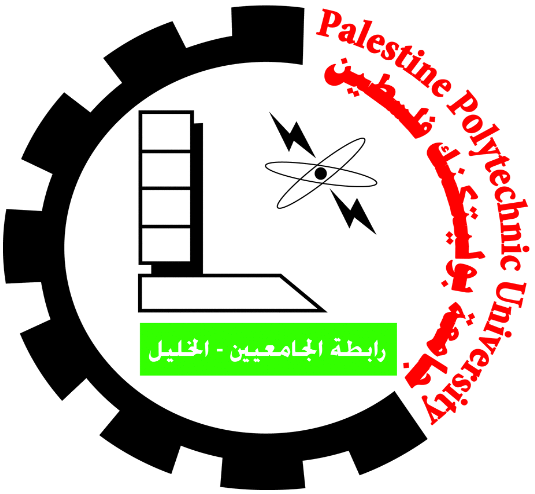

Therapy Far-Infrared Sauna

Project Team:

Sameeh Raddad **Mahdi Moqade**

Abdulrahman Abdelghafoor

Supervisor:

Dr. Ramzi Qawasma

Submitted to the College of Engineering
in partial fulfillment of the requirements for the degree of
Bachelor degree in Biomedical Engineering
Palestine Polytechnic University

May. 2016

Palestine polytechnic University

Hebron – Palestine

College of Engineering

Electrical Engineering Department

Therapy far-infrared sauna

Project Team:

Sameeh Raddad **Mahdi Moqade**

Abdulrahman Abdelghafoor

By the guidance of our supervisor , and by the acceptance of all members in the testing committee , this project is delivered to department of electrical and computer engineering in the college of engineering and technology , to be as a partial fulfillment of the requirement of the department for the degree of B.sc .

Supervisor signature

Testing committee signature

---------- **----------** **----------**

The head of department signature

جامعة بوليتكنك فلسطين

الخليل – فلسطين

كلية الهندسة

دائرة الهندسة الكهربائية

Therapy Far Infrared Sauna

فريق المشروع

سميح رداد **مهدي موقدي**

عبد الرحمن عبد الغفور

بناء على نظام كلية الهندسة واشراف ومتابعة المشرف المباشر على المشروع وموافقة اعضاء اللجنة المناقشة , تم تقديم هذا العمل الى دائرة الهندسة الكهربائية .

وذلك للوفاء بمتطلبات درجة البكالوريوس في هندسة الاجهزة الطبية .

توقيع المشرف

توقيع اللجنة المناقشة

---------- ----------

توقيع رئيس الدائرة

الإهداء

إلى مخرج إلبشرية جمعاء من إلظلمات إلى إلنور محمد صلى الله عليه وسلم

إلى أمهاتنا وأ بائنا إلذين تعبوإ حتى يرونا كبارإ نبحر في محيط هذه إلحياة

إلى إخوتنا و أخوإتنا إلذين لم ولن يبخلوإ علينا بشئ

إلى أصدقائنا و أحبابنا إلذين لولاهم لم نكن وصلنا إلى هنا

إلى إلشموع إلتي تحترق لتضئ للاخرين الدروب أساتذتنا الذين لم يبخلوإ بعطائنا كل ما لديهم

إلى كل من أضاء بعلمه عقل غيره وهدى بالجوإب الصحيح حيرة سائليه

فأظهر بسماحته تواضع العلماء وبرحابته سماحة العارفين و أخجلنا بهتامه

إلى كل من ساعدنا ولو بجملة أو حتى كلمة

إلى كل محب للعلم ومتيم به

إلى أولئك إلذين حرموإ حريتهم خلف إلقضبان لجل هذإ إلوطن إلغالي

إلى أولئك إلذين فقدوإ حياتهم لكي نبقى نحن على هذإ إلوطن ولا نفرط بحبة ترإب منه

نهدي هذإ إلعمل إلمتوإضع رإجين من المولى عز وجل القبول والنجاح

ولنذكر هنا كلمة إ لصفهاني حين قال إني ر أيت أنه لا يكتب إنسان كتاباً

في يومه إلا قال في غدِه لو غُير هذإ لكان أحسن ولو زِيد كذإ لكان يُستحسن

ولو قُدِم هذإ لكان أفضل ولو تُرِك هذإ لكان أجمل

وهذا من أعظم النعم وهو دليل على إستيلاء النقص على جملة إلبشر

List of Content

Acknowledgment

We would like to thank Palestine Polytechnic University, College of Engineering, and Electrical Engineering Department. Thanks from our hearts for all support and for this worthy learning environment.

Also thanks to the head of hopefulness, our parents. We would like to thank everybody shared in success of this work either by suggestion, directives, or tips. Thanks to Dr. Ramzi qawasmeh for their great efforts in supervision, suggestion, and providing experience to accomplish this work. Also we want to thank Eng. Fida'a Alja'fra For all helps and worthy suggestions and tips to accomplish this project.

Abstract

This project aims to build a sauna room which have the dimension of (110cm*110cm*210cm) that use far infrared radiations, the project achieves two goals the first one is therapy goal by use far infrared radiation which come from panel at wavelength of (4-14) micron which is called Biogenetic rays. So when the far infrared rays are applied, the water begins to vibrate breaking the ion bonds of the atoms held together by the water molecules. As the breakdown of the bond occurs, the encapsulated gases and other toxic substances are released. As we know, that 70% of the human body is water, also we provide some sensor to the project to measure some vital signal such as diagnostic heart rate to be sure that the user in safe side.

The second goal is to provide some relaxation to the user so we support this side by adding some accessories to the project such as LCD screen, stereo radio and some spots light to make the room more relax and comfortable.

الملخص:-

يهدف هذا المشـــروع الى بنـاء غرفـة ســـاونـا الاشـــعـة تحت الحمراء بعيدة المـدى بحيث تكون ابعـاد الغرفـة (110سم*110سم*210سم). يسعى بناء المشروع لتحقيق هدفين الهدف الاول هدف علاجي من خلال استخدام الاشعة تحت الحمراء بعيدة المدى والتي تصـــدر من خلال لوحات خاصـــه باطوال موجية تتراوح من 4 ميكرون الى 14 ميكرون تسـمى الاشـعة البيوجينية التي بدورها تعمل على تايين جزيئات الماء في الخلايا والدم مما يؤدي الى تكسـير الروابط بين الجزيئات بحيث يتم التخلص من المواد السامه وتحسين الدورة الدموية والظروف الصحية.

يحتوي جسم الانسان نسبه كبيره من الماء بمعدل يشكّل 70% حيث أن تنشيط جزيئات الماء يعمل على تحسين مستوى الاكسجين في اجسامنا وازالة الدهون والمواد الكيمائية والسموم من الدم، كما ويعمل ذلك على انتاج انزيمات تعمل على تنشيط عمليات الايض في جسم الانسان.

اما الهدف الثاني فهو توفير الاسـترخاء والاسـتجمام للمسـتخدم نظراً لما يواجهه بعض مسـتخدمين السـاونا التقليدية من شـعور بضـيق للتنفس وما الى ذلك، الجانب الاسـتجمامي تم دعمه من خلال تزويد المشـروع بعدد من الاكسـسـوارات كشاشة عرض ومسجل وبعض من الاضواء الخافتة للشعور بالراحة عند استخدام ساونا الاشعة تحت الحمراء. واخيرا تم تزويد المشروع بعدد من المجسات لقياس الاشارات الحيوية للمستخدم مثل قياس معدل نبضات القلب وذلك للتاكد من سلامته .

List of Figures :-

List of Tables:-

Chapter One

Introduction

1.1 Thesis Overview

1.2 Project Idea Description

1.3 Project Motivation

1.4 Main Objective

1.5 Literature Review and Related Work

1.6 List of Abbreviation

1.7 Economical Study

1.8 Schedule Time

1.1 Thesis Overview

Our body needs heat to stay alive, the air we breathe and the food we eat all become heat or energy within our cells. Traditionally, the eastern medicine believed that the cause of illness lies in the inner body temperature (means our unhealthy cells are cold due to a lack of energy). When the body temperature becomes lower than F°97.7 (36.5 C°), the organs will not function well and the immune system deteriorates, causing illnesses. The Far Infrared is very similar to the vibration of our healthy life force. Therefore FIR is very easily absorbed by the human body. Ninety percent of sickness comes from lack of inner heat caused by physical and mental stress. If we supplement heat within the autonomic nervous system, our circulation improves. So the self-healing becomes possible. According to this information we see the benefits of the far infrared sauna which is make to increase the body temperature. [1]

1.2 Project Idea Description

In this project a therapy far infrared sauna is designed and implemented, this device increase the body temperature through the interaction between infrared radiation and body organs, this interaction affect on the organs. So The main idea of the project is to use an infrared radiation in sauna instead of steam because the far-infrared radiation has many physical properties which have proven their ability in different therapeutic fields such as the skin, blood circulation and arthritis, and has been selected Far-Infrared, specifically because it has the ability to penetrate deeper in the human body.

1.3 Project Motivation

The project motivation appears when compared far infrared sauna with traditional sauna, the far infrared sauna distinct from the traditional sauna a lot of features, FIR saunas heat between 120°F to 150°F, Infrareds heat up in about 10-20 minutes Also FIR sauna dry and gentle, while Traditional saunas heat is 180° - 195°F and 20-35 minutes so it’s harsh and claustrophobic, infrared heat penetrates deeper into the body, infrared saunas will plug in standard home 220v wall socket.

Also some people suffer from shortness of breath when using a traditional sauna, but infrared sauna solves this problem and this one of the motivation for building infrared sauna, and Table (1.1) describe the Comparison between FAR and traditional sauna.

Table 1.1: Comparison Between FAR and Traditional Sauna [1]

	Therapy Infrared sauna	Traditional sauna
Temperature	45-65 °C	80-90 °C
Treatment time (per one session)	20-30 minute	30-45 minute
Power consumption	1.6 kW	6 kw
Heating Time	10-20 minute	20-35 minute
Patient comfortable	More	Less
Toxic removal	20%	3%

1.4 Main Objective

The main objectives of this project can be summarized as follow:

- Design a safe and comfortable infrared sauna for therapeutic purposes
- Use for diagnostic physical parameter and some vital signal for user
- Design a UBS circuit that keep power on when absence power source

1.5 Literature Review and Related Work

- **Heater lamp**

Infrared lamps were proven to be effective in warming the body directly. This allows deep heat that is responsible for good health to be absorbed by the body. Infrared lamps main functions include lessening inflammation, soothing pain, promoting proper metabolism and regulating physiological diseases.

- **Far Infrared Belts**

Far infrared belts can help you lose weight when you're working out by selectively heating a targeted area of the body. Far infrared heat will help the fat melt faster. the belts aren't a miracle weight loss product but they work very well to aid normal workout routines to reduce belly size.

1.6 List of Abbreviation

Table 1.2: List of Abbreviation

Abbreviation	Full Meaning
IR	Infrared
FIR	Far-Infrared
F°	Fahrenheit Degree
C°	Celsius Degree
PH	Potential Of Hydrogen
HR	Heart Rate
PPG	Photoplethysmography
ECG	Electrocardiogram
LCD	Liquid Crystal display

1.7 Economical Study

This section lists the overall cost of the project components that are considered in implementing system.

Table (1.3) contains the main required hardware components of the project design, and its estimated cost.

Table 1.3: Estimated Component Cost.

Type	Price	Quantity
1- FIR Panels	372 JD	4
2- Wood Cabinet	577 JD	1
3- HR Sensor	45 JD	1
4- Arduino board	20 JD	1
5- LCD	6 JD	1
6- UPS Battery	20 JD	1
7- wires and other components.	50 JD	-
8- shipping	200 JD	-
	Total Price = 1290 JD	

1.8 Schedule Time

In this section we make a plan for the predictive project tasks due to the time zone of both coming semesters, this time plan shown in the table (1.4) and table (1.5).

Table 1.4: Timing Schedule of the First

Weeks / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Collect Information	■	■	■	■												
Basic Design					■	■	■	■								
Specification Design									■	■	■	■	■			
Presentation Preparing														■	■	■
Documentation				■	■	■	■	■	■	■	■	■	■	■		

Table 1.5: Timing Schedule of the Second Semester.

Weeks / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Full Designing	■	■	■	■												
Purchasing the components				■	■	■	■	■								
System Implementation						■	■	■	■	■	■	■				
System analysis									■	■	■	■				
Documentation											■	■	■	■		

Chapter Two

Anatomical and Physiological

This chapter is divided into four sections; first section illustrates in details the anatomy and physiology of the skin, in the second section, an overview of cardiovascular system will be introduced. The third section talks about the Rheumatic arthritis of the human joints extremities. Finally the fourth section describes the structure of the eye.

2.1 Skin

The skin is an ever-changing organ that contains many specialized cells and structures. The skin functions as a protective barrier that interfaces with a sometimes-hostile environment. It is also very involved in maintaining the proper temperature for the body to function well. It gathers sensory information from the environment, and plays an active role in the immune system protecting us from disease. [2]

2.1.1 Skin Structure

Understanding how the skin can function in these many ways starts with understanding the structure of the 3 layers of skin - the epidermis, dermis, and subcutaneous tissue. [3]

2.1.1.1 Epidermis

The epidermis is the outer layer of skin. The thickness of the epidermis varies in different types of skin. It is the thinnest on the eyelids at 0.05 mm and the thickest on the palms and soles at 1.5 mm. [4]

The epidermis contains 5 layers. The layers are named from bottom to top as shown in figures [1-5]:

- Stratum Basale
- Stratum Spinosum
- Stratum Granulosum
- Stratum Licidum
- Stratum Corneum

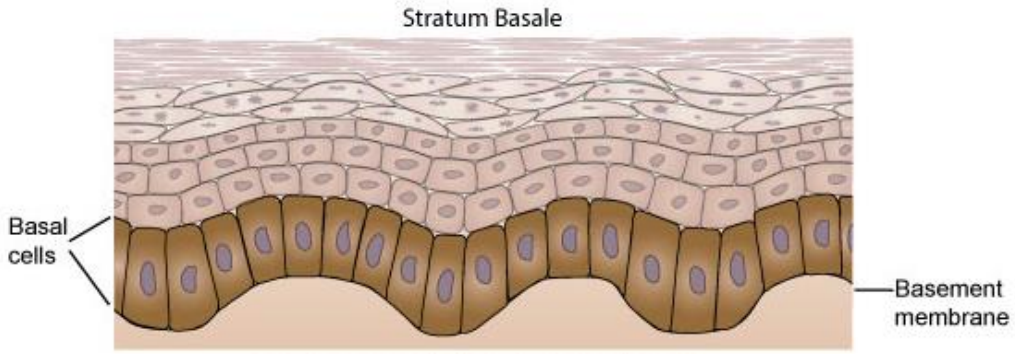

Figure 2.1: The Epidermis Layers (Stratum Basale) [4]

The stratum basale Figure (2.1) is the bottom layer of keratinocytes in the epidermis and is responsible for constantly renewing epidermal cells. This layer contains just one row of undifferentiated columnar stem cells that divide very frequently. Half of the cells differentiate and move to the next layer to begin the maturation process. The other half stay in the basal layer and divide over and over again to replenish the basal layer. [4]

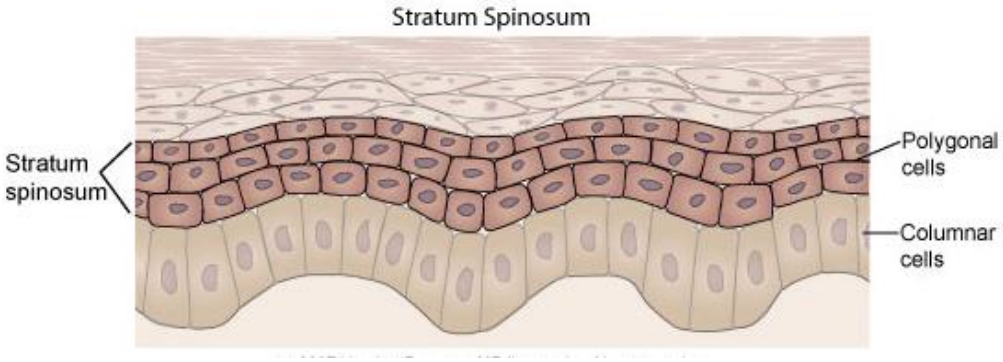

Figure 2.2: The Epidermis Layers (Stratum Spinosum) [4]

Cells that move into the spinosum layer figure (2.2), (also called prickle cell layer) change from being columnar to polygonal. In this layer the cells start to synthesize keratin.

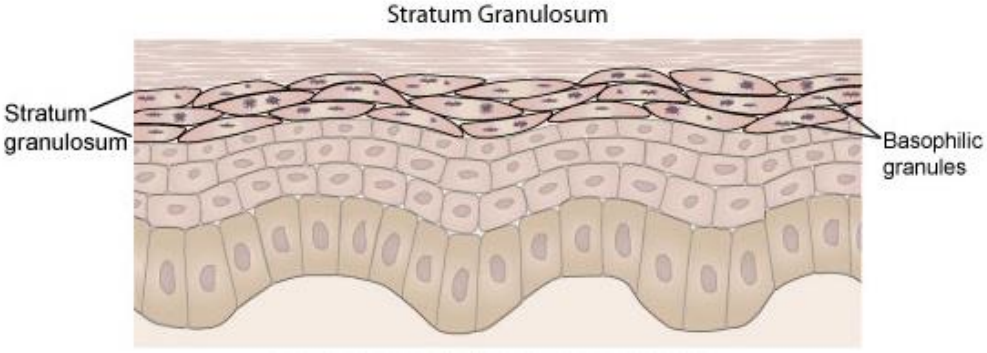

Figure 2.3: The Epidermis Layers (Stratum Granulosum) [4]

The cells in the stratum granulosum, or granular layer that shown in figure(2.3), have lost their nuclei and are characterized by dark clumps of cytoplasmic material. There is a lot of activity in this layer as keratin proteins and water-proofing lipids are being produced and organized.

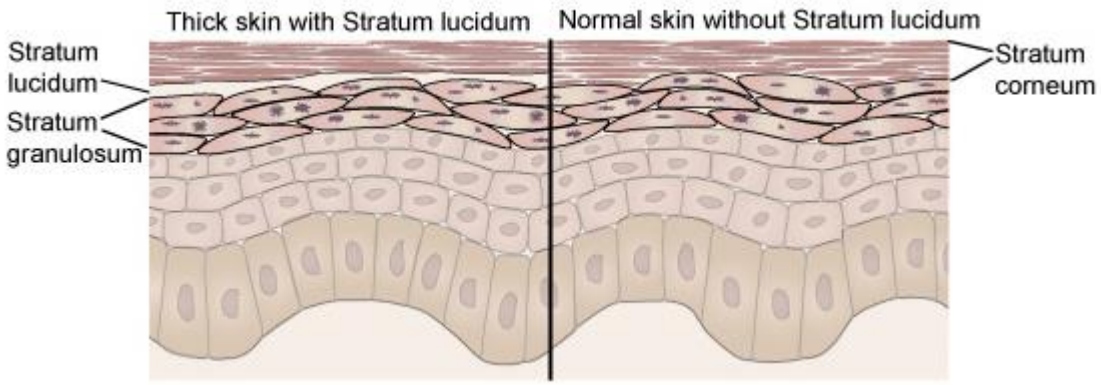

Figure 2.4: The Epidermis Layers (Stratum Licidum) [4]

The stratum lucidum layer shown in figure(2.4) is only present in thick skin where it helps reduce friction and shear forces between the stratum corneum and stratum granulosum.

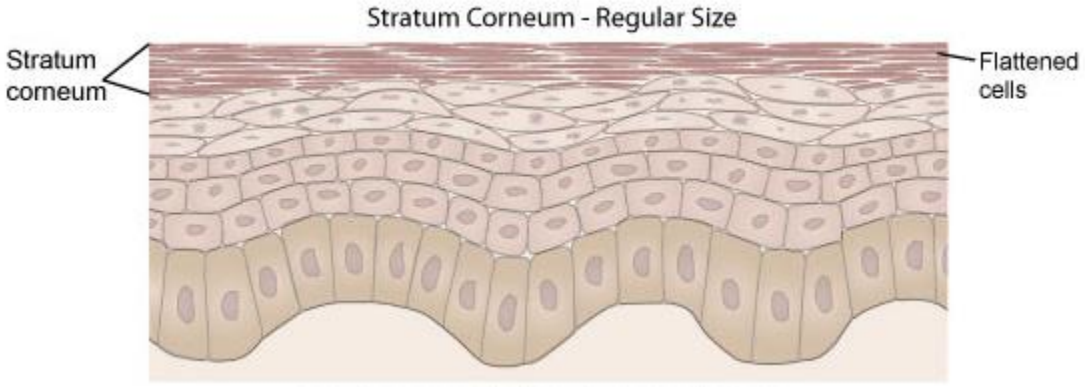

Figure 2.5: The Epidermis Layers (Stratum Corneum) [4]

The cells in the Stratum Corneum layer shown in figure(2.5) are known as corneocytes. The cells have flattened out and are composed mainly of keratin protein which provides strength to the layer but also allows the absorption of water.

2.1.1.2 Dermis

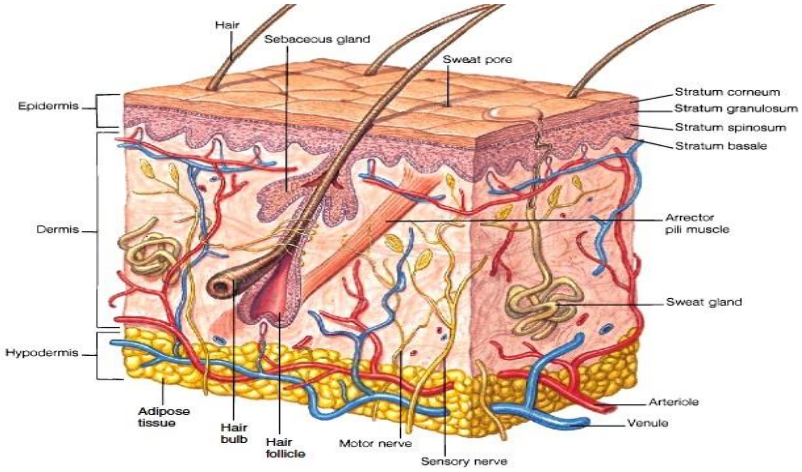

Figure 2.6: Dermis [5]

The dermis also varies in thickness depending on the location of the skin, see figure(2.6). It is 0.3 mm on the eyelid and 3.0 mm on the back. The dermis is composed of three types of tissue that are present throughout - not in layers. The types of tissue are: [5]

- Collagen
- Elastic tissue
- Reticular fibers

Layers of the Dermis

- The two layers of the dermis are the papillary and reticular layers.
- The upper, papillary layer, contains a thin arrangement of collagen fibers.
- The lower, reticular layer, is thicker and made of thick collagen fibers that are arranged parallel to the surface of the skin.

2.1.1.3 Subcutaneous Tissue

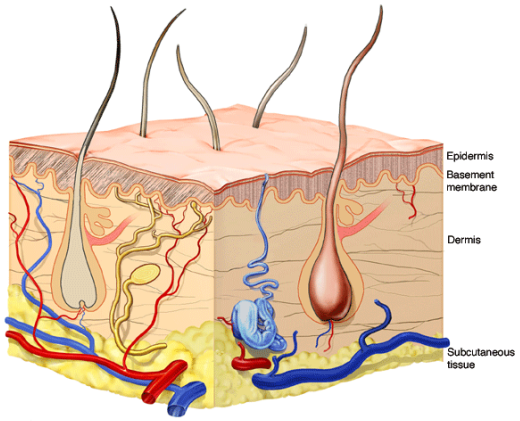

Figure 2.7: Dermis Layers [5]

The subcutaneous tissue shown in figure(2.7), is a layer of fat and connective tissue that houses larger blood vessels and nerves. This layer is important is the regulation of temperature of the skin itself and the body. The size of this layer varies throughout the body and from person to person.The skin is a complicated structure with many functions. If any of the structures in the skin are not working properly, a rash or abnormal sensation is the result. The whole specialty of dermatology is devoted to understanding the skin, what can go wrong, and what to do if something does go wrong. [5]

2.2 Cardiovascular System

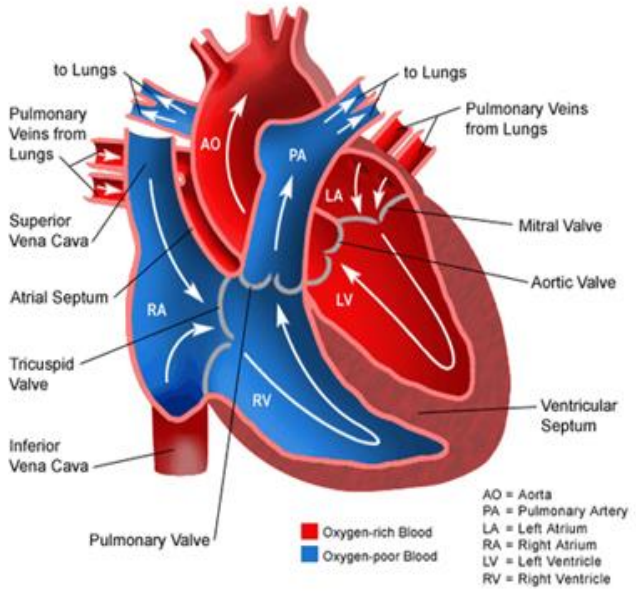

Figure 2.8: Cardiovascular System [6]

The heart and circulatory system that shown in figure(2.8), (also called the cardiovascular system) make up the network that delivers blood to the body's tissues. With each heartbeat, blood is sent throughout our bodies, carrying oxygen and nutrients to all of our cells.

The circulatory system is composed of the heart and blood vessels, including arteries, veins, and capillaries. Our bodies actually have two circulatory systems:

The pulmonary circulation is a short loop from the heart to the lungs and back again, and the systemic circulation (the system we usually think of as our circulatory system) sends blood from the heart to all the other parts of our bodies and back again. [7]

2.2.1 Pulmonary Circulation

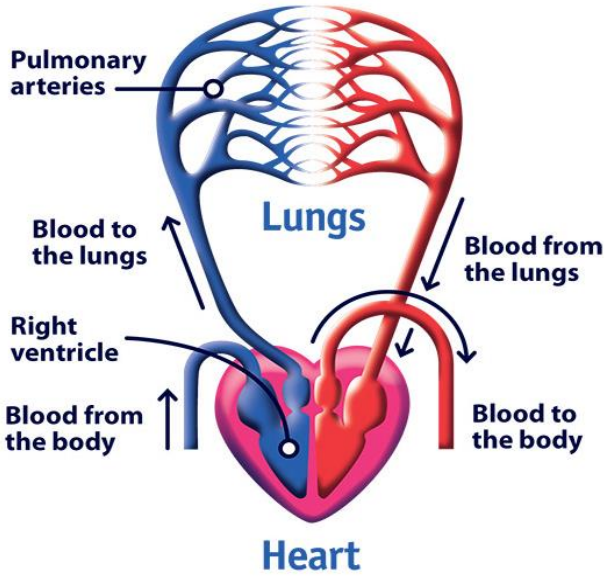

Figure 2.9: Pulmonary Circulation [7]

Pulmonary circulation is the movement of blood from the heart to the lungs for oxygenation as figure(2.9), then back to the heart again. Oxygen-depleted blood from the body leaves the systemic circulation when it enters the right atrium through the superior and inferior venae cavae. The blood is then pumped through the tricuspid valve into the right ventricle. From the right ventricle, blood is pumped through the pulmonary valve and into the pulmonary artery. The pulmonary artery splits into the right and left pulmonary arteries and travel to each lung. At the lungs, the blood travels through capillary beds on the alveoli where respiration occurs , removing carbon dioxide and adding oxygen to the blood. The alveoli are air sacs in the lungs that provide the surface for gas exchange during respiration. The oxygenated blood then leaves the lungs through pulmonary veins, which returns it to the left atrium, completing the pulmonary circuit. Once entering the left heart, the blood flows through the bicuspid valve into the left ventricle. From the left ventricle, the blood is pumped through the aortic valve into the aorta to travel through systemic circulation, delivering oxygenated blood to the body before returning again to the pulmonary circulation. [8]

2.2.2 Systemic Circulation

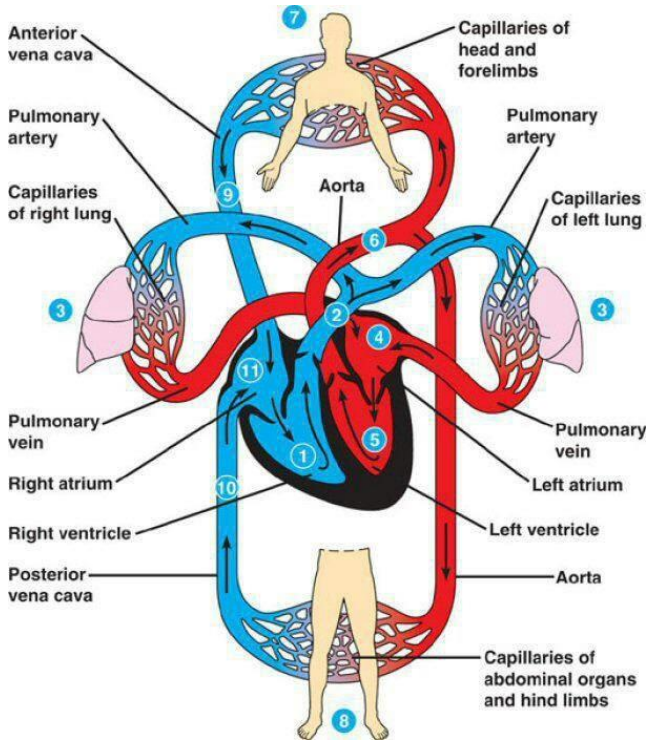

Figure 2.10: systemic Circulation [8]

Systemic circulation is the movement of blood from the heart through the body to provide oxygen and nutrients as shown in figure(2.10), and bringing deoxygenated blood back to the heart. Oxygen-rich blood from the lungs leaves the pulmonary circulation when it enters the left atrium through the pulmonary veins. The blood is then pumped through the mitral valve into the left ventricle. From the left ventricle, blood is pumped through the aortic valve and into the aorta, the body's largest artery. The aorta arches and branches into major arteries to the upper body before passing through the diaphragm, where it branches further into arteries which supply the lower parts of the body. The arteries branch into smaller arteries, arterioles, and finally capillaries. Waste and carbon dioxide diffuse out of the cell into the blood, while oxygen in the blood diffuses out of the blood and into the cell. The deoxygenated blood continues through the capillaries which merge into venules, then veins, and finally the venae cavae, which drain into the right atrium of the heart. From the right atrium, the blood will travel through the pulmonary circulation to be oxygenated before returning gain to the system circulation. Coronary circulation, blood supply to the heart muscle itself, is also part of the systemic circulation. [8]

2.3 Rheumatic Arthritis

Rheumatoid arthritis is a disease that affects the joints as shown in figure(2.11b). It causes pain, swelling, and stiffness. If one knee or hand has rheumatoid arthritis, usually the other does too. This disease often occurs in more than one joint and can affect any joint in the body. People with this disease may feel sick and tired, and they sometimes get fevers. Some people have mild or moderate forms of the disease with times when the symptoms get worse and times when they get better. Others have a severe form of the disease that can last for many years or a lifetime. This form of the disease can cause serious joint damage. Anyone can get this disease, though it occurs more often in women. Rheumatoid arthritis often starts in middle age and is most common in older people. But children and young adults can also get it. [9]

Doctors don't know the exact cause of rheumatoid arthritis. They know that with this arthritis, a person's immune system attacks his or her own body tissues. Researchers are learning many things about why and how this happens. Things that may cause rheumatoid arthritis are:

- Genes (passed from parent to child).
- Environment.
- Hormones.

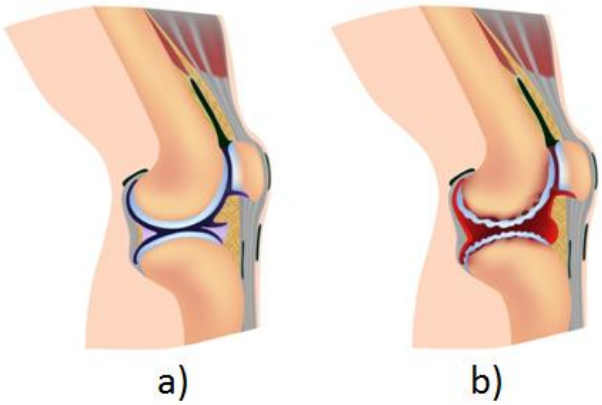

Figure 2.11: a) Healthy joint, b) Rheumatoid Arthritis [9]

2.4 Eye

While the eye is an extremely complex organ, it functions optically much like a camera system. For the sake of discussing common eye diseases, the following pictures can be referred to.

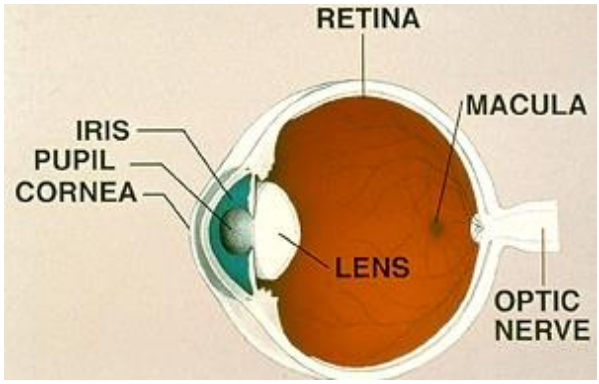

Figure 2.12: Schematic Drawing of the eye [10]

Basic anatomy of the Eye as shown in figure (2.12)**:**

- **Cornea**: Front part or "window" of the eye.
- **Pupil**: Regulate amount of light entering the eye.
- **Iris**: "Colored" part of the eye.
- **Lens**: Part of the eye that focuses images onto the retina.
- **Retina**: Innermost layer of the eye composed of light sensitive cells which pick up the images seen by the eye.
- **Macula**: That part of the retina responsible for central or "eagle eye" vision.
- **Optic Nerve**: Collection of nerve endings attached to the retina connecting the eyeball to the "seeing" centers of the brain.

The eye is our most important organ for finding out about the world around us! Sight is considered our most precious sense, and people fear blindness more than any other disability. The human eye measures only about 1 inch in diameter. [10]

The eye is extremely delicate, and like other organ systems in the body, it operates under very narrow physiologic parameters where temperature, blood flow, and other factors are delicately balanced. The eyeball is only one part a complex visual system which is composed of the eye and surrounding structures, the brain, and all the connecting nerve pathways between it and the brain. [10]

Chapter Three

Far Infrared Radiation (FIR)

3.1 Interaction Between Skin and FIR .

3.2 Effects of FIR on the Cardiovascular System.

3.2.1 Balance Body's PH degree.

3.2.2 Production of Nitric Oxide on the Blood Vessels.

3.2.3 Effect of Nitric Oxide on the Blood Vessels.

3.3 Effects of FIR on the Rheumatic Arthritis.

3.4 Effects of FIR on the Eye and Cataracts.

3.4.1 Effects of FIR on the Eye parts.

3.4.2 Infrared Cataract.

Far Infrared Radiation (FIR)

FIR is among the rays coming from the sun and the FIR waves are the safest and the most beneficial. Sunlight consists of different wave lengths of light. The complete electromagnetic spectrum consists of visible and invisible rays. The visible rays are red, orange, yellow, green, indigo, blue, and violet in color, known as rainbow colors. When combined they produce the "white light" that we experience every day. The invisible rays are Ultra Violet, X-rays, Gamma, Cosmic, Microwave, Long Wave, Electrical Wave, and Infrared. Infrared waves are between visible light and the microwave rays. Our sun produces most of its energy output in the infrared segment of the spectrum. Infrared light is in this spectrum's lower range, and although its rays aren't visible to the naked eye, it generates the warmth we feel on bright sunny days.

Far infrared (FIR) radiation ($\lambda = 3–100$ μm) is a subdivision of the electromagnetic spectrum that has been investigated for biological effects. The goal of this review is to cover the use of a further sub-division (3– 12 μm) of this waveband, that has been observed in both *in vitro* and *in vivo* studies, to stimulate cells and tissue, and is considered a promising treatment modality for certain medical conditions. Technological advances have provided new techniques for delivering FIR radiation to the human body. Specialty lamps and saunas, delivering pure FIR radiation (eliminating completely the near and mid infrared bands), have became safe, effective, and widely used sources to generate therapeutic effects. Fibers impregnated with FIR emitting ceramic nanoparticles and woven into fabrics, are being used as garments and wraps to generate FIR radiation, and attain health benefits from its effects.

Thermal radiation (or infrared) is a band of energy in the complete electromagnetic spectrum and it has been used effectively for millennia to treat/ease certain maladies and discomforts. Heated saunas are only one of the avenues (and perhaps the oldest) to deliver the radiation in a controlled environment and within a convenient treatment time. With the development of better technology to deliver pure far infrared radiation (FIR), the benefits from its effects have widened. Nowadays, specialty FIR emitting heat lamps and garments made up of filaments (fibers) impregnated with FIR emitting nanoparticles are becoming used to deliver these thermal radiation effects.

The wavelength of infrared waves varies from 0.76 micron to 1,000 microns. Near infrared (0.76 to 1.5 microns), mid infrared (1.5 to 4 microns), and far infrared (4 to 1,000

microns) shown in figure (3.1). While these rays share the attributes listed below, they are most noticeable in far infrared waves. [11]

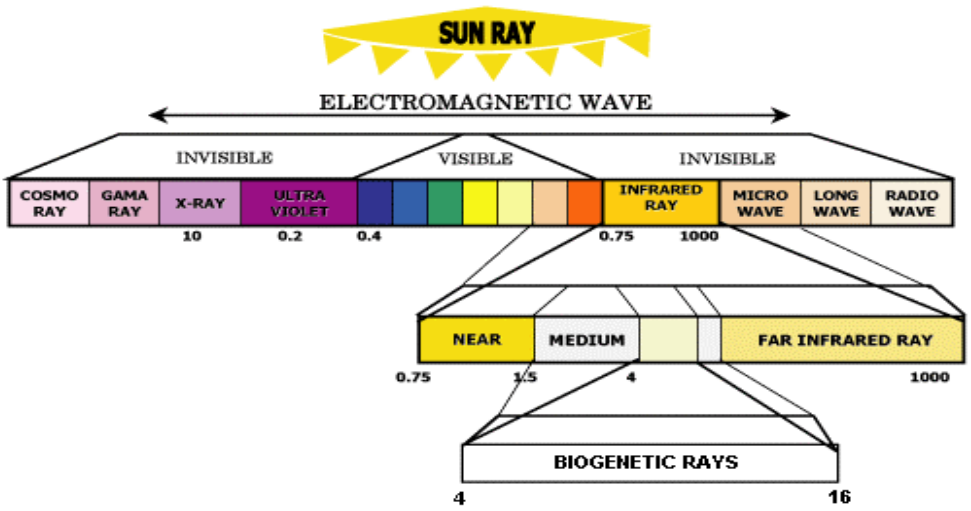

Figure 3.1: Sunlight Spectrum [11]

The FIR whose wavelength falls between 4 to 50 microns is also commonly called Biogenetic rays. Biogenetic rays have been shown to promote the healing and growth of living cells especially in plants, animals and human beings. FIR has the ability to remove toxins in the body, which are often at the core of many health problems. The build-up of toxins in a healthy body could block the normal blood circulation and impair the cellular energy. FIR can have beneficial results in a variety of illnesses because penetrates four or five centimeters into the dermis, from muscles into blood vessels, lymphatic glands and nerves. [11]

3.1 Interaction Between Skin and FIR .

FIR penetrates four or five centimeters into the dermis shown in figure (3.2), from muscles into blood vessels, lymphatic glands and nerves. [11]

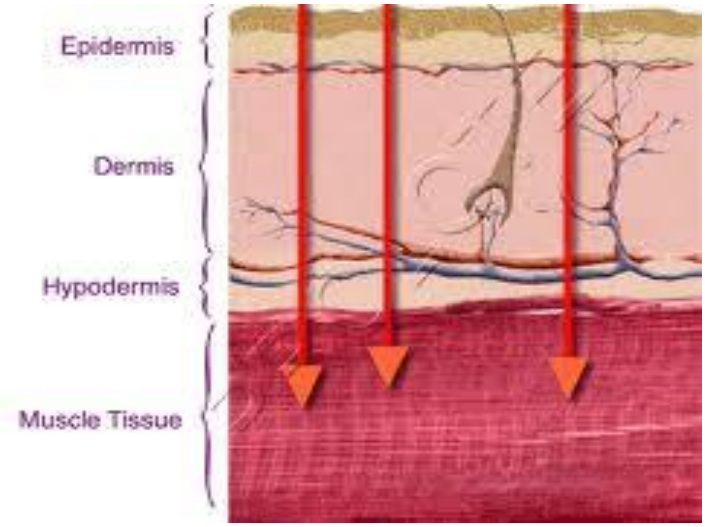

Figure 3.2: Penetration of the FIR on the skin [11]

The human body contains over 3,000 different types of enzymes that all require light photons to thrive. Far-infrared photons stimulate cells for proper enzyme production. The human body is a living photocell and depends on signals from light rays like far-infrared (FIR) in order to function properly.

The signals received by the individual cells from light photons signal the cell to perform certain actions, when there is a lack of light photons the cells cease their actions, become dormant, get diseased, and even die. When we provide enough FIR light to our body the cells perform the actions they are designed to perform and that keeps not only that cell healthy but all aspects of the entire body is healthier and can function the way it was designed.

Every single cell depends on light rays to signal the release of waste from the cell into the elimination system of the body. Without the proper light exposure the cells just keep holding onto its accumulated waste products until the signal comes.

Cells were obviously not designed to hold onto their waste products. Those that do become damaged, diseased and die off. These damaged cells are where cancers and disease can form.

So Proper light exposure would allow for proper enzyme production, proper waste disposal, proper metabolism and nutrient digestion and distribution and many other reactions that are signaled within the cells by exposure to far-infrared light. [11]

3.2 Effects of FIR on the Cardiovascular System.

By virtue of far infrared reaction, to increase the temperature of deep skin, expand microvascular, accelerate blood circulation, relive ferment, consolidate blood and cell metabolism, which has a great help on resume young and improve anemia.

3.2.1 Balance Body's PH degree .

Red blood cells are responsible for the transfer of oxygen, water to cells and tissues, as well as get rid of carbon dioxide and metabolites process outside the body where that water constitutes 72% of the installations of the blood cells, and as we know that during the disposal of carbon dioxide process, it's 7% of it is slushy in plasma while 23% of carbon dioxide associated with Alglobin protein component of hemoglobin, and the remaining 70% turn into bicarbonate ions according to this equation :

$$CO_2 + H_2O \longleftrightarrow H_2CO_3 \longrightarrow H^+ + HCO^-_3$$

Where that bicarbonate disposed from the red blood cells toward the plasma through Bring chlorine ion place, and the presence of bicarbonate ions in the plasma will form a buffer solution of PH in the blood. And also note that this interaction will not happen, but the presence of water molecules which will be activated by the far-infrared range that shown in figure (3.3) (which means that enhance the level of oxygen in the body through the easy of carbon dioxide expelled). [12]

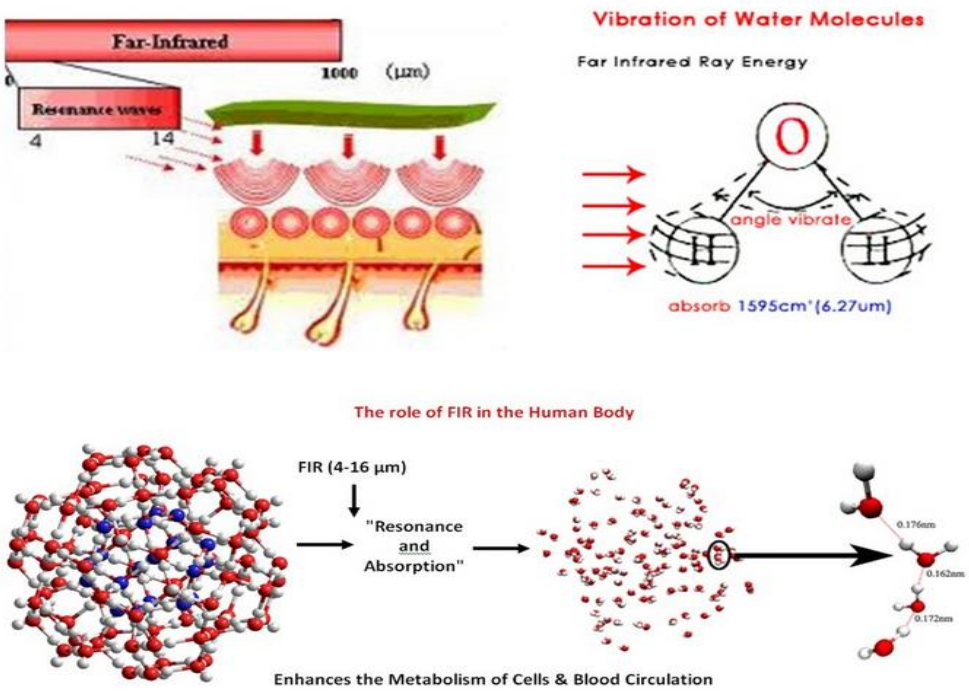

Figure 3.3: Interaction between FIR with Water. [12]

3.2.2 Production of Nitric Oxide on the Blood Vessels.

Water molecules oscillate continuously and this oscillation results wavelength (8-10) microns, and this oscillation is causing resonance with wavelengths resulting from the FIR. This compatibility cause ionization of water into hydrogen ions and hydroxide ions and this is known as (water activation).

One of the applications of FIR in their ability to breach human tissue used in activating enzymes in the body to create nitric oxide, since these rays penetrate the body and reach the organs that suffer from harmful substances for the body and the fact that the FIR is able to separate the water molecules that are associated with molecules toxins or other substances harmful to the body, and this molecular separation occurs through the FIR work that make vibrating ions which leads to broken links to atoms of water. See figure (3.4)

Oscillation of water ions causes firing enzymes that activate production of Nitric Oxide.

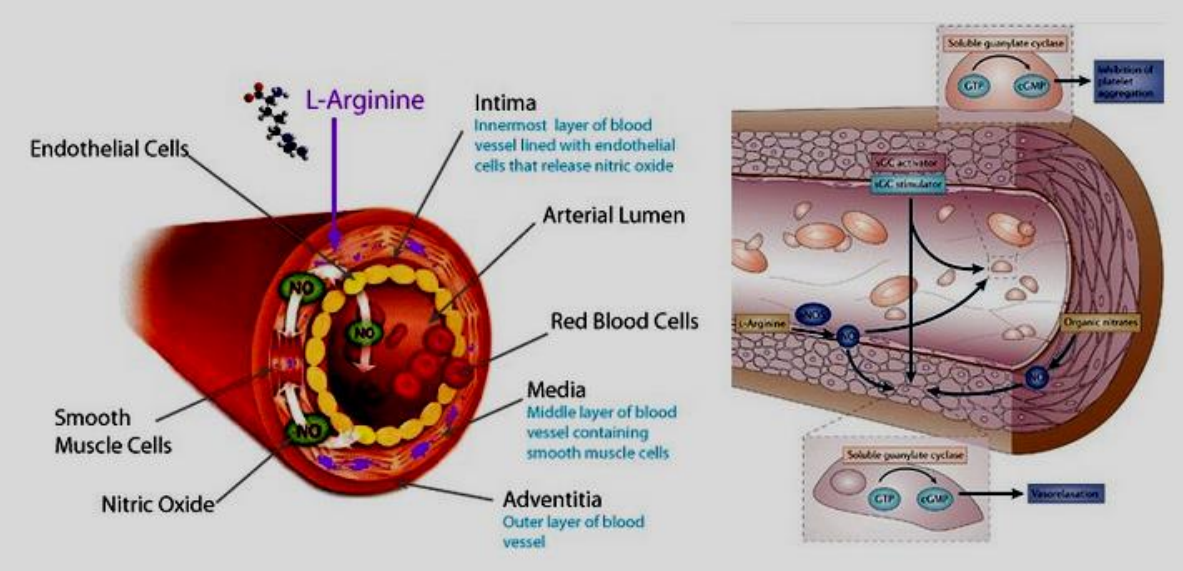

Figure 3.4: Production of Nitric Oxide on the Blood Vessels [13]

3.2.3 Effect of Nitric Oxide on the Blood Vessels.

Nitric oxide, known as the "endothelium-derived relaxing factor", such that the endothelium (inner lining) of blood vessel uses nitric oxide to signal the surrounding smooth muscles to relax shown in figure (3.5), thus resulting in vasodilatation and increasing blood flow. Nitric oxide is a tiny molecule. It is a gas, but dissolves in the fluids in and around cells. (Sometimes denoted •NO to show that it has an unpaired electron, which makes it react very readily with other molecules).

Cells of the immune system use NO to kill invading bacteria. In septicaemia (blood poisoning), bacteria circulate in large numbers in the blood, and, in response, if much NO is produced, this causes the blood vessels to relax. [13]

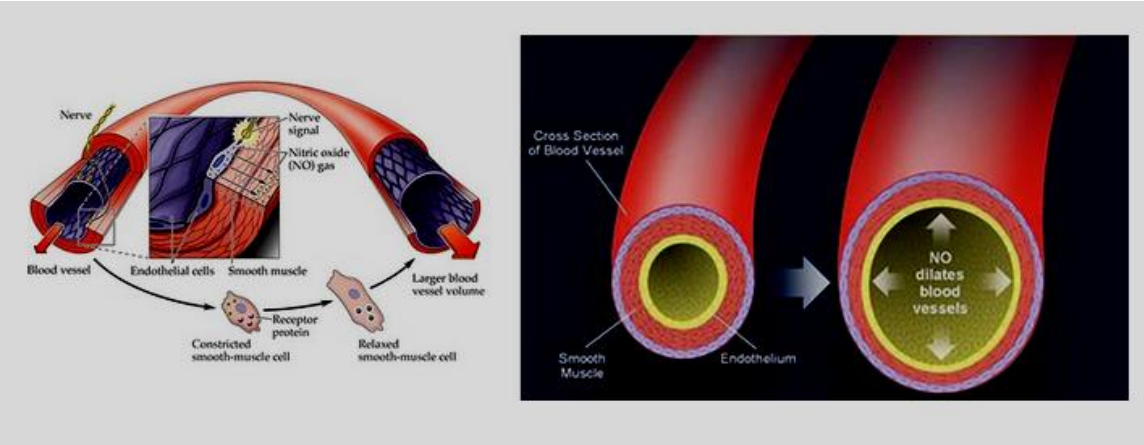

Figure 3.5: Effect of Nitric Oxide on the Blood Vessels [13]

3.3 Effects of FIR on the Rheumatic Arthritis.

The ability of far infrared rays -reaching penetration of large depths of up to joints in the muscles lead to the granting of the body warmth and relaxation of the muscles as well as the exchange of oxygen and nutrients from the cardiovascular system, and prevent the accumulation of burdensome materials and lactic acid and waste from aging, and the far infrared range have excellent ability to eliminate the swelling as well as alleviate the pain.

Heat has been shown to reduce pain sensation by direct action on both free-nerve endings in tissues and on peripheral nerves. There was a 20 percent decrease in rheumatoid finger joint stiffness at 45 degrees Celsius (112 degrees Fahrenheit) as compared with 33 degrees Celsius (92 degrees Fahrenheit), which correlated perfectly to both subjective and objective observation of stiffness. Speculation has it that any stiffened joint and thickened connective tissues may respond in a similar fashion. [14]

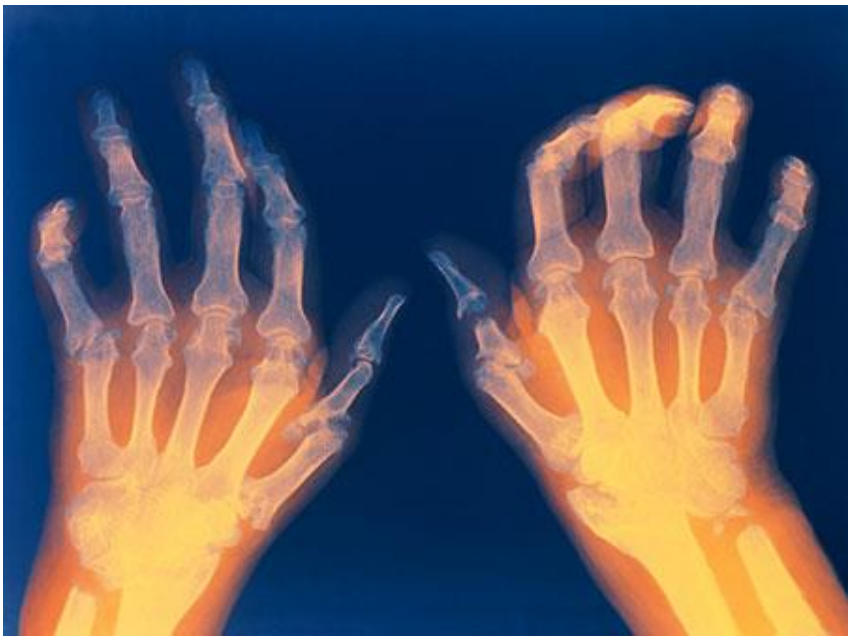

Figure 3.6: Interaction Between IR and Bone (Rheumatic Arthritis) [14]

Far Infrared energy heats things by direct, molecular excitation, without heating the air between the spaces. Your body absorbs Far Infrared heat waves that encourage the transfer of water across cellular membranes. Once this happens, and the cellular membranes are hydrated, your blood flow is enhanced and ultimately assists with an assortment of biologically beneficial healing functions. [14]

The most notable characteristic of Far Infrared heat is its exceptional ability to penetrate far below superficial skin layers. When this occurs, it constructs a natural resonance, which has numerous advantageous properties. Infrared energy is measured in wavelengths as microns, and the human body can best absorb infrared energy in the 3- to 50-micron range with the best absorption occurring at 9.4 microns (the same as the human body). These rays penetrate deep into the body where they gently elevate the body's surface temperature and assist in expanding capillaries which stimulates blood circulation. By elevating the sub-surface tissue temperature, a series of continual changes constructive to human health will be instigated. So far Infrared encourage microcirculation, therefore supplying more oxygen to injured tissues in cartilage, joints and musculoskeletal tissues. Inflammation subsequently subsides. [14]

far infrared assists in reduction of swelling and inflammation by improving lymph flow, Purportedly decreases joint stiffness directly .Also FIR May lead to increased endorphin production, which reduces pain.

3.4 Effects of FIR on the Eye and Cataracts.

The eye is the only part of the human body, which is negatively affected by infra-red; we will show the effect of IR on the most important parts of the eye. [15]

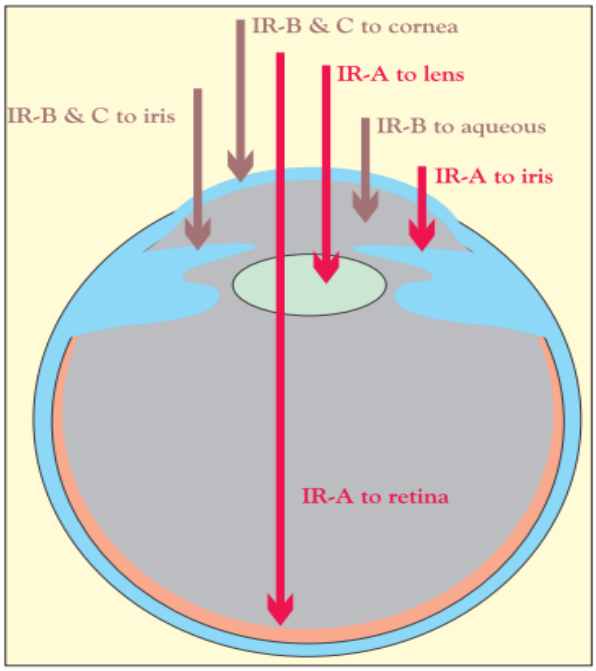

Figure 3.7: Infrared Radiation absorbed by the Eye. [15]

3.4.1 Effects of FIR on the Eye parts.

The effects of infrared radiation on the eyelids range from mild reddening to third degree burns and, eventually, death of the skin. To suffer the more severe effects, the eyelid must be exposed to very high levels of infrared delivered over a short period of time, or to low levels of infrared over a long period.

The radiation effects on the cornea from these wavelengths involve protein coagulation of the front and middle layers, High dose infrared damage to the cornea produces immediate pain and vascularization .Eventually, loss of transparency and opacification occur.

And the effect of the infrared on the retina and choroid is to cause a rise in temperature, which causes enzymes to denature; in general, temperatures more than 10° above ambient body temperature will produce permanent thermal damage. Many physical factors affect whether damage is done, including pupil size, the optical quality of the retinal IR image, heating effects to the retinal pigment epithelium can make shockwave effects to the melanin pigment.

3.4.2 Infrared Cataract.

Cataracts are the leading cause of visual loss in adults 55 and over. A cataract is a clouding of the natural lens inside your eye as shown in figure (3.8b). This lens, located behind the iris, works just like the lens of a camera focusing light images on the retina, which sends images to the brain. The human lens can become so clouded it prevents light and images from reaching the retina. A cataract can be the reason sharp objects become blurred, bright colors become dull, or seeing at night is more difficult, when the infrared radiation directly interacted with the eye it cause cataract. [16]

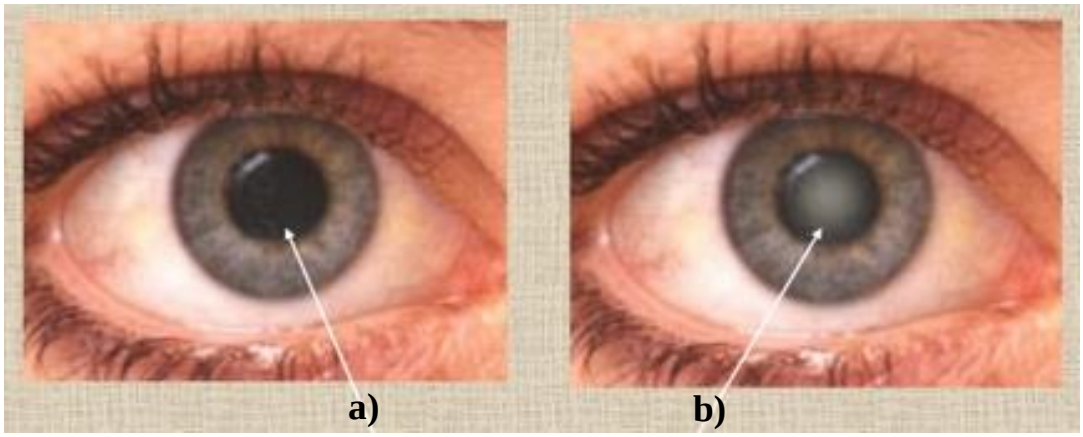

Figure 3.8: a) Normal Eye, b) Cataract Eye. [16]

Chapter Four

System Design

4.1 Electronic Units

4.1.1 Sensor Circuit

4.1.2 UPS Circuit

4.1.3 Control Circuit

4.1.4 Far Infrared (FIR) Panels

4.1.5 Accessories

4.2 The Cabinet

4.2.1 Lise Wood

4.2.2 Rock Wool

4.2.3 Thermal Glass

4.2.4 Cabinet Dimensions

System Design

This chapter includes the hardware and software components required to fulfill the optimal system design. Further, components of each stage will be explained in detail, also the selection of more adequate integrated circuits (IC_s) with required component values to accomplish each stage function and achieve the desired response of the electronics circuit connection employed in the design.

The conceptual design of the system composed from two main parts; electronic units and cabinet. The electronic units contains many components, the first one is panel which provide Far infrared (FIR) and heat to the room, the second one is heart rate (HR) sensor which measure the heart rate of the user, the third component is the control circuit that composed of arduino as a controller for the previous sensor, the forth component is the accessories that added to the room to give the user some relaxation, finally power supply source which feed all the previous electrical components.

The furniture parts which contains the thermal glass which is commonly consisting of a soda lime or silica that is a heat-resistant material, with a very low expansion coefficient and a high melting point. Heat resistant glass is a type of glass that is designed to resist thermal shock. This glass is believed to be better than any other ordinary glass available. This type of glass is generally used in kitchens and in industrial applications. It has been tested to withstand temperature changes of up to 100-degrees Celsius, which is the equivalent to 212 degrees Fahrenheit. Yet, ordinary glass would easily shatter if exposed to that extensive level of high temperature. The wood, the lise wood is the best wood for the sauna Because of the expansion and contraction qualities of the cellulose fibers within the wood itself. This wood has been shown to be non toxic. Both the World Health Organization and the Environmental Protection Agency have come out and stated, that there is no risk what so ever from lise.

4.1 Electronic Unit

As illustrated before, the electronic unit composed of many main sections; FIR panel section, control and sensor circuit section and accessories section, figure 4.1 shows how different component connected to each other to feed the electronic components such as sensors, Arduino, panels and accessories. It's important to note that the main system supply is a 220 volt socket that well be used to supply the panels and spots light, also use this 220volt socket to maintain a voltage form step down transformer and passes through two regulators to provide (+12) volt to supply the accessories and (+5) volt to supply the control circuit (Arduino).

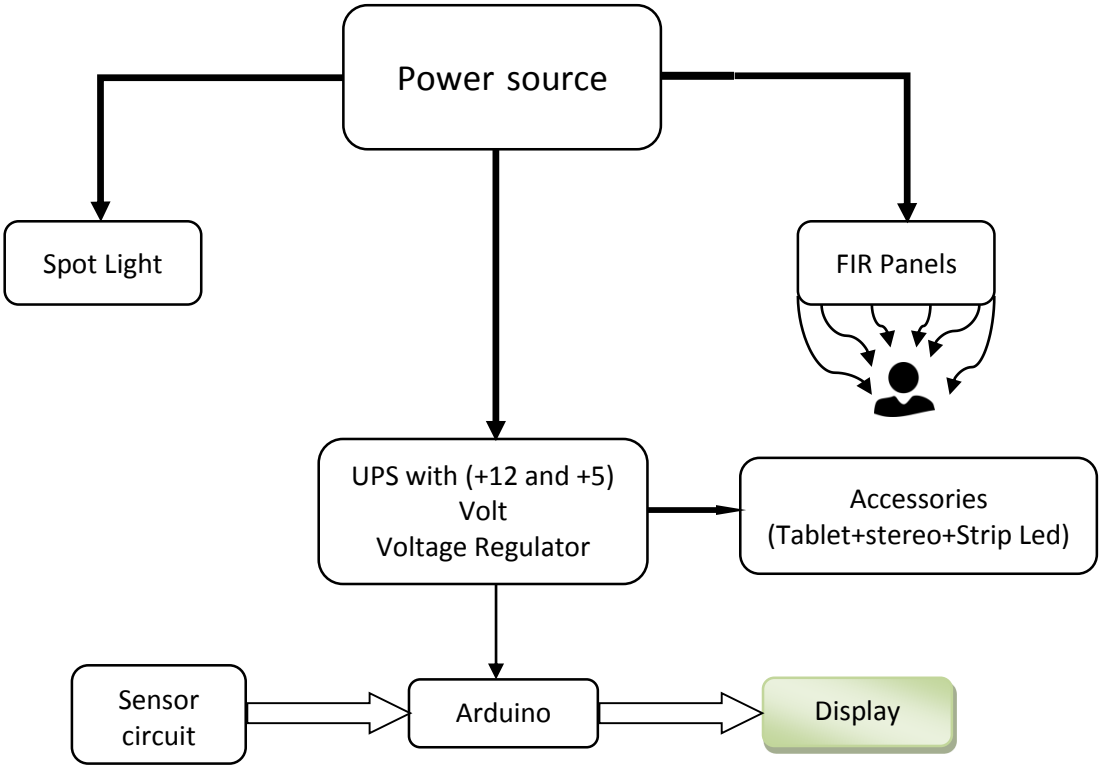

Figure 4.1: Electronic Units Diagram

4.1.1 Heart Rate

The heart rate sensor, will be used in this project to monitor the rate of heart-beat of the patient. The chosen transducer works on Photoplethysmography technique. This technique depends on the change of blood volume in the finger that produced by heart rate beat. Figure 4.2 show the connection of HR sensor to Arduino analog at pin (A0).

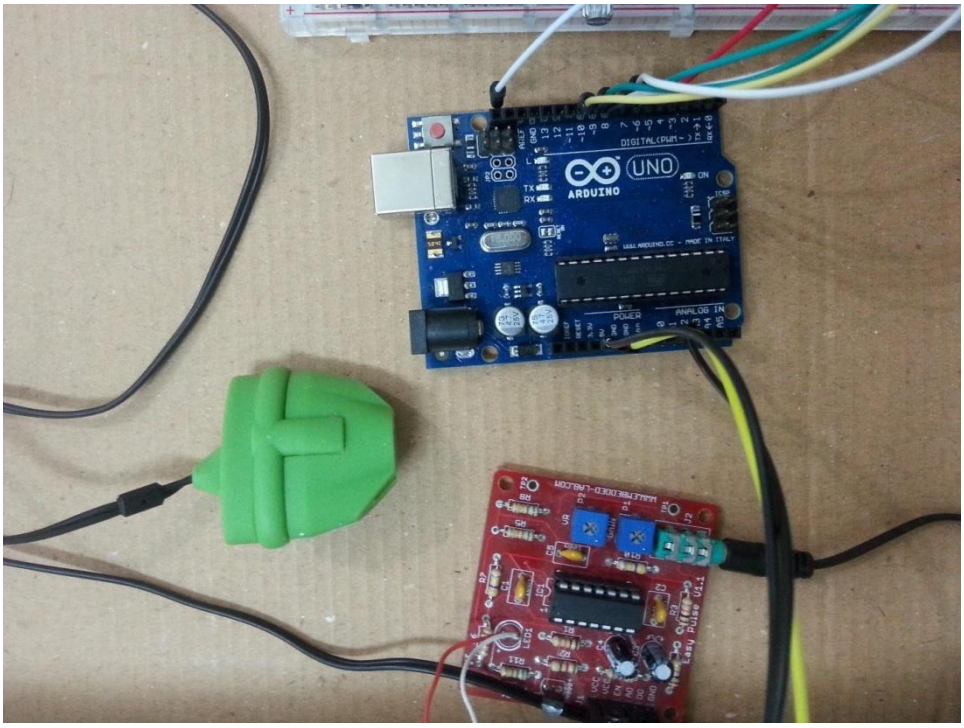

Figure 4.2: the Connection of HR Sensor to Arduino

The Photoplethysmography technique, discussed in the preceding chapter, depends on the amount of infra-red (IR) lights that reflected from the finger. Hence an IR LED is used to transmit IR light, where a photo transistor sensing the portion of light that is reflected back. The i ntensity of the reflected lights depends upon the blood volume.

A "TCRT1000 IR device as sensor" is used in this project. It consists from IR emitting-light source (LED) on wave length 940nm and light detector (phototransistor). The LED and phototransistor are arranged in the opposite direction to sense the reflective IR-beam from the changes in arterial blood volume in the patient's finger, as shown in the Figure 4.3.

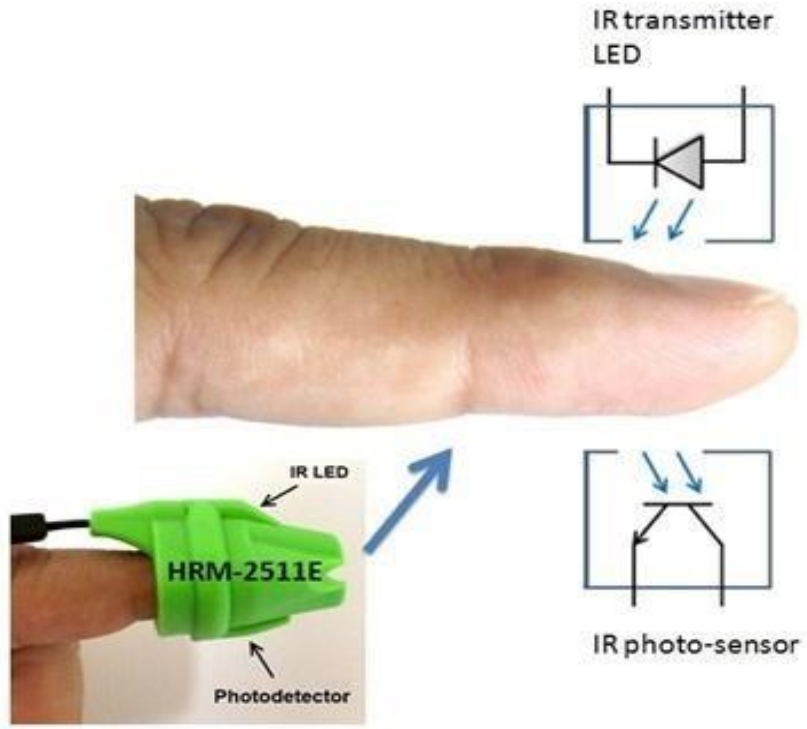

Figure 4.3: HR Sensor

Transmittance and reflectance are two basic types of Photoplethysmography. For the transmittance PPG, a light source is emitted in to the tissue and a light detector is placed in the opposite side of the tissue to measure the resultant light. Because of the limited penetration depth of the light through organ tissue, the transmittance PPG is applicable to a restricted body part, such as the finger or the ear lobe. However, in the reflectance PPG, the light source and the light detector are both placed on the same side of a body part. The light is emitted into the tissue and the reflected light is measured by the detector. As the light doesn't have to penetrate the body, the reflectance PPG can be applied to any parts of human body. In either case, the detected light reflected from or transmitted through the body part will fluctuate according to the pulsatile blood flow caused by the beating of the heart.

The following circuit showed in Figure 4.4, the ON/OFF control scheme for the infra-red light source. Note that the Enable signal must be pulled high in order to turn on the IR LED. The photodetector output (VSENSOR) contains the PPG signal that goes to a two-stage filter and amplifier circuit for further processing.

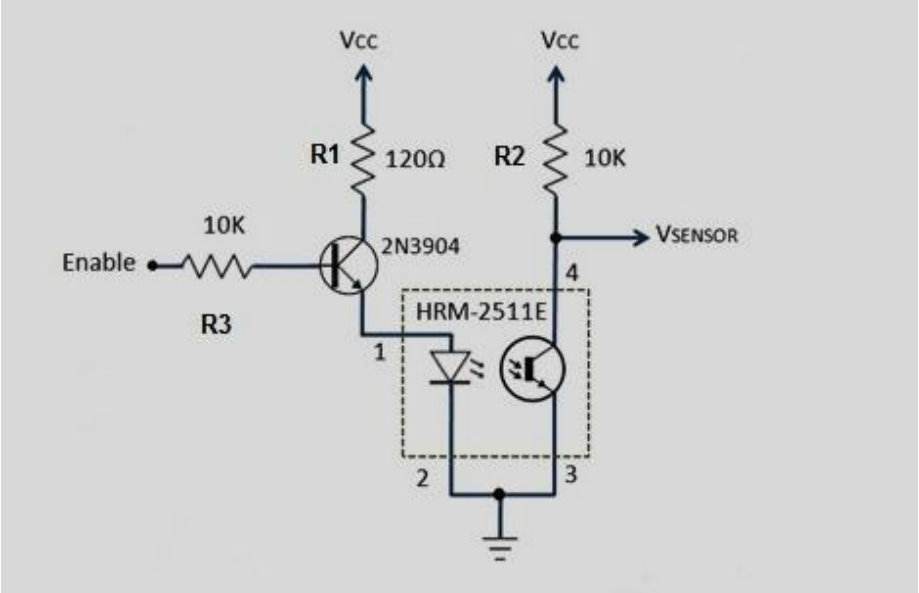

Figure 4.4: IR transceiver circuit

The transistor (2N3904) [Appendix-A] is chosen to deliver a constant current for IR- LED. According to TCRT-1000 data sheet [Appendix- B], the forward current (IF) at which the LED will transmit the desired wave length is at 20mA. This current is delivered by the transistor as collector current (IC). From data sheet of the transistor the DC gain current (β) is equal 60 when IC 20 mA.By using equation 4.1, the base current(IB) given by the following equation:

$$I_\beta = \frac{I_c}{\beta} \tag{4.1}$$

$$I_\beta = \frac{20}{60 * 1000} = 0.33\text{mA}$$

The resistance R3 that generates the desired Iβ is calculated by the following equation (4.2)

$$R_3 = \frac{V_{cc} - v_{BE}}{I_B} \tag{4.2}$$

The base-emitter voltage(VBE) and VCC are 0.8V and 5V respectively [Appendix-A], hence the value of R3 equal 12.7KΩ.

The PPG signal coming from the photodetector is weak and noisy. So we need an amplifier and filter circuits to boost and clean the signal. In Stage I instrumentation as shown in the Figure 4.5, the signal is first passed through a passive (RC) high-pass filter (HPF) to block the DC component of the PPG signal.

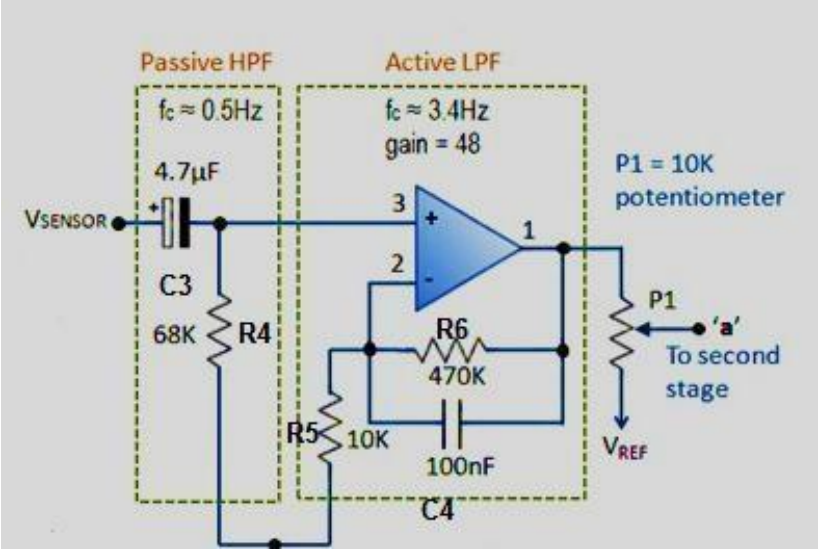

Figure 4.5: Band Pass Filter circuit

The cut-off frequency of the HPF is 0.5Hz, FC can be calculated by using R4 and C3 as expressed in equation (4.3):

$$F_C = \frac{1}{2\pi R_4 C_3} \tag{4.3}$$

Let C3 =4.7µF, the resistor values for R4 calculated through:

$$R_4 = \frac{1}{2\pi f_c C_3} \tag{4.4}$$

So the resister R4 is equal:

$$R4 = 68K\Omega$$

The output from the HPF goes to an Op-amp-based active low-pass filter (LPF), the cut-off frequency of the LPF is 3.4Hz, FC can be calculated by using R6 and C4 as expressed in equation (4.5):

$$F_C = \frac{1}{2\pi R_6 C_4} \quad (4.5)$$

Let C4 =100nF, the resistor values for R6 calculated through:

$$R_6 = \frac{1}{2\pi f_c C_4} \quad (4.6)$$

So the resister R6 is equal:

$$R6 = 470K\Omega$$

The Op-amp operates in non-inverting mode and has gain 48, gain can be calculated by using equation (4.7):

$$G = 1 + \frac{R_6}{R_5} \quad (4.7)$$

In order to achieve a full swing of the PPG signal at the output, the negative input of the Opamp is tied to a reference voltage (Vref) of 2.0V. The Vref is generated using a zener diode, Figure 4.6 shows the circuit of Vref.

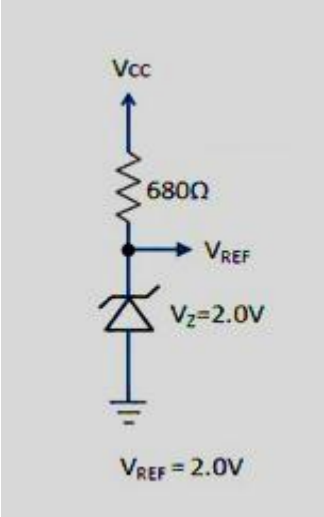

Figure 4.6: Reference voltage circuit

At the output is a potentiometer (P1) that acts as a manual gain control. The output from the active LPF now goes to Stage II instrumentation circuit, which is basically a replica of the Stage I circuit. Note that the amplitude of the signal going to the second stage is controlled by P1. The Opamp used in this project is MCP6004 [Appendix-C] from

Microchip, this op-amp operates with a single supply, rail to rail amplifier, has very high input impedance, and has high slew rate and Quad Op-amp.

The second stage also consists similar HPF and LPF circuits as shown in the Figure 4.7. The two-step amplified and filtered signal is now fed to a third Op-amp, which is configured as a non-inverting buffer with unity gain. The output of the buffer provides the required analog PPG signal. The potentiometer P1 can be used to control the amplitude of the PPG signal appearing at the output of the buffer stage.

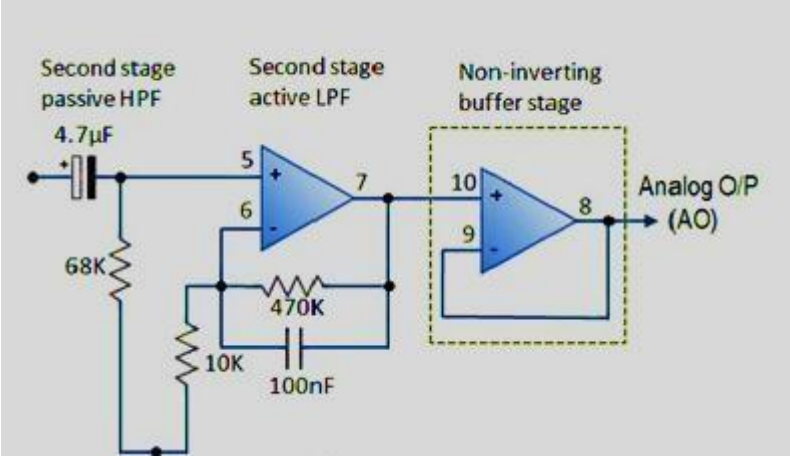

Figure 4.7: Second stage BPF and buffer circuit

The fourth Op Amp inside the MCP6004 device is used as a voltage comparator as shown in the Figure 4.8. The analog PPG signal is fed to the positive input and the negative input is tied to a reference voltage (VR).

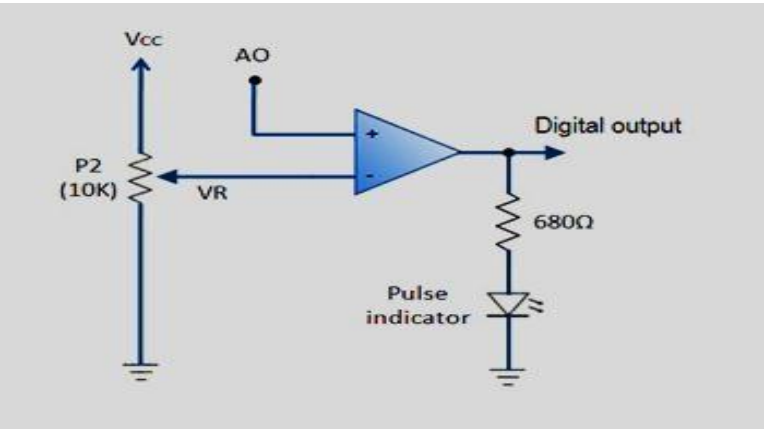

Figure 4.8: Comparator Circuit

The magnitude of VR can be set anywhere between 0 and 5 through potentiometer P2 Every time the PPG pulse wave exceeds the threshold VR, the output of the comparator

goes high. Thus, this arrangement provides an output digital pulse synchronous to heart beat , which enable the microcontroller to count heartbeat. Note that the width of the pulse is also determined by VR. An LED connected to the digital output blinks accordingly.

4.1.2 UPS Circuit

This circuit is a simple form of the commercial UPS shown in figure 4.9, the circuit provides a constant regulated 12 and 5 Volt output supply. In the event of electrical supply line failure the battery takes over, with no spikes on the regulated supply.

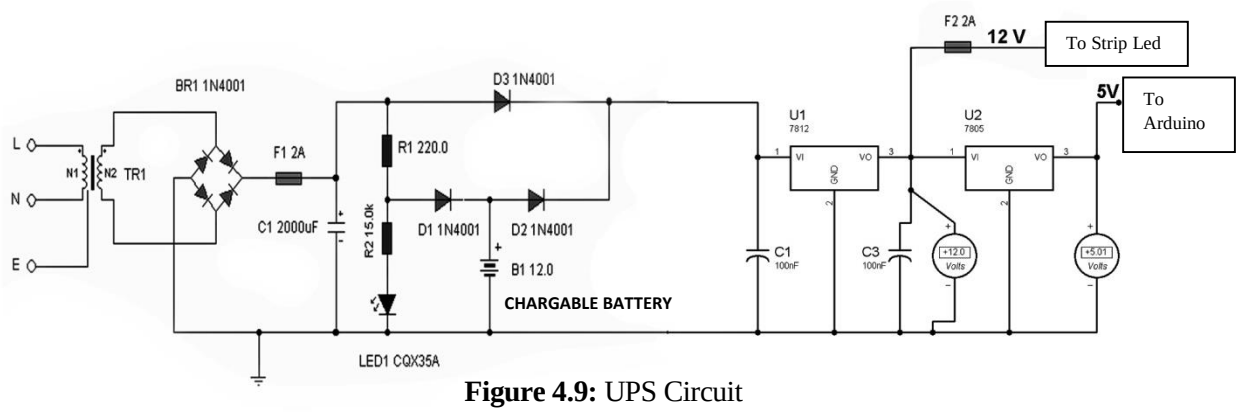

Figure 4.9: UPS Circuit

The previous circuit can be adapted for other regulated voltages by using different regulators and batteries. For a 24 Volt regulated supply use a 12 Volt chargeable battery in series and a 7812 and 7805 regulator. The 12 Volt feed the strip led and the 5 Volt for the arduino controller. TR1 has a primary matched to the local electrical supply which is 220 Volts. The secondary winding should be rated at least 24 Volts at 2 amp. FS1 is a slow blow type and protects against short circuits on the output, or indeed a faulty cell in a rechargeable battery. LED 1 will light ONLY when the electricity supply is present, with a power failure the LED will go out and output voltage is maintained by the battery.

The ability to maintain the regulated supply with no electrical supply depends on the load taken from the UPS and also the Ampere hour capacity of the battery. We were using a 4A/h 12 Volt battery and load from the 12 and 5 Volt regulator was 0.5 Amp then the regulated supply would be maintained for around 14 hours. Greater A/h capacity batteries would provide a longer standby time, and vice versa.

4.1.3 Control Circuits

Control circuit composed from Arduino microcontroller receives the physical signals from the sensor‟ circuit, processes them and display the results on the LCD screen.

The sensor‟ circuit have been connected to Arduino via digital and analog pins on the Arduino board which has 14 digital input/output pins (of which 6 can be used as PWM outputs) and 6 analog inputs pins.

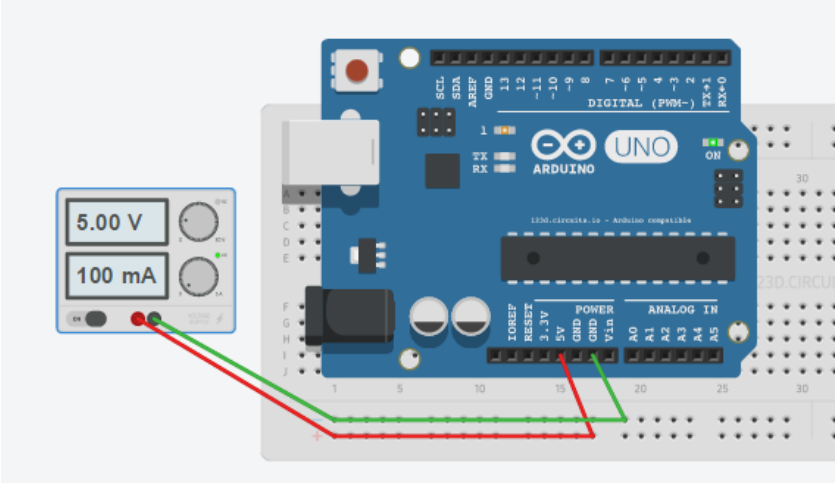

Figure 4.10: Arduino Microcontroller-power supply Interfacing

4.1.4 Far Infrared (FIR) panels:

There is many types of infrared panels such as carbon fiber and ceramic panels, we choose a carbon fiber panel [Appindex-D] because it gives infrared radiation more comfortable with human body, also carbon panels that shown in figure 4.11 are the most effective infrared heaters for sauna.

Figure 4.11: Carbon Fiber Panel

These 300 Watt heaters have a much larger surface area which covers 1000 times more body surface than any other style of infrared heater These heaters emit infrared radiation in the 4-14 micron range. This is the most ideal spectrum as it most closely match our bodies natural energy absorption. Unlike other ceramic tube style IRA heaters, the carbon fiber will not burn. The maximum temperature is 190 degrees compared to other heaters that can get glowing red hot (up to 600 degrees). The lower temperature emits longer waves which are deeper penetrating.

These heaters are made from a special carbon fiber paper that is laminated between two layers of fiberglass. This indestructible sheet is then framed using hand sanded bass wood frame.

The dimension of the heaters are 39.5" x 15.7" and come with protective wooden heat guards. These are the easiest heaters to install into any new or existing sauna cabin. Simply hang them on the wall in the same way you would a picture frame.

To calculate the number of the FIR panels that required to the room [17] :

The dimension of the room for one person is 3.5 ft in width (W) and length (L) and 6 ft in high (H).

$$W * L * H = \#\ ft^3 \tag{4.8}$$

$$3.5\ ft * 3.5\ ft * 6\ ft = 73.5\ ft^3$$

$$\#\ ft^3 * \ \#\ \text{watts in}\ ft^3\ (15\text{watt}) = \#\ \text{Total watts} \tag{4.9}$$

$$73.5\ ft^3 * 15\ \text{watt}/ft^3 = 1102.5\ \text{watt}$$

$$\frac{\#\ \text{Total watts}}{\#\ of\ watts\ of\ one\ panel} = \#\ \text{of panels required} \tag{4.10}$$

$$\frac{1102.5\ \text{watt}}{300\ \text{watt}} = 3.675 \approx 4\ \text{panels need}$$

4.1.5 Accessories

We add some accessories to the sauna to increase the relaxation and enjoyment for users, there is some accessories in sauna such as Stereo Radio/CD player if the user want to listen some music for relaxation also we add some spot lights to make the room more kind and romantic and there is LCD screen to allow user watch some movies as we see in the following figure 4.12.

Figure 4.12: Room Accessories

4.2 The Cabinet

In This section we want to describe in details the materials use in the therapy far infrared sauna such as wood and thermal glass which use to built the cabinet, so we need a special type of wood that bear high temperature, also the glass must be hard and not able to broke under high temperature.

4.2.1 Lise Wood

Lise wood which shown in figure 4.13 produces a natural oil that protects the sauna from both insects and deterioration, also lise has twice the stability of most commonly available conifers, due to its low density and shrinkage factors, on the other hand Changes in moisture have minimal effect on this type of wood.

Figure 4.13: lise Wood

Finally lise conceder as the most type of the wood that most comfortable for the human body, because it's non toxic such as other type of woods, Both the World Health Organization and the Environmental Protection Agency proof that there is no risk whatsoever from lise. [18]

4.2.2 Rock Wool

Rock wool is a mineral inorganic fibrous material with excellent and distinguished properties and the quality is stable and uniform. See figure 4.14.

It is efficiently applied in all fields of thermo-acoustic insulation; furthermore it is used in many industries activities. Rock wool is produced by melting mix of basalt, limestone and coke in a special vertical furnace at very high temperature about 1500 C.

Then the molten rock is made into thin fibers through a high speed centrifugal machine. After adding certain amount of binder, dustproof oil, silicon oil and mechanical operations .[19]

Figure 4.14: Rock wool

So in our project we use two layers of thermal wood and Rock wool between them to maintain heat inside sauna room.

4.2.3 Thermal Glass

Glass used in double glazing window for thermal insulation is known as Low E, or low-emissivity glass. It has a transparent metallic coating that works in two ways to economies heating energy as shown in figure 4.15. The dual action coating reflects heat back into the room. Thermal insulation glass should be used on face 2 or 3 of a double glazing unit.

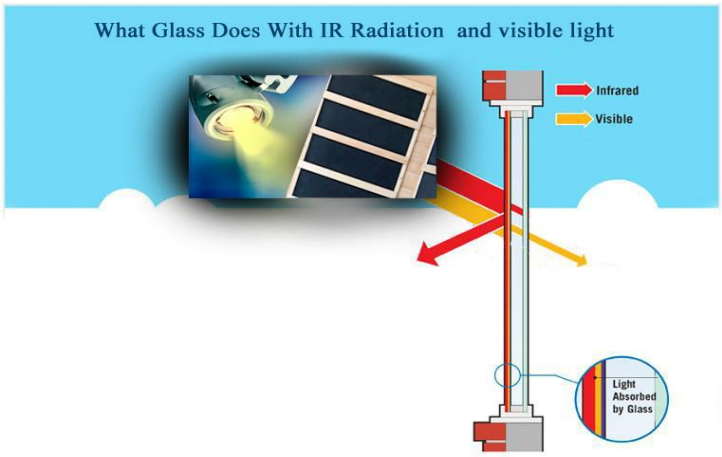

Figure 4.15: Function of Thermal Glass

The most efficient thermal insulation glass use a unique manufacturing process which builds up microscopic layers coating, using a technology known as sputtering, under vacuum conditions. This advanced process builds up a highly resistant, but it perceptively thin coating which gives it a much clearer appearance than other thermal insulation glass. The coating also allows maximum daylight and heat into the room for optimized solar gain. Some products have been shown to reduce heat loss by 24% more than traditional coated thermal insulation glass, and by 40% compared to standard double glazing window. Further energy savings can be made by using warm edge 'thermal break' spacer bars. These can reduce heat lost around the edge of the window by up to 65%. [20]

4.2.4 Cabinet Dimensions

In this section we want to describe the dimensions of the cabinet for all sides, we mean the top, bottom, left, right, front and interior back side as shown in the figures below:

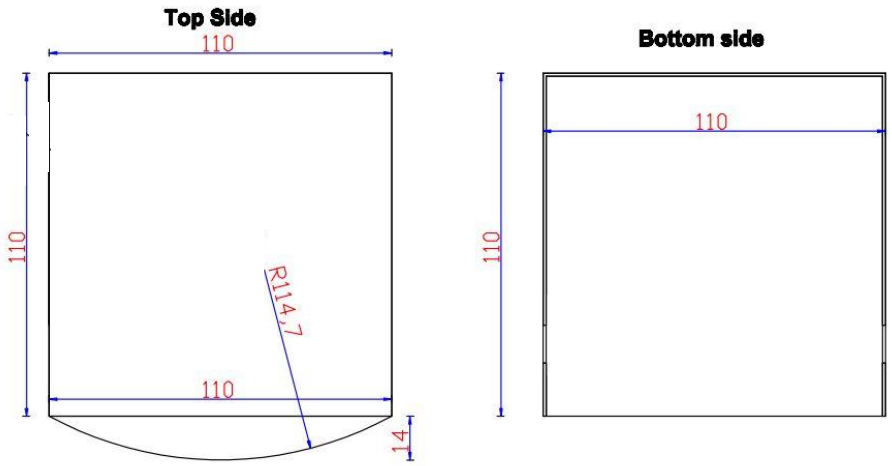

Figure 4.16: Top and Bottom Side

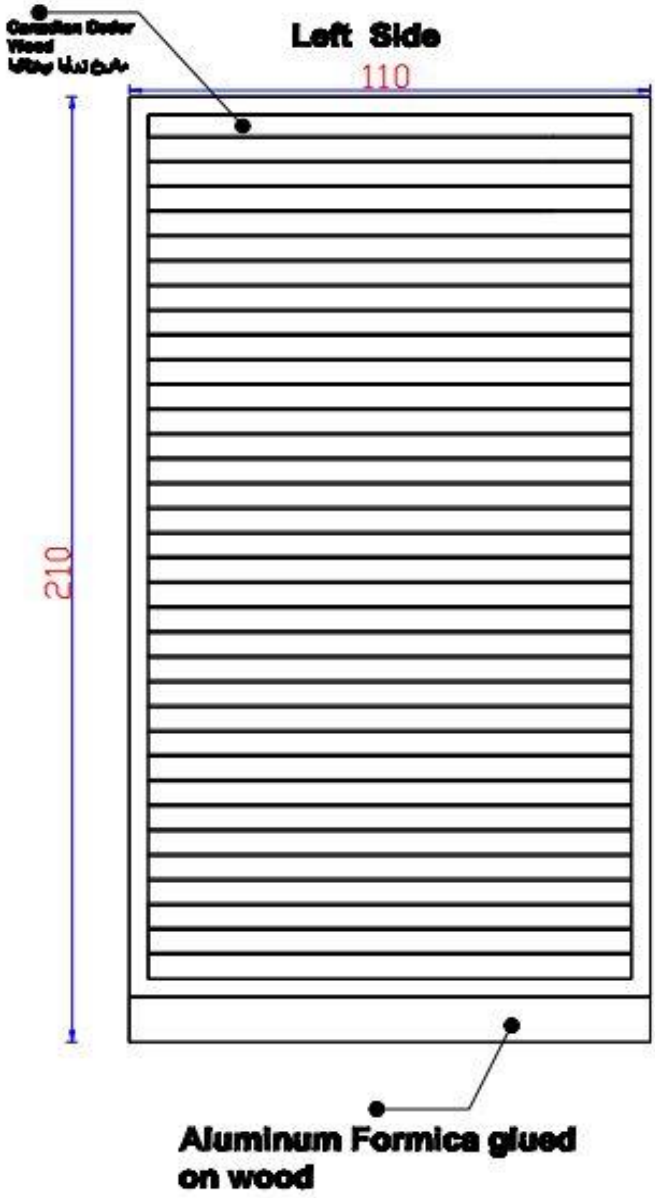

Figure 4.17: Left Side

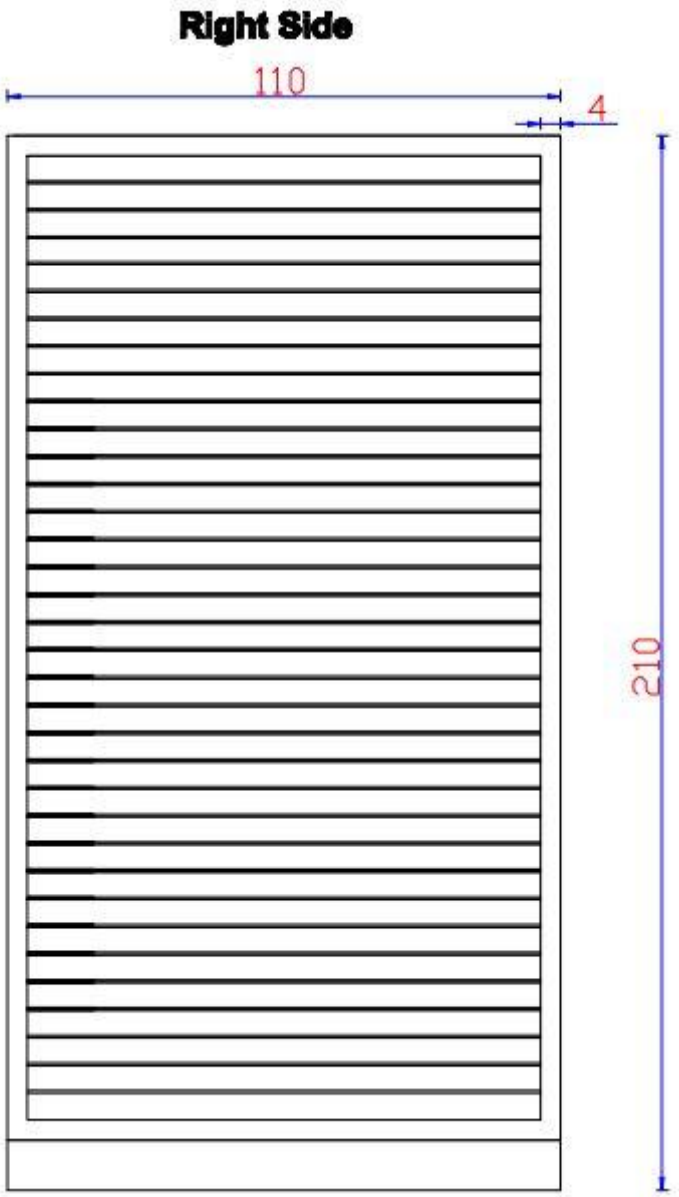

Figure 4.18: Right Side

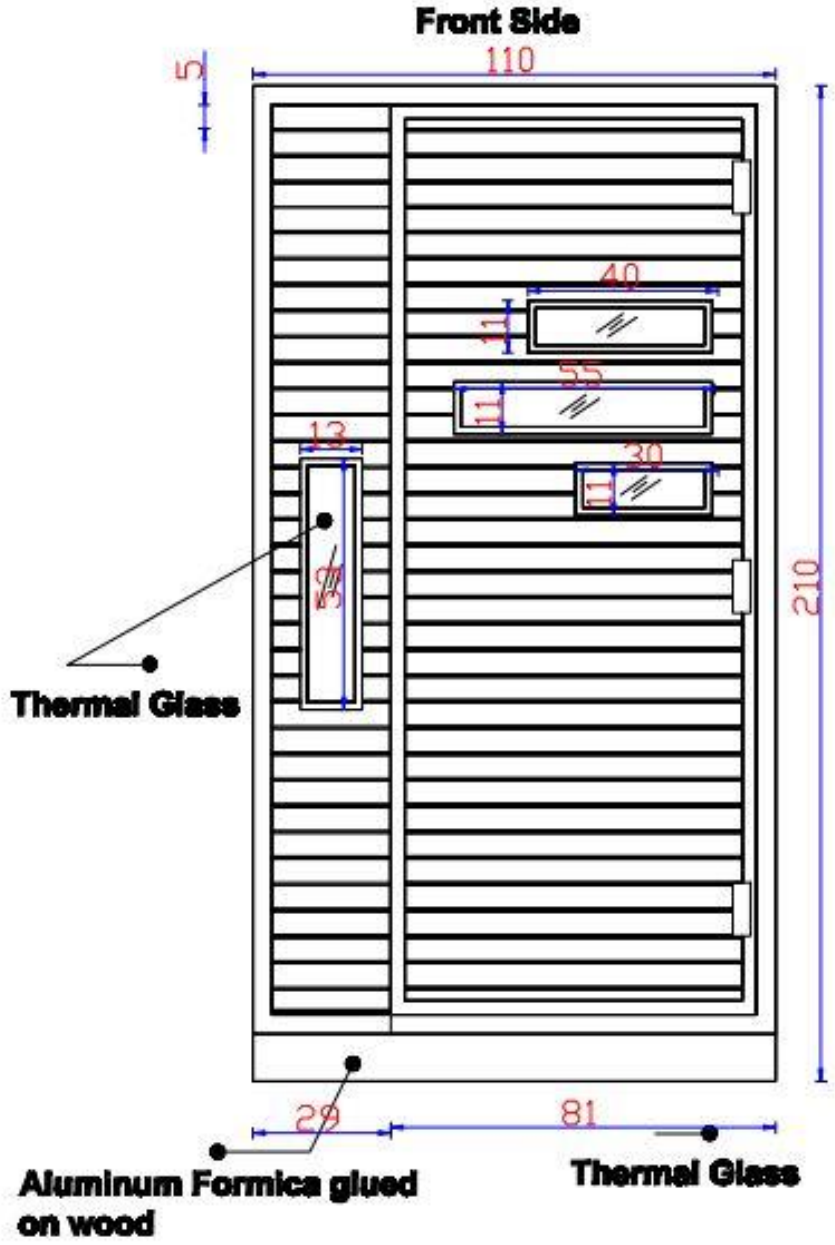

Figure 4.19: Front Side

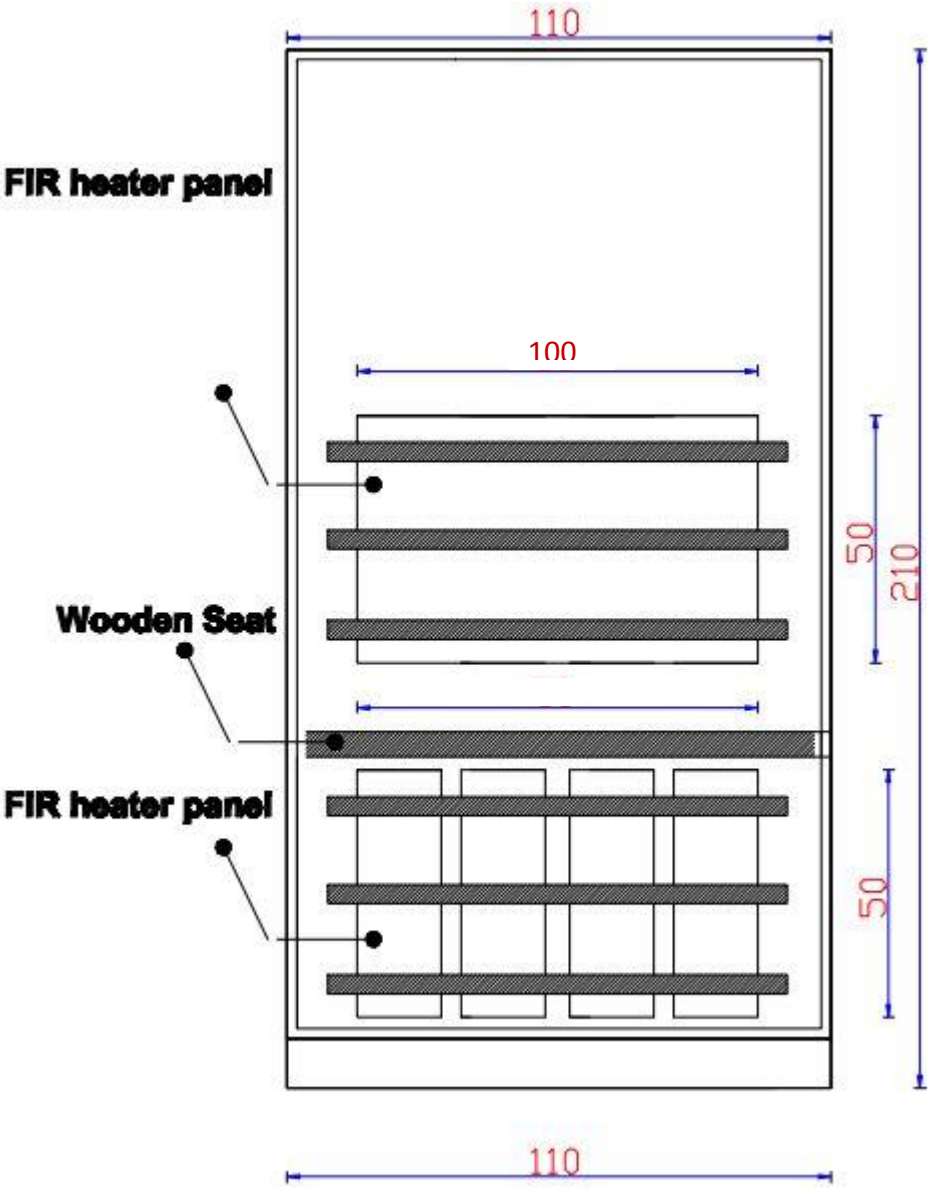

Figure 4.20: Interior Back Side

Chapter Five

Result And Conclusion

5.1 Introduction

5.2 Result and Analysis

5.2.1 Sensor Circuit

5.2.2 UPS Circuit

5.2.3 Cabinet Installation

5.3 Conclusion

5.4 Recommendation for Use

5.5 Challenges

5.1 Introduction

Results that obtained due to system implementation and testing are observed and recorded in this chapter. These results are recorded according to test procedures and give a good impact about the system. The results are studied and analyzed providing an important conclusions mentioned in this chapter.

5.2 Result and Analysis

5.2.1 Sensor Circuit and System Work

This section presents the result of using HR sensor that measure heart rate for the user and display it on the LCD screen.

The system will starts manually using push button lies beyond the user and it still running 20 minute (session time), the time then start countdown and display the remaining time on the LCD as shown in the figure 5.1 below.

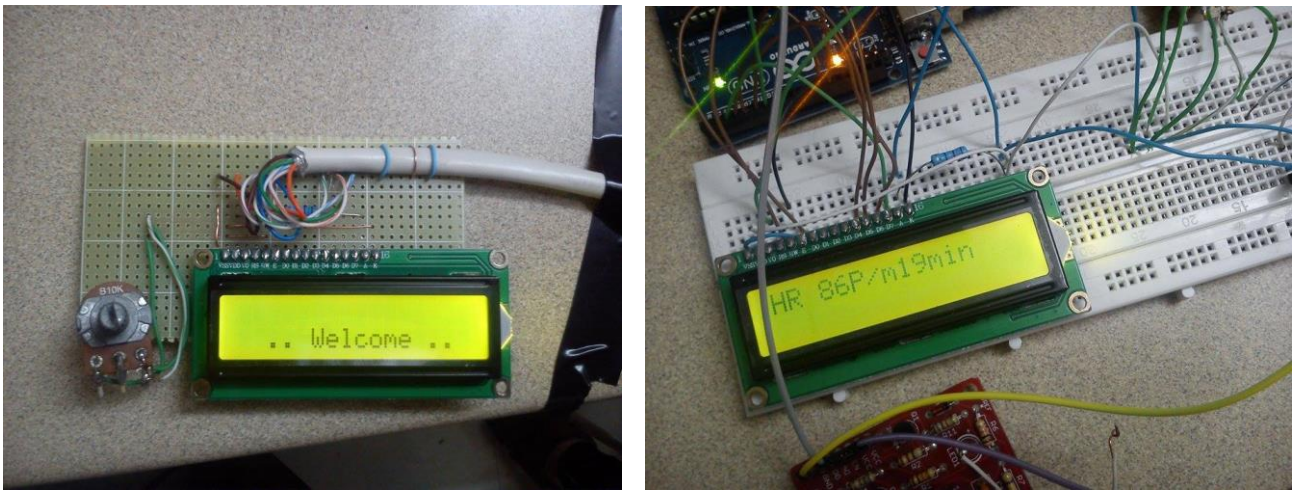

Figure 5.1: power supply available

5.2.2 UPS Circuit

As we discussed before UPS Circuit work in two direction, the first one when the power supply available the battery will be charging and at the same time feeds the strip led, as shown in figure 5.2.

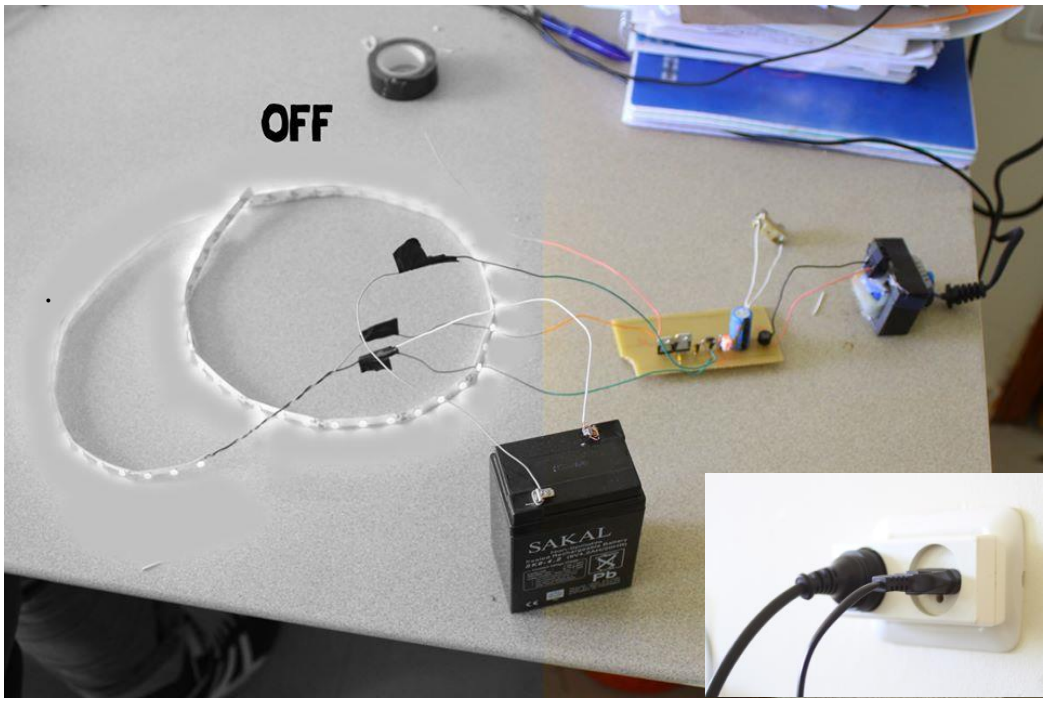

Figure 5.2: power supply available

The second case when the electricity is off the battery becomes the power supply that feeds the strip led as shown in figure 5.3

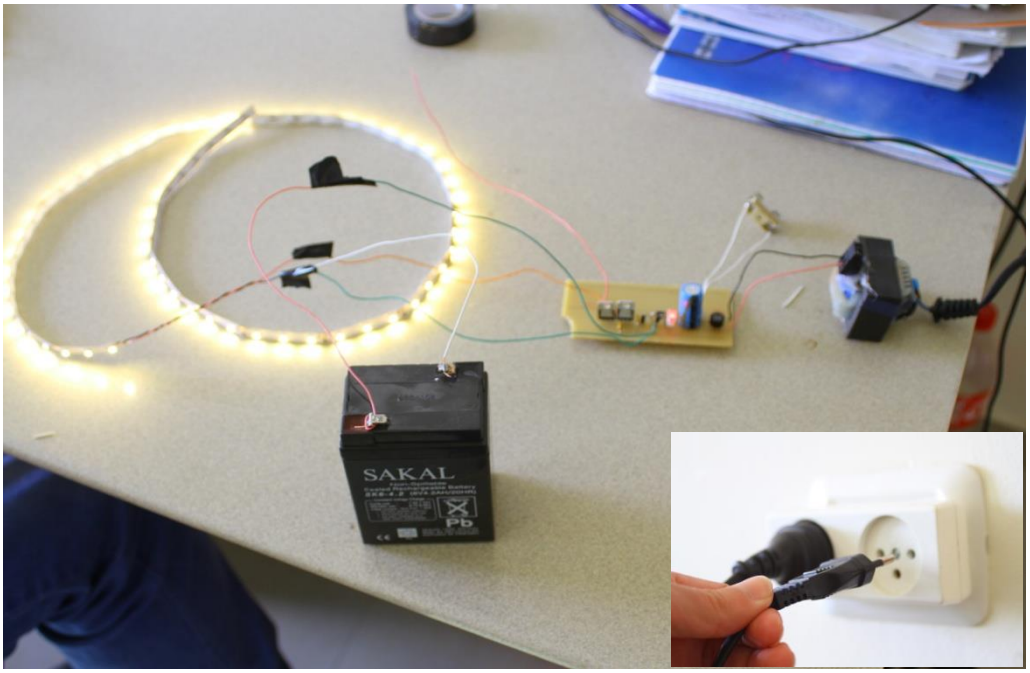

Figure 5.3: power supply unavailable

5.2.3 Cabinet Installation

In this section we discuses the steps that the cabinet pass through it, the first step is build the wooden structure of the cabinet with the dimensions as mentioned before, figure 5.4 show the first form of the cabinet.

Figure 5.4: First form of the cabinet

The second step is electrical wiring as shown in figure 5.5 that include distribution of wire around all cabinet faces which feed the spot light, panels, sensors and speaker.

Figure 5.5: Electrical Wiring

The third step is thermal insulation, the cabinet was insulated using rockwool to preserve wanted temperature inside the cabinet as the following pictures.

Figure 5.6: Thermal Insulation

5.3 Conclusion

The project achieve our aims according of use it and its appear the difference between it and the traditional sauna. First thing the user talk about there is no feeling of shortness breath such as in traditional sauna. On the other hand, the system considered as a portable system, so we can use it in any place.

The physical therapy centers and sport clubs praised the possibility of using this project according to its therapeutic effects.

5.4 Recommendation for Use

1. To regulate the temperature inside the sauna during your session, use the door (by setting it at an angle).

2. If you need more cooling, simply leave the door open until the air around you feel comfortable.

3. Drink plenty of fluids prior to, during, and after your sauna session.

4. If you take a hot /warm shower or bath before your sauna session, you may perspire more. Try it with and without bathing or showering first to determine which way you prefer.

5. To utilize the sauna's heat therapy effect, give your hair a hot oil treatment while in the sauna. Put oil or treatment into your hair and wrap it with towel. After the session is over, rinse your hair thoroughly.

6. Be sure to towel off excess sweat during your session to help the body perspire more freely.

7. To help relieve sore and tense muscles, massage the affected areas while in sauna to help heal faster.

8. Do not put any lotions or oils on the body or face when using the sauna. This may block the pores.

9. Shaving your face or legs with a razor while profusely sweating in a sauna yields an incredibly smooth result without the use of gels or foams.

5.5 Challenges

While designing the system, there are many challenge were faced, such as:

* Not all the required component for the project are available in the Palestinian market; as a result some of the main components were purchased from china, it take 7 days traveling to Palestine and then taken by Israel customs for two month ,this late our work and stop the work for several time .

** Product specifications required were not available in any company, so it has been designed according to our special specifications , this also delayed the import.

*** In-room design, the type of wood required is not available, so it was replaced by lise wood in addition to using rockwool

References

[1] Elenkov IJ, Webster EL, Torpy DJ, Chrousos GP. Stress, corticotrophin - releasing hormone, glucocorticoids, and the immune / inflammatory response: acute and chronic effects. Ann N Y Acad Sci 1999; 876: 1–11; discussion 11–13.

[2] H. Brannon, Skin Anatomy, (2014). Available at

http://dermatology.about.com/cs/skinanatomy/a/anatomy.htm

[3] Peter M. Elias, Skin Barrier Function, Curr Allergy Asthma Rep. Jul. 2008 .8(4). pp.299–305

[4] R. Randall Wickett, Marty O. Visscher, Structure and function of the epidermal barrier, Dec. 2006 : 34. pp.98-110.

[5] Shi S. Zhou, D. Li, Yi-Ming Zhou and Ji-Min Cao, The skin function: a factor of anti-metabolic syndrome, Medical College, Dalian University, Dalian, 116622, China. 2012.

[6] P. Driscoll, Skin and Skin Substitutes in Wound Management, 2013. Available at

http://www.mediligence.com

[7] Jean L. Bolognia, Joseph Jorizzo and Ronald Rapini. Dermatology: 2 volume set: Expert Consult Premium Edition, 2nd Edition 2007. 2432 pages. Mosby.

[8] D. weliam, "Systemic and Pulmonary Circulation." Boundless Anatomy and Physiology. 21 Jul. 2014. Available at

https://www.boundless.com/physiology.com

[9] John H. Klippel, Amye L. Leong, Michael D. Lockshin, National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), U.S.A. available at

http://www.niams.nih.gov/health_info/rheumatic_disease/default.asp

[10] Colin E. Willoughby, D. Ponzin, S. Ferrari, A. Lobo, K. Landau, Y. Omidi. Clinical and Experimental Ophthalmology: Department of Ophthalmology, University Hospital Zurich, Zurich, Switzerland, 2010; 38: pp.2–11

[11] Chung-Li, Clinical effects of far-infrared therapy in patients with allergic rhinitis. Chung-Yuan Christian University, Jun. 2014; 32023.

[12] john p. burrows, Balance Body's PH degree . Available at

http://www.feelgoodproducts.com/SD_whatis.html

[13] Br J. Pharmacol. The effect of arginine and nitric oxide on resistance blood vessels of the perfused rat kidney. University of London, 1989 Jul; 97(3):739-44.

[14] F. Vatansever , Michael R. Hamblin. Far infrared radiation (FIR): its biological effects and medical applications, 1 Nov. 2012; 4: pp.255–266.

[15] Ruth, W., Levin, M. and Knave, B. (1976) "Occupational hygiene evaluation of infrared emitters for drying automobile enamel".Study report AMMP 104176, Stockholm.

[16] Langley, R.K. et al (1960) "The experimental production of cataracts by exposure to light and heat". Arch. Ophthal. 63: 473-488.

[17] Calculations and Equations available at this site

http://www.heaters4saunas.com/300-wattinfrared-sauna-heater-carbon-fiber-220-vac-p-24.html

[18] http://www.lisewood.in/species/douglas-fir

[19] EN 13162 (2001), Thermal insulation products for buildings – Factory made mineral wool (MW) products – Specification. Brussels: European Committee for Standardization, pp 8-23

[20] http://www.double-glazing-info.com/Choosing-your-windows/Types-of-glass/Low-E-energy-saving-glass