ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

Remote Monitoring of Heart Related Issues using Patch Panel Antenna

OKEREKE C.O

DEPARTMENT OF ELECTRICAL /ELECTRONIC ENGINEERING,
THE FEDERAL POLYTECHNIC ADO-EKITI, EKITI- STATE, NIGERIA.

ABSTRACT: Health, health management, human survival and quality of life would always take dominate discussions at any level. Engineering, sciences, administration, religion and every other aspect of human endeavour is looking at improving these areas of human life. This paper is no different. The paper is looking at caring for patients with health related issues that can be detected by feeling the pulse of the patient in question. The paper looks at how the pulse of the patient can be detected, processed, amplified and transmitted to the necessary quarter. This becomes very important in case of emergencies. The innovative idea being patch panel antenna for the transmission of the picked pulses from the patient for immediate attention of the medical personnel

KEYWORDS: Healthcare, Patch Antenna, Microstrip, ECG, PPC, Photoplethysmography

I INTRODUCTION

With the rising cost of healthcare and a rising worldwide population, there is an increasing need for effective methods of reducing hospital readmissions and home-based screening tests. Remote monitoring technologies have the potential to provide near real-time health information and may also facilitate a means to observe important activity information in patients and aging adults in the comfort of their homes and hospitals. The reduction in size of digital processors and components for monitoring has allowed such technologies to become increasingly unobstructed. Furthermore, the widespread use of wireless connectivity make real-time monitoring in ambulatory conditions possible. The ability to monitor heart rate can provide important information for patients with cardiovascular diseases such as supraventricular tachycardia (SVT) or congestive heart failure (CHF). Furthermore, rapid detection of acute events like myocardial infarctions (MI) or atrial. Monitoring of breathing rate is also important for the screening of abnormal respiration that may occur in obstructive sleep apneas. Activity monitoring can be highly useful for providing a snapshot of the total daily activity in patients who require moderate exercise, for detecting and providing notifications of falls in the elderly population, or determining duration and position in bed for those in assisted living facilities.

II THE PROBLEM

Benjamin et al (2017) stated that of the 34 percent or 85.7 million adults in America 76 percent take medications, however just about 54.4 percent of those have their situation under control. In addition to this, those with blood pressure above 140/90 mm Hg, account for 77 percent of people who have stroke for the first time. Close to 50 percent (45.6 percent) of people with high blood pressure have not being able to have it regulated and forecasts show that about 41.4 percent of US adults will suffer hypertension by the year 2030, a rise of about 8.4 percent on the value estimated in 2012.

The term pulse could be defined as the rate at which the heart beats. Pulse and heart rate are often used interchangeably. Heart rate is the number of times your heart beat per minute (bpm). The normal heart rate for an adult in a resting position range between 60 and 100 beats per minute. They differ.com (2016); Birch (2017); Thiruvelan (2017).The pulse and strength of the heartbeat as well as the hardness of the blood vessel can also be observed. Sudden change in the rate at which the heart beat or a weak pulse, even a hard blood vessel could be caused by a heart disease. Pulsing can be felt in blood vessels near the skin surface, such as in your wrist, neck, or upper arm. To determine how fast the heart is beating, one can simply count the pulse rate.

Doctors usually check the pulse when conducting physical examinations or in an emergency, but you can easily learn to check your own pulse. Resting pulse the value obtained when the pulse is checked first thing in the morning

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

immediately after waking up or before one gets out of bed. The pulse can be checked before and after exercising. To check the pulse rate the beats are counted for a preset period of time. If it is counted for 15 seconds the number is multiplied by 4 to get the number of beats per minute and if it is counted for 2 seconds then it is multiplied by 3 to get the number of beats per minute. Pulses change from time to time. According to Gulatietal (2010), the easiest and best known method to calculate your maximum heart rate (MHR) is for male, MaxHR = 220-Age, Female MHR = 206 – (0.88 * age). It will be faster when you exercise, have a fever or are under stress. It will be slower when you are resting.

To implement the project as a heart rate monitor attached to the wrist requires an accurate technique in Large Scale Integration and expertise in order to make the device compact and easily worn on the wrist. The device for making such integration accurately is not easily accessible. Thereby the implementation of this project will be fulfilled by using home-brewed do-it-yourself techniques.

A patch or Microstrip antenna, also known as rectangular patch antenna is a kind of small form factor radio antenna with low profile which may be mounted on a flat surface. It is made of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground plane. It also consists of a layer of a dielectric material between the two metal sheets.
Microstip antennas are very relevant and have found themselves useful in various industrial, medical and scientific applications. The fact that they can be printed directly on a circuit board is making the use of microstrip antennas to be on a continuous rise. Low cost, low profile and easy fabrication are some of the reasons why it has found its way into the mobile phone market.

III ADMINISTRATION OF THE INSTRUMENT

In the administration of the patch antenna, the patch is worn on the wrist coupled with some electronics to sense and monitor the user’s daily activities and heart rate to improve health. It has multiple functions which includes, monitoring the fitness of the body, measuring heart rate of an individual. The heart rate can easily be measured by touching the back of wearable device with the press of one finger.

The patch can extremely be effective when used properly. It sounds obvious, but several other factors can affect the reliability of the whole system, example of one of those factor is the skin color, since the method of obtaining the pulse is by means of some infrared light shone on the surface of the skin, the darker the skin color, the lesser the absorption of the light, and hence more light is reflected and thereby causing an unstable or unclear photoplethysmography waveform. Also in the same form, if the skin color is too light, the light will be absorb too much and thereby less light will be reflected such that most of the desired signal will be lost. One sure method of overcoming this problem is to make use of variable gain amplifier, so that the gain of the amplifier can me adjusted for different skin color either manually or automatically.
Also the patch must not be too tight or too loose, if it is worn too tight, it puts pressure on the blood vessels and thereby affecting the normal blood flow rhythm, and the retrieved pulse rate will be affected drastically. Also if the patch is worn too loose, the reflective light sensor will not make perfect contact with the body and hence the data measured may be invalid.

IV APPLICATIONS OF PATCH ANTENNAS

The microstrip patch antenna sare famous for their performance nd robust design. Microstrip patch antennas have applications in various fields such as in the medical field, satellites and even in the military systems just like in the rockets, aircrafts missiles and many more. Now they are booming in the commercial aspects due to their low cost of the substrate material and the fabrication. Microstrip patch antenna has a number of applications. Some of these applications are listed below:

1. Mobile and satellite communication application
2. Global positioning system applications
3. Radio frequency identification(RFID)
4. Interoperability formicrowave ccess (WiMax)
5. Radar application

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

V REVIEW OF RELATED LITERATURES

A. Bhartiaand Bahl(1980) in Srivastava&Gayal (2017) in their article describes the design of a multi-layer, dual linearly polarized microstrip patch array antenna with resonant frequencies at 28.9and 29.4GHz respectively. The array contains 256 elements. The patches are printed on the top surface of a two-layer back-to-back Duroid 5880 substrate with a ground layer in between. The dielectric constant of the Duroidis2.2,the thickness of each layer is 0.025 cm, and the thickness of the adhesive is 0.0038cm.The vertical polarization is excited through a corporate feed structure on the top surface of the top layer. The horizontal polarization is similarly excited by a corporate feed printed on the bottom surface of the bottom layer.This corporate feed electro magnetically excites the slots provided in the common ground plane and they in turn couple their energy to the radiating patches.A differential 180°phase shifter is provided for alternate elements of each column on
The bottom layer and each row on the top layer so that all the elements of the array are excited in phase.The element dimensions are 0.314x0.325cm and the spacing between elements is 0.76 cm. The slot dimensions are 0.0225 x 0.1875 cm.

B. In this paper by Herscovici(1998), it describes about printed microstrip antennas and arrays that have limitations in terms of bandwidth and efficiency, all imposed by the very presence of the dielectric substrate. Microstrip arrays printed on a very thin film and separated from the ground-plane by foam were successfully designed; however, the fabrication difficulties associated with the use of foam considerably increases the fabrication cost. In this same paper, a new concept is presented, rather than using super stratageometry,the"printedcircuit"is etched out of metal and supported in "strategicpoints"by(metallic or nonmetallic)posts. The main motivation for this work was to obtain large microstrip arrays, which exhibit a higher efficiency than conventional ones, and can be fabricated using in expensive large quantity production techniques. However, this technology was also used to develop many new types of microstrip antennas. Microstrip elements and arrays based on this technology were designed and fabricated at L, S, and C bands.

C. In the interest of the consumer, the cost of manufacturing and the dimensions of each array will be kept to a minimum. Therefore, all the microstrip antenna elements will be strip line fed enabling each element to share a common ground plane(Chen and Chia ,2006). This will allow all the antenna elements to be fabricated on a single dielectric sheet. The dielectric substrate, separating the ground plane and the antenna patches, has a dielectric constant(ε_r)of2.2 and a thickness of 0.05lcm (20mil).Single rectangular patches will first be fabricated to determine the proper dimensions for a patch operating in the Kuband(1.7GHz-12.7GHz). Once the dimensions of a single patch were determined an 8x8 and 16x16 planar arrays were fabricated using duplicates of the a fore mentioned patch. Each array was first tested without a parasitic patch layer. Thee-plane and H-plane patterns were measured using the far-field antenna testing range at NASA Lewis.

D. Barret, 1984 in his article examined the comparison in the gain of a single patch with a superstrate with that of a single patch without a superstrate and reports the experimental results for a2×8 array antenna with a superstrate and a 4×8 array antenna without a superstrate. A dielectric superstrate layer above a microstrip patch antenna has remarkable effects on its gain and resonant characteristics. This paper experimentally investigates the effect of a superstrate layer for high gain on microstrip patch antennas. The gain of antenna swith and without a superstrate is measured and found that the gain of a single patch with a superstrate was enhanced by about 4d Biovertheone without a superstrate at 12GHz.The impedance bandwidth so fa single patch with and without a superstrate for VSWR<2wereabove11%.Thedesigned2×8arrayantennausingasuperstratehadahigh gain of over 22.5 dB and a wide impedance bandwidth of over 17% radiated field can be accomplished.

VI MICROSTRIP PATCH ANTENNA DESIGN

A Microstrip Patch Antenna is made of a thin patch that placed a small portion of a wavelength above a conducting ground plane. A dielectric is used to separate the patch and the ground plane .Copper is used most times as the patch conductor and could assume any shape. However for this particular project a rectangular patch would be used because, this would simplify the analysis and performance forecasting. The patches are usually photo-etched on the dielectric substrate and the substrate is usually non-magnetic. One very important parameter is the relative permittivity. The relative permittivity improves the fringing fields that of the substrate are an important parameter to consider. It is because relative permittivity will

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

enhances the fringing fields that account for radiation. This type of antenna is characterized by its width W, length L and thickness h, as shown in figure 1

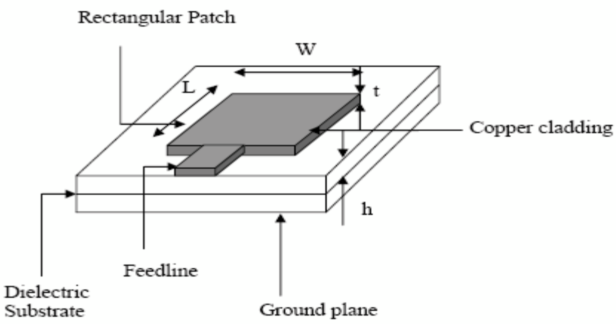

Figure 1: Rectangular Microstrip Patch Antenna.

Consider a basic rectangular patch micro strip antenna as shown in Figure1.Currentisexcitedonthefeedline to the patch and a verticalelectric field between the patch and the ground plane, if we assume a voltage input at the feedlinewhen operating in the transmitting mode So therefore the patch element resonates at certain wavelength and this result in radiation.

For the patch element to resonate at certain wavelength and radiate energy, we have assume a certain voltage input

VII THE TRANSMITTER

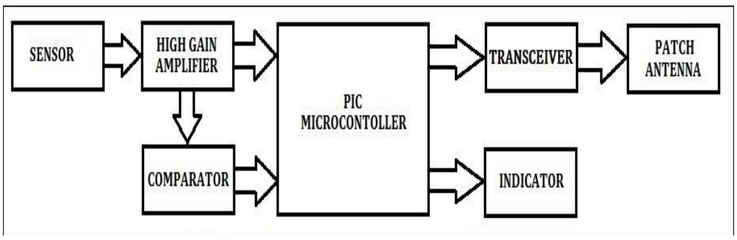

Figure 2: Block Diagram of the Transmitter

Non-invasive and continuous measurement of blood pressure can enable an effective 24/7 monitoring of hypertensive patients to timely prevent cardiovascular problem and precisely regulate Anti-hypertension cures.
The above shown block diagram shows the implementation of patch antenna with biomedical electronic circuit to transmit wirelessly the obtained data. The sensor measures the required data while the data is amplified and conditioned before it is fed to the microcontroller for the required calculation. The blocks are explained below:

A SENSOR

Different sensors are required for the different data needed to be acquired. In this project, we intend to measure the heart rate using a non-invasive PPG (Photoplethysmography) measurement technique. The PPG is the main parameter to be measured while others will be calculated from the latter.

B PPG (PHOTOPLETHYSMOGRAPHY)

A **photoplethysmogram**(**PPG**) is the measurement of the volume of an organ. It is plethysmogram obtained optically. PPG are frequently measured using a pulse oximeter. It illuminates the skin and measures variations at which light is being absorbed (Shelley, 2011).The perfusion of blood to the dermis and subcutaneous tissue of the skin is being monitored by an orthodox pulse oximeter. Heart pumps blood to the periphery with each cardiac cycle. By the time the pressure pulse reaches the skin it could have been slightly damped, but it is still enough to distend the arteries and

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

arterioles in the subcutaneous tissue. If the pulse oximeter is attached without properly squeezing the skin, a pressure pulse can also be seen from the venous plexus, as a small secondary peak.

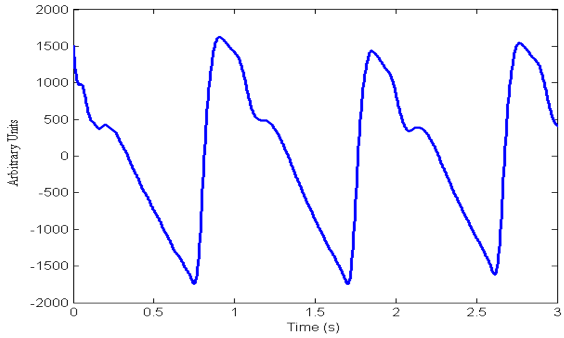

Figure 3: A Typical PPG Waveform

The pressure pulse caused by a change in volume is sensed by an infrared light emitting diode (LED) which illuminates the skin and then measure the amount of light either transmitted or reflected to a photodiode. Cardiac cycle appears as a peak respectively, as seen in the typical PPG waveform shown in figure 3. Since blood flow to the skin can be modulated by various other physiological systems, the PPG can also be used to monitor hypovolemia, respiration, and other circulatory conditions(Reisner*et al*, 2008).Furthermore, the shape of the PPG waveform differs from individual to individual, and differs with the manner and location in which the pulse oximeter is attached. There are basically two methods of obtaining a PPG signal, they are:

1. Transmissive method
2. Reflective method

In the transmissive method, a source of light – visible or infrared is used to illuminate the skin. The light is allow to penetrate the skin layer and diffused light reaching the other side of the skin is retrieved by the aid of a light sensor. This is usually worn or clipped on flexible and thin part of the body like the finger tips, the ear lobe etc.

In the reflective method, the source of light illuminates the skin and the reflected waveform is picked up using an optical sensor. This method is more lossy. But with good signal conditioning circuit, it can work as perfect as the transmissive counterpart. It major advantage over the trasmissive method is that it can be worn on any part of the skin but it is mostly used on the forehead, the palm and sore, the forearm, wrist etc

C ECG (ELECTROCARDIOGRAPHY)

Electrocardiography is the process by which the electrical activity of the heart is recorded over a period of time. This is done by placing electrodes on a patient's body. The electrodes detect tiny electrical changes that occur on the skin that arise from the heart muscle depolarizing during each heartbeat. In a normal*12 lead ECG*, ten electrodes are placed on the patient's chest and limbs while twelve different angles ("leads") are used to measure of the heart's electrical potential over a period of time(usually 10 seconds). By this method, the overall magnitude and direction of the heart's electrical depolarization is being obtained at each instant throughout the cardiac cycle (Aswini, 2010).The *voltage* versus *time* graph produced by this medical procedure is known as **electrocardiogram** (abbreviated *ECG* or *EKG*).

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

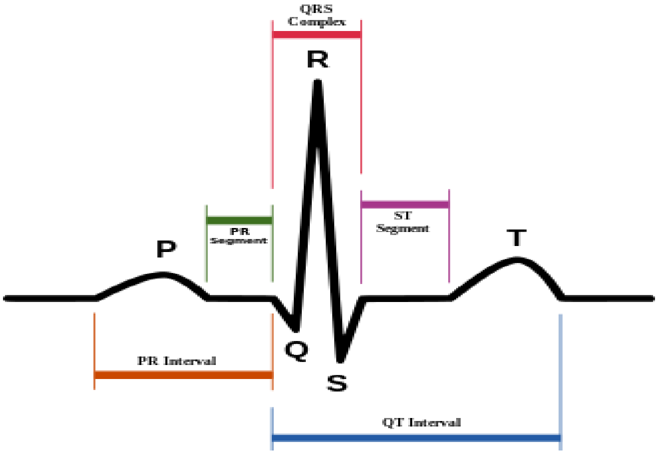

Figure 4: A Typical ECG Waveform

A healthy heart will usually have awell-ordered progression of depolarization during each heartbeat. It starts with pacemaker cells in the sinoatrial node, it extents through the atrium, goes through the atrioventricular node and then spreads all the way through the ventricles. This systematic way of depolarization accounts for the characteristic ECG tracing. To a specialist, ECGs convey very large amount of information that has to do with the structure of the heart and the function of its electrical conduction system(Walraven, 2011).As well as other things, an ECG can also be used to measure the size and position of the heart chambers,the rate and rhythm of heartbeats, the presence of any damage to the heart's muscle cells or conduction system, the effects of heart drugs, and how implanted pacemakers are functioning. (Braunwald, 1997).

D RELATIONSHIP BETWEEN ECG AND PPG

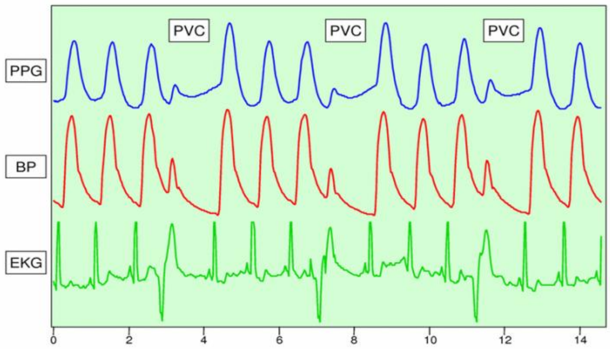

Figure 5: A diagram showing the relationship between PPG and ECG

The diagram shown in figure 5shows the relationship between the PPG and ECG to calculate the blood pressure. It is seen from the diagram that the difference between the peaks of the PPG waveform and the ECG waveform correlates with the blood pressure of the patient under observation. This difference is called Pulse Width Transit Time (PWTT). Because the PWTT has a relationship with the blood pressure, it can be used to calculate the blood pressure of a given patient.

E HIGH GAIN AMPLIFIER

The high gain amplifier consist of an instrumentation amplifier, inverting and non-inverting amplifiers and buffer amplifier. The amplifier design must fulfil the following specification for high fidelity of signal amplification:

- High noise rejection
- High Common Mode Rejection Voltage
- Low input offset voltage

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

- Low input offset current
- High input impedance
- Low output impedance

The signal voltage level generated by the PPG and ECG circuits are in the order of microvolts, so the amplifier must be able to amplify this signals to minimum acceptable value for processing by the controller.

F COMPARATOR

The comparator is an active electronic device which compares the voltages or current at its two input, and the output depends on the magnitude of the inputs. For practical op-amp purposes, if V1>V2, the output is driven to the positive supply voltage and if V1<V2, it is driven to the negative supply voltage. The switching time is limited by the slew rate of the op-amp.

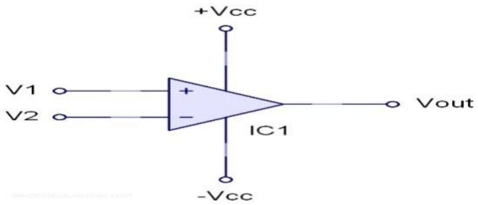

Figure 6: Diagram of a Comparator

The comparator in this design is used as a waveform converter – to convert the ECG and PPG signal to square wave (digital pulses) for the microcontroller to be able to analyze the data.

G MICROCONTROLLER

The heart of the circuit is the PIC (Peripheral Interface Controller) microcontroller by Microchip Corporation. The microcontroller accepts the signal from the amplifiers and the comparator, carries out the necessary calculations, obtain the heart rate (in BPM), send the acquired data to the transceiver circuit where the data are packed together and broadcasted through the patch antenna to a remote receiver. The transmitter acquires the measurement every fifteen (seconds) and count the number of heart pulses observed, the heart pulses are encoded in a packet for transmission by the transceiver.

H TRANSCEIVER

The transceiver is Nordic semiconductor NRF24L01+ RF transceiver IC. It works in the range of 2.4GHz to 2.5GHz which fulfils the ISM frequency band. It communicates with the microcontroller (MCU) via Serial Peripheral Interface (SPI) protocol. After receiving a complete packet from the MCU, it transmit it over the air to a remote receiver operating at the same channel. The NRF24L01+ have up to 25 user configurable channel, up to 6 multipoint communication and a coverage of about 100 feet at maximum transmitting power. Its small scale form factor makes it useable in the actualization of this project.

I THE RECEIVER

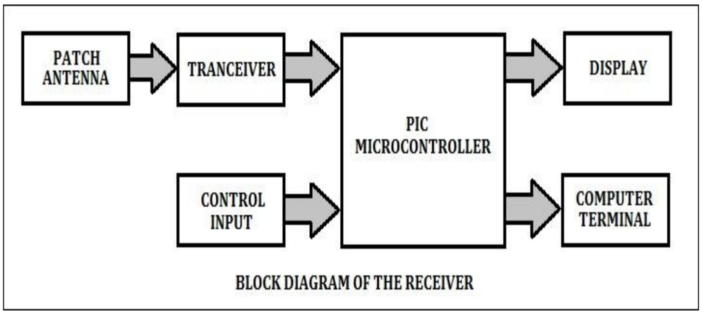

Figure 7: Diagram of the receiver section

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 5, Issue 11, November 2018

The block diagram of the receiver is somehow similar to the transmitter, only that it listens for a valid packet from the transmitter through the antenna to the transceiver. The receiver will acknowledge the transaction by sending back an acknowledge signal to the transmitter. The received data will be reversed processed in the microcontroller to obtain the heart rate which is then displayed on a 3 digit, 7 segment display. The received data is also sent in its raw form to the computer terminal for further processing like storage, logging, manipulations and other related calculations

VIII DESIGN CALCULATION

Components Selection/Parameters

For the design of a rectangular Microstrip Patch Antenna, there are three essential parameters:

• ***Frequency of operation (fo):*** The resonant frequency of the antenna must be properly selected. The frequency range of 2400-2500 MHz is what the Industrial Scientific Medical (ISM) systems uses. Hence the designed antenna must operate within this. 2.4 GHz is the resonant frequency selected for this design.

• ***Dielectric constant of the substrate (ε_r):*** 4.7 is the value of the dielectric constant of the material used for this design. A substrate with a high dielectric constant has been chosen because it reduces the dimensions of the antenna.

• ***Height of dielectric substrate (h):***since we want to use the microstrip patch antenna in a wearable bio-medical device, it is very important that the antenna is very portable. As a result, the height of the dielectric substrate is selected as 1 mm.

Hence, the essential parameters for the design are:

• *fo= 2.4 GHz*

• $\varepsilon_r = 4.7$

• *h = 1mm*

Design Procedure for Calculation

Step 1: Calculation of the Width (W):

Using $W = \frac{c}{2f_o\sqrt{\frac{\varepsilon_r+1}{2}}}$

Substituting $c = 3.0 \times 10^8\ m/s$, $\varepsilon_r = 4.7$ and f_o= 2.4 GHz, we get:*W* = **0.0278m = 27.8 mm**

Step 2: Calculation of Effective dielectric constant (ε_{reff}):

Using $\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}}$

Substituting ε_r= 4.7, *W* = 27.8 mm and *h* = 1mm we get:

εreff = **4.17**

Step 3: Effective length (*Leff*) calculation:

Using $L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$

Substituting ε_{reff}= 4.17, $c = 3.00 \times 10^8$ m/s and f_o= 2.483 GHz we get:L_{eff}= **0.0295 m = 29.5 mm**

Step 4: The length extension (ΔL) Calculation:

Using $\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{W}{h}+0.8)}$

ΔL = **1.911 mm**

Step 5: Actual length of patch (*L*) calculation:

Using $L = L_{eff} - 2\Delta L$

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

Substituting L_{eff}= 29.5 mm and ΔL = 1.911 mm we get:
L = 25.68 mm

Step 6: Ground plane dimensions (*Lg*and *Wg*) calculation:
For practical considerations, it is essential to have a finite ground plane since transmission line model is only applicable to infinite ground planes. It has been shown that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater than the patch dimensions by approximately six times the substrate thickness all around the periphery. Hence, for this design, the ground plane dimensions would be given as:
Lg= 6h + L = 6(1) + 25.7 = 31.7 mm
Wg= 6h + W = 6(1.5) + 27.8 = 33.8 mm

Step 7: Determination of Inset feed depth (y_o):
An inset-fed type feed is to be used in this design, the feed depth is given by y_0. The feed point must be located at that point on the patch, where the input impedance is 50 ohms for the resonant frequency. Hence, a trial and error method is used to locate the feed point. In this case we use PSO to obtain the optimum feed depth, where the return loss (R.L) is most negative (i.e. the least value). There exists a point along the length of the patch which gives the minimum return loss.

$$R_{in\,(y-y_0)} = R_{in\,(y=0)} \times \cos 4\frac{\pi y_0}{L}$$
$$where\ R_{in\,(y=0)} = 0.5 \times (G1 \pm G12)$$

Using the first equation (assuming that ZC in the second equation is 50 Ω) where $R_{in\,(y=y0)}$ = 50 Ω
we get: **y_0 = 13 mm**

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

IX DESIGN FLOWCHART

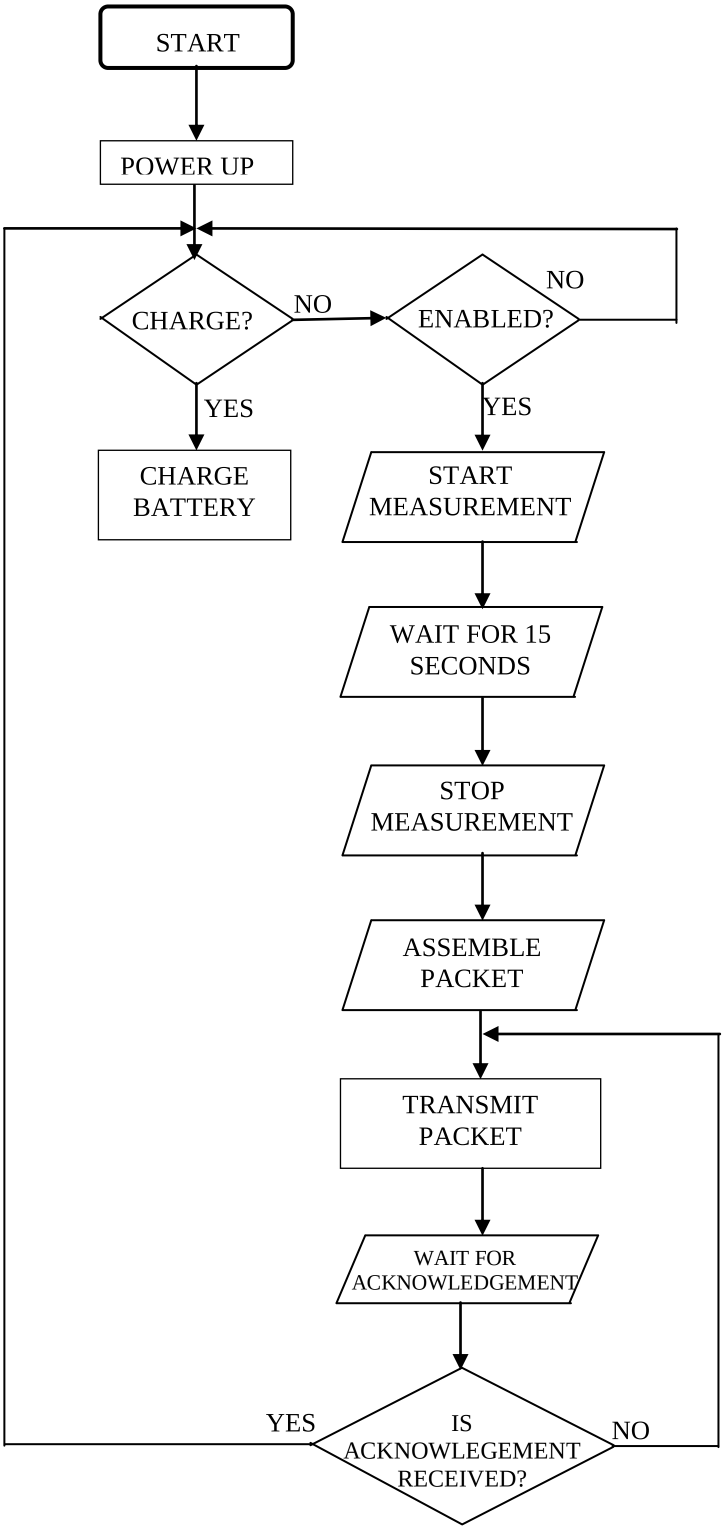

Figure 8: Design Flowchart

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 5, Issue 11, November 2018

X RESULTS

Table 1: Table of Results

Parameter	Conditions	Value			unit
		Min	Nom	Max	
Operating voltage	Transmitter	3.0	3.3	3.6	Volts
	Receiver	3.3	5.0	5.5	Volts
Operating Current	Transmitter	20 (Standby)	400	700	mA
	Receiver	120	160	230	mA
Range	At 0dB transmission power	-	30	45	metre
Transmitter Operating time	Battery capacity = 700mAH	40	55	60	minutes

XI CONCLUSION

The results reflect it is possible to produce wearable devices that meet initial product requirements for biomedical applications and perform moderately well function of a pulse carrier. It is expected further work is required in order to improve the current design. The following sections suggest a few issues to consider, if further attempts are made to improve the existing design. And also further research can be made on the possibility of measuring the hate rate of the patient over long distance, in a situation where a doctor is probably not available in that vicinity.

For further processing, a computer program or its supporting data can be developed to fix or improve it. This includes fixing security vulnerabilities and other bugs, and improving usability or performance. Though meant to fix problems, poorly designed computer program can sometimes introduce new problems.

Substrate: It is important to understand that at frequency above 500MHZ, a signal trace becomes an element itself of the circuit with distributed resistance, capacitance and inductance. The current G10 substrates have been found to be exceedingly "lossy". As a result of constant di-electric control, low dissipation factor and controlled thickness rather than employ typically used high volume printed circuit boards similar to G10 substrate.

Closer input impedance match: Improvement in terms of better input impedance match is possible, which will result in a "smoother" VSWR response over the 2.4-2.5GHZ. Ideally the VSWR of a broadband antenna should be flat over the frequency band concerned, reflecting a VSWR of 1. When compared to the commercial product, the commercial antenna showed a steady VSWR response. Similar response is desired from all broadband antennas. In future, the broadband input impendence match can be optimized to flatten the VSWR response over the concerned frequency band. Subsequently, the rectangular broadband antenna requires further inspection since it did not meet the VSWR of 1.5:1 requirement.

REFERENCES

Aswini Kumar M.D(2010)*;* *"ECG- simplified."*. LifeHugger.Retrieved 11 February 2010.
A. T. Reisner, P. A. Shaltis, D. McCombie, and H. H. Asada(2008); *"Utility of the Photoplethysmogram in CirculatoryMonitoring"*, Anesthesiology, vol. 108, pp. 950-958,.
Bailey M.C and Deshpande M.D. (1984): *"Analysis of Rectangular Microstrip Antenna"*, NASA technical paper 2276.
Barrett R.M.(1984):*"MicrowavePrintedCircuits– The Early Years"*,IEEETrans.Microwave TheoryTech., vol32, no.9,pp.983-900.
Benjamin E.J., Blaha M.J., Chiuve S.E., Cushman M., Das S.R., Deo R., …Muntner P.(2017):*"Heart disease and stroke statistics—update: a report from the American Heart Association"* American Heart Association Statistics Committee and Stroke Statistics Subcommittee.

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 5, Issue 11, November 2018

Birch J.(2017) *"what's the difference between resting heart rate and blood pressure"* available at https://blog.fitbit.com/resting-heart-rate-blood-pressure/ accessed 13/3/2018

Braunwald E. (1997); *Heart Disease: A Textbook of Cardiovascular Medicine, Fifth Edition*, p. 108, Philadelphia,W.B. Saunders Co., ISBN 0-7216-5666-8.

Carver K.R. and Mink J.W. (1981): "Microstrip Antenna Technology." IEEE Trans. Antennas & Propagation, vol. AP-29, no. 1, pp. 2-24.

Chen andChia M.Y.W.(2006): " *BroadbandPlanarAntennas Designand Applications*", JohnWily&Sons,Chichester,UK.

Derneryd A.G. (1976): *"Polarized Microstrip Antennas"*. IEEE Trans.Antennas & Propagation, vol. AP-24, no. 6, Nov. 1976, pp. 846-851.

Derneryd, A.G. (1978): "*A Theoretical Investigation of the Rectangular Microstrip Antenna Element"*. IEEE Trans. Antennas & Propagation, vol. PIP-26, no. 4, pp. 532-535.

Herscovici N (1998): "New Considerations in the Design of Microstrip Antennas" IEEE Transactions on Antennas and Propagation, vol. 46, no. 6

K. Shelley and S. Shelley(2001); "*Pulse Oximeter Waveform: Photoelectric Plethysmography"*, in Clinical Monitoring, CarolLake, R. Hines, and C. Blitt, Eds.: W.B. Saunders Company, pp. 420-428.

Lo Y. T, Solomon D, and Ichards W.F. (1979): *"Theory and Experiment on Microstrip Antennas"*. IEEE Trans.Antennas & Propagation, vol. AP-27, no. 2, Mar. 1979, pp 137-145.

Mutiara A.B., Refianti R., Rachmansyah,(2011): *"Design of microstrip antenna for wireless communication at 2.4Ghz."* Faculty of Computer Science and Information Technology, Gunadarma University, JlMargonda Raya No. 100, Depok 16424, Indonesia.

Patel B.D. (2013): "*Microstrip Patch Antenna-A historical Perspective of Development*", Conference on Advances in Communication and Control Systems 2013

Punit S.(2004): *"Design of a compact microstrip patch antenna for use in wireless/cellular devices."* Master's thesis, The Florida State University

Praveen K., Sanjeeva K.R., Sumanth T., Mohana N.R., Kumar R.A., Harish Y., (2013): *"Effect of Feeding Techniques on the Radiation Characteristics of Patch Antenna: Design and Analysis"*International Journal of Advanced Research in Computer and Communication EngineeringVol. 2, Issue 2.

Srivastava D and Gayal B (2016): "*Design and Simulation of Microstrip Antenna with Enhanced Bandwidth and Compact Size for Missile Application"* Imperial Journal of Interdisciplinary Research Vol-2, Issue-8.

They differ.com (2016): *"Difference between heart rate and blood pressure"*available at https://theydiffer.com/difference-between-heart-rate-and-blood-pressure/ accessed 13/3/2018

Thiruvelan (2017): *"Pressure and heart rate"***.** Available at http://healthy-ojas.com/pressure/pressure-heart-rate.html accessed 13/3/2018

Walraven, G. (2011); Basic arrhythmias (7th ed.), pp. 1–11

Wong K.L. (2002): "*Compact and BroadbandMicrostripAntenna*",JohnWiley&Sons,NewYork.

AUTHOR'S BIOGRAPHY

OKEREKE C.O

DEPARTMENT OF ELECTRICAL /ELECTRONIC ENGINEERING,
THE FEDERAL POLYTECHNIC ADO-EKITI, EKITI- STATE, NIGERIA