along with conventional pressure sensors such as piezoelectric sensor & microphone. This can improve accuracy of the system and the system can be made more compact and generalized. With such a design scheme we can acquire more significant data for detailed analysis of the signal. Artificial Neural Networks will be very useful for the signal analysis in this case. Not so much work is done yet in developing ANN for diagnosis of various diseases based on Nadi Vigyan

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