iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3236

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Clinical Usage of Peripheral Perfusion Index in Individuals with Pain – A Preliminary Study

Pavithra S M[1], Swetha J[2], Shruthi Rajalakshmi S[3]
[1, 2 3] *B.E Biomedical Engineering Graduates (Rajalakshmi Engineering College)*

Abstract: Introduction: Peripheral Perfusion Index (PI Value) is a unique parameter that can be calculated from pulse oximeter reading. Perfusion Index thus represents a non-invasive measure of peripheral perfusion that can be continuously and noninvasively obtained from a pulse oximeter. The PI Value is influenced by pain. Higher the pain, higher will be the PI Value.
Material and Methods: Pulse Oximeter readings were taken for 5 healthy individuals at the sites of pain and without pain using a Pulse Rate Sensor. The upper and lower peak values of one of the selected wave from the waveforms of the measured parameter is taken and used in the formula to compute the PI value.
Results: The PI Value ranges from 0.02 to 20%. It is found that for all healthy individual the PI Value is between 3 and 20, which are standard values. The difference in PI Value with pain and without pain is studied.
Conclusion: PI Values are very informative in understanding pain. Thus PI Values can be used in understanding the effectiveness of anaesthesia in patients during operation and after operation, the indication of circulation in operated body parts. It is a vital parameter and therefore it must be measured for all critically ill patients.
Keywords: PI Value, Pain, Pulse Oximeter, Pulse Rate Sensor, Peripheral Perfusion Index.

I. INTRODUCTION

Peripheral Perfusion Index can be used as an early indicator for circulatory disorders. During any clinical abnormalities, the peripheral blood flow will be deviant prior to other changes in vital parameters [1]. PI Value can be calculated from Pulse Oximeter values. Pulse Oximeter works by the principle of spectrophotometry: the relative absorption of red light (absorbed by deoxygenated blood) and infrared light (absorbed by oxygenated blood) at the extremities (fingertip, toe or ear lobes) of the subjects correlates to arterial blood oxygen saturations.

A certain amount of light will be absorbed and some will pass through. This may be due to the varying absorption potential of the oxygenated and deoxygenated blood. The amount of light that will be detected by the light detector at the other side of the extremities will depend upon the concentration of oxygenated or deoxygenated blood [2]. The PI Values can be very efficient in diagnostic purposes. The PI Value is found to be very useful during Intensive surgeries for understanding the effectiveness of anaesthesia [3]. During vasodilation, the blood circulation is seamless and there will be no circulatory issues, but while vasoconstriction occurs, the blood circulation is not smooth and there might be some circulatory issues. Detection of an increase in PI is a sign to the physician of the successful onset of anaesthesia and no increase in PI in a patient denotes that the given anaesthesia might be an early warning of anaesthetic failure [3, 4]. The importance of measuring PI Values for newborns is very high. Any fluctuations in PI Value will reflect in the acute illness of newborns [5].

The early days of the premature newborns are very important; any change in their vitals have to be taken very seriously. The PI Values taken during an infant's early days gives a lot of information about their oxygen perfusion and overall blood circulation [6]. The application of SAB (Spinal Subarachnoid Block) during Caesarean surgeries, the PI Value is elevated immediately after the application of SAB [7]. Presence of nerve blocks can be found using PI Value. The patients with nerve blocks show lower PI Values than patients without nerve blockage [8]. Hence the extraction of PI from Pulse oximeter is carried out in an efficient and uncomplicated procedure.

II. MATERIALS AND METHODS

The Peripheral Perfusion index is a vital parameter that is not found in latest Patient Monitoring devices. The procedure for measuring and tracking the data is very simple. A simple pulse oximeter is sufficient for measuring the PI Values.

A. Materials

The prototype was designed with basic electronic components, viz., PulseSensor – Pulse Rate Sensor and Arduino UNO R3 – Microcontroller.

B. Pulse Rate Sensor

Pulse Sensor is a sensor used to measure and view the real time pulse rates. The sensor is a module that can be interfaced with Arduino. The sensor has LEDs present in them, which is responsible for measurement. The principle behind the process is Spectrophotometry i.e., the light from LEDs will be reflected, absorbed or passed through the site of measurement. The light which is reflected will be measured using a photo detector, from which the amount of light reflected is analysed. Using these values it is understood whether the blood has higher or lower level of Oxygen or less and whether Vasodilation or Vasoconstriction has occurred. This sensor is very essential in measurement of PI Value.

C. Arduino UNO R3

Arduino is a microcontroller used in this prototype for determining PI value by interfacing with a Pulse oximeter sensor. Arduino is a microcontroller capable of handling more than one sensor at a time. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. Connect it to a computer using a USB cable to get started. The boards are equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communication interface, including USB on some models, which are also used for loading programs from computers. The measuring of data is controlled by Arduino. Arduino is programmed swiftly and efficiently using C Language.

D. Measuring Pulse Rate using PulseSensor

Pulse Sensor is used to measure the Pulse rate. The site of measurement is usually fingertips, toes or earlobes. It is because, the blood flow at the extremities contains information as the other body parts and it is very comfortable and feasible to measure non – invasively at these sites. The Pulse sensor has three pins, namely: '+' RED wire = +3V to +5V '-'BLACK wire = GND and 'Signal' PURPLE wire = Ao. These are connected to Arduino to the pins, RED to 5V, Black to GND and PURPLE to Ao as shown in the Fig 1. Upon placing the sensor on subject's fingertip, the real time live pulse rate waveform is seen in Arduino's Serial Monitor.

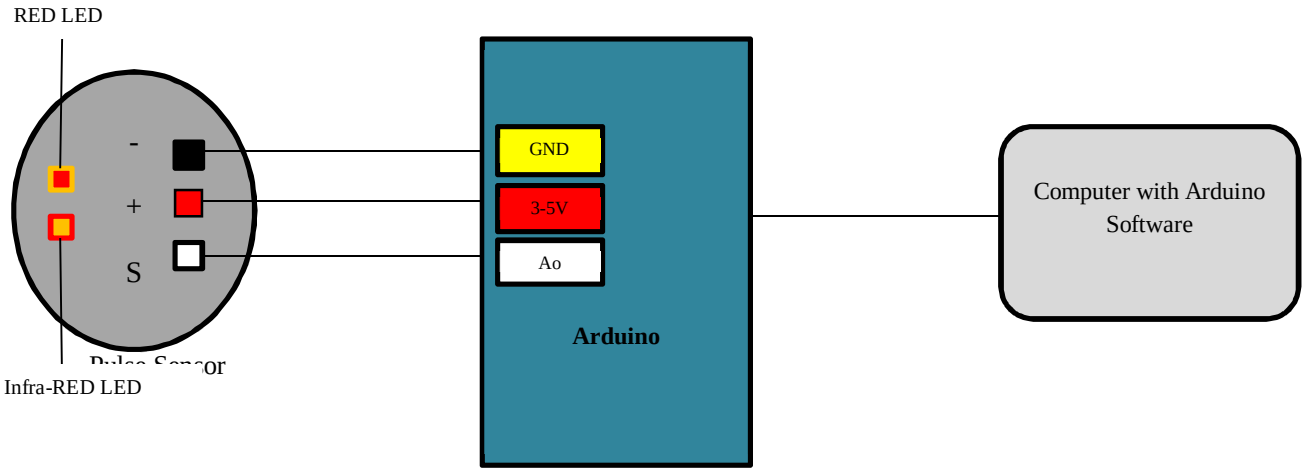


Fig: 1 Connection between Pulse Sensor and Arduino

E. Calculating PI Value from Pulse Rate

The Perfusion Index (PI Index) can be calculated using the following formula:

$$\text{PI Value} = \frac{\text{Difference in amount of light}}{\text{Total amount of light}} * 100 \text{ ---- Formula 1}$$

A single wave is selected from the pulse waveform and the upper peak and lower peak are noted. In this formula (Formula 1), the difference in amount of light is the difference between the upper and lower peaks and the total amount of light is the upper peak. The pulse rate waveform can be explained as the result of measuring the reflected light from the applied light (from LEDs). The peak waves are the varying amounts of reflection caused due to the blood movements and other physiologies.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

III.RESULTS AND DISCUSSION

Upon calculating, the PI value will be between the ranges 0.02 – 20%. Higher the PI Value, lower the abnormalities in blood circulation or fewer complications in overall health status of the patient. The PI values for 5 healthy individuals were calculated. Their PI Values with pain is seen to be higher than their respective PI Values without pain. The values are shown in the table (Table 1). Fig 2 shows the Pulse sensor output waveform of a 60 years old healthy female, measured at the site without pain.

Fig 2.a, 2.b shows the upper and lower peak values of Pulse wave without pain. Fig 3 shows the Pulse sensor output waveform of a 60 years old healthy female, measured at the site with pain. Fig 3.a, 3.b shows the upper and lower peak values of Pulse wave with pain. From the waveforms, the PI Value is calculated and it is studied that the PI Value shows a sudden spike when measured at sites with pain. The same was observed in other 4 healthy individuals (Refer Table 1 for Values).

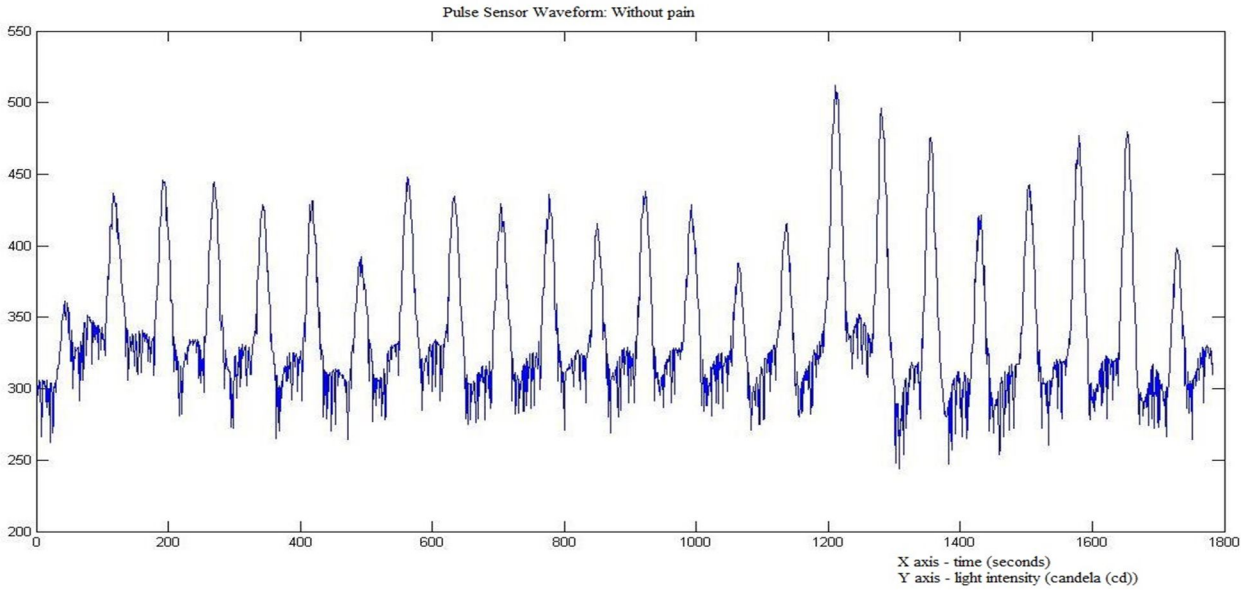


Fig 2: Pulse Sensor waveform of a 60 year old female without any pain

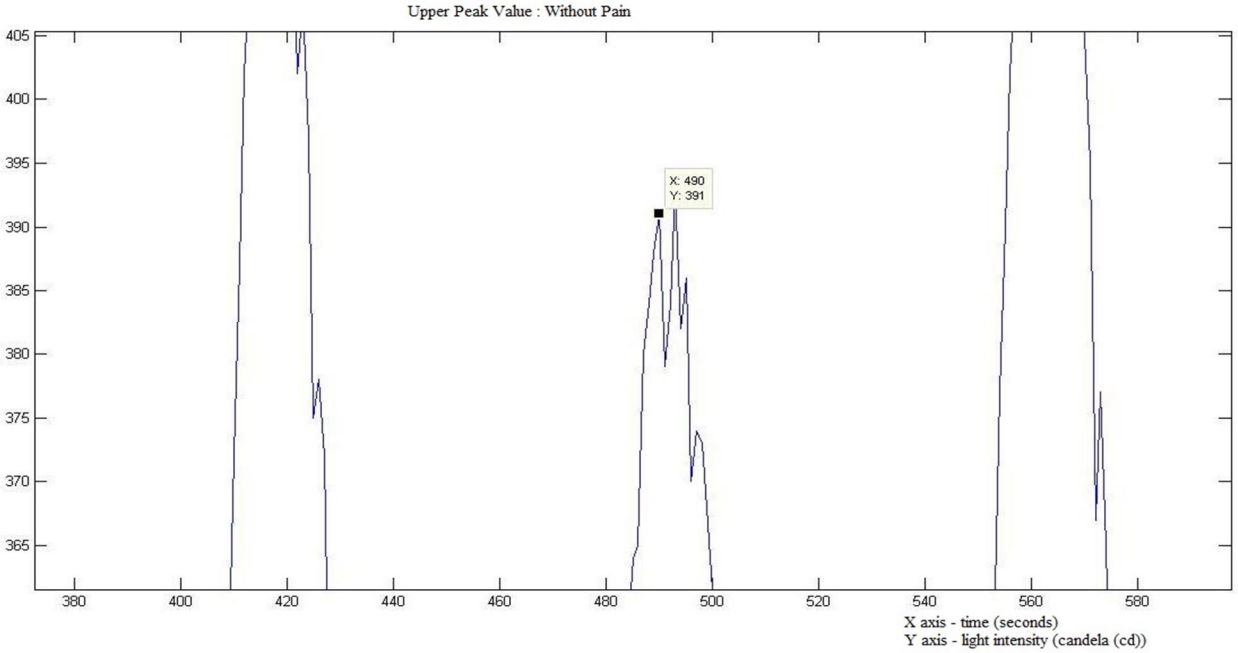


Fig 2.a: Pulse Sensor waveform Upper peak of a 60 year old female without any pain

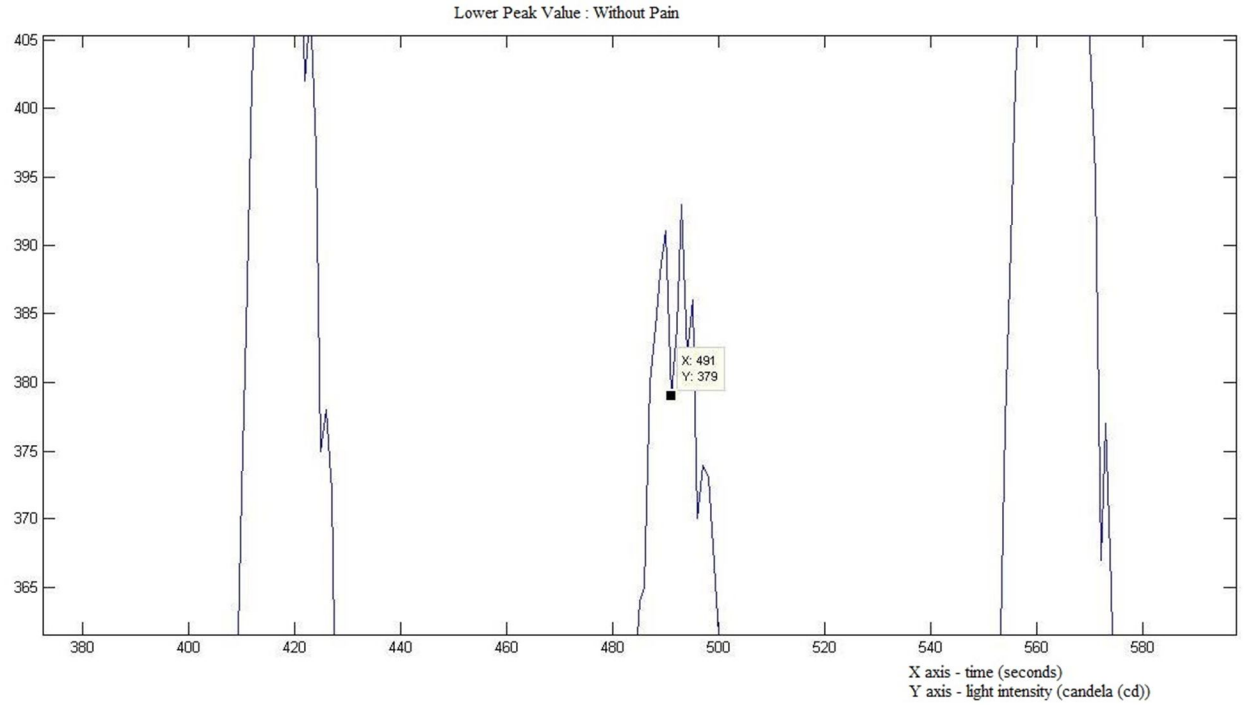


Fig 2.b: Pulse Sensor waveform Lower peak of a 60 year old female without any pain

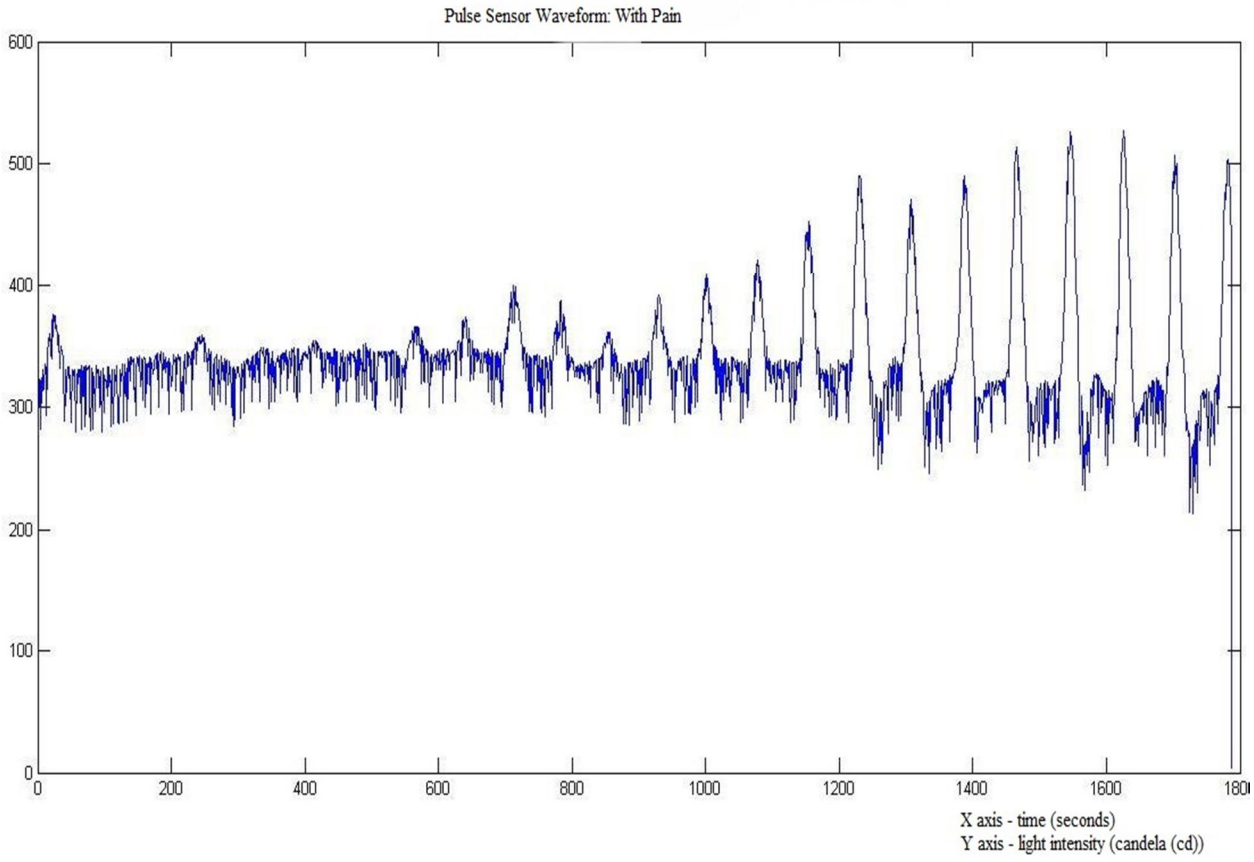


Fig 3: Pulse Sensor waveform of a 60 year old female with pain

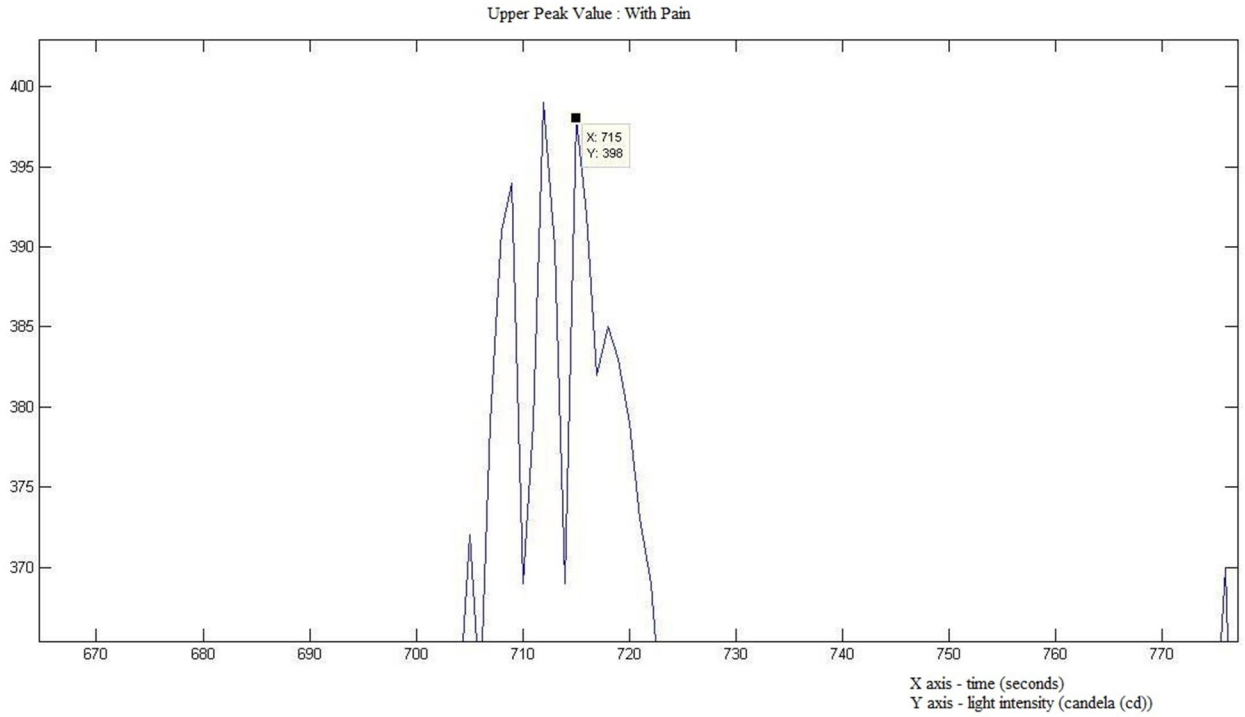


Fig 3.a: Pulse Sensor waveform Upper peak of a 60 year old female with pain

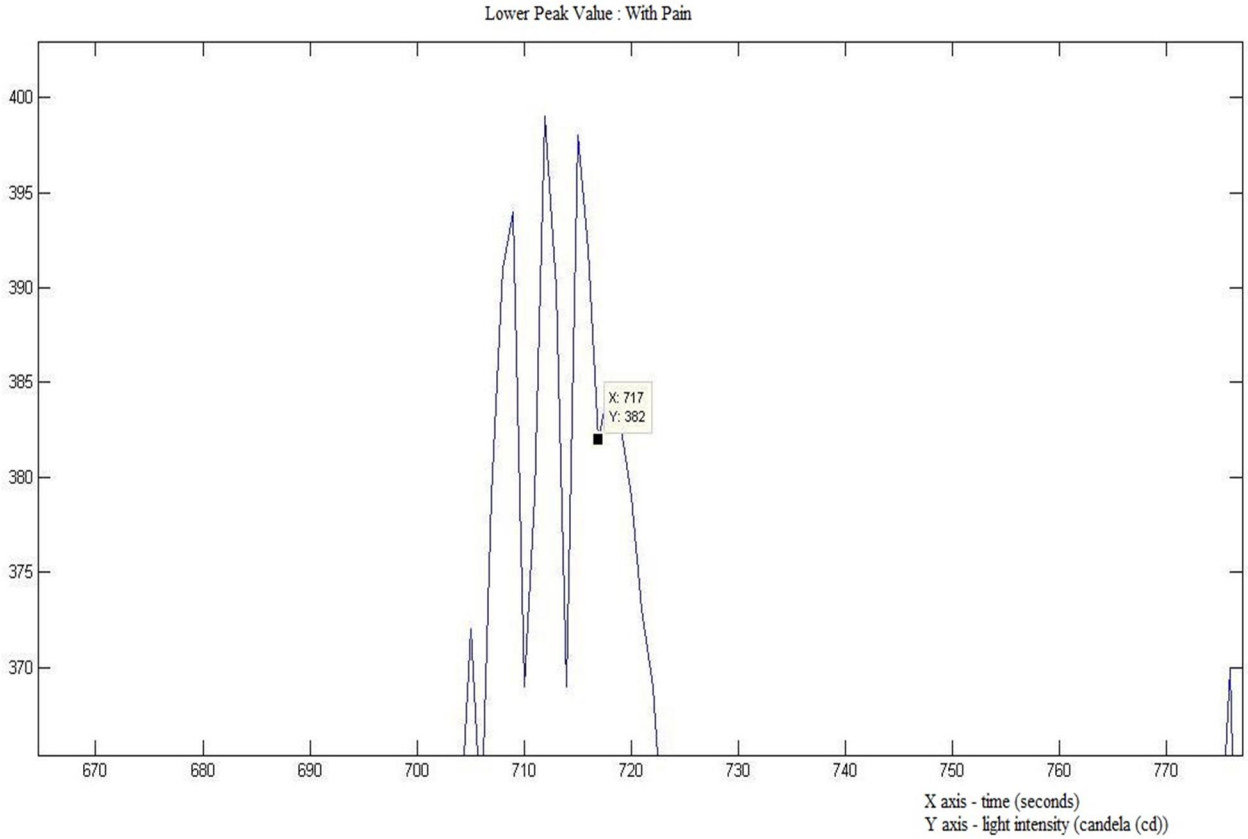


Fig 3.b: Pulse Sensor waveform Lower peak of a 60 year old female with pain

Table 1: PI Values (Parameters and Calculation of PI Value)

Subject Number	Age	Without Pain		PI Value (%)	With Pain		PI Value (%)
		Upper Peak Value	Lower Peak Value		Upper Peak Value	Lower Peak Value	
1	21	378	354	6.3	495	448	9.4
2	21	363	338	6.8	351	326	7.1
3	60	391	379	3	398	382	4
4	52	350	330	5.7	391	363	7.1
5	58	336	314	6.5	361	336	6.93

A. Discussion

The PI Value of critically ill patients can demonstrate high clinical information. During a surgery, the patient undergoing anaesthetic effect will be continuously monitored. It is identified that the site of anaesthesia causes an increase in Vasodilation. It is known that general anaesthesia causes the patient to become unconscious and localised anaesthesia will make the site absence from any sort of sensation. Therefore, the patient will not be able to express if any pain is experienced. Pain is often related to Vasodilation, because pain is accompanied by an immune reaction, which is a result of high blood circulation [9, 10]. During high blood flow, the PI Value will be high. So a rise PI Value depicts a successful anaesthetic effect, whereas a low PI Value will indicate that the patient still experiences pain [4].

For clinically sound individuals, the PI Value is found to be high. While calculating PI Value at the site of pain, healthy individuals have shown sudden spike in their PI Value which is due to the occurrence of wound healing at the site of pain. These individuals experience vasodilation at the location of pain. This is the reason of sudden spike in PI Value.

IV. CONCLUSION

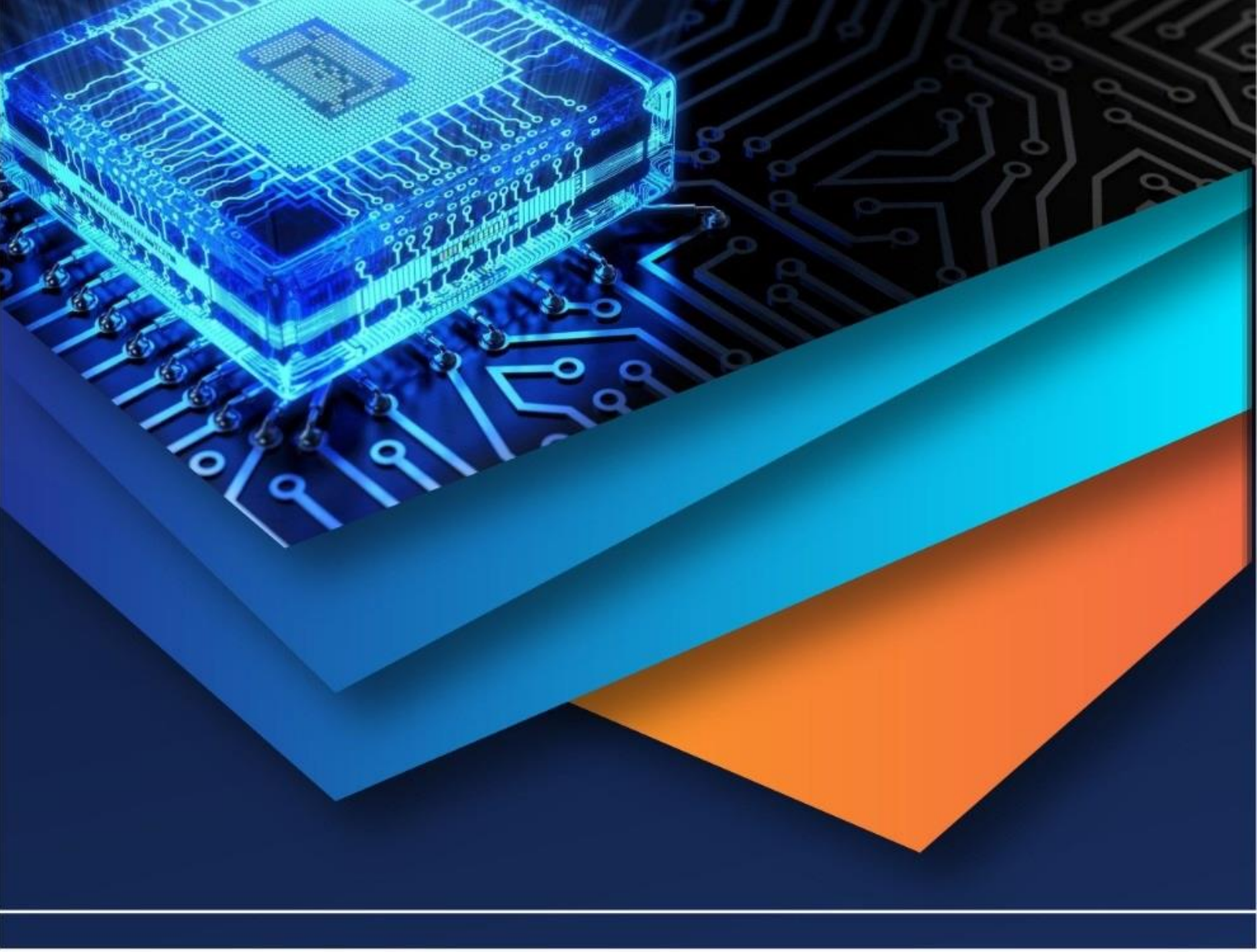
Considering the limited sample size and all individuals being clinically normal, this PI measuring prototype can be tried for larger sample size with various clinical conditions to understand the feasibility of such prototype in clinical usage. Hence this parameter can be used for diagnosis for critically ill patients.

V. ACKNOWLEDGEMENT

This research was funded by Tamilnadu Council of Science and Technology under the Student Project Scheme of the Academic year 2016-17. We would like to thank Mrs R Kalpana, Head of The Department of Biomedical Engineering, and Dr S N Murugesan, Principal, Rajalakshmi Engineering College for the immense support and guidance.

REFERENCES

[1] Lima, Alexandre Pinto, Peter Beelen, and Jan Bakker. "Use of a peripheral perfusion index derived from the pulse oximetry signal as a noninvasive indicator of perfusion." Critical care medicine 30.6 (2002): 1210-1213.
[2] Goldman, Julian M., et al. "Masimo signal extraction pulse oximetry." Journal of clinical monitoring and computing 16.7 (2000): 475-483.
[3] Kowalczyk, Michał, Anna Fijałkowska, and Andrzej Nestorowicz. "New generation pulse oximetry in the assessment of peripheral perfusion during general anaesthesia—a comparison between propofol and desflurane." Anaesthesiology intensive therapy 45.3 (2013): 138-144.
[4] Hager, Helmut, Dayakar Reddy, and Andrea Kurz. "Perfusion index-a valuable tool to assess changes in peripheral perfusion caused by sevoflurane." Anesthesiology 99 (2003): A593.
[5] Piasek, Carolina Z., Frank Van Bel, and Augusto Sola. "Perfusion index in newborn infants: a noninvasive tool for neonatal monitoring." Acta Paediatrica 103.5 (2014): 468-473.
[6] Cresi, Francesco, et al. "Perfusion index variations in clinically and hemodynamically stable preterm newborns in the first week of life." Italian journal of pediatrics 36.1 (2010): 6.
[7] Takeyama, K., et al. "Is the Perfusion Index Useful in Early Detection of High Spinal Subarachnoid Block during Cesarean Section?." The Tokai journal of experimental and clinical medicine 41.4 (2016): 190-197.
[8] Kus, Alparslan, et al. "Usefulness of perfusion index to detect the effect of brachial plexus block." Journal of clinical monitoring and computing 27.3 (2013): 325-328.
[9] Kaada, B. "Vasodilation induced by transcutaneous nerve stimulation in peripheral ischemia (Raynaud‘s phenomenon and diabetic polyneuropathy)." European Heart Journal 3.4 (1982): 303-314.
[10] Skorupska, Elżbieta, et al. "Intensive short-term vasodilation effect in the pain area of sciatica patients-case study." BMC Research Notes 7.1 (2014): 6



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY