Palestine Polytechnic University

Collage of Engineering

Electrical Engineering Department

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Design and Implementation of an Optical System for Skin Treatment

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By the Guidance of our supervisor, and by all members in the testing committee, this project delivered to department of electrical engineering in the college of engineering ,to be as a partial Fulfillment of the requirement of the department for the degree of B.Sc

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بناء على نظام كلية الهندسة وإشراف ومتابعة المشرف المباشر على المشروع وموافقة أعضاء اللجنة الممتحنة ، تم تقديم هذا المشروع الى دائرة الهندسة الكهربائية ، وذلك للوفاء بمتطلبات درجة البكالوريوس في هندسة الاجهزة الطبية .

توقيع المشرف

توقيع اللجنة الممتحنة

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توقيع رئيس الدائرة

الإهداء

بدأنا باكثر من يد وقاسينا اكثر من هم وعانينا الكثير من الصعوبات وها نحن اليوم والحمد لله نطوي سهر الليالي وتعب الايام وخلاصة مشوارنا بين دفتي هذا العمل المتواضع .

الى منارة العلم و الامام المصطفى الى الامي الذي علم المتعلمين ، الى سيد الخلق الى رسولنا الكريم محمد صلى الله عليه وسلم .

الى من وقف دائما الى جانبي ....الى من دعمني وقدم يد العون .....الى ابي (طاهر عطون) و الى الينبوع الذي لا يمل من العطاء وحاكت سعادتي بخيوط منسوجة من قلبها والدتي العزيزة والى الغالي زوجي الذي وفر لي كل وسائل النجاح (علاء) ...والى مهجة قلبي وربيع حياتي طفلي (وسام). (ليلى)

الى الذي قال تعالى فيهما "واخفض لهما جناح الذل من الرحمة وقل رب ارحمهما كما ربياني صغيرا". صدق الله العظيم،الماس الذي لا ينكسر .. نبع العطاء الذي زرع الأخلاق بداخلي وعلمني طرق الارتقاء إلى أبي الطيب ، إلى روح أبي الطاهر الذي علمني كيف أمسك بالقلم وكيف أخط الكلمات بلا ندم يا سنداً كان يصلب ظهري وحاجزاً كان يقف أمام انهيار نفسي جعلك ربي سبباً ما في نفسي فهذبتني أحسنت تهذيبي وأدبي ،الزهرة التي لا تذبل.. نبع الحنان ..التي ساندتني ووقفت إلى جانبي حتى وصلت هذه المرحلة من التقدم والنجاح .. إلى من تعجز الكلمات عن وصفها وتسكن في أمواج لسماع اسمها .. إلى أمي والى كل من وقف الى جانبي لأصل الى طريق النجاح . (مي)

إلى التي ما هدأ قلبها يوماً خوفاً و حرصاً محبةً و عطفاً حناناً و رحمة ، إلى التي جعلت بنبضها حياتي مشرقة و أرسلت بإبتسامتها لقلبي الآمال متألقة.. أمي ، إلى الذي ما فتئ يوماً أن يقول لي كن كما عهدتك ، و ابذل جهدك ، و أنر حياتك بالإيمآن و لا تخف فالله معك ، أخلص في نيتك و توكل على الله.. أبي إلى من تحملوا خيري و شرِّي و أحسنوا لي رغم ما في و لم يبخلوا بالدعاء لي... ..الى الذين أناروا بتضحيتهم الطريق لي إلى إخوتي فك الله اسرهم (صائب).

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Abstract

The number of patients that suffer from skin diseases are increased annually ,such as Vitiligo and Psoriasis .There are many methods and techniques used in treating skin diseases .The most popular method is based on optical technologies .These technologies are usually used Broadband ultraviolet (BBUV),because of it physiological effect on the skin during the treatment procedure.

In this project an optical system is designed to produced ultraviolet B (UVB) ,light by Xenon lamp.

The required wavelength will be obtained using optical filter, the position of the filter will be determined using servo motor , that is controlled by Arduino Uno .The mode of operation can be selected by a switch on the front panel of the device .The time of the procedure is displayed on .

ملخص المشروع :

عدد المرضى الذين يعانون من الامراض الجلدية مثل الصدفية والبهاق يزدادون باستمرار .هناك العديد من التقنيات التي تستخدم لعلاج مثل هذه الامراض الجلدية ومن اكثر التقنيات المستخدمه وافضلها هي التقنيات الضوئية التي تستخدم الاشعة الفوق بنفسجية ذلك بسبب قدرتها على تفاعل فسيولوجيا وكيميائيا على جلد المريض اثناء فترة العلاج .

صمم هذا النظام لينتج اشعه فوق بنفسجية باستخدام لمبه اكزينون ، ويتم الحصول على الاطوال الموجية الخاصة لعلاج الامراض باستخدام مرشحات ضوئيه تم تثبيتها على عجله خاصة لتدور باستخدام سيرفو موتور . يتم التحكم بالنظام باستخدام متحكم دقيق (اوردينو) .

يتم اختيار المرض الذي سيتم علاجه باستخدام مفاتيح خاصة على واجهه النظام، وعرض العمليه باستخدام شاشه العرض.

List of abbreviations

UVB :Ultra violet type B.

UVA :Ultra violet type A.

BB-UVB :Broadband ultraviolet.

NB-UVB: Narrowband ultraviolet.

AC: Alternating current .

DC :Direct current.

IR :Infrared .

PUVA: Psoralen plus UVA: phototherapy treatment where the skin is sensitised using psoralen before exposure to UVA ligh

LCD : liquid-crystal display.

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Chapter one

Introduction

1.1 Overview

Sun rays can help improve or prevent your symptoms of many inflammatory skin conditions. The source of this beneficial effect, which is unseen by the naked eye, is called the ultraviolet light. In light therapy, machines are used to produce ultraviolet light, which is directed on your whole body or the area of your skin that needs treatment. This ultraviolet light is made up of different wavelengths, including the two forms that are used in light therapy ultraviolet A (UVA) and ultraviolet B (UVB).

UVA on its own causes gradual skin pigmentation (tanning), but has little effect on skin inflammation. For treatment of skin disease, UVA is given together with a chemical, which sensitizes your skin to the light (psoralen). Psoralen given with UVA is known as PUVA. PUVA is a more intensive treatment, so you will usually only have it if treatment with UVB hasn't worked for you.

UVB therapy includes broad-spectrum UVB (which uses the full spectrum of UVB radiation) and narrow-band UVB (which focuses on a small part of the light spectrum). Narrow-band UVB is becoming more common because the reduced spectrum avoids some of the more harmful wavelengths. It's more intensive than broad-spectrum UVB, so treatment sessions are often shorter. Children can have UVB treatment but they need to be able to stand or sit still during the treatment and it's also safe for pregnant women. However, PUVA isn't a suitable treatment for children or pregnant women.

It is known that for every skin disease the skin has a better response for a specific wavelength range more than other wavelengths .In this project, this feature is used for multi skin diseases treatment system using optical filters which is a light beam that produces a wide range of wavelength filtered to the desired specific range for the treated skin disease , then focused on the patient skin for predefined amount of time.

Two skin diseases were chosen in this project: Vitiligo, Psoriasis.Each of them has a different range of wavelengths that the skin best reacts with .Those ranges will be gained from an appropriate optical filter before reaching the patient.

1.2 Projects objective

1) Study and understand the skin structure, function and its diseases.

2) Design a drive circuit to select the required wavelength.

3) Design a control system using Arduino microcontroller.

1.3 Project Importance

1) Treatment of more than one than one skin disease.

2) An easy programmed interfacing system .

3) provides a safe and comfort treatment for patients .

1.4 Literature Review

1) Skin treatment including patterned *light ,US 20120253430 A1*

According to various embodiments, methods are provided for forming patterned distributions of materials in the skin of a subject. A desired pattern may be formed by delivering a photoresponsive material to the skin and exposing the skin to light or other electromagnetic energy to cause a reaction or conversion of the photoresponsive material. In some embodiments, a photoresponsive material may be delivered into or onto the skin in a pattern. In some embodiments, patterned light may be delivered to the skin. One or both the photoresponsive material and light may be patterned in order to form a desired distribution of material. Materials distributed in or on the skin may have a variety of properties for aesthetic, cosmetic, functional, health, or medical purposes. Features of various embodiments will be apparent from the following detailed description and associated drawings.

2) Broadband targeted UVB phototherapy for localized vitilogo, Akar A Tunca M, Koc E, Kurumlu Z ,2009

Phototherapy with ultraviolet B (UVB) or PUVA has been used in the treatment of vitiligo for many years. The aim of this study was to analyze retrospectively the efficacy and safety of targeted broadband UVB phototherapy in patients with localized vitiligo. Thirty-two patients (14 male, 18 female), aged 18-65 years, High Dose Targeted Phototherapy System. Patients were treated twice or thrice weekly, totaling 20 to 60 sessions. Out of 32 total patients, only four patients (12.5%) showed visible repigmentation. In two patients, repigmentation was more than 75%. Other two patients showed mild repigmentation (less than 25%). All the lesions responsive to treatment were facial lesions. Mild adverse events recorded in 3 of 32 patients.

3)Treatment of skin disorders using UV ,*US 8486056 B2*

Skin disorders such dermatitis eczema, lichen planus , psoriasis, and vitiligo, are treated by applying high doses of ultraviolet light to diseased regions of a patient's skin.. The ultraviolet light has a wavelength within the range of about 295 nanometers to about 320 nanometers and preferably is between about 300 nanometers and about 310 nanometers. High doses of ultraviolet light are restricted to diseased tissue areas so as to avoid risk of detrimental side effects in healthy skin, which is more susceptible to damage from UV light. Cooling the skin prior to and/or while exposing the skin to the UV light can be used to minimize tissue damage resulting from exposure to the UV light. Higher doses of UV light can therefore be employed without injurious affects.

1.5 Economical studies

the following table represent the costs of the main components

The total cost for the project 1000$ these divided on :

Table (1.1): cost table

Optical filter and lense	512$
Power supply	70$
Arduino	42$
Electrical wire and regulator and resistor and capacitor	23$
Fan and LCD	32$
Wheel of filter and stand for lamp	171 $
Programming	150$

1.6 Time Schedule

The Table (1.2) shows the activities that done in the project, and the time of each one through semester.

Table (1.2): time plane for first semester

Weeks / Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Project determinations																
System Analysis																
System Design																
Documentation																

Table (1.3): Time plane for first semester

Weeks / Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Hard ware Design																
Implementations and testing																
Soft ware design																
Documentation																

Chapter Two

The Human Skin: Structure And Function,Diseases

2.1 Skin structure and function

The human skin is the outer covering of the body. In humans, it is the largest organ of the integumentary system. The skin has multiple layers of ectodermal tissue and guards the underlying muscles, bones, ligaments and internal organs. Human skin is similar to that of most other mammals, except that it is not protected by a fur. Though nearly all human skin is covered with hair follicles, it can appear hairless. There are two general types of skin, hairy and glabrous skin ,because it interfaces with the environment, skin plays a key role in protecting the body against pathogen and excessive water loss Its other functions are insulation, temperature regulation, sensation, synthesis of vitamin D. [1]

2.1.1 Skin components

Skin has mesodermal cells, pigmentation, or melanin provided by melanocytes, which absorb some of the potentially dangerous ultraviolet radiation (UV) in sunlight. It also contains DNA-repair enzymes that help reverse UV damage, such that people lacking the genes for these enzymes suffer high rates of skin cancer.The skin is the largest organ in the human body. For the average adult human, the skin has a surface area of between 1.5-2.0 square metres (16.1-21.5 sq ft.), most of it between 2–3 mm (0.10 inch) thick. The average square inch (6.5 cm^2) of skin holds 650 sweat glands, 20 blood vessels, 60,000 melanocytes, and more than 1,000 nerve endings.[2]

2.1.2 Skin functions

1) Protection: an anatomical barrier from pathogens and damage between the internal and external environment in bodily defense, Langerhans cells in the skin are part of the adaptive immune system.

2) Sensation: contains a variety of nerve endings that react to heat and cold, touch, pressure, vibration, and tissue injury.

3) Heat regulation: the skin contains a blood supply far greater than its requirements which allows precise control of energy loss by radiation, convection and conduction. Dilated blood .

4) Control of evaporation: the skin provides a relatively dry and semi-impermeable barrier to fluid loss , Loss of this function contributes to the massive fluid loss in burns.

5) Aesthetics and communication: others see our skin and can assess our mood, physical state and attractiveness.

6) Storage and synthesis: acts as a storage center for lipids and water, as well as a means of synthesis of vitamin D by action of UV on certain parts of the skin.

7)Water resistance: The skin acts as a water resistant barrier so essential nutrients aren't washed out of the body. [2]

2.1.3 Pigments

There are at least five different pigments that determine the color of the skin.These pigments are present at different levels and places.

1) Melanin: It is brown in color and present in the germinative zone of the epidermis.

2) Melanoid: It resembles melanin but is present diffusely throughout the epidermis.

3) Keratin: This pigment is yellow to orange in color. It is present in the stratum corneum and fat cells of dermis and superficial fascia.

4) Hemoglobin (also spelled haemoglobin): It is found in blood and is not a pigment of the skin but develops a purple color.

5) Oxyhemoglobin: It is also found in blood and is not a pigment of the skin. It develops a red color.[2]

2.1.4 Skin layers

Skin is composed of three primary layers as shown in figure (2.1) :

1)The epidermis, which provides waterproofing and serves as a barrier to infection.

2)The dermis, which serves as a location for the appendages of skin.

3)The hypodermis.

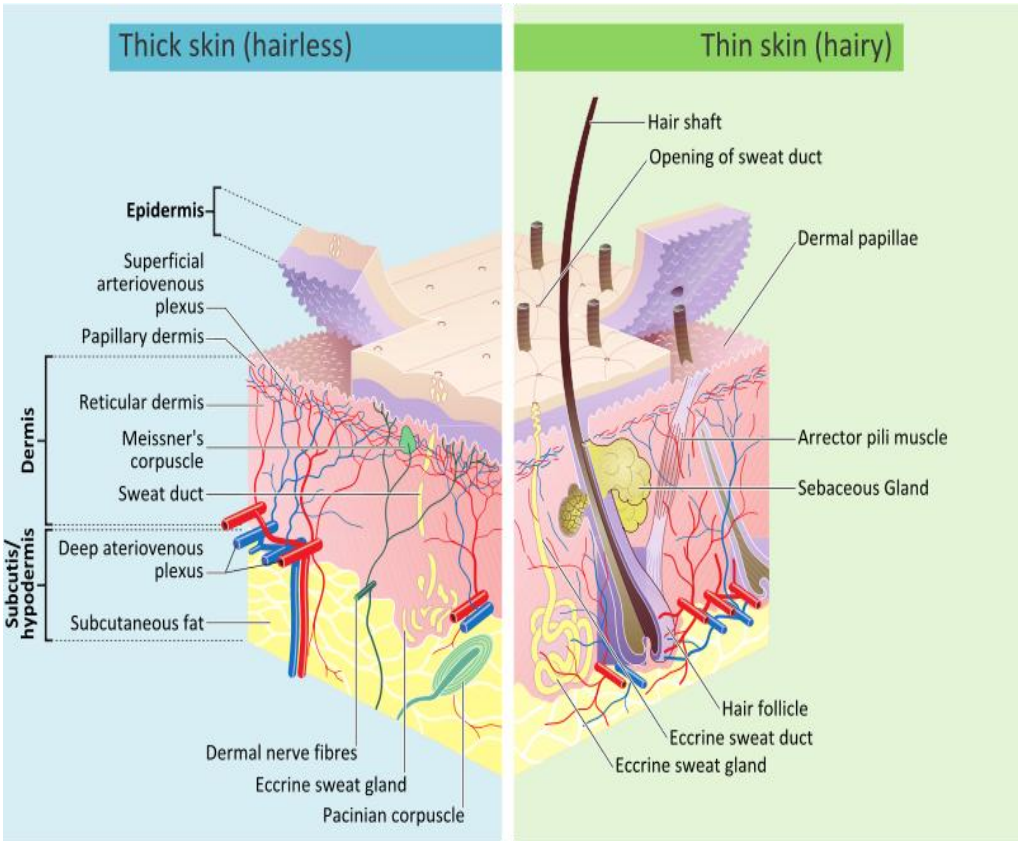


Figure (2.1): The skin structure.

2.1.4.1 Epidermis

Epidermis, is the outermost layer of the skin. It forms the waterproof, protective wrap over the body's surface and is made up of stratified squamous epithelium with an underlying basal lamina.

The epidermis contains no blood vessels, and cells in the deepest layers are nourished by diffusion from blood capillaries extending to the upper layers of the dermis. The main type of cells which make up the epidermis are merkel cells, keratinocytes, with melanocytes and Langerhans cells also present. The epidermis can be further subdivided into the following strata (beginning with the outermost layer): corneum, lucidum (only in palms of hands and bottoms of feet), granulosum, spinosum, basale.

Cells are formed through mitosis at the basale layer. The daughter cells move up the strata changing shape and composition as they die due to isolation from their blood source. The cytoplasm is released and the protein keratin is inserted. They eventually reach the corneum and slough off (desquamation). This process is called "keratinization". This keratinized layer of skin is responsible for keeping water in the body and keeping other harmful chemicals and pathogens out, making skin a natural barrier to infection.[3]

2.1.4.2 Dermis

The dermis is the layer of skin beneath the epidermis that consists of connective tissue and cushions the body from stress and strain. The dermis is tightly connected to the epidermis by a basement membrane. It also harbors many nerve endings that provide the sense of touch and heat. It contains the hair follicles, sweat glands, sebaceous glands, apocrine glands, lymphatic vessels and blood vessels. The blood vessels in the dermis provide nourishment and waste removal from its own cells as well as from the Stratum basale of the epidermis.[3]

2.1.4.3 Hypodermis

The hypodermis is not part of the skin, and lies below the dermis. Its purpose is to attach the skin to underlying bone and muscle as well as supplying it with blood vessels and nerves. It consists of loose connective tissue and elastin. The main cell types are fibroblasts, macrophages and adipocytes (the hypodermis contains 50% of body fat). Fat serves as padding and insulation for the body.[3]

2.2 Skin Diseases

There are different type of skin diseases this project deal with Vitiligo , Psoriasis.

2.2.1 Vitiligo

Vitiligo is a condition in which your skin loses melanin, the pigment that determines the color of your skin, hair and eyes. If the cells that produce melanin die or no longer form melanin, slowly growing white patches of irregular shapes appear on your skin.Vitiligo usually starts as small areas of pigment loss that spread and become larger with time.These changes in your skin can result in stress and worries about your appearance.

There is no cure for Vitiligo. The goal of treatment is to stop or slow the progression of depigmentation and, if you desire, attempt to return some color to your skin.[4]

2.2.1.1 Causes of Vitilgo

Most people with Vitilgo are otherwise healthy and have normal skin texture and sensation. However, the condition may be more common in people with certain autoimmune diseases - diseases in which your immune system reacts against your body's own organs or tissues such as [4]

1)Addison's disease

2) Vitamin B-12 deficiency

3)Anemia (pernicious anemia

4) Thyroid disorders, including hyperthyroidism and hypothyroidism.

2.2.1.2 Vitilgo signs and symptoms

The main sign of Vitilgo is pigment loss that produces milky-white patches (depigmentatiosn) on your skin as shown in figure (2.2), Other less common signs may include.[4]

1)Premature whitening or graying of the hair on your scalp, eyelashes, eyebrows or beard.

2)Loss of color in the tissues that line the inside of your mouth (mucous membranes).

3)Loss or change in color of the inner layer of your eye (retina).

Although any part of your body may be affected by Vitilgo, depigmentation usually first develops on sun-exposed areas of your skin, such as your hands, feet, arms, face and lips. Vitilgo generally appears in one of three patterns:

1)Focal. Depigmentation is limited to one or a few areas of your body.

2)Segmental. Loss of skin color occurs on only one side of your body.

3)Generalized. Pigment loss is widespread across many parts your body. [4]

Figure(2. 2):Vitilgo patient

2.2 Psoriasis

Psoriasis is defined as an auto-immune disease affecting both skin & joints. Three types of psoriasis treatable with phototherapy are Pustular, Guttate and Plaque.The condition is non-contagious, but is chronic. Psoriasis commonly causes reddened scaly patches on the skin. These scaly patches are identified as psoriatic plaques which are inflamed with excessive skin production. The skin in these areas can be whitish in color.

Psoriasis can vary in severity from small and barely noticeable to severe full body coverage. It can affect the fingernails and toenails (called psoriatic nail dystrophy). Commonly, psoriasis affects the skin of the elbows and knees, but it can affect any area on the body. In addition to the affects it has on the skin, psoriasis can also cause the joints to become inflamed. This is called psoriatic arthritis. Many people with psoriasis also end up with psoriatic arthritis. Currently, the cause of psoriasis is unknown. Factors that may bring about psoriasis include alcohol consumption and smoking, stress and genetic factors There are now many treatments available for psoriasis, including phototherapy. Psoriasis is chronic, but with treatments now available, the skin condition can be kept under control.[5]

2.2.1 Types of Psoriasis

There are different type of posoriasis [5]

1) Plaque Psoriasis

Plaque psoriasis is the most common form of the disease and appears as raised, red patches covered with a silvery white buildup of dead skin cells or scale. These patches or plaques most often appear on the scalp, knees, elbows and lower back. They are often itchy and painful, and they can crack and bleed**.** as shown in figure (2.3).

2) Guttate

Guttate [GUH-tate] psoriasis is a form of psoriasis that often starts in childhood or young adulthood. This is the second most common type of psoriasis, after plaque psoriasis. About 10 percent of people who get psoriasis develop Guttate psoriasis as shown in figure (2.4) **.**

3) Inverse

Inverse psoriasis (also known as intertriginous psoriasis) shows up as very red lesions in body folds. It may appear smooth and shiny. Many people have another type of psoriasis elsewhere on the body at the same time as shown in figure (2.5).

4) Pustular

Pustular [PUHS-choo-lar] psoriasis in characterized by white pustules (blisters of noninfectious pus) surrounded by red skin. The pus consists of white blood cells. It is not an infection, nor is it contagious as shown in figure (2.6).

5) Erythrodermic

Erythrodermic [eh-REETH-ro-der-mik] psoriasis is a particularly inflammatory form of psoriasis that often affects most of the body surface. It may occur in association with von Zumbusch pustular psoriasis. It is a rare type of.

Psoriasis, occurring once or more during the lifetime of 3 percent of people who have psoriasis. It generally appears on people who have unstable plaque psoriasis. This means the lesions are not clearly defined. Widespread, fiery redness and exfoliation of the skin characterize this form, as shown in figure (2.7) .

Figure(2.3) : Plaque

Figure(2.4) : Guttate

Figure (2.5): Inverse

Figure (2.6): Pustular

Figure (2.7): Erythrodermic

Chapter Three

Light Nature, Skin Interaction And Treatment

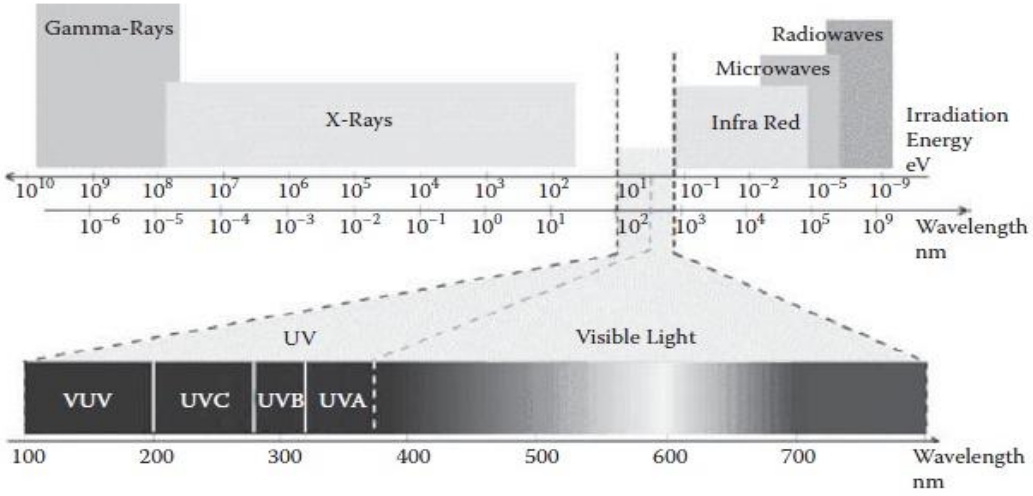
3.1 Introduction

Light is defined as the electromagnetic radiation with wavelengths between 380 and 750 nm which is visible to the human eye. Electromagnetic radiation, such as light, is generated by changes in movement (vibration) of electrically charged particles, such as parts of 'heated' molecules, or electrons in atoms (both processes play a role in the glowing filament of incandescent lamps, whereas the latter occurs in fluorescent lamps). Electromagnetic radiation extends from γ rays and X-rays through to radio waves and to the long radio waves. This is often referred to as 'the electromagnetic spectrum.[6]

3.2 The nature of light

An alternative physical description of light is to consider radiation as being emitted as discrete parcels of energy, called photons, which have dual nature – that of a particle and a wave. The fundamental parameter that distinguishes one part of the electromagnetic spectrum from another is the wavelength, which is the distance between successive peaks of the radiated energy (waves). Photons' energy levels are determined by measuring their wavelength (expressed in units of length and symbolized by the Greek letter lambda λ .Frequency is measured in number of cycles (wave peaks) per second and is expressed in Hz .The amplitude is a quantitative characteristic of light, while wavelength (intrinsically linked to photons' energy and frequency) characterizes the nature of light qualitatively.

Light is a very small component of the electromagnetic spectrum and is the part that can be perceived by the human eye. Radiation just beyond the red end of the visible region is described as Infra-red (IR), and radiation of shorter wavelength than violet light is called Ultra-violet (UV). The UV portion of the spectrum is divided into three regions as shown in (figure 8).[7]



Figure(3.1): Light Spectrum

1) UVA(315-400nm)

2) Broadband ultraviolet (BB-UVB) radiation 280 to 320 nm.

3) Narrowband (NB-UVB) 311 to 313 nm.

4) UVC(100-280nm)

3.3 light skin interaction

Interaction with skin and eyes depends on the wavelength of the radiation, absorption of electromagnetic radiation is typically related to warming of the tissue exposed which has mostly indirect consequences. However, radiation of shorter wavelengths, due to the higher characteristic photon energy, can excite electrons such that chemical processes are initiated which may have detrimental side effects. A well known mechanism is the detrimental effect of UV radiation on living cells.

Ionizing radiation consists of high-energy photons that can ionize at least one electron from an atom or molecule. Ionizing ability depends on the energy of individual photons, and not on their number. The ability of photons to ionize an atom or molecule varies across the electromagnetic spectrum. X-rays and gamma rays can ionize almost any molecule or atom; far ultraviolet light can ionize many atoms and molecules; near UV, visible light, IR, microwaves and radio waves are non-ionizing radiation .

.

Like sunlight on water, UV, visible and IR radiation can be partially reflected from the outer surface of the skin and eyes, and as it penetrates the tissue it can be scattered in various directions (including backwards) from microscopic particles and structures such as fibers (e.g., present in the dermis of the skin).

Ultraviolet radiation, especially with short wavelengths, is strongly absorbed by bulk tissue, i.e. by organic molecules like proteins, lipids and DNA. Most of the UV-B radiation is therefore absorbed in the outermost superficial layer (the epidermis of the skin). The absorbed energy from UV radiation is not only converted into 'heat' (i.e. thermal energy from increased movement of molecules).

In the eye, visible radiation is absorbed by special photo-pigments that trigger electrochemical stimuli to optical nerves ,most photochemical reactions caused by UV radiation in the skin and eyes are detrimenta proteins and DNA become damaged and dysfunctional, either by directly absorbing UV radiation or by being damaged through an intermediary step, such as reactive oxygen species generated from another UV-absorbing molecule. Hence, UV radiation can be considered harmful. Overly damaged cells will die and disassemble in a well-orchestrated manner. Fortunately, our skin is well adapted to UV-induced damage which also arises upon exposure to the sun. Cells react, alarm signals are produced (i.e. stress responses mediated through cascades of molecular reactions), and the damaged molecules and cells are repaired or replaced. [8]

3.4 Diseases treatment

Diseases chosen in this project are vitiligo and Psoriasis.

3.4.1 Vitiligo treatment

There are many different treatment options available .Prior to beginning a treatment regimen, the nature and stability of the patient's vitiligo should be properly assessed. Patients and their healthcare providers should discuss the time frame of treatment being considered.[9]

3.4.1.1 Treatment options include

1)Topical preparations.

2) Non-targeted UV phototherapy.

3) Targeted UV phototherapy.

4) PUVA therapy.

5) Systemic Drugs.

6)Skin Grafting, melanocyte transplantation, other surgical options.

3.4.1.2 Treatment options have different aims and include

1)Reducing inflammation

2)Slowing or stopping the progression of vitiligo

3) Activating secretion of melanocyte-promoting substances in the skin cells (keratinocytes) and hair follicles

4)Stimulating melanin production in melanocytes

5)Grafting non-vitiligo skin into vitilogo-regions

6)Implanting healthy skin or healthy melanocytes by themselves into vitiligo skin

7) Depigmenting the skin

8) Camouflaging depigmented areas and homogenizing skin tone. [9]

3.4.2 Psoriasis treatment

There are different Types of Phototherapy Treatments depending on your circumstances, your doctor may prescribe phototherapy using light in the Ultraviolet-A (UVA) or Ultraviolet-B (UVB) range for treating psoriasis.

When comparing the two, UVB has the added advantage of producing fewer adverse side effects, as the long-term use of the psoriasis medication psoralen is eliminated.

When using UVA light, doctors often combine UVA phototherapy with an oral or topical medicine called psoralen. The addition of psoralen (PUVA) makes the skin more sensitive to the UVA light, producing a greater effect than UVA light alone, but introducing the potential for side effects from using psoralen.

An improved understanding of UVB light allowed doctors to better refine phototherapy treatment by including a very precise range of UVB wavelengths, called narrowband UVB light (NB-UVB). Evidence has given new hope to psoriasis sufferers and suggests that NB-UVB phototherapy treatments offers even better treatment results than broadband UVB therapy for certain patients. Currently

NB-UVB is one of the main treatments for patients with mild to severe psoriasis. Broadband UVB lamps emit a broad range of light over the UVB spectrum.[10]

Chapter Four

Project Design

4.1 Introduction

In order to design and implement an optical system for skin treatment. The following block diagram in figure (4.1) depicts how all component (of the hardware system) connect to each other, from the light source (xenon lamp) which concentrated by a double thick convex lens .Then the wall of filter will move-by servo motor-according to the selected mode.

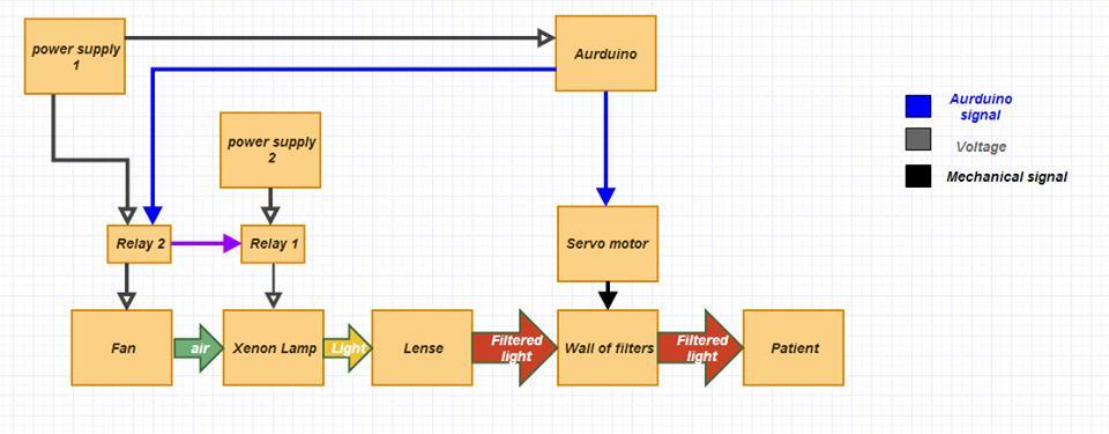


Figure (4.1): General block diagram**.**

4.2 Xenon lamp

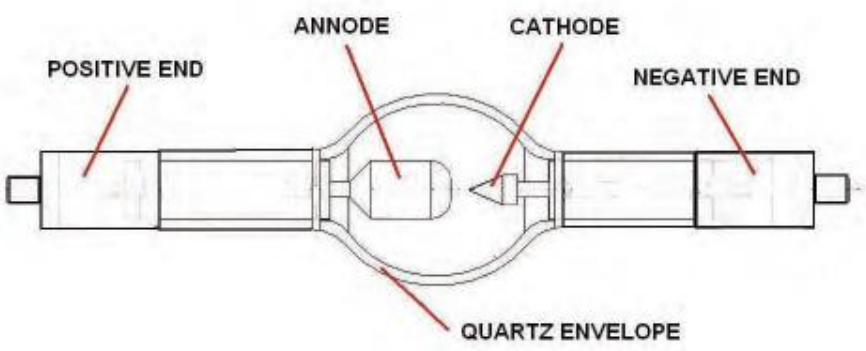
Is a specialized type of gas discharge lamp, an electric light that produces light by passing electricity through ionized xenon gas at high pressure. It produces a bright white light that closely mimics natural sunlight. Xenon arc lamps are used in movie projectors in theaters, and for specialized uses in industry and research to simulate sunlight.

Xenon arc lamps can be roughly divided into three categories:

1)Continuous-output xenon short-arc lamps

2)Continuous-output xenon long-arc lamps

3)Xenon flash lamps (which are usually considered separately)



Figure(4.2) : Lamp diagram – Basic Layout & parts Diagram.

Quartz Envelope – The thick clear glass that the lamp is built within. The quartz has high strength to withhold the high internal operating pressures, as well as having very specific optical properties for the transmittal of a specific spectrum of light.

Positive & Negative Ends – The ends of the bulb serve many purposes. The thick outer end caps provide a means to mechanically mount the bulb into a fixture, as well as make proper electrical connections.

Electrodes – The Anode and Cathode are the two electrodes that the arc, or flame, flows across. The smaller, or Cathode, is negatively charged, and the tip is where the flame originates from. The larger, or Anode, is positively charged, and receives, or lands, the flame. Both Electrodes are made from pure Tungsten, and then specially treated to survive the lamp's operating characteristics.

Xenon lamps emit a broad spectrum from UV to IR (185-2000 nm) similar to sunlight. They have high output intensity, high stability, and long life.[11]

4.3 lenses

A lens is made up of a transparent refracting medium, generally of some type of glass, with spherically shaped surfaces on the front and back. A ray incident on the lens refracts at the front surface (according to Snell's law) propagates through the lens, and refracts again at the rear surface..

The ray-tracing techniques and lens formulas we shall use here are based again on Gaussian *optics*, just as they were for mirrors.

As we have seen, Gaussian optics—sometimes called paraxial optics—arises from the basic approximations sin $\phi = \varphi$, tan $\phi = \varphi$, and cos $\phi = 1$. These approximations greatly simplify ray tracing and lens formulas, but they do restrict the angles the light rays make with the optical axis to rather small values of 20° or less.[12]

4.3.1 Types of lenses

If the axial thickness of a lens is small compared with the radii of curvature of its surfaces, it can be treated as a *thin* lens. Ray-tracing techniques and lens formulas are relatively simple for thin lenses .If the thickness of a lens is not negligible compared with the radii of curvature of its faces, it must be treated as a *thick* lens. Ray-tracing techniques and lense-imaging formulas are more complicated for thick lenses, where computer programs are often developed to trace the rays through the lenses or make surface-by-surface calculations.[12]

4.3.1.1 Double (Thick) convex lens

This focusing lens will used to focus the light from the xenon lamp to the filters. A thick lens will use instead of two thin lenses.
The plane on which the extension lines (Principle plane) of the ray incident from the first focus and the ray emerged from the lens intercept, as shown in (figure 4.3).[12]

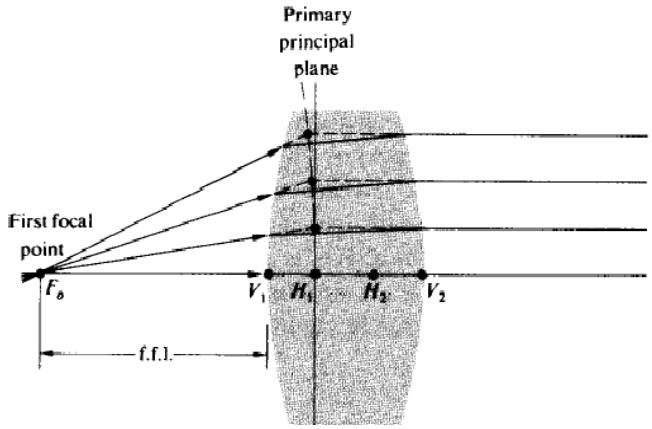


Figure (4.3): Principle plane

The same as the principle plane (Secondary Plane) except that the ray is from the second focus as shown in figure (4.4)

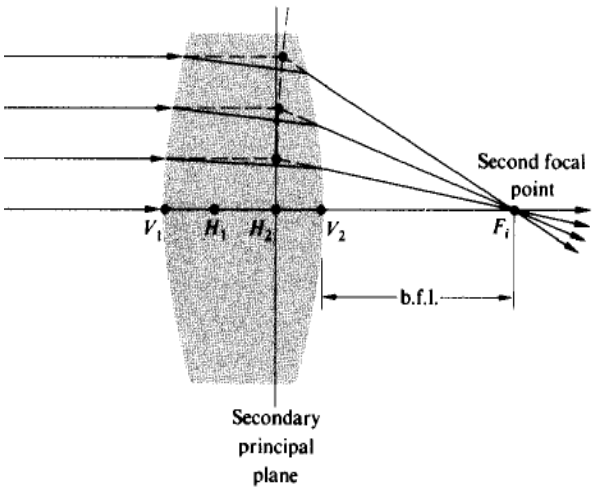


Figure (4.4) : Secondary plane.

First principal point H1 the intersection of the Principle plane and the optical axis. Second principal point H2 the intersection of the secondary plane and the optical axis.

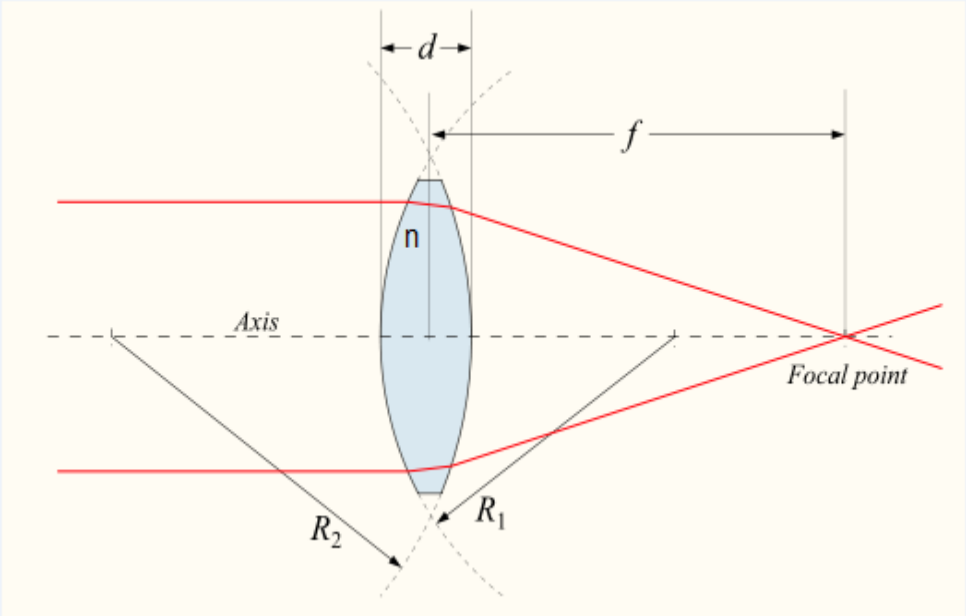


Figure (4.5.1) : Thick convex lens.

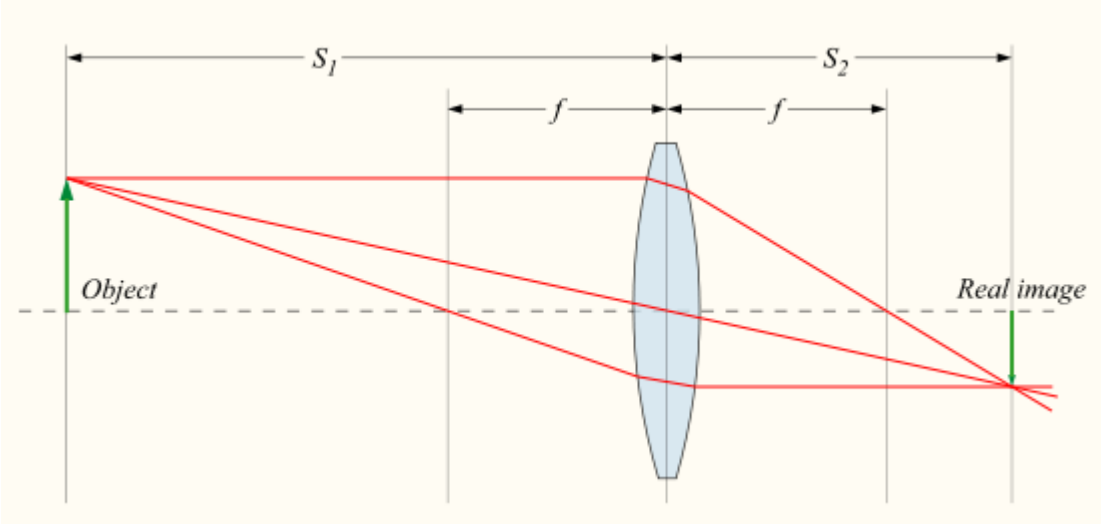


Figure (4.5.2) : Thick convex lens.

Calculations were made to find the distance between each component :

$$1/f = (n-1)\,[1/R1 - 1/R2 + (n-1)d / nR1\,R2] \ldots \text{Equation(1).}$$

Where:

d : Diameter = 9.00 mm

R1 : Effective Focal Length EFL =13.5 mm.

R2 : Back Focal Length BFL=12.32 mm.

f : Focal point.

P : is the power of the lens

n : Index of refraction for glass= 1.52.

1/f= (1.52-1) [1/1.35cm – 1/1.232cm+ (0.52)*0.9cm / 2.528]

=(0.52)[0.74-0.81+0.468/2.528]

(0.52)[0.74-0.81+0.185]

=(0.52)0.115=0.0598

F=16.72

Where:

S1 : distance between light source and the convex lense .

S2: distance between convex lens and filter.

1/f = 1/S1 + 1/S2

Let S1=5cm

0.0598=1/5+1/S1

0.0592-0.2=-0.1408

1/0.1408=7.10cm

4.4 Optical filters

Optical filters are often used to attenuate certain wavelengths of light and produce an overall desired detector response as shown in figure(4,7).

Interference filters rely on harmonic interference between waves to provide very narrow passbands. Thin metal films are spaced half the desired wavelength apart by a dielectric spacer. Interference filters are capable of bandwidths less than 10 nm.

Absorptive filters typically consist of glass that has been doped with a concentration of dye that absorbs particular colors. Since spectral transmission varies logarithmically with thickness, the band pass can be reduced by thickening the filter. [13]

Two filters used:

300nm CWL, 10nm Bandwidth, 12.5mm Mounted Diameter used for Vitiligo

307nm CWL, 10nm Bandwidth, 12.5mm Mounted Diameter used for Psoriasis.

Figure (4.7): Optical filters

4.5 Fiber optic

Fiber optic was used in this project to transfer the filtered light beam to the patient .

4.5.1 Definition

Fiber optic is the technology in which light is passed through a plastic or glass fiber so that it can be directed to a specific location. If the light is encoded (modulated) with an information signal , then that signal is transmitted over the fiber- optic path. [14]

1)Very high bandwidth.

2)Very low weight and small size.

3)Low loss compared with other media.

4)Freedom from electromagnetic interference (EMI).

5)High degree of electrical isolation.

6)Explosion –proof.

7)Good data security.

8)Improved fail-safe capability.

4.5.2 Fiber optic constructed

The light is "guided" down the center of the fiber called the "core". The core is surrounded by a optical material called the "cladding" that traps the light in the core using an optical technique called "total internal reflection." The fiber itself is coated by a "buffer" as it is made to protect the fiber from moisture and physical damage. The buffer is what one strips off the fiber for termination as shown in figure (4.8) **.[15]**

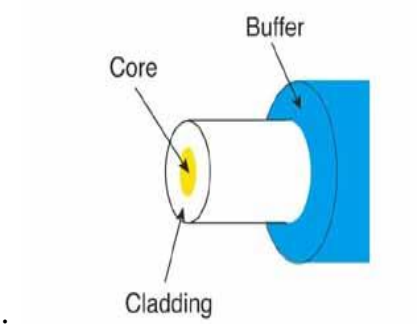


Figure (4.8): Fiber optic

4.6 Filter Wheels

A moving circular wall with optical filters placed on it , is set for a known distance away from the collimating lens , its motion is controlled by a controlling circuit connected to it .

Figure (4.9) : Walls of Filters

4.7 Servo motor

4.7.1 Introduction Servo motor

Servo motors have been around for a long time and are utilized in many applications They are small in size but pack a big punch and are very energy-efficient. Because of these features, they can be used to operate remote-controlled or radio-controlled toy cars, robots and airplanes .Servo motors are also used in industrial applications, robotics, in-line manufacturing, pharmaceutics and food services.[16]

Figure (4.10): Servo disassembled.

4.7.2 Servo motor constructed

Inside there is a pretty simple set-up: a small DC motor, potentiometer, and a control circuit. The motor is attached by gears to the control wheel.

When the shaft of the motor is at the desired position, power supplied to the motor is stopped. If not, the motor is turned in the appropriate direction. The desired position is sent via electrical pulses through the signal wire. The motor's speed is proportional to the difference between its actual position and desired position. So if the motor is near the desired position, it will turn slowly, otherwise it will turn fast. This is called proportional control. This means the motor will only run as hard as necessary to accomplish the task at hand, a very efficient little guy.[16]

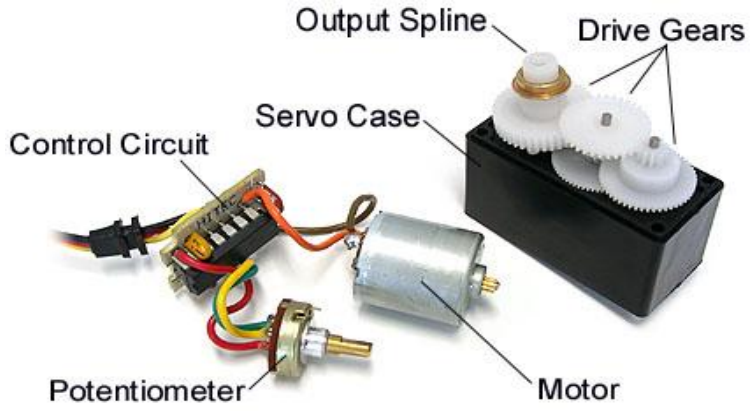


Figure (4.11): Servo constructed

4.7.3 Types of Servo Motors

There are two types of servo motors AC and DC. AC servo can handle higher current surges and tend to be used in industrial machinery. DC servos are not designed for high current surges and are usually better suited for smaller applications. Generally DC motors are less expensive than their AC counterparts. These are also servo motors that have been built specifically for continuous rotation, making it an easy way to get your robot moving. [16]

4.7.4 Servo motor applications

Servos are used in radio-controlled airplanes to position control surfaces like elevators, rudders, walking a robot, or operating grippers. Servo motors are small, have built-in control circuitry and have good power for their size.

In food services and pharmaceuticals, the tools are designed to be used in harsher environments, where the potential for corrosion is high due to being washed at high pressures and temperatures repeatedly to maintain strict hygiene standards. Servos are also used in in-line manufacturing, where high repetition yet precise work is necessary .Of course, you don't have to know how a servo works to use one, but as with most electronics, the more you understand, the more doors open for expanded projects and projects' capabilities.[16]

4.8 Power supply

A special power supply was used with 22.8 voltage to be suitable with the xenon lamp . For the other component the motor and the Arduino , 9 volt regulator was used .

4.9 Arduino

Is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. it's intended for artists, designers, hobbyists and anyone interested in creating interactive objects or environments.

4.9.1 Definition

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other Actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software running on a computer (eg Flash Processing, MaxMSP).[17]

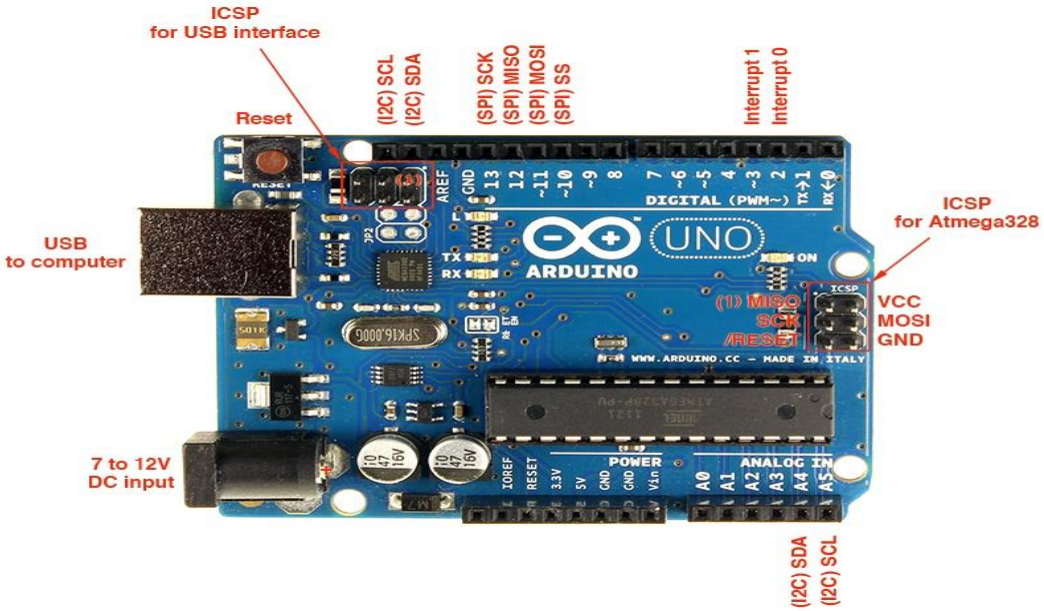


Figure (4.12) : Arduino Uno

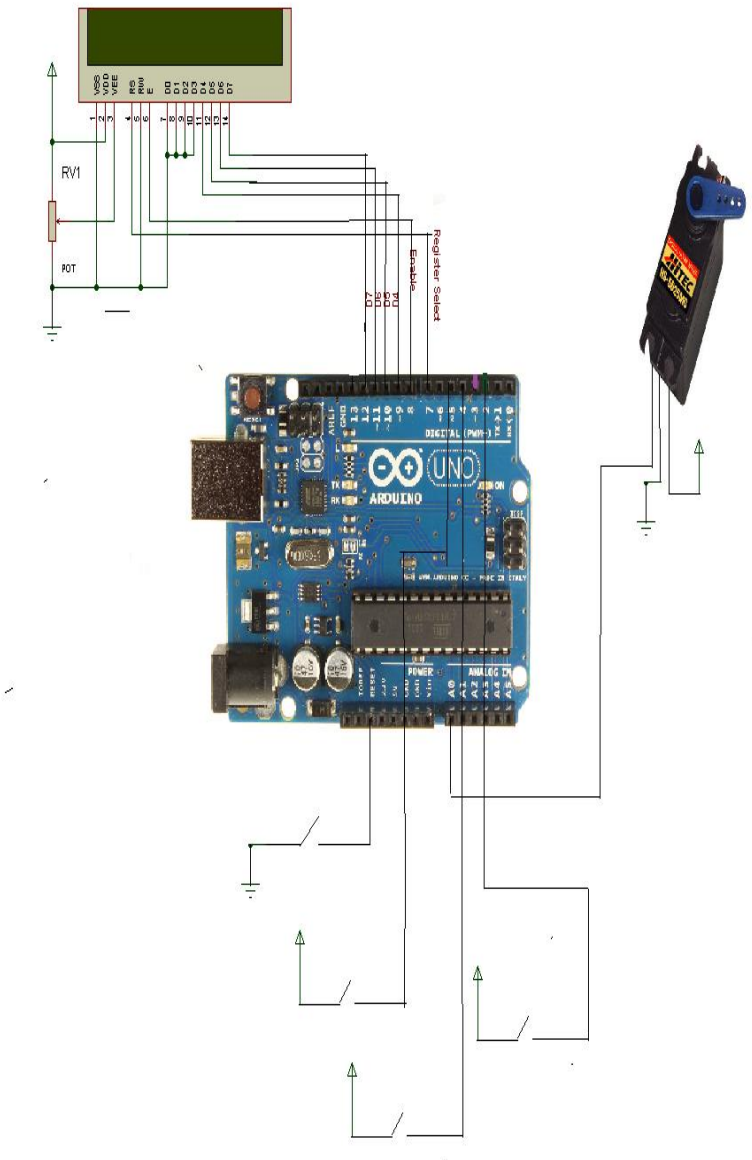
4.9.2 The Arduino Uno

A microcontroller board based on the ATmega328 (datasheet). It has 14 digital input / output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.[17]

Table 4.1 Summary of the Arduino Uno

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6

4.9.3 Arduino connection



Chapter Five

System Implementation and Testing

5.1 Introduction

Practical implementation and testing for the skin treatment system have been done in second semester .When subsystem was implemented and tested individual then connected these subsystem to each other .xenon lamp composition .This project aims to separate the useful wavelength from the Xenon lamp which has a wide wavelength to treat the vitiligo and the psoriasis.

5.2 Power supply

A special power supply was used with 22.8 voltage to be suitable with the xenon lamp . For the other component the motor and the Arduino , 9 volt regulator was used .

Figure (5.1): Power supply

5.3 The Xenon lamp

Is connected to a 22.8 v power supply , also it's connected to a relay (which take it's signal from the Arduino). The lamp composition and it's construct from the positive & negative polarity with a special base .The xenon lamp produce a lot of heat so it must be encloses with cooling fan connected with the lamp at the same relay .

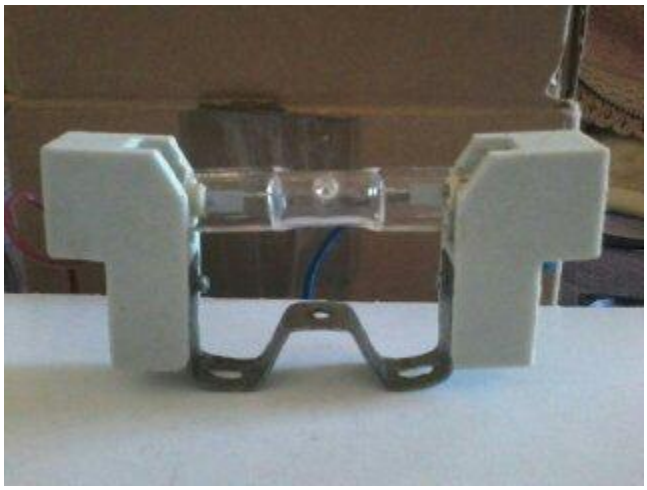


Figure (5.2): Xenon lamp

5.4 Double convex lens

This lens placing in a Circuitous disk 5 cm from the lamp to be paralleled to the lamp and to the wheel of filters .Also it's covered with a wall to prevent scattering the light.

Figure (5.3) : Double convex lens .

5.5 Wheel of filters with Servo motor

This wheel placed 7 cm after the convex lens, move with respect to the selected mode by connected it with servo motor .The servo motor turn on by 9 voltage from the Arduino , also it's controlled by the Arduino .

Figure (5.4): Servo motor

Figure (5.5) :Wheel of filters with servo motor

5.6 The Fan

The xenon lamp produce a lot of heat so it must be cooling by fan .

Figure (5.6): The Fan

5.7 Arduino

The Arduino is used to control the work of the hole system . the selection of the mode by switches ,the LCD screen and the servo motor movement and start lamp on and off .

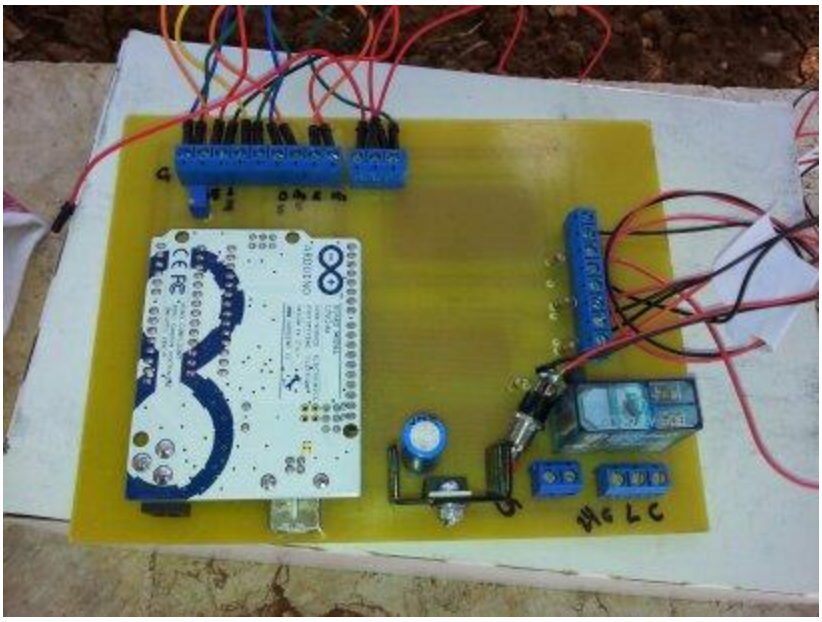


Figure (5.7): Arduino connection in the project

5.8 software Implementation

5.8.1 Flow charts

A flow chart illustrate the steps of process and stages of the project shows in the figure (5.8).

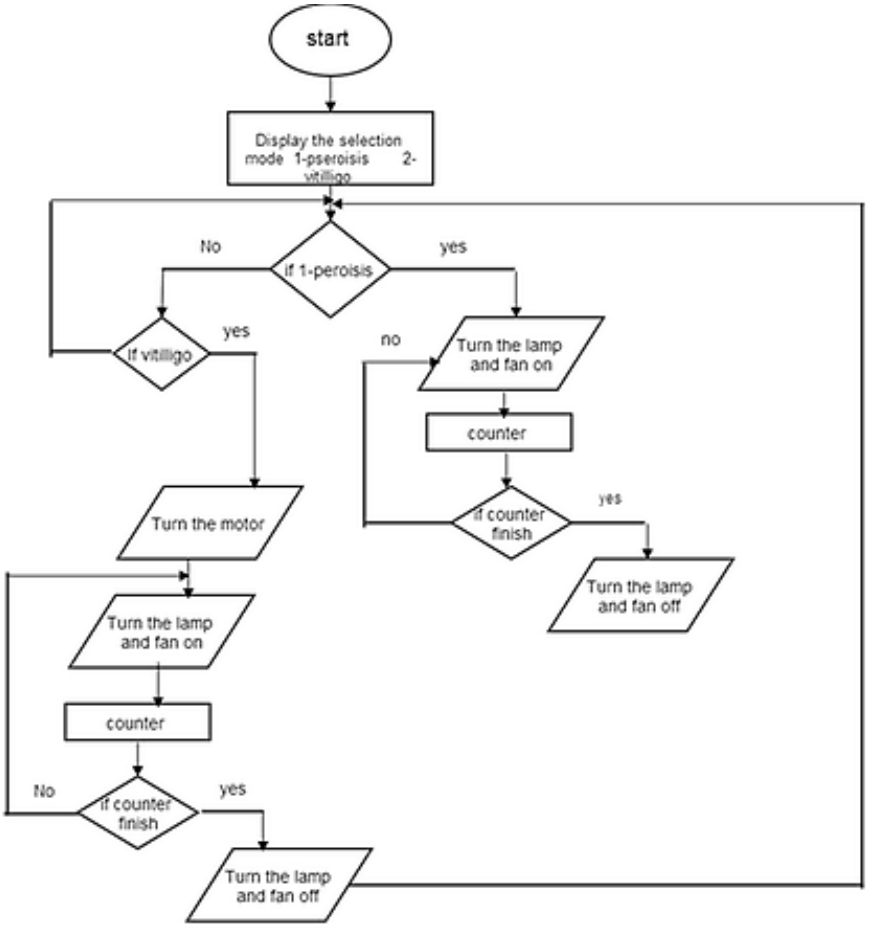


Figure (5.8): Flow chart of the project

5.8.2 Software needed for the project

In this project Arduino used to control the whole system

```
#include <LiquidCrystal.h>
#include <Servo.h>
 LiquidCrystal lcd(7,8,9,10,11,12);
 Servo myservo;
 int runFor = 10; // time is 180

void setup()
{
  pinMode (2,INPUT);//yes
  pinMode  (5,INPUT); //P
  pinMode  (6,INPUT); //V
  pinMode (13,OUTPUT);//fan , lamp

  lcd.begin(16, 2);
  myservo.attach(3);  // attaches the servo on pin A0 to the servo
object
   myservo.write(0);
 delay (1000);
  myservo.detach();    // Detach again

  lcd.setCursor(0, 0);
  lcd.print("Welcome to skin");
  lcd.setCursor(0, 1);
  lcd.print("treatment system");
  delay ( 2000);
  lcd.setCursor(0, 0);
  lcd.print("project team       ");
  lcd.setCursor(0, 1);
  lcd.print("Laila  Mai  Saeb");
  delay ( 3000);
    lcd.setCursor(0, 0);
    lcd.print("project Supervisor ");
    lcd.setCursor(0, 1);
    lcd.print("Dr.Ramzi  Qawasma  ");
   delay ( 3000);
    lcd.setCursor(0, 0);
    lcd.print("plz Sel ur mode  ");
    lcd.setCursor(0, 1)
    lcd.print("1-P  2-V ");

}
```

```
void loop()
{
      int p = digitalRead (5);
     int v = digitalRead (6);


if ( p==HIGH && v==LOW )
{
      lcd.setCursor(0, 0);
    lcd.print(" Start Treatment      ");
    lcd.setCursor(0, 1);
    lcd.print("  yes        NO        ");

  int yes = digitalRead (2);
  int no = digitalRead (4);
  if ( yes==HIGH )
  {

 digitalWrite (13,HIGH );
 timer ();
  }




}

   if ( v==HIGH && p==LOW )
{

      lcd.setCursor(0, 0);

    lcd.print(" Start Treatment      ");
    lcd.setCursor(0, 1);
    lcd.print("  yes        NO        ");

  int yes = digitalRead (2);
  int no = digitalRead (4);
  if ( yes==HIGH )
  {

 digitalWrite (13,HIGH );
   myservo.attach(3);
 myservo.write(180);
   delay (1000);
  myservo.detach();    // Detach again
  timer ();
    }}}



  void timer() {

      lcd.setCursor(0,0);
            lcd.print ("     ");
```

```
    lcd.setCursor(0,1);
      lcd.print ("TIMER:");


   for(int timer = runFor;timer > 0; --timer){

   if(timer >= 10)
   {
      lcd.setCursor(6,1);
   }

   else {
      lcd.setCursor(6,1);
      lcd.print("0");
      lcd.setCursor(7,1);
   }


   lcd.print(timer);
   lcd.print(" SECOND!");
   delay(1000);
   }


   lcd.setCursor(0,1);
   lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("plz Sel ur mode");
    lcd.setCursor(0, 1);
    lcd.print("1-P  2-V ");
   digitalWrite (13,LOW);
  myservo.attach(3);
  myservo.write(0);  // Move servo to other end
  delay (1000);
  myservo.detach();    // Detach again

}
```

5.9 Testing

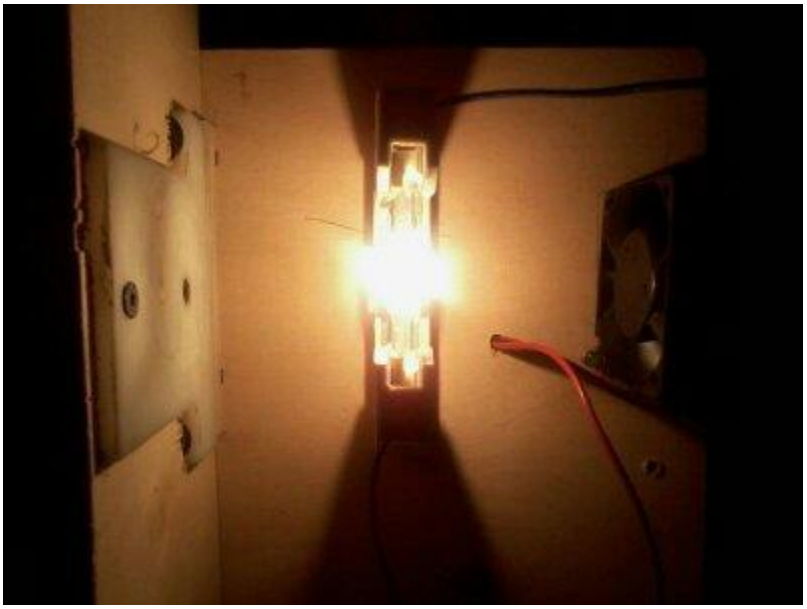


Figure (5.9) :Testing for Xenon lamp.

Figure (5.10): Test the Double convex lens and how its concentrate the light.

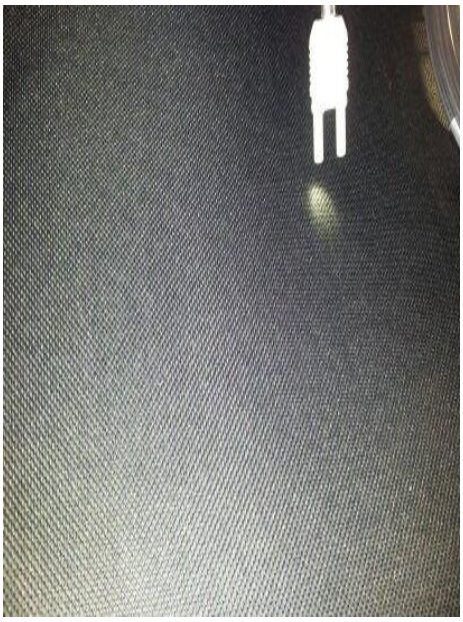
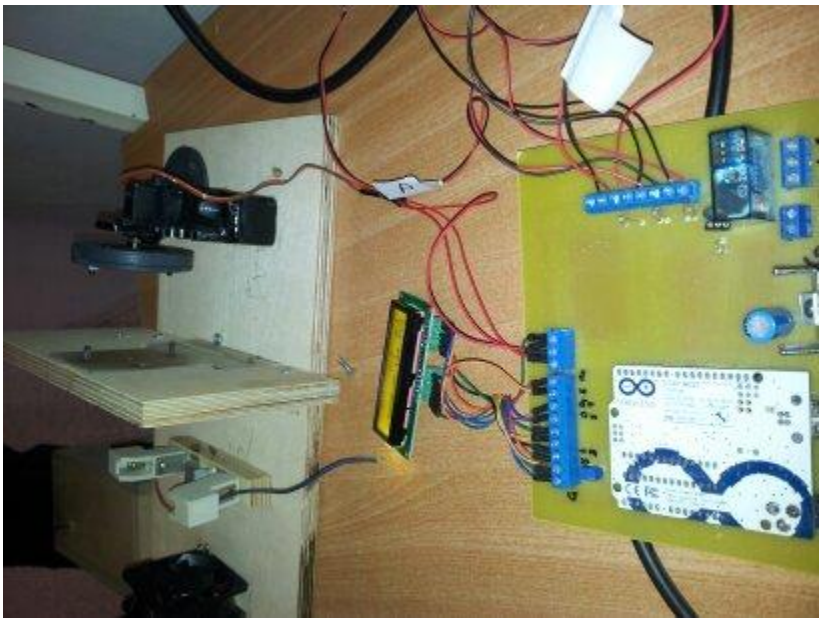


Figure (5.11): Test The Fiber Optic



Figure(5.12): Test The Arduino With Servo Motor.

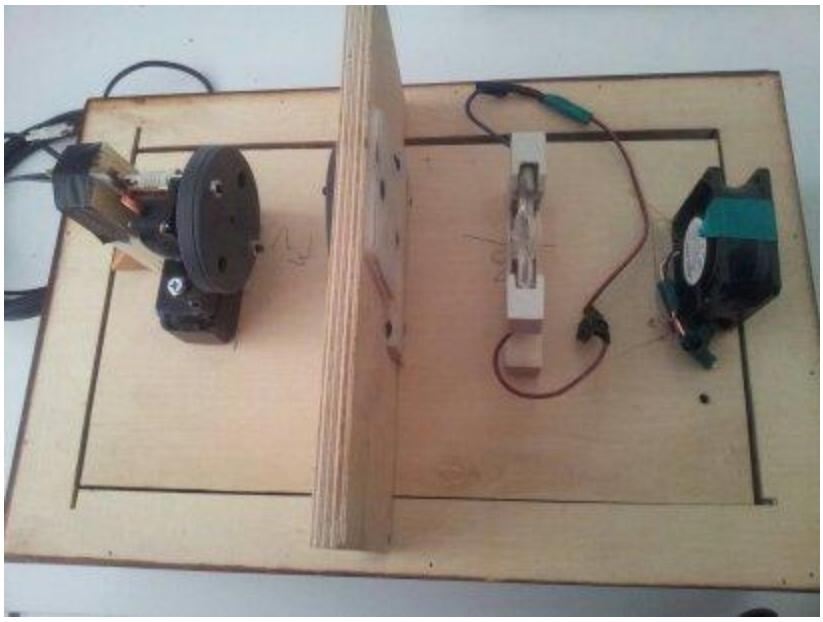


Figure (5.13) : The subsystem connect with each other.

5.10 Conclusion

1) An optical system that treats more than one disease was designed and implemented .In addition to a supporting easy to use interfacing system which was made using Aurduino.

2) Dealing with an invisible light forced a very specific type of power supply to supply the lamp with its electric current needed for it.

3) The optical treatment effect out of this system will have a good efficiency knowing that a high power lamp and a collimating lens were used.

4) A specific treatment time (1min) was chosen to get the best effect with safe and no harm for the patient. The system will automatically turn of the lamp and stop treatment session.

5) Giving the doctor the ability to give every patient the appropriate times.

5.11 Challenges

1) The high cost of the optical filter and lenses

2) Getting order parts from embedded optical company in America which required a long time until these part reaching .

3) Design the structure of the project

5.12 Recommendations

1) This system can be improved to become a mobile system.

2) When dealing with invisible light a special wave length receptor should be used.

3) Other diseases can be treated if there effective light wave length is chosen.

Coating Curve

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COATING CURVE

297nm Bandpass Interference Filter: 10nm FWHM, OD ≥4.0 Coating Performance
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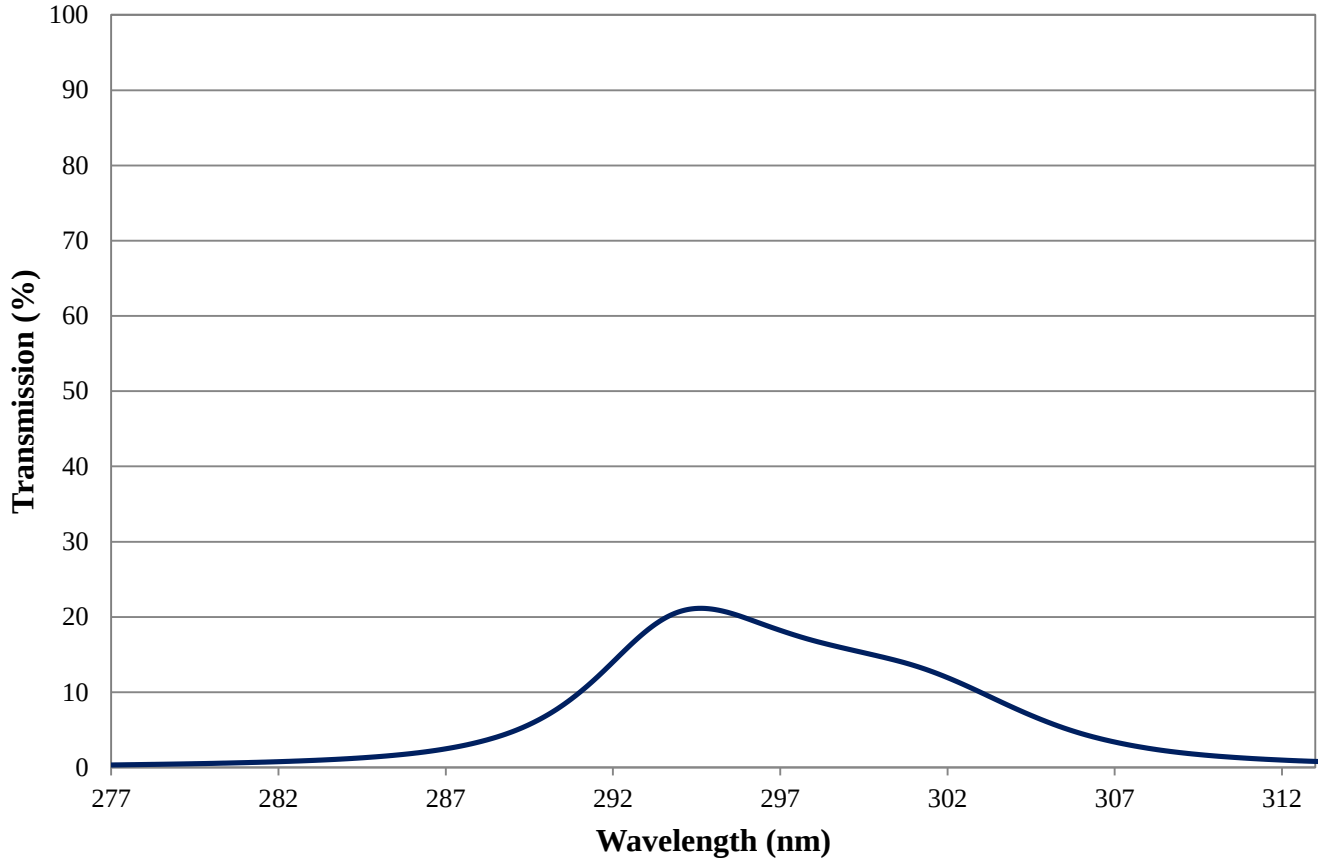

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Coating Curve

Edmund Optics Inc.
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COATING CURVE

313nm Bandpass Interference Filter: 10nm FWHM, OD >4.0 Coating Performance
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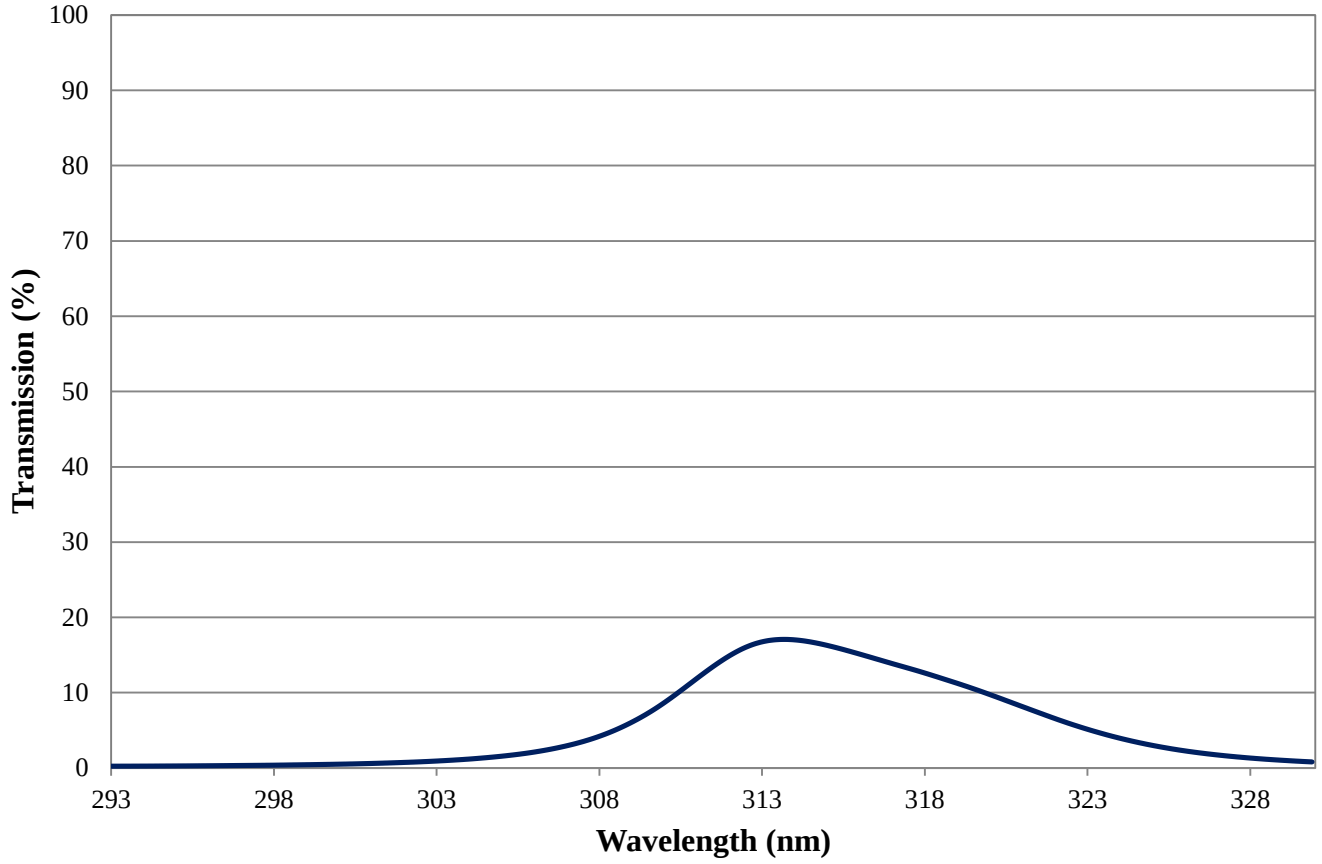

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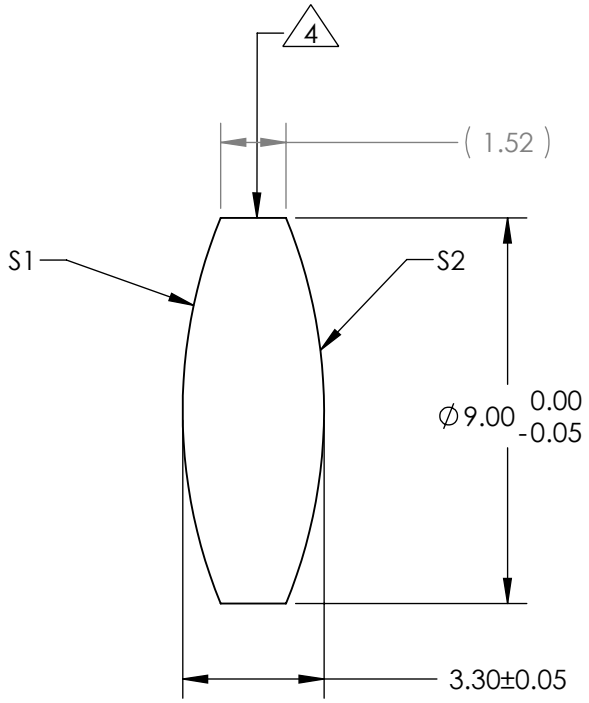
NOTES:

1. ALLOWABLE OPTICAL MATERIAL: GRADE A FINE ANNEALED
   SCHOTT: Fused Silica 458/678
2. CENTERING TOLERANCE:
   BEAM DEVIATION: 3-5 arc min.
3. COATING (APPLY ACROSS COATING APERTURE)
   S1: UV-VIS [400-700nm]
   Rabs ≤1.0% 350-450nm
   Rave ≤1.5% 250-700nm
   S2: UV-VIS [400-700nm]
   Rabs ≤1.0% 350-450nm
   Rave ≤1.5% 250-700nm

△4. FINE GROUND SURFACE

5. FOCAL LENGTH TOLERANCE: ±1%



FOR INFORMATION ONLY:
DO NOT MANUFACTURE PARTS TO THIS DRAWING

	S1	S2
SHAPE	CONVEX	CONVEX
RADIUS	11.84	11.84
SURFACE QUALITY	40-20	40-20
CLEAR APERTURE	8.10	8.10
BEVEL MAX FACE	0.25mm x 45˚	0.25mm x 45˚

EFL (AT 587.6nm)	13.5
BFL (AT 587.6nm)	12.32
ALL DIMS IN	mm

Edmund Optics®

TITLE	LENS UV-DCX 9MM DIA X 13.5MM FL UV-VIS
DWG NO	49258

SO5NF STD

UPC : N/A **Model** : S8213 **Qty.** : 1 *New Product*

Package:

One polybag one piece

Description:

.20g with torque2.8kg-cm (2.8V)3.2kg-cm (6V); wire:
18cm Metal Gea r Servo.

Feature:

- Futaba, JR, Sanwa and Hitec compatible.

Important Notes:

- Specify the connector type when you purchase the servo.
- Refer to the figure when installing the servo accessories.
- For engine powered airplanes and boats, rubber must be used to reduce vibration.
- Please choose correct model for your application.
- Torque over-loaded will damage the servo's mechaniSM-.
- Keep the servo clean and away from dust, corrosive gas and humid air.

Specification

(Specifications are subjected to change without notice.)

Wire (cm)	Size (MM)					Weight		4.8V			6V		
								Speed	Torque		Speed	Torque	
	A	B	C	D	E	g	oz	sec/60°	kg-cm	oz-in	sec/60°	kg-cm	oz-in
18	2.8.8	13.8	30.2			20		0.20	2.8		0.18	3.2