iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** I **Month of publication:** January 2021

DOI: https://doi.org/10.22214/ijraset.2021.32788

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue I Jan 2021- Available at www.ijraset.com

Smart Therapeutic Treatment for Varicose Disease

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Abstract: ***The vein that carries the deoxygenated blood gets nodule and thick due to defect in their valve which becomes varicose veins. These are most common in legs. These varicose veins are caused by damaged or weak valves of veins that facade to collection of blood in the vein which increase the pressure and cause pain. Mostly the treatment for varicose vein is by invasive methods such as surgery, laser therapy, RF endogenous therapy and sclerotherapy. In any surgery, the first important aspect is an insertion of an intravenous (IV) catheter. The major problem face by the physicians is hazard in accessing vein for IV drug delivery or taking blood samples for test. In case that children, adults, critical care patients etc. It is very difficult task. Unnecessary puncturing of veins occurs due to poor visibility. Wrong puncturing may leads many problems such as blemish or permanently damage the vein. To overcome from these problems there is a need of vein disclosure system. We propose sensor used wearable socks based non-invasive diagnostic& therapeutic solution for varicose vein using thermal and vibration therapy. Since it is a non-invasive method, it gives the patient to aesthetic relief from their pain without pain with IoT based diagnostic and therapeutic solution.***

Keywords: Scelerotheraphy, Force Sensor, Peltier Crystal, Anklet Accelerometer.

I. INTRODUCTION

Varicose veins are inflamed veins that can be seen nether the surface of the skin, more appears in the legs because it is where it exerts more force to charge the weight of the torso, but are not the only places where varices can glaring . In addition, they can cause mild pain, blood clots, skin sores and itching .Confer to the WHO (World Health Organization), varicose veins are superficial, cylindrical or vascular veins and can be caused by many factors such as: sedentary lifestyle, pregnancy, exposure to heat, overweight, wear tight clothes and shoes, etc. Its main function is to prevent the return of blood to the heart repeatedly, so the veins of the body tend to degenerate and more if you live sedentary, the most common areas are the legs. According to the WHO, varicose veins are a very common problem that almost 10% of the world population suffers; the rate is higher in women, in addition, the risk of developing varicose veins increases with age, with 35% of active people and increases between 50 to 60% when it comes to a sedentary lifestyle.

Varicose veins are classified by grades from I to IV, usually begin as an aesthetic problem showing a thin turquoise blue lines, giving the sensation of itching, heaviness and fatigue, then when going up grade, varicose veins can be freak out in the surface of the skin with small swellings and finally if they are not treated in time or the damaging factors of varicose veins continue to be applied, they can produce ulcers, internal circulation failures and inflammations of large areas in the leg2.The detection of suspected varicose veins in the legs early can help prevent hasten progress, although it is a medical condition that progresses slowly, is aggravated when they are shown superficially, in addition to feeling itching, cramping, etc. which are some symptoms of early varices. If in the event an early detection and healing process is displaced, the symptoms are ulcers, inflammation and swelling, bleeding from the veins near the skin and finally sensibility in the legs.

The vein that carries the deoxygenated blood gets bulged and thick due to deformity in their valve which becomes varicose veins. These are most common in legs. These varicose veins are caused by impaired or weak valves of veins that lead to collection of blood in the vein which increase the pressure and cause pain.

Mostly the treatment for varicose vein is by invasive methods such as surgery, laser therapy, RF endogenous therapy and sclerotherapy. In any surgery, the first important aspect is an insertion of an intravenous (IV) catheter. The major problem face by the physicians is adversity in accessing vein for IV drug delivery or taking blood samples for test. In case that children, adults, critical care patients etc.

It is very difficult task. Redundant puncturing of veins occurs due to poor visibility. Wrong puncturing may leads many problems such as blemishes or permanently damage the vein. To overcome from these problems there is a use of vein detection system. We propose sensor used wearable socks based non-invasive diagnostic & therapeutic solution for varicose vein using thermal & vibration therapy. Since it is a non-invasive method, it gives the patient to aesthetic relief from their pain without pain with IoT based diagnostic and therapeutic solution.

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A. *IoT in Healthcare*

Before Internet of Things, patients' synergies with doctors were limited to visits, and text communications. There was no way a doctor or hospitals keep monitor patients' health continuously and make recommendations accordingly. According to recent research, by 2020, 40% of IoT devices will be used in the healthcare industry, while today; the medical IoT has a 22% share of the whole IoT market. Always, more than 60% of medical organizations worldwide are already implementing IoT solutions. In the upcoming years, the number of patients and specialist in healthcare using IoT-connected devices for health monitoring will grow by 44.4% every year. The Internet of Things in healthcare can be a explanation to a number of problems that have accompanied medicine throughout history. The Internet of Things and healthcare can commonly give great results.

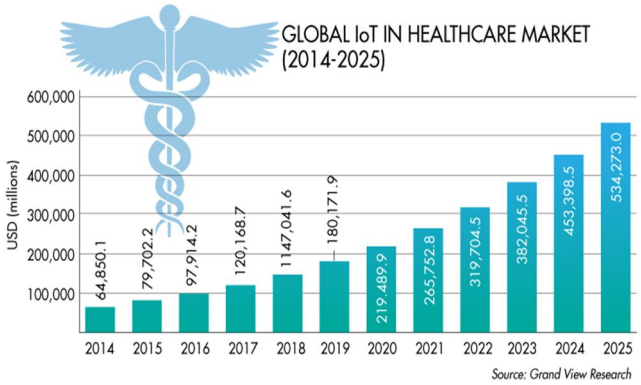


Fig 2.1 Global IOT in HealthCare

Internet of Things (IoT)-empowered machinery have contrived remote monitoring in the healthcare sector possible, unleashing the potential to keep patients safe and healthy, and empowering physicians to deliver superlative care. It has also expanded patient engagement and fulfillment as interactions with doctors have become easier and more efficient. Moreover, remote monitoring of patient's health helps in constricted the length of hospital stay and prevents re-admissions. IoT also has a major brunt on reducing healthcare costs naturally and improving treatment outcomes. IoT is undoubtedly revamping the healthcare industry by redefining the space of devices and people interaction in delivering healthcare solutions. IoT has applications in healthcare that assist patients, families, physicians, hospitals and insurance companies.

B. *Uses of IoT in Healthcare*

The assortment of uses of IoT in healthcare doesn't limit with smart watches or bracelets that monitor our heart rate. There are torrent of hardware and software startups that do their best to provide high-end solutions for current healthcare problems and leverage the benefits of Internet of Things in healthcare applications.

1) *Cardiomo:* Cardiomo is a product drafted to monitor the state of a body. It is a special sticker with sensors that track elemental biometric parameters such as body temperature, pulse, pressure, etc. All this knowledge is then transmitted to a dedicated mobile application. The planner position Cardiomo as a product that allows **monitoring of the status of elderly patients**. However, this device can be used at any age. Cardiomo may soon be introduced into professional medicine.

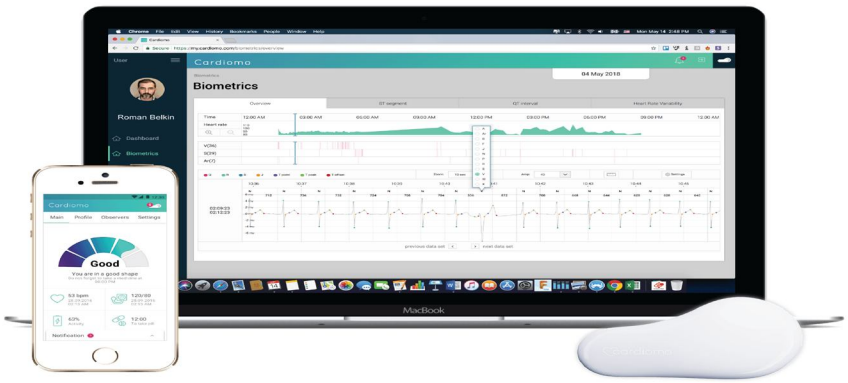


Fig 2.2 Cardiomo

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2) *Elvie Pump:* Elvie Pump is a apparatus that will be useful for new mothers. It is an contemporary breast pump that works absolutely silently. The idea was to develop a device that doesn't require any physical effort. Elvie Pump has become just that. the breast pump is portable and very compact. Just place it on your chest and press the power button. No more effort is needed. You can attach the device to the free Elvie Pump app to monitor milk volume, browse pumping history for each breast, and turn on/off the pump remotely. The device is completely microscopic and has a minimum weight, so it can be installed, for example, before a walk. Smart Hospital by Z-works is a full-grown virtual hospital. Its creators afforded the ability to read a huge amount of data, from body temperature to motion features. In total, Smart Hospital is able to access and analyze more than 20 types of data. In addition, Smart Hospital grants choosing the appropriate treatment method, depending on the information obtained from the analysis of biometric parameters: heart rate, breathing rate, body temperature, etc. The developers considered that Smart Hospital is able to save people from a long wait for medical care in the future.
3) *Aira:* The problems that blind and visually impaired people commonly face have always been very acute. The startup Aira offers a solution. The company conspires with **Google Glass** and is developing an add-on that will offer audio tips. Thus, it will be much smoother for a blind person to move around the city. To run Aira, you need to touch the glasses sensor three times, which in turn will call an assistant - a member of Aira support team. After touching it three times, this assistant receives the depiction and all the information about the wearer: the history of their illness, their current location, contacts of people who need to be contacted urgently in case of an emergency, etc.

C. *Existing Treatments Of Vericose Veins*

For patients with symptomatic veins and large venous incompetence, surgery has been the optimal treatment for many years. Inadequate evaluation and operations done to inferior standards gave varicose vein surgery a suspect reputation, but in recent years thorough treatment by interested specialists has become more widespread. Evidence from a recent UK based randomized controlled trial has shown that varicose vein surgery is both clinically and cost effective (within the normal parameters of the National Health Service).Nevertheless, varicose veins may gradually recur by a process of neovascularisation (regret and enlargement of veins) even after thorough surgery, or they may develop elsewhere in the legs.

1) *Conventional Surgery:* This intermittently means saphenofemoral ligation (not just a "high tie" but ligation of the long saphenous vein flush with the femoral vein) with stripping of the long saphenous vein and phlebotomies (stripping is supported by evidence from randomized controlled trials). Precise technique varies, mostly with the aim of reducing postoperative bruising. Patients with obese legs or big varicose veins may have considerable post-operative bruising, but many patients have little discomfort and recover quickly, requiring no further intervention and being completely rid of all their varicose veins.
2) *Radiofrequency And Laser Ablation:* These are substitute to stripping of the long saphenous vein. If done without any other kind of treatment they may cause some varicose veins to abandon, but usually varicose veins need to be dealt with by phlebectomies or sclerotherapy. Radiofrequency and laser ablation each comprise passing a probe up the long saphenous vein from knee level to the genitals under ultrasound guidance and then ablating the vein in sections. This avoids a genitals incision and may lead to less bruising and quicker recovery. These benefits have been documented in small randomized studies for radiofrequency ablation and by large case series for both methods, but the scale of the advantages remains uncertain. Some surgeons use these techniques under local anesthetic infiltration rather than general anesthesia. The precise place of laser and radiofrequency ablation remains uncertain. They require dedicated equipment and use of intraoperative duplex ultrasonography, and they take longer to do than conventional surgery in experienced hands. The amount of benefit for patients is variable: obvious varicose veins still need to be treated, and phlebectomies of large veins are often the main cause of bruising and discomfort after the operation—not the groin incision. Varying longer term results (two to three years) have been reported, but in general fallout seems similar to those of surgery. It has been implied that endogenous ablation techniques may lead to less neovascularisation in the groin than surgical dissection, so reducing this cause of recurrence of varicose veins.

D. *Sclerotherapy*

1) *Conventional Sclerotherapy:* This comprises injection of a sclerosant—commonly sodium tetradecyl (STD) or polidocanol—into varicosities, followed by a period of compression bandaging and/or compression hosiery. There is little good demonstrate on how long compression needs to be worn and advice varies from a few days to three or four weeks. The main risk of sclerotherapy is injection farther the vein, which can result in local tissue necrosis and scarring.

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Conventional sclerotherapy is a clinically and cost effective treatment for smaller varicose veins, particularly those that are not subject to upstream incompetence and those below the knee. However, its results are not long lasting in the existence of saphenofemoral reflux (the most usual situation for varicose veins with troublesome symptoms): a randomized controlled trial found that most varicose veins recur within five years. Sclerotherapy became popular in the 1970s, but its use then declined because so many varicose veins recurred.

2) *Foam Sclerotherapy:* This involves mixing sclerosant with a small quantity of air (or other gas) to produce foam that spreads rapidly and widely through the veins, pushing the blood aside and causing the veins to go into spasm. This is regarded to increase the effectiveness of sclerosant in obliterating long segments of superficial veins. Duplex ultrasonography is used to guide placement of the injecting cannula in the chosen vein and to monitor spread of sclerosant through the veins. The treated leg is bandaged, and compression hosiery is advised for up to a month after treatment. After treatment, larger varicose veins are commonly hard and outstanding for many weeks before they gradually shrivel. Further sessions of foam treatment may be enforced for extensive or bilateral varicose veins.

II. RELATED WORKS

Ruizong Zhu1, Huiping Niu (2019) "Analysis of Varicose Veins of Lower Extremities Based on Vascular Endothelial Cell Inflammation Images and Multi-Scale Deep Learning" – IEEE, 2019.

Obtained images of vascular endothelial cells in patients with varicose veins of the lower extremities and normal subjects &convolution layers extract multi-scale features of vascular endothelial cell images. The MFM activation function is used to introduce a competitive mechanism that extracts more features that are compact and reduces network layer parameters. The network uses a 3×3 convolution kernel to improve the network feature extraction capability and use the 1×1 convolution kernel for dimensionality reduction to further streamline network parameters.

Naomi Christianne Pereira1, Jessica D'souza(2019) "Obesity related disease prediction from healthcare communities using machine learning" – IEEE, 2019 Machine learning based obesity & varicose prediction. Pick the most suitable algorithm with the best accuracy through ROC, Confusion Matrix, and Calibration Plot and test it with various sampling schemes.

Gennady Victorovich Savrasov (2019) "Comparison of Mechanical Parameters of the Great Saphenous Vein under Various Test Conditions" – IEEE, 2019

They were studied by comparison between mechanical parameters of veins using uniaxial tension in air at a room temperature and in the sodium chloride solution at 37°C. Due to the substantial nonlinearity of the stress-strain data and the lack of suitable constitutive equation the proposed parameters for comparison were maximum stress, maximum strain and Young's moduli at small and large strains.

AkshayNagrel (2019) "Varicose Veins of Lower Limb: Clinical Presentation and Management" – Research gate, 2019.

This existing system has been carried out to studied demographic factors; evaluate clinical presentation and outcome of various modalities of management of varicose veins of lower limb. All patients underwent clinical tests and venous Doppler and accordingly appropriate treatment in the form of conservative, surgical or endogenous laser ablation was given. Complications following the procedures were studied. Results: A total of 39 (72%) patients out of 54 were below the age of 50 years. A prominent vein over lower limb was most common presentation. Sapheno-femoral junction was most commonly involved vein. Male preponderance was observed with a male to female ratio of 12.5:1. Venous Doppler had accuracy of 92.59% in detecting sapheno-femoral and perforator incompetence. Results of endovenous laser ablation are similar to surgery but with less morbidity. This system studied revealed the disease is prevalence in active phase of life with male preponderance. Majority of the patients had great saphenous vein incompetency and the complications are more when both great saphenous and perforator systems are involved. Venous Doppler is the investigation of choice as it has high accuracy

Dr. RahamBacha (2013) "Doppler Ultrasound in the Assessment of Lower Limb Peripheral Veins" –Research gate 2013.

Different provocative measures were used for the diagnosis of venous pathologies. Compression technique, echogenic contents and color Doppler were used for the diagnosis of deep vein thrombosis, Valsalva and augmentation techniques were used for chronic venous insufficiency, low frequency transducer was applied for deep located veins. Collected data from the examination was compared with Clinical, etiological, anatomical and pathological (CEAP) classification System. Results: Among 100 patients 81(81%) females and 19 (19%) males were diagnosed for different venous diseases i.e. chronic venous insufficiency and DVT with diverse presentation of venous reflux, dilated perforators, and varicose veins. DVT was observed in 9 Legs, (Left 55.5%, right 45.5%). Right and Left leg ratio for varicose veins was 1:2. Along with other sonographic signs of chronic venous insufficiency, dilated incompetent perforators observed in 51% of individuals

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III. PROPOSED DESIGN

Vein detection is one of the latest biomedical approaches
researched today. While the concept behind the method is simple, there are various challenges to be found throughout the design and implementation of a device concerning the lighting system and machine learning – decision tree algorithms at a very low price. The major problem confronted by the doctors today is difficulty in accessing veins for intra-venous drug delivery. With ill-advised detection of veins, several problems like bruises, rashes, blood clot etc. occur. Therefore a non-invasive subcutaneous vein detection system has been developed success-fully based using SPO2 sensor, flex sensor, force sensor, accelerometer sensor & tilt sensor to find early varicose validating in the diagnosis of a venous thrombosis using machine learning and therapeutic solution in treatment of varicose veins done with help of Peltier crystal and vibrator which is provides blood flow evenly using heat & vibration. Non-invasive therapy method does not need a catheter or any incision that makes a way for the operation; it takes very less time for the procedure as well as for the recovery. In view of this wearable socks, we are using SPO2, force sensor, accelerometer sensor, flex sensor & tilt sensor to monitors the blood flow, pressure and long time standing which reduces blood regulation inside body leads to varicose vein. This sensor values are fed to pic microcontroller and status will be updated in the app/webpage through ESP 8266 – 12E Node MCU module. Cool & heat energy based therapies can be applied to tissues throughout the body to achieve numerous therapeutics result. It attains a desired treatment effect, reaching a temperature to the target tissue of at least about 50ºC. Low cost wearable device based sock therapy, we would like to use the peltier crystal & vibration to treat the varicose vein non-invasively and increases blood flow inside veins. Non-invasive therapy method does not need a catheter or any incision that makes a way for the operation; it takes very less time for the procedure as well as for the recovery. In view of this wearable socks, we are using SPO2, force sensor, accelerometer sensor, flex sensor & tilt sensor to monitors the blood flow, pressure and long time standing which reduces blood regulation inside body leads to varicose vein. This sensor values are fed to pic microcontroller and status will be updated in the app/webpage through ESP 8266 – 12E Node MCU module. Cool & heat energy based therapies can be applied to tissues throughout the body to achieve numerous therapeutics result.

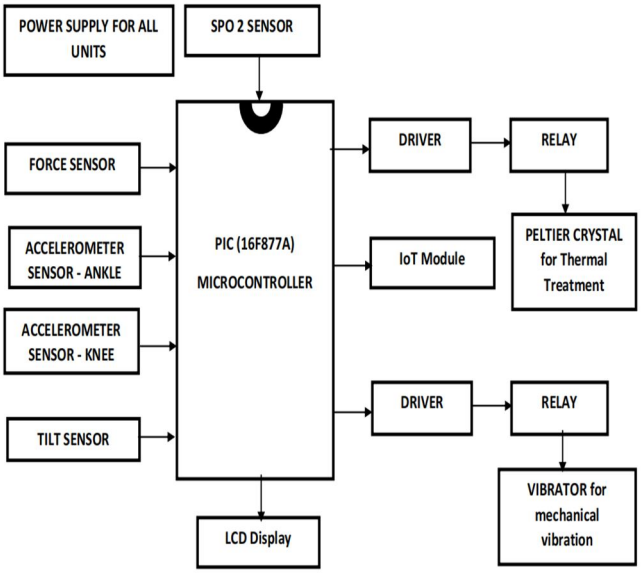


Fig 3.1 System Architecture

It carries out a desired treatment effect, reaching a temperature to the target tissue of at least about 50ºC. Low cost wearable device based sock therapy, we would like to use the peltier crystal & vibration to treat the varicose vein non-invasively and increases blood flow inside veins .In this thermoelectric therapy there are two ways of treatment, one by thermal and another by non thermal- Mechanical.

A. Mechanical Vibration Therapy

It uses pulses of sound waves to penetrate tissues. While this still has a minor melting implement on the tissues, it also causes expansion and contraction in the tiny gas bubbles of the soft tissues. This helps to decrease the intemperate response, reducing tissue swelling and thus decreasing pain. The best way for treating varicose vein non-invasively will be by mechanical therapy.

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B. Thermoelectric Therapy

Thermal therapy uses a more continuous transmission of sound waves. The sound waves cause microscopic vibrations in the deep tissue molecules, a temperature difference by transferring heat between two electrical junctions and increasing heat and friction. The warming effect encourages curative in the soft tissues by increasing the metabolism at the level of the tissue cells.

C. Accelerometer

An accelerometer is a device that determines proper acceleration; proper acceleration is not the clone as coordinate acceleration (rate of change of velocity). For illustration, an accelerometer at rest on the surface of the Earth will calculate acceleration due to Earth's gravity, straight upwards (by definition) of $g \approx 9.81\ m/s^2$. By diverge, accelerometers in free fall (falling against the center of the Earth at a rate of about $9.81\ m/s^2$) will measure zero. Accelerometers are equipment that computes acceleration, which is the rate of change of the velocity of an object. They determine in meters per second squared (m/s^2) or in G-forces (g). A single G-force for us available on planet Earth is identical to $9.8\ m/s^2$, but this does vary slightly with elevation (and will be a different value on different planets due to variations in gravitational pull). Accelerometers are favorable for sensing vibrations in systems or for orientation applications.

D. TILT Sensor

A tilt sensor is equipment that is used for measuring the tilt in multiple axes of a reference plane. Tilt sensors compute the tilting position with reference to gravity, and are used in numerous applications. It allows you to detect orientation or inclination. They are small, inexpensive, low-power and easy-to-use. Their modesty makes them popular for toys, gadgets and appliances. They are indicated to as "mercury switches", "tilt switches" or "rolling ball sensors". The tilt sensor is a factor that can detect the tilting of an object. However it is only the identical to a pushbutton activated through a different physical mechanism. This type of sensor is the environmental-friendly report of a mercury-switch. These sensors consist of a rolling ball with a conductive plate below them. When the sensor gets capability, the rolling ball falls to the bottom of the sensor to form an electrical connection. When the sensor is tilted, the rolling ball doesn't spill to the bottom so that the current cannot flow the two end terminals of the sensor. This basic tilt switch can efficiently be used to detect orientation. Inside the car are pair of balls that make contact with the pins when the case is upright. Tilt the case over and the balls don't touch, thus not accomplishing a connection. There are numerous uses for these basic sensors, but keep in mind you might need to use some denouncing code, as the sensor isn't immune to small vibrations.

E. SPO2 sensor

SpO_2 is analysis of the amount of oxygen attached to the hemoglobin cell in the circulatory system. Put transparent it is the amount of oxygen being carried by the red blood cell in the blood. SpO_2 Is given in as a proportion, normal is around 96%. The "S" stands for saturation. Pulse oximetry is a non-invasive method to grant the monitoring of the oxygenation of a patient's hemoglobin. A sensor is placed on a microscopic part of the patient's body, effectively a fingertip or earlobe, or in the case of an infant, across a foot. Light with red wavelengths and light with infrared wavelengths is conclusively passed from one side to a photo detector on the other side. Developing absorbance of each of the two wavelengths is measured, conceding determination of the absorbance due to the pulsing arterial blood alone, excluding venous blood, skin, bone, muscle, fat, and (in most cases) fingernail polish. Based upon the ratio of changing absorbance of the red and infrared light caused by the difference in color between oxygen-bound (bright red) and oxygen-unbound (dark red or blue, in serious cases) blood hemoglobin, a measure of oxygenation (the per cent of hemoglobin molecules bound with oxygen molecules) can be made.

F. Force Sensor

Force sensitive resistor with a curved, 0.5" diameter, sensing area. This FSR will vary its resistance depending on how much pressure is actuality applied to the sensing area. The harder the force, the lower the resistance. When no pressure is vitality applied to the FSR its resistance will be larger than 1MΩ. This FSR can sense applied force wherever in the range of 100g-10kg.Interlink Electronics FSRTM 400 series is part of the single zone Force Sensing Resistor family. Force Sensing Resistors, or FSRs, are robust polymer thick film (PTF) devices that display a decrease in resistance with increase in force applied to the surface of the sensor. A Force Sensor is a sensor that helps in evaluating the amount of force applied to an object. By observing the amount of change in the resistance integrity of force-sensing resistors, the applied force can be calculated. Force Sensors is that they respond to the applied force and convert the value into a measurable quantity. The amount of change caused to the resistance values gives the measure of the amount of force applied. Overall length: 2.375", Overall width: 0.75", Sensing diameter: 0.5".

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IV. EXPERIMENTAL ANALYSIS

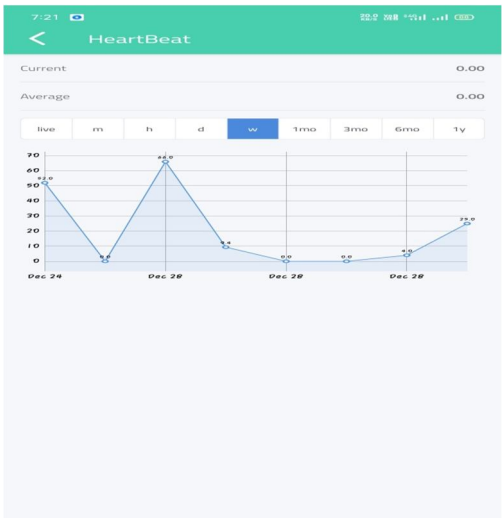


Fig 4.1 Heartbeat Prediction

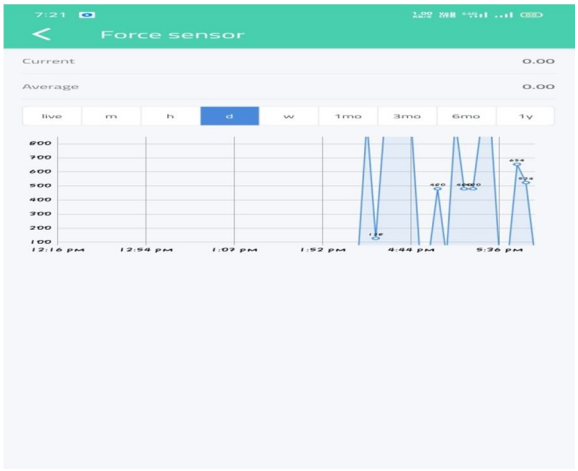


Fig 4.2 Force Sensor

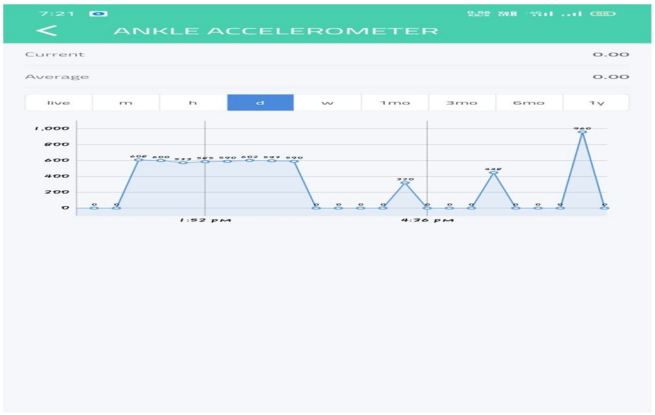


Fig 4.3 Ankle Accelerometer

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V. CONCLUSION

Chronic venous disease (CVD) of the lower extremities is a debilitating health issue with a wide range of symptoms, including varicose veins, excessive leg swelling, heaviness in the legs, and ulceration In this paper a sensory system based on accelerometer, force sensor & SPO2 sensor unit was proposed for lower leg movement detection. An experimental procedure was designed to assess the proposed sensory system for leg movement detection in 3 different body postures of sitting, standing and walking. Collected sensory data from a male subject is processed and analyzed in the subsequent section. Collected sensory data from a male subject is processed and analyzed and also monitored through IoT. IoT achieve a desired treatment effect, reaching a temperature to the target tissue of at least about 50ºC. Low cost wearable device based sock therapy, we would like to use the peltier crystal & vibration to treat the varicose vein non-invasively and increases blood flow inside veins. In this thermoelectric therapy there are two ways of treatment, one by thermal and another by non-thermal- Mechanical therapy

VI. FUTURE WORK

As a future work, we want to measure the depth of the varicose veins because if the varicose vein is very deep, it is an indication that it does not need to be superficial to be serious. In addition, not only to analyze varicose veins, also another type of pathology that can be identified through the temperature difference.

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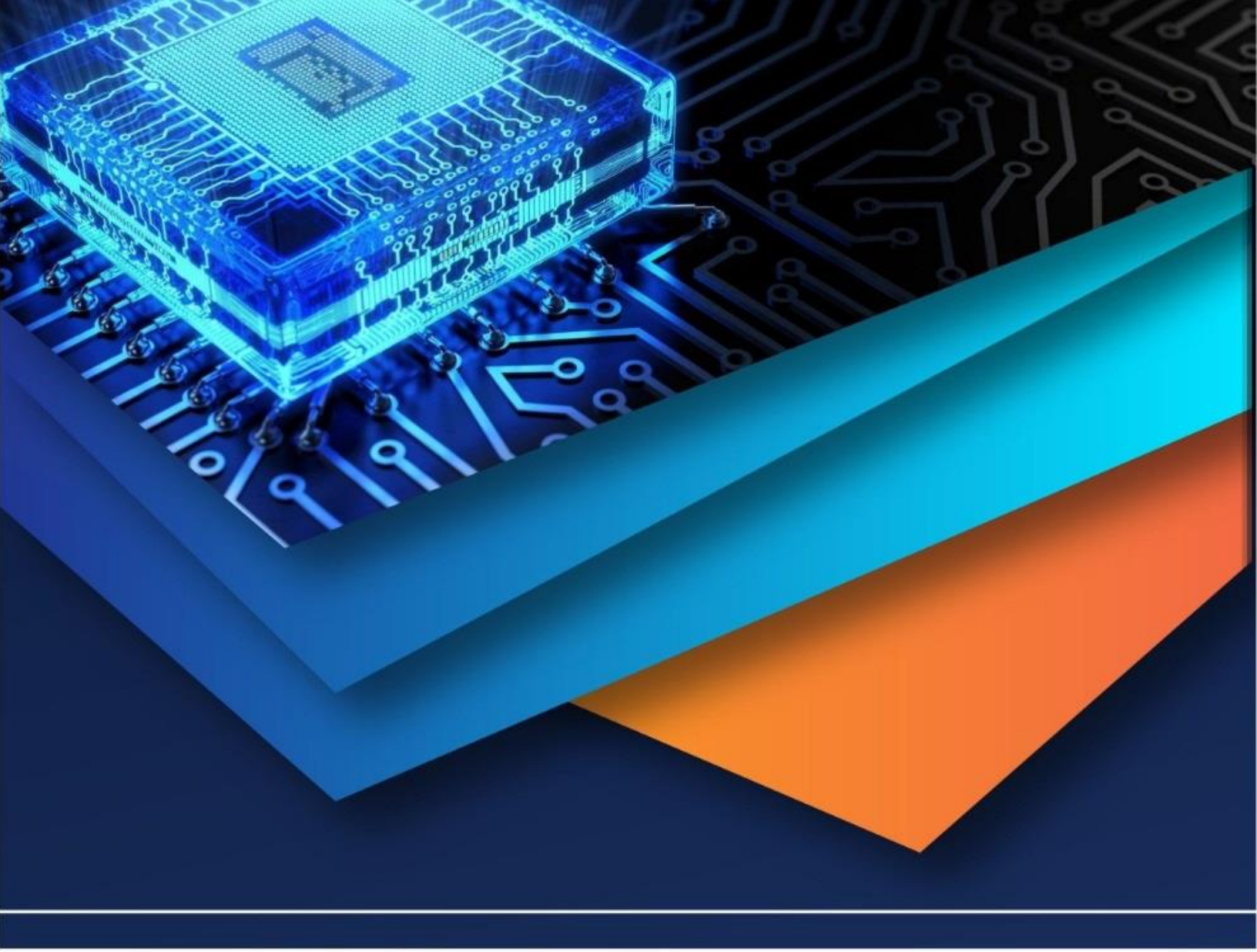
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