

THE VEIN LOCATOR

**A GRADUATION PROJECT TO
THE GRADUATE SCHOOL OF
NEAR EAST UNIVERSITY**

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Abstract

In this thesis you are going to find a complete explanation of a LED vein finder device with heating system. There are also some researches about heat effects on vasodilation and some information about arm veins. Connection of LEDs and peltier's circuit diagrams are also presented. You will also find some trials and comments about vein finding operation with our device. There are also 5 interviews about our device with health personnel which externalizes their opinions about a LED vein finder device with heating system. Also as you can understand the device is the first of its kind. Because there is no any other led vein finder device with heating system. The idea of heating has founded by one of our group mambers Hasan. Then we have started to make some researchs about the idea to find out it's possibilities. After some searching and asking people who are dealing with blood taking procces they have all commented positivly. With respect to their comments we have started to our project. In this thesis you will see our researches and practices about our device.

1.Introduction

In this report you are going to find detailed information about a LED vein finder with heating system.

The difference of this device is the heating system as you can notice. You are going to find detailed information about the heating system in next pages. The heating system idea was not clear for us because we weren't sure about its function. We know that our veins getting bigger in summer times to lose heat easily. We thought that if local heat can also expand the veins it would be very use full for us to use it in vein finder device. Then we started to search about that information. We have asked 2 different doctors and both of them supported our idea. They said that it should expand the vein and also it will help disperse the medicine. One of the doctors wanted to try the device after it is completed.

(Doctors: Dr.Ahmet Sert from Özel Can Hastahanesi Salihli/Manisa, Dr. Cihangir Cengiz from Özel Doğu Akdeniz Hastanesi Defne/Hatay)

(Nurses: Sercan Tağ, Selçuk Yılmaz, Hülya Sert)

We have also found information through the internet, all of the information was supporting our idea. But there wasn't any active usage of this idea for the vein expanding. As much as we know this is the first trial of that idea.

We hope we can help people in this way.

1.1 Risks of Injection

1.1.1 What diseases can be contracted through unsafe injection practices?

The diseases most frequently transmitted through unsafe injection practice are hepatitis B (estimated 21 million cases per year), hepatitis C (estimated 2 million cases per year) and HIV/AIDS (estimated 260 000 cases per year). In addition, unsafe injections can cause abscesses and lead to septicaemia. Less frequently, haemorrhagic fevers and malaria can also be transmitted.

1.1.2 How many people become infected each year due to unsafe injection practice?

Who estimates that annually 21 million hepatitis B infections, 2 million hepatitis C infections and 260 000 HIV/AIDS cases may be caused by re-use of syringes and needles without sterilization. 1 The viruses that can be transmitted through unsafe injections can remain “silent” in the body for a long time before they cause symptoms. Thus, unsafe injections can lead to a silent epidemic that occurs many years after the original events.

Result: As you can see here there are many risks in injection. In patients whom has thin veins or in the babies the risks are multiplied because to find the vein, nurses trying again and again. Every trying increases the risks of infection 100%. There are some ways to visualize the vein and make the correct shot. Like infrared vein finders and LED vein finders.

Note: The values that we used here are research of World Health Organization in 2011. (Brundtland, 2011)

1.2 Why Do We Need a Vein Finder?



Figure 1: Skin Damage

This picture is one of my friends arm. She gave blood sample 1 week before this photo has been taken. Her arm was worse than this photo. She is saying that I cannot sleep night before the injections. Because she knows that her veins are very thin and they are going to stab the needle times and times again. She is saying that, they are trying minimum 5 times to find the vein and also they are moving the needle inside of the arm to locate the vein. The pain is unexplainable. She also told me that if there was a vein finder and expander, it would very easy for me to go to the hospital. For a normal person this event can be a part of the day easily. But it can be a nightmare for the people with thin veins.

This is just one example for us to improve vein finding technology.

1.3 Further Problems In Thin Veined Patients



Figure 2: Port Wounds

Ports:

In medicine a port is a small medical appliance that is installed beneath the skin. A catheter connects the port to a vein. Under the skin, the port has a septum through which drugs can be injected and blood samples can be drawn many times, usually with less discomfort for the patient than a more typical "needle stick".

Ports were found to be associated with increased rate of infections and are no longer available in the US.

The port is usually inserted in the upper chest (known as a "chest port"), just below the clavicle or collar bone.

You may not be aware of the seriousness of the thin vein problem but it is serious. Because if nurses can not find your vein easily they offer you a port implantation which can causes bigger problems.

1.4 Materials That We Are Going To Use For Isolation

For the heating isolation we are going to use silicon again. Silicone is widely used in isolation area because of its properties.

Here are some of them;

- Does not lose its physical properties in low and high temperatures (-50, 250)
- Doesn't effected by air conditions, radiation, aging or salt.
- It doesn't have any effect on human body because it is an inert material.
- It has very high ark resistance. (in case of any short circuits)



Figure 3: Silicone Insulator

1.5 Why We Don't Use Infrared to Visualize The Veins?

Near infrared waves are short and not hot in fact you cannot even feel them which is what makes them particularly dangerous to susceptible tissues, such as skin and eyes.

Skin exposed to IR provides a warning mechanism against thermal effect in the form of pain. Eyes, on the other hand, may not. Since the eye cannot detect IR, blinking or closing the eyes to help prevent or reduce damage may not happen. IR or near IR [700nm-1400nm], raises the internal temperature of the eye, essentially “baking” it. Medical studies indicate that prolonged IR exposure can lead to lens, cornea and retina damage, including cataracts, corneal ulcers and retinal burns, respectively. That can both effect patient and nurses whom is going to do injection. That's way infrared is not well suitable for visualizing the veins. We are also going to visualize the veins of babies. Their exposure may be more dangerous than the adults.

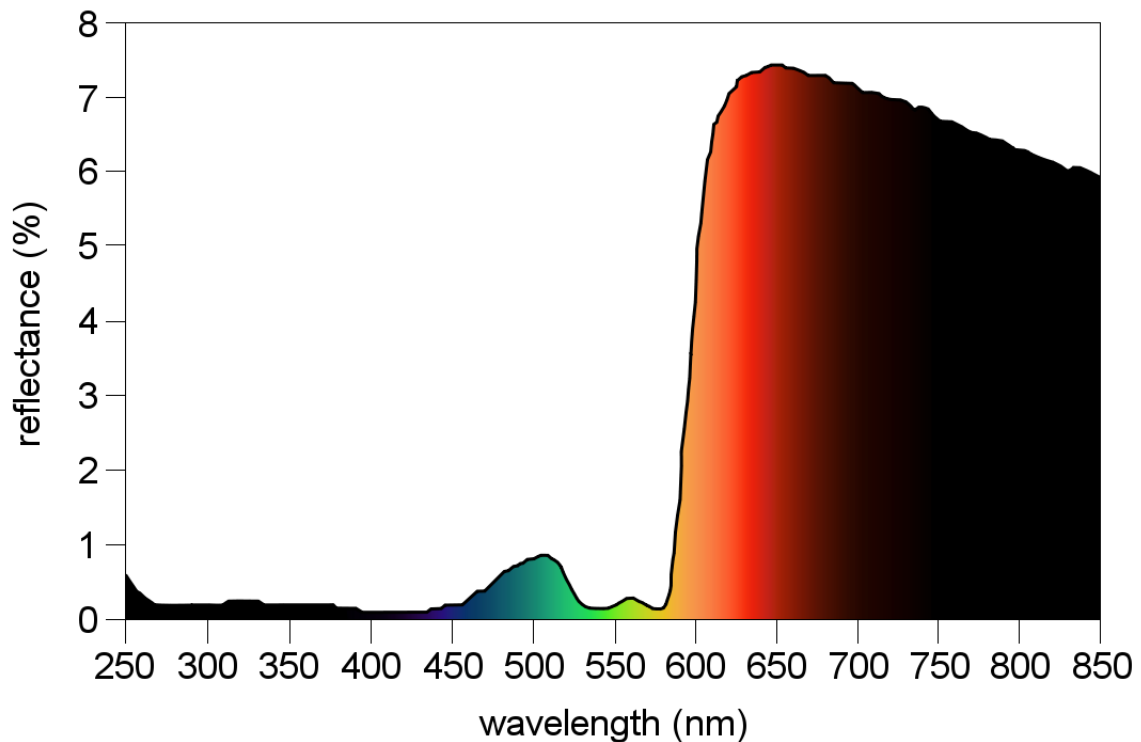


Figure 4: Blood's color spectrum

To choose the right color we should know the blood's repond to light. As we can see here blood is mostly red and orange. So if we use orange and red LEDs the veins going to appear black. (Andrew Hussie, n.d)

1.6 Literature Survey

According to a research in Department of Anesthesiology, St Lukes Roosevelt Hospital Center, Columbia University College of Physicians and Surgeons, New York, USA obesity has decreased the visibility of the veins on African-American or Asian ethnicities, and they have tried VueTek's Veinsite VF device in order to increase the visibility of the vein, Patient characteristic profiles were obtained from 384 subjects (768 observations). Observations has been showed that the visibility of veins for cannulation increased for all subgroups using a new VF device.

Accourding to a research named, Effect of local heating and vasodilation on the cutaneous venoarteriolar response 12 subjects has been experimented. Heater elements, heat sensors, dopler flow probes and radial tonometric devide has been setted on the participians. After applying 42 Celcius for 10 minutes to the skin 0.6 mm enlargement has been observed and also blood flow speed has been increased 26 mm/s. (Jean Charcchafliief, 2015)

1.7 Statistical Data

Graph has been taken from a vein finder device experiment which has the same LED circuit as our VF device.

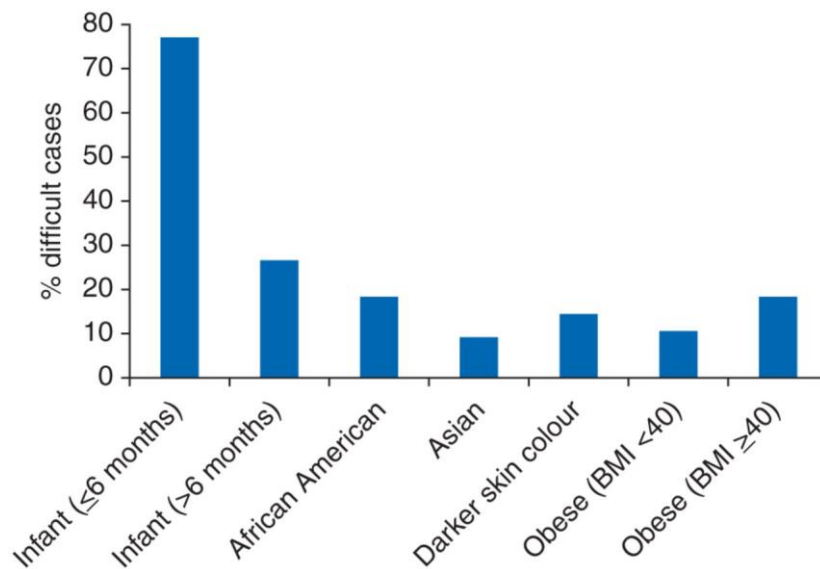


Figure 5: Statistical Data

1.8 Interviews

Before starting to questions we have well explained our device with all the specifications belongs to it to the participants. By knowing that, they have answered the questions.

Questions asked to people who are working in hospitals or clinics. Specially those who take blood sample from patients with a needle.

Questions

- 1- Are you having trouble during blood sample taking operation?
- 2- How frequently are you facing with thin veined patients and what kind of problems you having?
- 3- Is there any device that you are using for thin veined patients?
- 4- Would you want to have our vein finder and expender device?
- 5- What are your advices or comments about our device?

NOTE: We took permission from the participants to be able to use their comments in our reports and presentation.

1.8.1 Interview-1

Name: Hülya Sert

Job: Nurse

Working at: Gölarmarmara İlçe Hastahanesi - Manisa

Address/Tel.: 0 530 306 4398

- 1- In normal patients I am not having any problem because I am an experienced nurse I can be able to detect the right vein. But when a thin veined patient come in front of me I am having some troubles. It is very hard to find their veins. Finding their correct vein is very stressful for me and very painful for them.
- 2- Almost every working day I am facing with thin veined patients. If I need to give a percentage it is about 20%. The main problem with thin veined patients is pain. The operation is really painful. Because to be able to find their vein we are moving needle inside of the skin which creates too much pain. The second problem is appearance of the skin. It took about 10 days for a bruise to disappear from their arms. Maybe it is okay for men but it is not cool for women.
- 3- Actually we don't have any device but we have a rubber. We tie it to the patient's arm which increases the blood pressure and blocks the blood. Which enlarges the vein little bit. In this way it is little bit easy for us to spot the vein.
- 4- It would be very nice for me to have that type of device. Because It is very hard to watch someone having pain in front of you. And it is harder if you are the one who makes the pain.
- 5- My advice to you is do not increase the price. Keep it as low as possible because there are too many people who needs something like that. So this device can be very helpful for them. It is very hard for normal people to understand them. And thank you for your thoughtfulness in developing this device.

1.8.2 Interview-2

Name: Selçuk Yılmaz

Job: Nurse

Working at: Behçet Uz Çocuk Hastanesi-İzmir

Adress/Tel: 0 554 867 2159

- 1- Yes, I am having some problems sometimes but not all the times. I am heaving problems specially with babies. No one wants to stab a needle to a baby.
- 2- Because I am a new nurse I didn't faced to many thin veined patients. But generally I am having trouble with heavy weighed patients. Because their veins are under the fat tissue.
- 3- No there isn't any device. I am using my instincts most of the time.
- 4- Actually I didn't understand the main idea of that device but if it shows me the vein it would be great for me to have it. That time there won't be any problem with thin veined people and would be less stressful working conditions.
- 5- I don't have any comment for you but it would be great if you bring me one of your devices.

1.8.3 Interview-3

Name: Sercan Tağ

Job: Nurse

Working at: Atatürk Eğitim ve Araştırma-Katip Çelebi Hastanesi-İzmir

Adress/ Tel: 0539 944 2003

- 1-** I am having problem with thin veined people and also overweight patients. It is really difficult to take blood sample from them. I am trying minimum 3-4 times to take the blood.
- 2-** I am always facing with thin veined patients. We had to stab the needle too many times in order to find the vein. Thus patients get nervous and when they get nervous I also get nervous and that makes my job more difficult. You may not know but if we can't take blood sample or we can't eject medicine to the body we have to drive patients to the interventional radiology to implant a port in order to make the process easy. And this operation leaves scares on their body because this is a surgical operation. Yes, the port makes our job easy but it is very difficult for the patients to have it. Then also there is a removing operation also. The ports can stand there maximum for 15 years. Did you understand how difficult can be a vein finding operation.
- 3-** There is no any device or method. We are just putting thinner needle tip to be able to go inside the vein. Bigger needle tips can break the vein which can cause internal bleeding.
- 4-** I think it would be great both for me and for the patients. because patients get very nervous during blood taking operation. And on the other hand I has a psychological affect for nurses too. Because when a nurse creates pain on patient both patients and their friends shows overreaction which is degrading.
- 5-** I thing it is a great device. Some times patients' treatments hold up because of blood taking operation. With this device the process will speed up.

1.8.4 Interview-4

Name: SimgeÖksüz

Job: Student at Near East University, Health Sciences Faculty- Nutrition and Dietetics Department

Adress/Tel.: smgoksz@gmail.com - 0533 875 2440

She is a thin veined patient

I am having too much pain during the blood taking operation. Finding my veins are very difficult for the nurses. Every time that I gave blood sample my vessels got damaged and internal bleeding occurs. Which leads bad appearance for at least 1 week. Because my vessels are thin and nurses stab the needle times and times again which causes damage. Since my childhood I never wanted to go to hospital because of that problem. I had cancer 1 years ago and to be able to take the medicine they implanted a port to the left side of my chest. The stress of cancer was enough for me and plus that surgical operation made me very uncomfortable. After defeating cancer removing operation occurred, it was a problem also and the scar of it also remains and reminds me of cancer whenever I see it. I am still afraid of going hospitals and that kind of device would help me a lot.

2. The Vein Locator

The vein locator, help of the visualization of veins at any part of the body by the help of the LED light which use “Side-Transillumination” method to help the vessel entry. What is more, by the help of C shape ring, only the needed part of the body is lighting up.

According to the “Side-Transillumination” method ; the light of Led light shines from the out of the concerned area into the skin. Bright light circle ;is focused under the skin and directed to the centre of the circle. The focused light, under the skin; it’s like a source of imaginary light with a moving focus are constituted of a light volume. This technique provides one way lightening of a small part of tissue area at the any part of the body and it’s not constituted the shadows which are limited the use of another Transillumination Techniques.

Light which is coming from each LED group has specific characteristics which is chosen in order to projecting optimal vein above the different skin tones.

At the same time , red light is also providing the better penetration on the darker skin tones. If it is wanted to projecting the more superficial vein or spider vein , it is used orange leds. If it is scanning the deeper and nourishing veins or the skin which has dark pigmentation are used red leds.

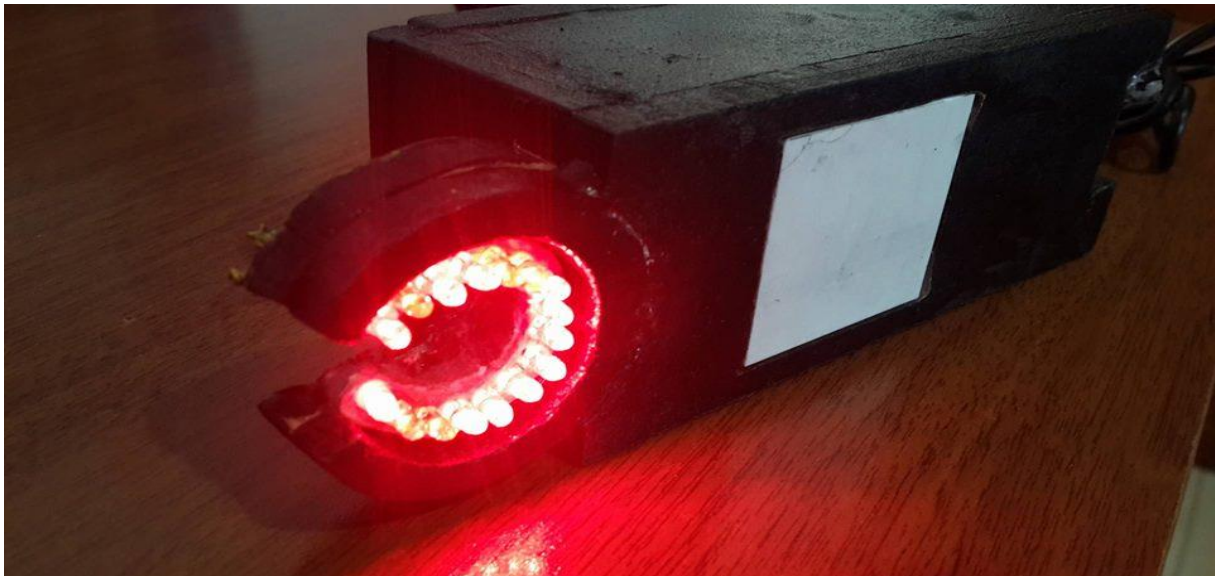


Figure 6: The Vein Locator

2.1 LED CHARACTERISTIC

The characteristics of a red light are optimal in order to projecting the deeper vein. Red light allows to show the deeper vein or artery in easier way and also they are not harmful for the skin when they transmit through the skin. Red leds are also required less power for shining.

At the same time , red light is also providing the better penetration on the darker skin tones. So it can be suitable for every skin color.

The led system contains 16 red leds desing in c-shaped which connected to the chargeable battery. The alignment of leds provide better picture of vessel on the surface of the skin.

The power of the leds adjust by variable resistor. We used variable resistor to adjust and change the light intensity according to the power.

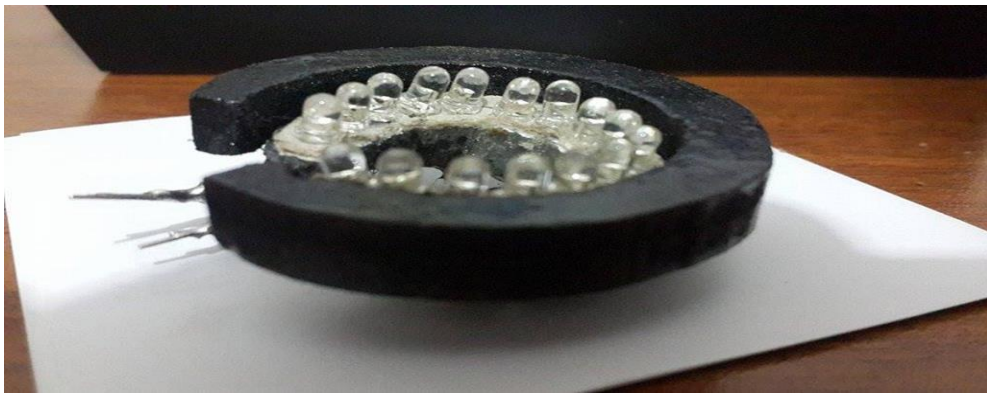


Figure 7: LEDs System

Each LED has a different operating voltage. Before the calculation of the needed resistance value, we should know the red leds and the orange leds operation voltage.

2.1.1 Operation Voltage of the LEDs

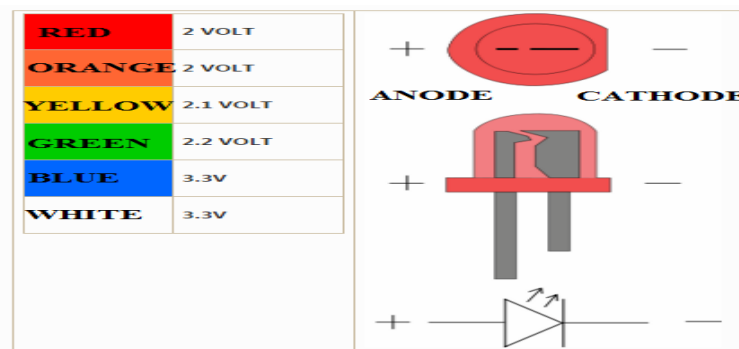


Figure 8: Voltage Distribution

2.2 Circuit System of the Vein Locator

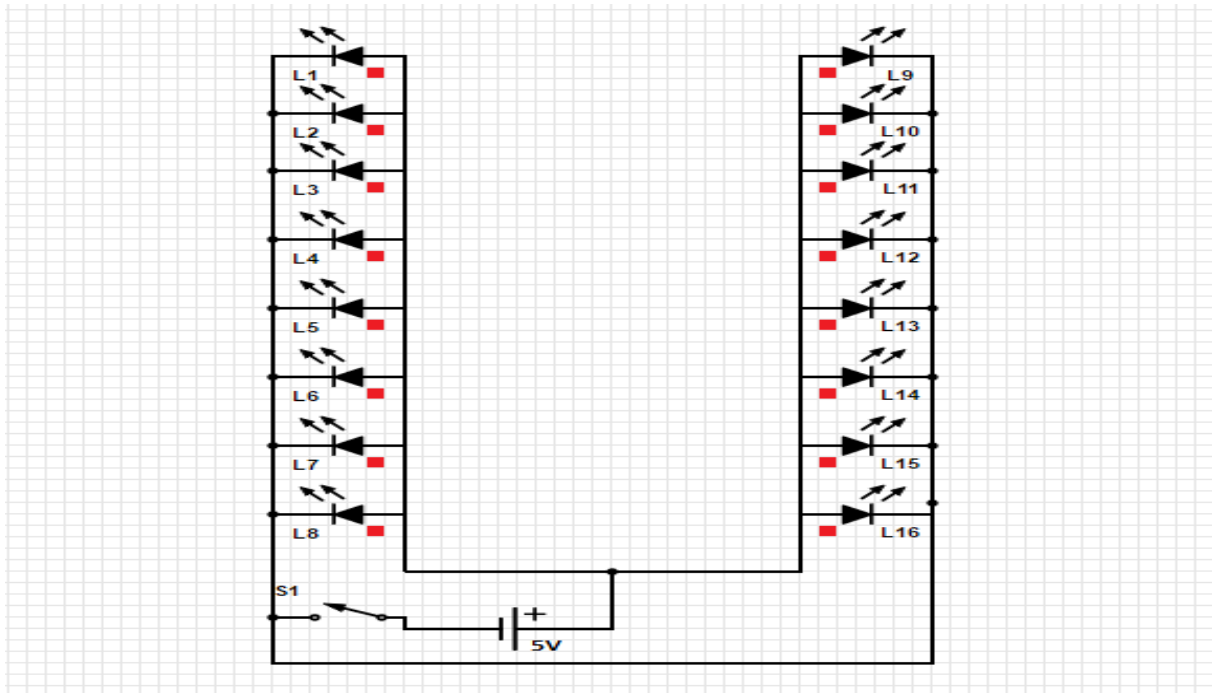


Figure 9: Circuit Diagram

Vein locator consist of 16 leds that are connected parrallel to the each other. 5V source used to feed the led system and also the brightness of led lights adjusted by variable resistor in order to increase and decrease voltage.

2.3 The Heat Source

In addition this, devices also include the heat source. The purpose of using the heat source is to help the vessel to widen for blood taking, which is visualized by the vein locator system.

The Peltier will be used for provide the heat.

Peltier effect; . Peltier (Thermoelectric coolers) create a temperature differential on each side. One side gets hot and the other side gets cool. Therefore, they can be used to either warm something up or cool something down, depending on which side you use. The Peltier effect is a temperature difference created by applying a voltage between two electrodes connected to a sample of semiconductor material. The most common combination of materials in the thermocouples of Peltier elements are the two semiconductors Bismuth and Telluride. This phenomenon can be useful when it is necessary to transfer heat from one medium to another on a small scale. The Peltier effect is one of three types of thermoelectric effect; the other two are the Seebeck effect and the Thomson effect. The semiconductor cubes with extra free electrons are known as N-type semiconductors, while those with few free electrons are P-type semiconductors. The pairs of P and N semiconductor cubes are set up and connected in an array so that the pairs have an electrical series connection, but a thermal parallel connection. When a current is applied to this system, the way the current flows through the semiconductors induces a temperature difference, and causes the heat-sink side of the Peltier element to heat up, and the cold side to cool. (Jean-Charles Athanase, n.d)

2.3.1 An inside view of the Peltier element:

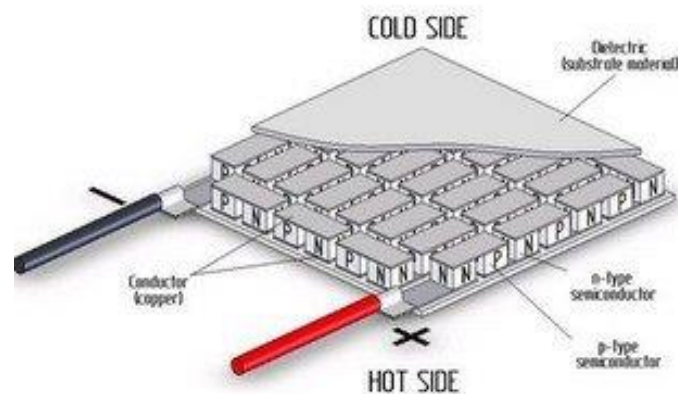


Figure 10: Peltier System

A Peltier element, with ceramic plates to partially insulate the inside from the outer environment.



Figure 11: Peltier

Of course it will be not contact directly with the skin, the insulation will be used to prevent extra heat and supply the security.

2.3.2 Expenses:

- 16 LEDs (12 red) ;..0.16 TL
- 1 variable resistor ;.....0.5 TL
- 5 volt DC output adaptor;.....20 TL
- 1 Peltier;.....22 TL
- Thermal insulation materials.....15 TL
- Circuitry:.....12 TL
- Total:.....~70 TL = 25 \$

2.3.3 Prices of similar devices:

- 1) Veinlite EMS PRO; 279.0 \$
- 2) Veinlite LED; 469.0 \$
- 3) Veinlite EMS; 239.0 \$
- 4) Veinlite PEDI; 188.0 \$
- 5) Handheld Infrared Vein Finder Locator; 1,680.00 \$
- 6) Hospital Injection Vein imaging Viewer Infrared Projection ;3,580.00 \$

3. Biological Application

3.1 Biological Interface of Vein Locator:

Generally, the vein locator used to create reflection image of the blood vessels on the skin by using led system. In addition, vein locator use in clinical environment to via physicians or nurses to help visualization of blood vessels and entrance of the blood vessels during the blood taking process.

In this part of the report is explaining the biological interface of the machine such as blood vessels, arm veins, what is the name of arm veins, the ideal arm vein for blood taking process, their applications, the ideal diameter of the arm veins and the normal blood flow velocity for the arm veins.

3.1.1 Blood Vessels:

Blood vessel are organs of the circulatory system. Their duty is transport blood through the human body. Fundamental types of the blood vessels are the *arteries* which carry blood away from the heart and the *veins* which carry blood from the capillaries back toward the heart. The word vascular, meaning relating to the blood vessels, is derived from the Latin *vas*, meaning vessel.

During blood taking process, most preferable blood vessel are *arm veins*. The most widely used field of the vein locator is visualizing of arm veins easily.

3.1.2 Arm Veins:

There are three types of arm vein that used in the blood taking.

1. Basilic Vein
2. Cephalic Vein
3. Antecubital Vein
4. Median Vein

ANTERIOR VEINS OF THE ARM DETAIL

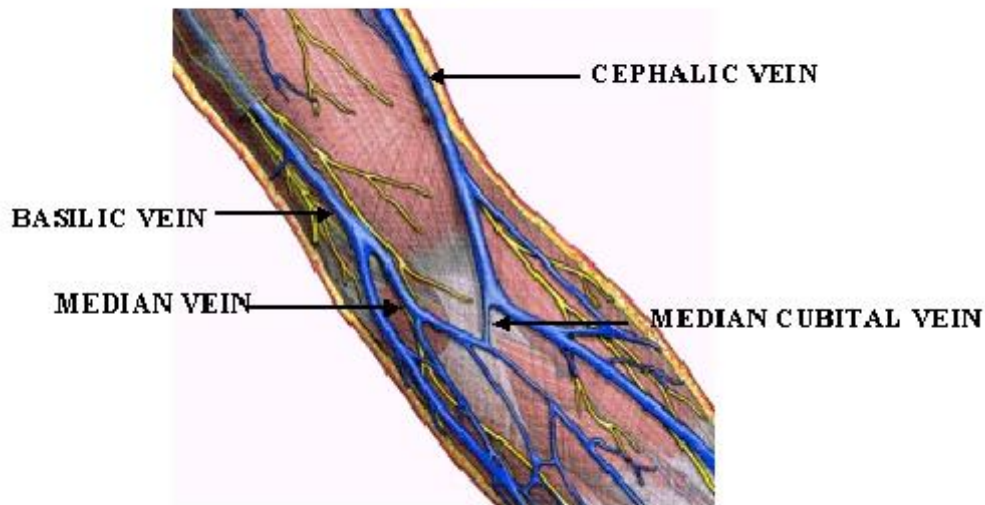


Figure 12: Arm Veins

3.1.3 Features of Arm Veins:

- For opening the peripheral path of vein, arm veins are use.
- The most widely used arm veins are *basilic vein*(vena basilica) and *cephalic vein*(vena cephalica).
- Generally, *basilic vein* is the fist choice for entrance to vein when cephalic vein is used during blood taking that cause difficulty to push forward the injector through the vein. Because cephalic vein join together with axillary veins with vertical angle.

3.2 Structure of Basilic Vein:

The basilic vein passes along the back of the forearm on the ulnar side for a distance and then curves to the surface below the elbow. It continues to move up the medial side until it reaches the middle of the upper arm. There, it enters deep into the tissues and joins the brachial vein. As the basilic and brachial veins merge, they form the axillary vein. (Dr. Duran Karabel, 2007)

3.2.1 What is the normal diameter of the Basilic Vein?

In normal conditions the internal diameter of basilic vein is between the 4.96-5.09 mm for healty people which don't have any disease.

3.2.2 What is the normal blood flow velocity of the Basilic Vein?

In normal conditions the average internal blood flow of basilic vein is about 150mm/s for again healthy people.

3.3 Structure of other arm veins:

Generally, in normal condition without any effect to effect the veins, the diameter of cephalic and median vein has same diameter which is between 2-2.6 mm and its average is 2.5 as a result of research.

The blood flow velocity of all veins are same whic is about 150 mm/s as we work before in basilic vein.

But arteries have more blood flow velocity is about 500 mm/s.

WE WILL USE PELTIERTO EXPAND BASILIC VEIN(VASODILATION) FOR MAKE EASY TO FIND THE VEIN DURING BLOOD TAKING.

3.4 Vasodilation:

Vasodilation refers to the widening of blood vessels. It results from relaxation of smooth muscles cells within the vessel walls, in particular in the large veins, large arteries, and smaller arterioles. In essence, the process is the opposite of vasoconstriction, which is the narrowing of blood vessels.

When blood vessels dilate, the flow of blood is increased due to a decrease in vascular resistance. Therefore, dilation of arterial blood vessels (mainly the arterioles) decreases blood pressure. The response may be intrinsic (due to local processes in the surrounding tissue) or extrinsic . In addition, the response may be localized to a specific organ (depending on the metabolic needs of a particular tissue, as during strenuous exercise), or it may be systemic.



Figure 13: Vein Entry

3.4.1 Vasodilation of basilic vein by using heat source:

As we know the normal diameter of basilic vein is around 5 mm for people without any disease. But in old people, in children, in obesity and in the cold weather the basilic vein is become narrow. So in this point we will apply heat source on basilic vein, make it expand which cause vasodilation. When the heat source will active, the diameter of the basilic vein increase between 1.28-1.84 mm and it becomes suitable condition for blood taking. Also expanding basilic vein may lead to increase blood flow velocity (normal 150mm/s) which make easy blood taking again.

3.5 What is the most ideal amount of heating?

We want to expand basilic vein by using heat source. But when we use heat source, the amount of source must just increase the diameter of vein it should not be burn the people skin. So the ideal value of heating is about 40-45 degree celcius which just expand the vein.

Lastly, we will use variable resistor (potentiometer) in heat source to set the heat at ideal condition about 40 degree celcius.

4.Result

	Age	Sex	Skin Color	Body Type	Feedback
Subject 1	23	Male	Light-Skinned	Thin	Arm veins visualized easily
Subject 2	25	Male	Light-Skinned	Normal	Arm veins visualized easily
Subject 3	24	Female	Light Skinned	Over weight	Had some issues, but arm veins visualized
Subject 4	23	Female	Light Skinned	Fat	Very difficult to visualize the veins, veins seen barely
Subject 5	16	Male	Blond	Thin	Arm veins visualized easily
Subject 6	48	Female	Light Skinned	Normal	Arm veins visualized easily
Subject 7	55	Female	Blond	Fat	Very difficult to visualize the veins, veins seen barely
Subject 8	23	Male	Light Skinned	Fat	Had some issues but arm veins visualized
Subject 9	24	Female	Light Skinned	Over weight	Very difficult to visualize the veins, veins seen barely
Subject 10	23	Male	Dark Skinned	Over Weight	Had some issues but arm veins visualized

5. Discussion

Our device is already an improved version of current market devices. There is no any other device which is more advanced than our device in LED vein finder device market. But as we study our device and try it on patients we have seen some absences. Actually it is enough for a blood taking operation but there are some ideas which can make the device better.

First improvement may the sterilization liquid. If we could put a pumping system under the device. It could sterilize the area which is going to be used for blood taking.

Second one is the size. Actually it is not an improvement but if we could find a smaller battery, we would build the device smaller which could lead to easy operation of the device during blood taking operation.

Thirdly if there could be an opportunity for us to make more LED heads for different body parts. Actually it is not necessary because our device is for arm veins. But different LED specifications can help us to visualize other veins in our body.

Also our heating system is constant at 55 Celsius but it may not necessary to give 55 Celsius every time. So if there would be a variable resistor and heat sensor which shows the given heat it would be more useful for the user.

6. Conclusion

In conclusion, the vein locator is a device that used to imaging blood vessels on the arm. We use led instead of infrared lamp because infrared is very harmful which damage the human skin and it spread harmful rays.

We can desing 24 leds in the c-type shape and connect these in parallel circuit. We use rubber materials to cover the leds and use variable resistor to control the voltage and current.

In addition we use heat source to expand blood vessels which is about 40 degree celcius. Rubber and silicone materials used to cover the leds and for supplying insulation.

In biological way, vein locator usually used on arm veins which are basalic,cephalic and median veins and this device reflects the light on the skin to show these veins during the blood taking process.

As a result the vein locator help physicians in a way and supply easier progress to them.

7.References

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