Ayurvedic Pulse Diagnostic Techniques to Develop Modern Non-invasive Disease Diagnostic Devices

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Abstract— *Ayurvedic medicine is an oriental deep medical science based on the unique concept of the tridosha, namely Vata, Pitta, Kapha. According to the Ayurvedic medicine, Vedic medical science is disease diagnosis by pulse analysis. However, the diagnosis is subjective and the accuracy depends on the experience and practice of the Ayurvidic practitioner. Thus, researches can be carried out to find solutions for subjective errors and increase the accuracy. Some of the currently conducted researches show optimistic results where the results of Ayurvedic practitioner's diagnosis and the results gives from the electronic device tally with each other. Subsequently, non-invasive diagnostic devices can be developed with the help of modern electronics and mathematical algorithms with reduced cost and time for the diagnosis. Moreover, it might become a good approach to protect the declining valuable techniques of Ayurvedic medicine. .*

Keywords— **Ayurvedic Medicine, Pulse Analysis, Non-invasive Diagnostic Devices**

This is a review article based on the *Ayurvedic* pulse diagnostic technique which can be studied thoroughly to develop non-invasive low cost diagnostic devices. Aim of this article is to arise the need of non-invasive low cost diagnostic devices and suggesting fusion of wrist pulse analysis used in *Ayurvedic* medicine and modern electronics as a solution to fulfil the need.

1.0 Introduction to Ayurvedic Medicine

Ayurvedic medicine is an impressive and unique medical science originated in ancient India which is being used for both in diagnostics and treatments (Walia & Singh, 2010). "Prakrati Nidana", the characteristics of individuals such as body size, hair, weight, appetite, skin etc is the base of Ayurvedic medicine. (Joshi, 2005).

There are two main purposes in Ayurvedic Medicine. Maintain good health by prevention and cure diseases by appropriate diet, lifestyle, panchakarma and rejuvenation are the two main purposes of Ayurvedic medicine (Vaidya et al., 2015). Every living being is made of five elements correspond to the five senses in human. Earth/ Prithvi, water/ Apa, fire/ Tejas, Air/ Vayu and space/ Akash correspond to smell, taste, sight, touch and hearing respectively. Vata, Pitta, Kapha, the primary life forces or doshas made of above mentioned elements correspond to energy of movement, energy of digestion or metabolism and the energy of lubrication and structure in turn (Walia & Singh, 2010 & Joshi, 2005). Every cell in human contains single dosha or combination of two or three doshas which is unique to each individual. This concept of tridosha recognized as the foundation of Ayurvedic medicine represents the humeral balance. Dosha type of a person is determined by the domainting type of tridosha of that particular person and his characteristics depends accordingly. (Walia & Singh, 2010). Nadi Vijnanam is one of the important diagnostic methods used in Ayurvedic medicine. Nadi refers to pulse in vein and arteries. Vijnanam refers to examination and understanding pulses (Joshi, 2005). Characteristics of the pulse waves depends on the blood flow. As blood flows throughout the body, even to the cellular level, that is a very good perception to disease diagnostics (Patil et al.,2015). Perfect early diagnostics either physical or mental could be made by the ancient ayurvedic expertise by examine the pulse patterns in specific points of the body and in some cases they have predicted the date and time of the death. (Joshi, 2005).

2.0 Pulse Analysis based Diagnosis

There are nine prominent points as shown in figure 1 is used for pulse examination by using one or more of three central finger tips of the practitioner. Radial artery sensation or wrist pulse analysis known as fivanadi is the most common technique of wrist pulse analysis (Joshi, 2005). Radial pulse of the patient at radial fossa is examined with slightly pressed three middle finger tips of right hand of the Ayurvedic practitioner while supporting the patient's hand with his left hand as shown in figure 2 (Patil et al., 2015). Throbbing nature of the pulse is observed mentally by the practitioner. Vata is observed by the first index finger tip, pitta is observed by the middle finger tip and kapha is observed by the third (ring) fingertip (Walia & Singh, 2010). The right hand pulse is sensed in men and left hand pulse is sensed in female (Uebaba et al. 1993).

According to the internal biochemical and physiological functions, there are hundreds of different nadi patterns. Thus, both qualitative analysis and quantitative analysis are important in pulse analysis. Moreover, the variations of the levels of tridosha leads to the different patterns of pulse according to amplitude, rate, rhythm, shape, regularity and hardness. High levels of Vata, Pitta, Kapha manifest a snake's curved scrawling,

frog's jump and swan's smooth slow rhythm respectively

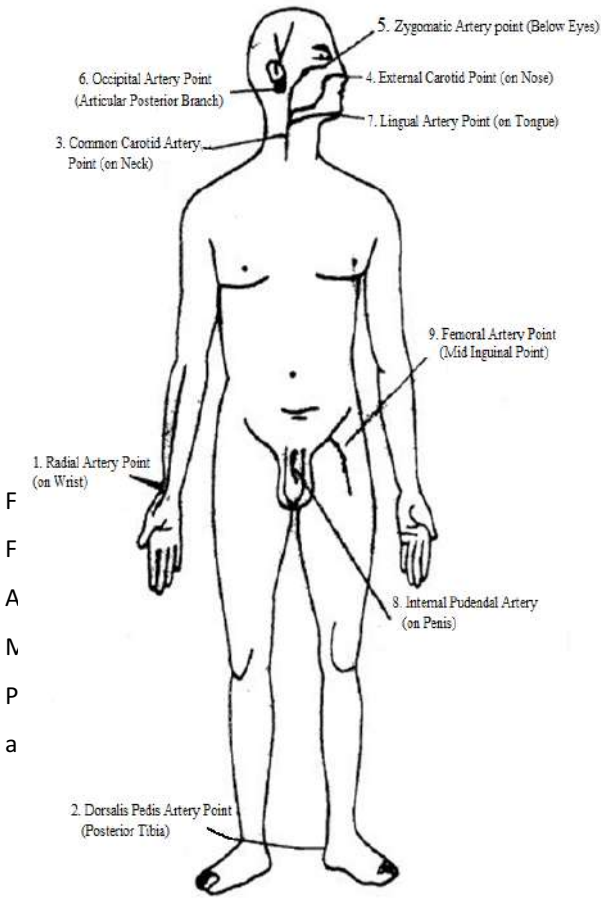


Figure 1. Nine prominent points of the body where pulse can be sensed.

F

F

A

M

P

a

as shown in figure 3 (Joshi, 2005).

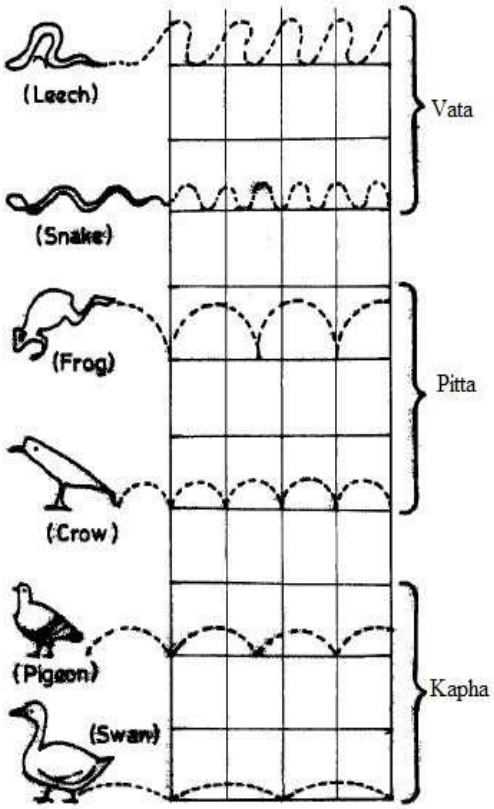


Figure 3. Different patterns of pulse according to the *Ayurvedic* medicine.

The most important parameters in pulse analysis are pulse amplitude which is the distance from the rest position to a point of the signal and the pulse rate which is the number of pulse signals occur per minute. To measure the pulse rate with the help of modern technologies, peak detection algorithm can be used.

Dhatus are the seven levels of radial pulse readings which are laid in-between the superficial layer and the inner core of body. According to the pressure applied on radial artery the level of pulse sensing is changed. These levels elaborate more details about the sub types of *doshas*, status of *prana*, *theja*, *ojus* and conditions of seven tissue levels. For examples, first layer or the superficial layer is called *rasa dhatu* and capillary layer is called *raktha dhatu.* Sensing the first layer is *Vikurti.* It indicates the current health condition of the person. Seventh layer is the deepest level where obliterate pulse is sensed. It is known as *prakruti* and contains details about basic constitution of the person. For a healthy person, *prakruti* and *vikruti* levels are equal (Lad, 1996).

3.0 Inaccuracy of Manual Pulse Reading

The pulse readings can be inaccurate due to erroneous finger positioning. Accurate reading can be obtained only if the three fingers are placed at same level. Moreover, any throb may not be felt if the index finger is placed directly on radial tubercle.

A thick subcutaneous fat layer can interrupt the sensation of the pulse too.

In addition, premature births and umbilical strangulation also affect the pulse of a person from the birth. Thus, questioning the patient is important. Probably the accuracy depends on persistent and prolonged practice. *Ayurvedic* practitioners use their own unique techniques developed with the clinical practice for pulse analysis. (Lad, 1996).

4.0 Electronic Devices for Pulse Analysis

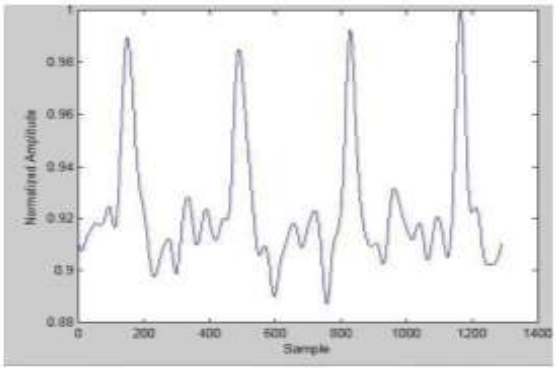
There are prototype designs which have been developed during several researches to diagnostic purposes according to *Ayurvedic* medicine by pulse analysis.

One such design is *Nadi Tharangini*, which consists of three flexible diaphragms element provided with strain gauge and a high grade industrial transmitter cum amplifier of output 4-20 mA. 500 Hz sample rate and 16-bit quantizer which convert the output of amplifier to 2-10 V with 500ohms resistor have been used in *Nadi Tharangani*. However, the data collected from *Nadi Tharangani* was not much accurate due to electrical and electronic noise. Nevertheless, the developed system with proper shielding reduces the noise level to a negligible value (Joshi *et al*., 2007).

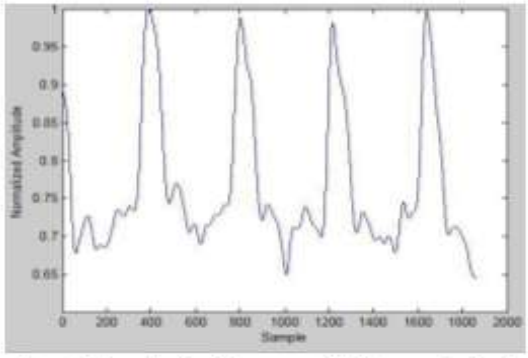
Ashok Bhat and his fellows developed another *Nadi Tharangani* system which holds the patent number US 20100152594 A1. This system captures small pressure units accurately and reproducibly with negligible noise. During their research, six pulse waveforms are acquired from the same subject, three from each hand. Exact values are captured by introducing small air gap between the each sensing element and skin and computer algorithms. Pulse data are classified into different types and sub-types. This system is supposed to minimize the human pulse examination errors and provide accurate and quantitative information for diagnostic purposes (Bhat *et al*., 2008).

Nadi Yantra composed with three identical piezo based sensors, amplifiers, data acquisition subsystem and filtering circuitry, is another objective approach towards the pulse diagnosis. Positions of the three fingers like protrusions are adjusted at the tip as required to figure out best points for signal capturing. Springs are attached to protrusions to eliminate natural damping (Kumar *et al.*, 2008).

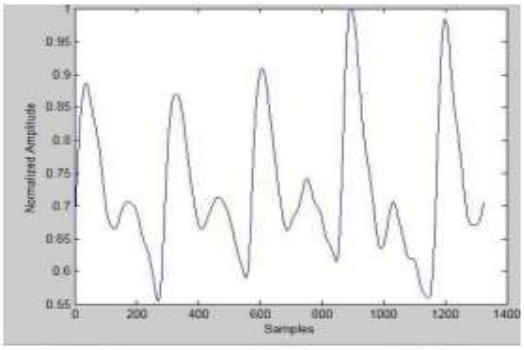
Nadi Parikshan Yantra, a three point radial pulse examination system consists with three identical data acquisition channels which is used to capture pressure data at *vata, pitta* and *kapha*. Three identical pressure sensors of 10mm diameter arranged on an acrylic module is used to capture the signals simultaneously. Sensors were kept apart approximately 6mm from the adjacent sensor. These three sensors are connected to three identical data acquisition channels by using coaxial cables and three different channels are used to display the acquired signal on the computer screen (Kalange *et al*., 2012).



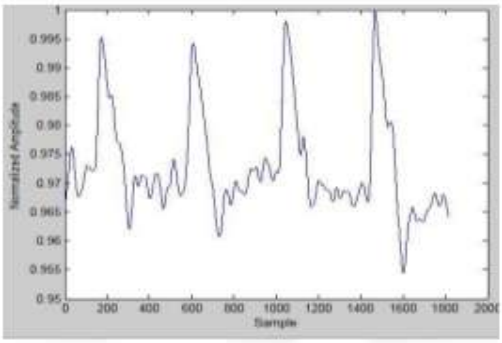
Vata Signal of a Person with Back Pain



Vata Signal of a Person with Stomach Pain



Vata Signal of a Noramal Person



Vata Signal of a Person with Fever

Figure 4. Different pulse obtained for *Vata* signal in different health conditions (Bhat et al., 2008).

Another system for pulse examination was developed using optical pulse sensors, microcontroller ATMEGA328 and LabVIEW software. is used to display the data. 8th order butterworth low-pass filter (180Hz) with a flat frequency response is used for pre-processing. Data was classified into *Vata, Pitta* and *Kapha* according to the pulse repetition rate, frequency, amplitude, mean and standard deviation. This system is supposed to help the physicians for *Nadi pariksha* and prognosis of cardiac related disorders. Furthermore, it can be used as a home based health monitoring system as it is a portable wearable device (N, Shivaram, and Shridhar, 2016).

Prototype system was suggested to capture human wrist pulses using three piezoelectric sensors. NI USB-6210 multifunction data acquisition card and MATLAB were used for data acquisition and processing. This system can be used to detect diabetes either by *tridosha* analysis or ANN as soft computing tool. The real time PC based system helps to check the *prakriti* of the subject at any time according to the heart rate variability (Kulkarni, 2016).

One more pulse capturing system was developed using piezoelectric transducer which is an active transducer and had a good dynamic response without a dc shift. Transducer was attached to a small sphygmomanometer cuff. Cut-off frequency and the gain of the filter/ amplifier circuit is 100 Hz and 10 respectively. Power line interference noise was removed by using a notch filter of 50 Hz. To validate the result of classification of data into *Vata, Pitta, Kapha,* comparison with standard pulse pattern for *Vata, Pitta* and *Kapha* and guidance of *Ayurvedic* practitioners were taken. Accordingly, conclusion was made as *Vata, Pitta and Kapha* can be classified by observation of pulse repetition rate of waveforms (Kalange & Gangal, 2007).

An autoregressive (AR) model with the selected reference value was developed for wrist pulse signal time series analysis. The residual error (difference between the actual measurement of the new signal and the by reference signal) was calculated and considered as the disease sensitive feature. Wrist pulse signals were acquired using a Doppler ultrasound device. The analyzed results showed the accuracy over 82% in distinguishing healthy persons from patients with acute appendicitis and more than over 90% for other diseases. Thus, the conclusion was made as wrist pulse analysis can be used to indicate patients of specific diseases among healthy subjects (Chen *et al., 2011*).

After conducting a case study, Alakananda Devi states that Ayurvedic pulse based diagnosis is capable of doing non-invasive diagnosis which gives similar results to new techniques such as biopsy or CAT scan. Moreover, early diagnosis of cancers can be done non-invasively without any side effects (Devi, 2013).

5.0 Conclusion

Accordingly, the conclusion can be made as non-invasive diagnostic devices might be developed with the help of fusion of *Ayurvedic* medicine and modern technologies with reduced cost and time for the diagnosis. Moreover, it might become a good approach to protect the declining valuable techniques of Ayurvedic medicine.

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