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The Bio infusion system for measuring the vital parameters of the patient

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Abstract— This paper is based on incorporating multiple sensors to measure important parameters namely the PPG[1], heart rate, respiration, nerve conduction analysis (NCA)[2] and SpO2[3] and differential temperature. The PPG, heart rate and stamina are measured using IR emitter and detector. The respiration rate is measured using resistance temperature detector (RTD)[4] sensor. The nerve conduction using electrodes. The sensors are interfaced to computer through signal conditioner and embedded board. The collected data from the patient is stored in the computer and it is also shared to the doctor, so that the condition of a patient can be analyzed by doctors in any part of the hospital wherever they are. Thus it reduces doctor's workload and also gives more accurate results. The most advantages of this system is non-invasive and low cost.

Keywords—SpO2, PPG, Heart Rate, NCA, RTD.

I. INTRODUCTION

To analyze the patient health condition and to identify the problem, the basic parameters are necessary for the doctor. The basic parameters like heart rate, respiration rate ,nerve conduction, SpO2 are important .These parameters contains the most valuable information about the patient condition and also gives the condition of cardio vascular system and nerve system.

Heart rate is the number of beats per minute, which is the most important characteristics and related to safety and death of human being. Heart rate reflects the pulse of human ventricular and atrium cycle of systole and diastole. The comprehensive information of shape, speed and rhythm of the pulse wave from PPG along with heart rate is important physiological and pathological characteristic of human cardio vascular system.

The SpO2 is the amount of oxygen saturated in the blood, which indicates the capacity of blood carrying oxygen or the amount of ionization content in blood because the iron carries oxygen in the blood. The

speed of ionization reaction in blood is called stamina. This parameter is the important for respiration and circulation analyzes.

Nerve conduction analyzes detect a problem with nerve. Nerve conduction studies may also be done to find the cause of symptoms, such as numbness, tingling, and continuous pain. NCA measures how fast an electrical impulse moves through your nerve. NCA contains the basic information about the nerve disease known as Parkinson syndrome.

Respiration rate is measured using RTD sensor. Resistance Temperature Detectors (RTDs) are temperature sensors that contain a resistor that changes resistance value as its temperature changes. It is very useful in hospital environment. By using this RTD sensor the temperature of the patient body is calculated accurately.

The data collected from the sensor is given to the PC. It records file separately, which can be used for future references by the doctors. The data is shared so that the doctor can see the patient condition at anytime from anywhere.

II. METHODOLOGY

The figure 1 shows the general block diagram and flow of bio infusion system.

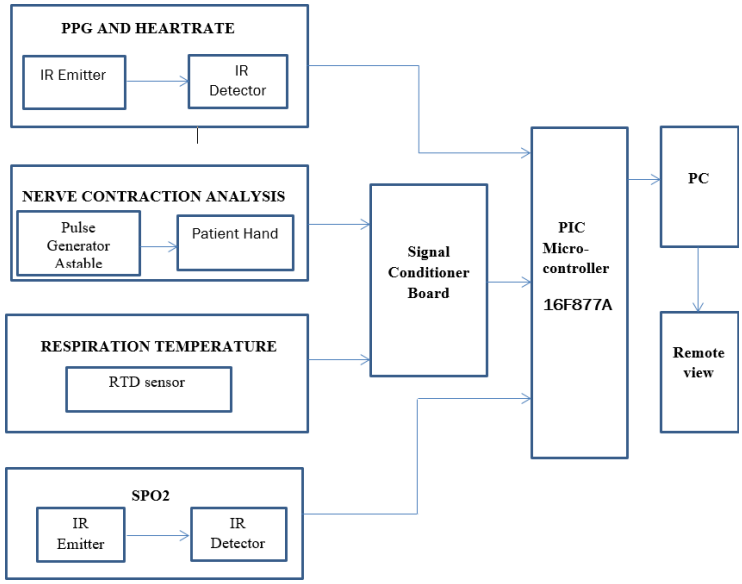


Fig 1. Block Diagram

2.1. Photoplethysmography

The principle of Photoplethysmography is reflective or refraction light changing with blood volume in the microvascular of tissue .Here we using IR emitter and detector to measure the PPG signal. The IR source emits the IR signal into the human fingertip and the IR detector receives the signal which is transmitted or reflected from the body tissue. As the heart beats, the value is changed with the blood volume. Photoplethysmography utilizes Beer-Lambert's law[5], which states that the absorption of light to the properties of the material through which the light is traveling. By definition, the absorbance of material as Equation (1):

$$A = \mathcal{E}cL \qquad (1)$$

Where A is the absorbance, a dimensionless quantity, normally termed the optical density. Ɛ is the wavelength dependent extinction coefficient, c is the concentration of the absorber and L is the optical path length.

The transmittance of material sample is related to its absorbance A and given by Equation (2):

$$T = \frac{I_t}{I_0} = e^{-A} \qquad (2)$$

Where T is the transmittance of material, I_0 is the source light intensity and I_t is the transmitted light intensity.

The figure 2 shows the Measurement of PPG.

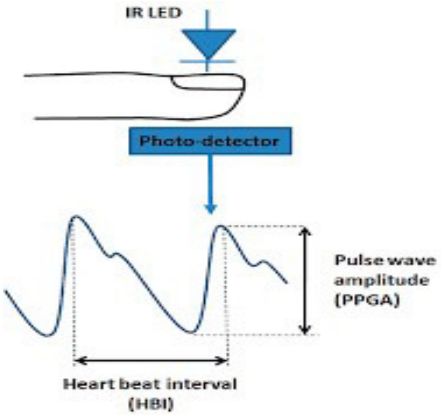


Fig 2. Measurement of PPG

2.2. Heart Rate

Heart rate is one of basic parameter for analysing diseases We using infrared light to measure heart rate on a finger with a considerable number of arterial blood can get the a better result. The PPG pulse signal is synchronous with the beating heart and cycle of arterial contraction and diastole, therefore we can extract the information of heart rate with peak detection.

So we can obtain the relationship between the incident light intensity (I_0) and the transmitted light intensity (I_t) by Equation (1), (2):

$$I_t = I_o e^{-\varepsilon cL} \qquad (3)$$

Usually the dissipation of light in the air is very few. It mainly decided by the distance between LED and skin. When people stay in calm the dissipation can be neglected. Light arrives the skin, some of will be reflected by the skin surface directly, and another transmitted light will be reflected by the tissue and blood. So we can separate the I_s into two part, one is reflected light I_r, and another is transmitted light I_t. Following is the relation between I_s, I_r and I_t:

$$I_s = I_r + I_t \qquad (4)$$

Where: I_s is the light intensity of skin surface, I_r is the directly reflected light and I_t is the transmitted light. Furthermore, the receiver of light sensor get many part of light I_r, I_t and outside disturbance I_d.

$$I_a = I_r e^{-\varepsilon 1 c 1 L 1} + I_t e^{-\varepsilon 2 c 2 L 2} + I_d \quad (5)$$

Where: I_a is the all light intensity of receiver sensor; I_d is the outside disturbance light intensity. So we can conclude from the equation: To measure the heart rate with the green light mainly determined by the absorbance of tissue and blood which is changing with the heart pulse. PPG signal can be disturbed by distance and outside light, so we should avoid this kinds of noise in system design.

2.3. Nerve conduction analysis

A nerve conduction test also called a nerve conduction study measures how fast an electrical impulse moves through your nerve. NCA can identify nerve damage. During the test, your nerve is stimulated, usually with electrode patches attached to your skin. Two electrodes are placed on the skin over your nerve. One electrode stimulates your nerve with a very mild electrical impulse. The other electrode records it. The resulting electrical activity is recorded by another electrode. This is repeated for each nerve being tested.

One electrode is connected to right hand and another to left hand. An electric pulse given through right hand and detected on left hand.

2.4. Respiration

Measurement of respiration rate is a vital parameter for adequate health monitoring. It measures the temperature difference between inhalation and exhalation phases of respiratory cycle. By analysing the respiration rate, we can detect abnormalities like tachypnea, bradypnea and apnea and also the unusual or sudden change in respiratory rate, sleeping disorder. Here we use the RTD sensor for measuring the respiration rate.

The common values of resistance for a platinum RTD range from 10 ohms for the bird-cage model to several thousand ohms for the film RTD. The single most common value is 100 ohms at 0ºC. The bridge output voltage is an indirect indication of the RTD resistance. The bridge[6] requires four connection wires, an external source, and three resistors that have a zero temperature coefficient. To avoid subjecting the three bridge-completion resistors to the same temperature as the RTD, the RTD is separated from the bridge by a pair of extension wires:

The figure 3 shows the Wheatstone bridge with RTD sensor.

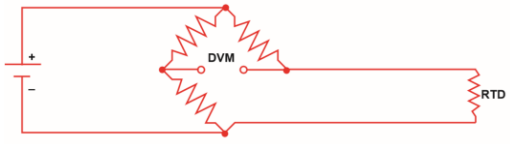


Fig 3. Wheatstone bridge with RTD sensor

These extension wires recreate the problem that we had initially: The impedance of the extension wires affects the temperature reading. This effect can be minimized by using a three-wire bridge configuration:

The figure 4 shows the Three wire Wheatstone bridge with RTD sensor.

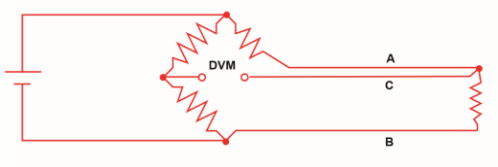


Fig 4. Three wire Wheatstone bridge with RTD sensor

2.4.1. Resistance to Temperature Conversion

The RTD is a more linear device than the thermocouple, but it still requires curve-fitting. The Callendar-Van Dusen equation[7] has been used for years to approximate the RTD curve

$$R_T = R_0 + R_0\alpha\,[T - \delta - (\frac{T}{100} - 1)(\frac{T}{100}) - \beta(\frac{T}{100} - 1)(\frac{T}{100})^3]$$

Where:

R_T = Resistance at Temperature T

R_o = Resistance at T = 0ºC

α = Temperature coefficient at T = 0ºC (typically +0.00392Ω/Ω/ºC)

δ = 1.49 (typical value for .00392 platinum)

β = 0 T > 0

0. 11 (typical) T < 0

The exact values for coefficients α , β , and δ are determined by testing the RTD at four temperatures and solving the resultant equations. This familiar equation was replaced in 1968 by a 20th order polynomial in order to provide a more accurate curve fit.

2.5. SpO2

The SPO2 is one of the important parameter for analyzing stamina level in the body. The percentage is called blood oxygen saturation or SpO2. Oxygen saturation is an indicator of oxygen transport in the body, and indicates if sufficient oxygen is being supplied to the body, especially to the lungs. This percentage should be between 94 percent and 100 percent, which indicates a healthy level of hemoglobin carrying oxygen through the blood. Here we use IR emitter and detector to measure stamina level of a person.

2.6. Signal Conditioner

Signal conditioners are essential to improve field received signals. Signal conditioner job starts from simple amplification to protection. For our circuit input will be 0v to 1000mv and must be amplified to 5volts.when we do amplification we would like to follow below mentioned objectives.

2.6.1. Objectives of signal conditioner

1. It must consume very low current from the source.
2. It should have greater isolation between input and output.
3. Provision to adjust zero value (minimum operating point).
4. Provision to operate span (maximum operating point).
5. Removing the unwanted frequencies during amplification and from the power source.
6. Creating offset and null adjustments which may occur during amplification. Offset and null is the one which is available in all OPAMPS.
7. To provide good enough current to the subsequent devices with protection.
8. Signal conditioner must protect the subsequent devices from hazardous high voltage signals.

2.6.2. Circuit Explanation

The voltage of 0v to 1000mv is fed to the PR2 potentiometer. Whose value is 20k.PR2 has a series resistor of 200k (R2) and has again resistor of 1000k (R5) which gives approximately five times amplification. PR2 can be considered as a span adjustment potentiometer.R3, R4, PR1 forms a potential divider network.R3 is connected to the positive (+ve) voltage in series with 56k resistor.

Similarly R4 is connected to negative voltage through 56k.Both R3,R4 joins opposite ends of PR1 and center pin of PR1(slider) is connected to the OPAMP input through 1000k resistor(R14).

By using the above circuit we can set zero value irrespective of offset. PR1 will be treated as zero adjustment. Resistor R6, R7 is to compensate offset and null.R15 is connected to the inverting input to remove ground noises. Capacitor C1 acts as integrative filter to remove high frequency noises because of amplification.C2 is a low pass filter, -ve pin is connected to output of OPAMP because IC1 is an inverting amplifier whose output will be

-ve.R8 and R12 are fixed 10k resistors. Where R8 is the input resistor for inverting and R12 is feedback resistor. When input resistors and feedback resistors are of same value then gain will be unity. So the output of IC2 at pin no.6 will be 5v in case of 100% smoke.

R10 and R11 are offset and null resistors. R9 is similar purpose of R15.C3 is an integrative filter and C4 is low pass filter.R13 is to prevent overloading of signal conditioner. The resistor used is 1k.Beyond 5mA is not allowed to consume from signal conditioner.D5 is a zener diode whose breakdown voltage is 5v.

If in case of any mal functions at the smoke chamber or from power supply and from signal conditioner may create a output voltage equal to supply voltage of signal conditioner(12v).If 12v goes to PIC which may get failed because it needs zero to 5v.So this zener diode will do all functions and assure all 5v to PIC.

The figure 5 shows the Signal Conditioner.

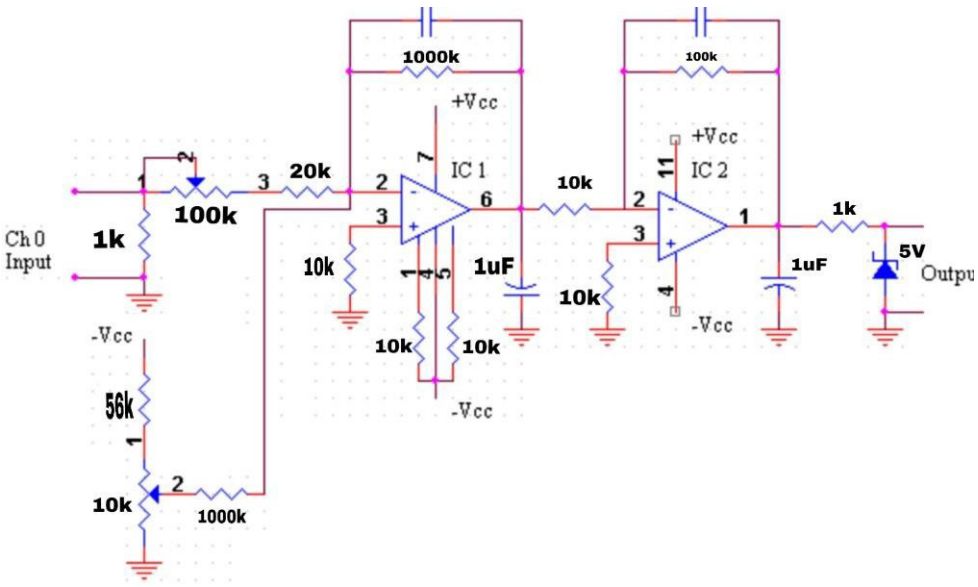
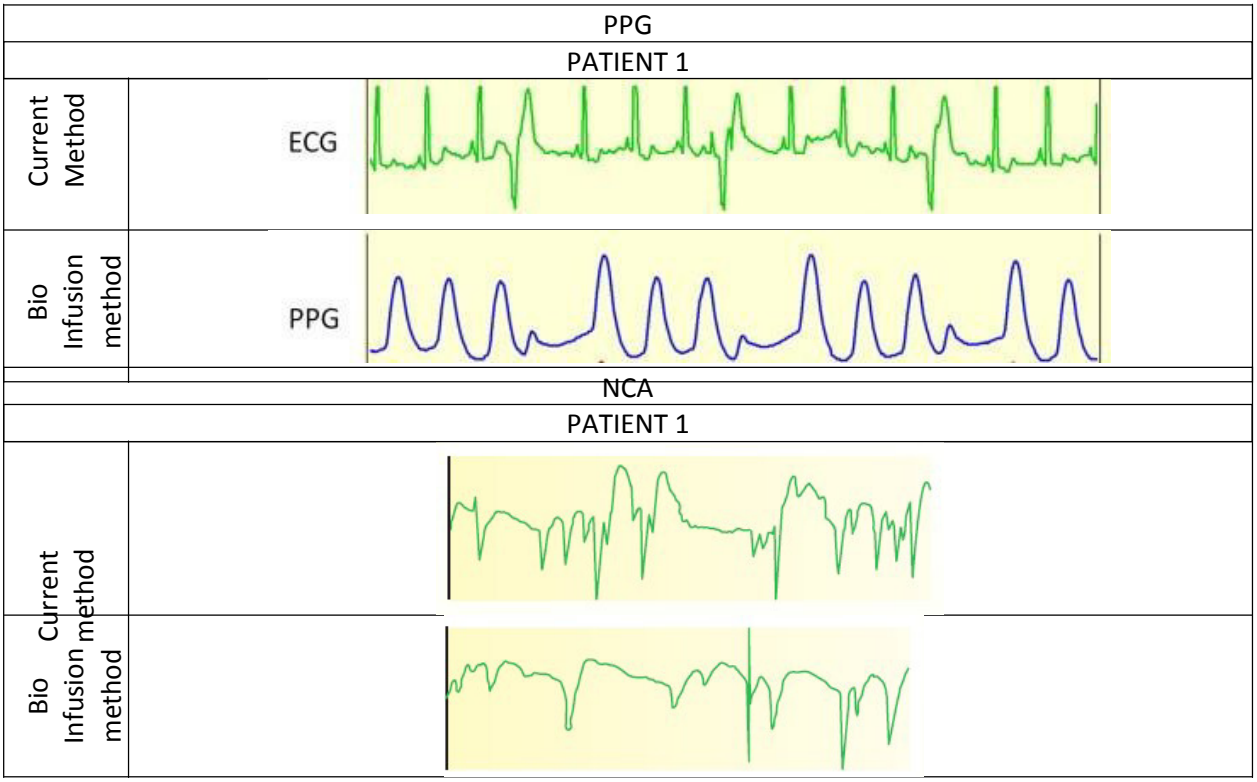


Fig 5. Signal Conditioner

III. RESULT

	Heart Rate/min		SPO2		Respiration/min	
PATIENT	Current method	Bio Infusion method	Current method	Bio Infusion method	Current method	Bio Infusion method
PERSON 1	72	73	97	95	13	20
PERSON 2	73	72	95	96	19	14
PERSON 3	74	73	99	94	15	22



IV. CONCLUTION

The bio infusion system is developed for measuring the various vital parameter of the human in hospital environment and wearable environment. This system measure the basic parameter for analyzing the problematic part of the human and gives prior information according to the data collected from the patient. The doctor can monitor his patient in anytime from anywhere. This system is low cost and gives high accuracy of data by rectifying motion artifacts. Thus by analyzing few patient with our bio infusion system gives better result when comparing with the doctors data.

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