A Literature Survey on Different Types of Pulse Based Sensor for Acquisition of Pulse

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ABSTRACT

Examination of Pulse (Nadi Parikshan) is one of the non invasive method for disease diagnosis in Ayurveda. The pulse at the wrist signifies the presence of life. In Nadi Parikshan Physician recognizes health and ill health of a person by investigating pulse at radial artery. According to Ayurveda, the root cause of the disease is imbalance of three doshas i.e. vat, pit and kaph. The health status of the person is examined by Ayurvedic physician by feeling palpation from three fingers (index, middle and ring) placed on the radial artery for vat, pit and kaph respectively. NadiParikshan requires a lot of experience as well as a high level of skill in pulse reading, hence there is a need to develop pulse diagnosis system to obtain accurate diagnosis of disease. Different types of sensors have been used in developed pulse diagnosis system. This paper presents a review of various techniques used for measurement of pulse and proposes three channel wrist pulse acquisition system to acquire pulses at radial artery.

Keywords: Pulse, Vat, Pit, Kaph, Sensor.

1. INTRODUCTION

Examination of pulse to diagnose disease was recognized by Indian Physicians in twelfth century A.D. [1]. According to Ayurveda there are three biological doshas namely vata, pitta and kapha (in Sanskrit) in the body. Dosha means darken, spoils or causes things to decay. In ayurveda, tridosha terminology is indicative of vat, pit and kaph. Ayurvedic Physician identifies the doshas by feeling the palpation over radial artery with the help of three fingers by placing them 2 cm below wrist. Index, middle, ring finger are used to identify vat, pit, kaph respectively. Decision regarding dosha is made by physician by feeling pulse, if the movement of pulse resembles movement of snake then it indicates increase of vata, during increase of pitta it is similar to movement of frog, during increase of kaph it resembles movement of swan [2]. But this method of examination of pulse depends upon expertise of physician, so accuracy varies accordingly. There is a need to prove this feeling of pulse and diseases diagnosed in form of waveforms on a monitor, so that it becomes easy and convenient to use this ancient noninvasive method accurately for novice practitioners.

2. CLASSIFICATION OF PULSE BASED SENSOR

Sensor is to be used which replicate the three fingers of ayurvedic physician. Sensor must be placed upon radial artery, as when blood flows in radial artery, it exerts pressure on the walls of artery and this pressure is to be measured .Sensor is designed based on different working principles such as strain gauge, piezoelectric, force sensitive resistor, ultrasonic frequency and optical sensor.

2.1. Strain guage sensor

Aniruddha Joshi et al. [3] designed Nadi Tarangini for obtaining pulses. The system Nadi Tarangini contained a strain gauge based sensor having the diaphragm at its center, followed by a transmitter cum

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amplifier and by digitizer for quantification of analog signals. Dimensions of strain gauge sensor used were of order of 1×1 cm. The diaphragm at the center was deformed by the pressure exerted by an artery and thus the system was found to capture pulse waveforms as a time series data. Reproducibilty of collected waveform was checked as pulse waveform of single health person was recorded at different times for five consecutive days. It was found that waveforms obtained were reproducible and matched with literature waveforms.

Bhaskar Thakker et al. [4] designed a pulse acquisition system for wrist using sensor based on piezoresistive principle. In this system, pulse acquisition was performed using three piezoresistive type of sensors. A circuit for signal conditioning was designed using an instrumentation amplifier to amplify the weak wrist pulse signal followed by removal of unwanted frequencies using a low pass filter. For the digitization of signals, microcontroller was used and for real time monitoring data were displayed on LCD. In order to observe signals in better way touch interface was included for better access. For processing of the signals in offline mode recording was performed on the memory card. The waveforms obtained were compared with waveforms present in literature and were found to have good match.

2.2. Piezoelectric sensor

While making measurement using strain gauge transducer, waveform obtained was noisy and there was DC shift due to the holding pressure and the DC shift varied as the holding pressure changed. Secondly, the strain gauge requires a power source for its operation. On the other hand, piezoelectric transducer has good dynamic response, it does not show DC shift because of holding pressure and is an active transducer. Therefore, piezoelectric transducer can also be used for human pulse detection.

Mahendra Kumar et al. [5] developed an electro-mechanical system, namely 'Nadi Yantra.' Piezoelectric based pressure sensors were used to capture the signals from the radial artery at the wrist. The raw signal obtained was filtered, amplified and transferred to the PC. Biopac 150 system was used for data acquisition. Waveforms obtained were found to match with present literature waveforms. Waveforms were found reproducible and hence the system achieved stability. Signal processing techniques such as power spectral analysis and bandpower were applied to observe features of three signals. An experiment was carried out on 5 subjects and signals were captured before and after lunch. It was found that the amplitude of vat rises before lunch and falls post lunch while the amplitude of pit and kaph rises post lunch. Further, for processing of pressure signals, wavelet based techniques were used for the identification of percussion peaks.

M. Sharmila Begum et al. [6] designed a system named Nadi Tarangini. The system comprised of three sensors in a similar manner as compared to three fingers of a physician. Spring system was attached to the sensors. Type of sensor used was based on piezo film. The developed system was tested upon around 200 students. Thereafter, raw signal obtained was filtered, amplified and read by a software application and graphs were plotted with respect to time. Waveforms obtained were found to be reproducible and were compared in case of different type of diseases. Further, it needs to be expanded to diagnose different types of diseases like cancer.

Sajana K. Mathew et al. [7] developed a hardware in which pulse signals were acquired using sensor based on piezoelectric property. Single sensor was used and placed at radial artery. The pulses were obtained and processing was carried out with an embedded system. For proper acquisition of signal MPLAB software was utilized. Further, using MATLAB, calculation of mean factor was performed with respect to age and the heart beat of the subject was read from a pulse oximeter. An experiment was performed on 5 subjects of different age groups and found that mean value increases as age increases. It was found that the people of the same type of age group had similar mean value. The system needs to be extended to three sensors for better results.

2.2.1. PZT Material

A.E Kalange et al. [8] proposed a system in which a transducer based on piezoelectric properties was used for detecting the human pulse. Piezoelectric sensor was used as no power supply was required and also it was capable of detecting dynamic pressure. Sensor was placed upon wrist and data obtained was further processed using signal conditioning circuit. Signal conditioning circuit comprised of buffer amplifier, low pass filter and notch filter to remove noise. Pressure on the wrist was maintained through sphygmomanometer cuff. Pulse waveforms were recorded on a digital storage oscilloscope. It was found that three doshas had different frequencies.

2.2.2. **Ultrasonic Frequency**

A.E. Kalange et al. [9] developed nadi parikshan yantra for three point radial pulse examination. For simultaneous measurement of the radial pulse at three points three pressure sensors (operating at ultrasonic frequency) with the identical characteristics were mounted on acrylic module. These sensors were held together on wrist using velcrow tape. First the examination of pulse was performed by nadi vaidya and then on the same subject using nadi parikshan yantra. Single sensor (ML T 1010) was used to determine optimum contact pressure of sensor, frequency and time domain analysis of single point was carried out. Statistical comparison using t test was performed and it was found that the acquired different doshas can be differentiated.

2.3. Optical Sensor

Roopini N et al. [10] developed a portable prototype of nadi prakshan yantra. Sensors used were based upon the principle of photoplethysmography. Optical sensors were used to acquire signal from the wrist. Acquired signal for further processing was given to microcontroller ATMEGA328. Appropriate selection was done in order of Butterworth filter to remove noise. Signal conditioning was performed using LabVIEW software. Data was acquired and collected from around 100 subjects and features such as amplitude, mean, frequency were calculated. Also, data was tested and validation by using neural network.

2.4. Force Senstive Resistor Sensor

Akshita Baisware et al. [11] proposed design using technology based on virtual instrumentation. For wrist pulse acquisition sensor used was Force Sensitive Resistor (FSR). In FSR when pressure is applied it changes resistance which further causes a change in voltage. Single FSR was used to sense pressure, which was further followed by acquisition through NI DAQ card. Force / pressure was converted to a voltage and a plot of voltage was obtained in LabVIEW on front panel. Signal conditioning was performed in LabVIEW using filters of suitable order and amplifiers. Data was collected from single pulse point, thus for effective and accurate results it needs to be expanded to three sensors.

3.   PROPOSED WORK

In the proposed design of pulse diagnosis system as shown in Fig. 1.1, three sensors will be used for direct pulse detection from the wrist. MPXM2053D sensor from FREESCALE based on piezoresistive principle shall be used to acquire the pulse signals. Furthermore, signal conditioning circuit will be designed using instrumentation amplifier and amplified signal shall be displayed and analyzed on Tektronix MSO 2014 mixed signal oscilloscope 16 CH MSO. Real time monitoring will be performed using myRIO DAQ card in LabVIEW myRIO 2014 software National Instruments and the excel sheets will be then imported to Matlab. Three channel wrist pulse signals acquired will be analyzed for disease diagnosis.
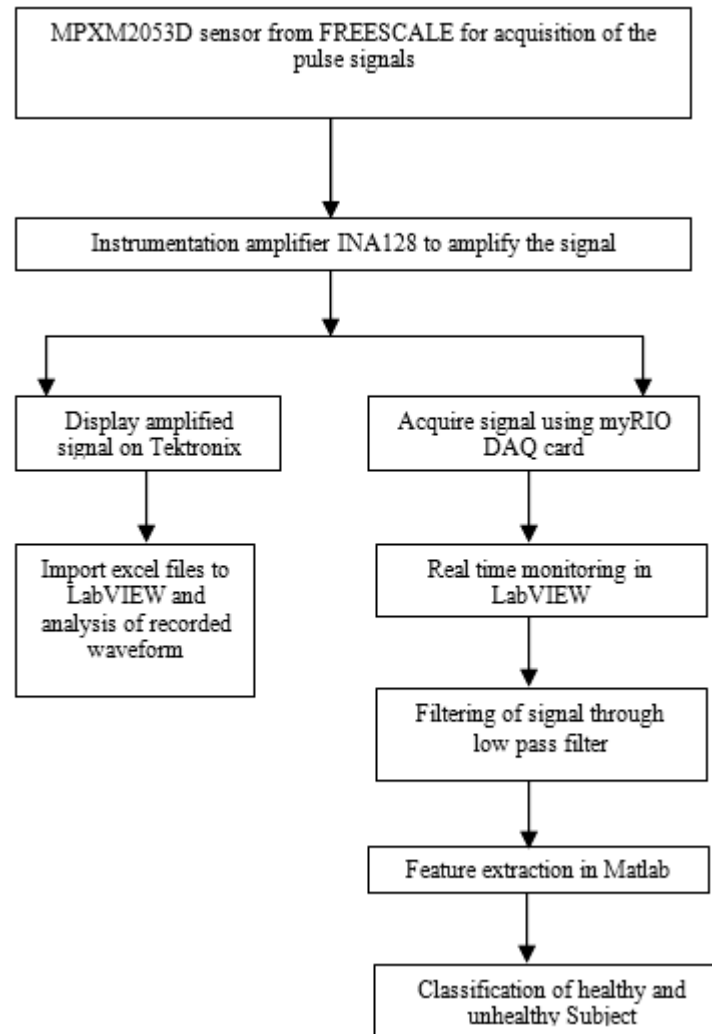
Figure 1: Proposed architecture

4. CONCLUSION

Pulse diagnosis can be properly carried by using three pulse sensors for vat, pit and kaph. Choice of pulse sensor can be made depending upon different working principles such as piezoelectric, strain gauge, optical. Different data acquisition techniques and software can be used. Waveforms obtained resemble waveforms as given in literature. Further, in the proposed research work efforts will be to use three channels portable device and to correlate diseases with waveforms obtained, it could yield significant results.

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