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Portable Foot Dorsiflexion for the Treatment of Deep Vein Thrombosis

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Abstract— Deep Vein Thrombosis is a condition where a thrombus is formed in a deep vein situated at the lower extremity of the leg. This clot can block the flow of blood in the leg or may travel to the lungs and cause a potentially fatal pulmonary embolism. The incidence of DVT is particularly high after hip or knee surgery but may occur whenever patients are immobilized over a period of time. The techniques that have been followed to treat DVT have many drawbacks such as the compression devices have limited patient compliance and the blood thinning drugs have limited effectiveness on the clot. Active or passive movement of the ankle, alone or in combination can reduce the incidence of DVT. Since active movement is not feasible by the patient, the treatment device is attached to a patient's ankle to deliver passive movement to promote blood flow. The device includes a battery or AC supply, actuator, lcd, controller, coupling elements like socks, screws etc., The controller performs the logical operation as well as it provides the input to the power driver which supplies the required voltage needed by the actuator for the dorsiflexion movement. The degree of movement can be made visible with the help of lcd , thus by looking at the display we will get to know about the maximum angle beyond which the patient cannot move his/her foot as it produces pain. The patient can manipulate the device with the help of an external switch thereby they will be able to increase or decrease the external force that induces the passive movement.

Keywords— DVT, Passive movement, pulmonary embolism

I. INTRODUCTION

Nowadays many devices are invented to promote painless treatment and doctors are replaced by medical robots. Sophistication is one key factor that has been given greater importance in medical world. About 2 million people are affected annually of deep vein thrombosis out of which for nearly 3 lakh people the DVT turns into pulmonary embolism and they die every year due to this medical condition. Deep vein thrombosis (DVT) is caused by a blood clot in a deep vein and can be life threatening .It occurs at any age. Non-specific signs may include pain, swelling, redness, warmness, and engorged superficial veins. Pulmonary embolism, a potentially life-threatening complication, is caused by the detachment (embolization) of a clot that travel to the lungs. Together, DVT and pulmonary embolism constitute a single disease process known as venous thromboembolism. The three factors of Virchow's triad - venous stasis, hypercoagulability, and changes in the endothelial blood vessel lining (such as physical damage or endothelial activation) - contribute to DVT. Other related causes include activation of immune system components, the state of micro particles in the blood, the concentration of oxygen, and possible platelet activation. One of the important acquired risk factor include major surgery and trauma, both of which may increase the risk because of tissue factor from outside the vascular system entering the blood. In orthopedic surgery, venous stasis may be temporarily provoked by a cessation of blood flow as part of the procedure. Traditionally, the means of improving venous blood flow or decreasing blood clot include medications and a variety of compression devices. Known compression devices include elastic compression stockings, graduated and sequential compression stockings and foot compression devices such as those made under the brand name Medi Strumph or by the Kendall Corporation of Mansfield, Mas sachusetts or the Jobst Corporation of Toledo, Ohio. Use of compression devices are cumbersome, since the care provider must first fit or adapt the device to the varying size and shape of the patient's limb. Furthermore, the difficulty encountered by a user in applying the devices to the limb often results in discomfort and associated decreased patient compliance. An even more serious disadvantage to such devices are the potential detrimental effects of direct compression to the arterial vasculature in patients

with peripheral vascular disease (PVD). For these reasons, other means of preventing DVT, such as mechanical manipulators of the lower extremities, have been developed. There is very little awareness among people about the multiple risk factors caused by DVT.

II. DORSIFLEXION MOVEMENT

Dorsiflexion is defined as flexion of the foot in an upward direction and occurs at the ankle. When our foot is pulled into this rigid position, the toes are higher than the heel while considering a horizontal plane. The primary muscles responsible for dorsiflexion include the tibialis anterior, extensor hallicus longus, extensor digitorum longus, and peroneus teritus. These muscles are part of the anterior compartment of the leg. As per the theoretical study movement of the foot for one minute it will produce a significant and sustained increase in the venous outflow.

Fig.1 Movement of foot

A. Dorsiflexor

The foot flexion device, when applied to the foot or feet of a patient, stimulates circulation and provides physiotherapy. Preferably, the device dorsiflexes the patient's foot or feet, that is, it moves the foot about the ankle joint in a natural motion to thereby move the toes of the foot towards and away from the patient's knee, which in turn exercises the muscles of the foot, ankle and calf to thus achieve enhanced circulation of blood and lymph in the lower extremities and increased flexibility of the joints of the ankle and foot. By performing continuous flexion of the muscles of the lower leg and feet, a foot flexion device provides therapy directed toward preventing both disease and atrophy in the lower extremities.

III. PROPOSED SYSTEM

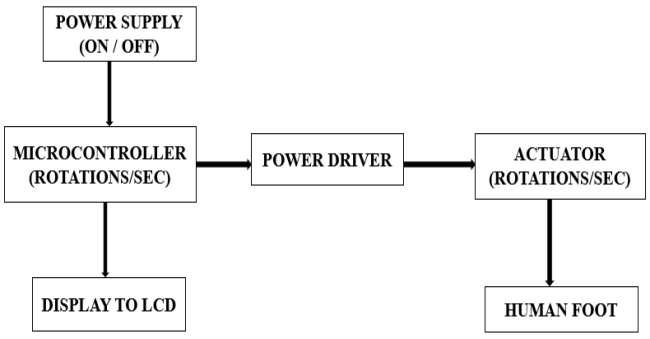

Fig 2.Block diagram of proposed system

From the above figure microcontroller performs the logical operation as well as it provides input to the power driver which supplies the required voltage needed to the actuator. To perform this operation microcontroller requires dc voltage. The ac voltage, typically 220V is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. The resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also maintains the same dc value even if the input dc voltage varies. This voltage regulation is usually obtained using one of the popular voltage regulator IC units (RS 232). The controller used here is atmega162 v and it is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, In-Circuit Emulators, and evaluation kits.AVR can be used for both battery powered and continuous power supply applications. As it uses basic programming concepts, coding in AVR is easier. If the entered value is wrong then the AVR will automatically reset the value with the help of watchdog and produces the required amount of voltage to drive the circuit. The Driver circuit used here has high-efficiency. High-current power driver ideal for driving a wide variety of load in systems are powered from 4.5V to 26V. PWM operation and low output stage on-resistance significantly decrease power dissipation in the amplifier. The power amplifier is fully protected against faults with short-circuit, thermal, over-voltage, and under-voltage protection. Faults are reported back to the processor to prevent devices from being damaged during overload conditions. The output from driver is given to the actuator. Actuator is used to convert electrical signal into physiological unit. It consist of a dc servo motor and a shaft for angle rotation. The dc servo motor is an automatic device which gives precise angle movement and accurate positioning. From this the angle rotation is given accurately to the patients without pain and it is viewed using lcd.

A. Flow Diagram

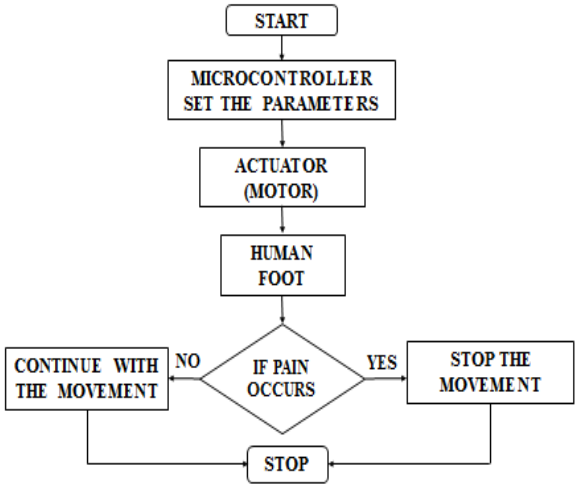

Fig 3.Flow diagram for proposed method

Initially we set the parameters ie. Angle (5, 10, 15 & 20) in degrees and time delay (3s) in the microcontroller using embedded c. The output from the controller is given as input to the actuator thereby it facilitates dorsiflexion movement. If the patient experiences any kind of pain or inconvenience then the process is stopped if not the treatment is given for some more time.

IV. RESULT AND DISCUSSION

Thus the proposed system offers simple and painless treatment of DVT provided the patient can do any other work in a relaxed state. Normal range of motion of dorsiflexion is said to be 10 degrees while walking but for patient's affected with DVT this

movement is not feasible, hence in the proposed system the patient's foot is moved till 20 degrees. The neutral position is equal to 0 degrees. Patients should move the feet and ankles postoperatively in order to minimize the risk of venous thrombosis.

V. CONCLUSION

Nowadays people are going for painless treatment. This invention will produce a unique foot flexion device capable of enhancing blood and lymph flow in the lower extremities of individuals to thereby decrease their risk of deep venous thrombosis, peripheral vascular disease and other conditions characterized by decreased circulation. The flexion device can be easily applied by a patient or health care provider to a patient's foot or feet. Yet this device minimally restricts patient movement and provides controllability with respect to the range or extent of flexion, the rate of flexion, and the amount of force applied to cause flexion of an ankle and lower leg portion in the device. It can be controlled either automatically or manually by a patient using the device or by a non-patient operator, for example, a nurse or other medical attendant. It is portable, easy to use and light weight foot flexion device.

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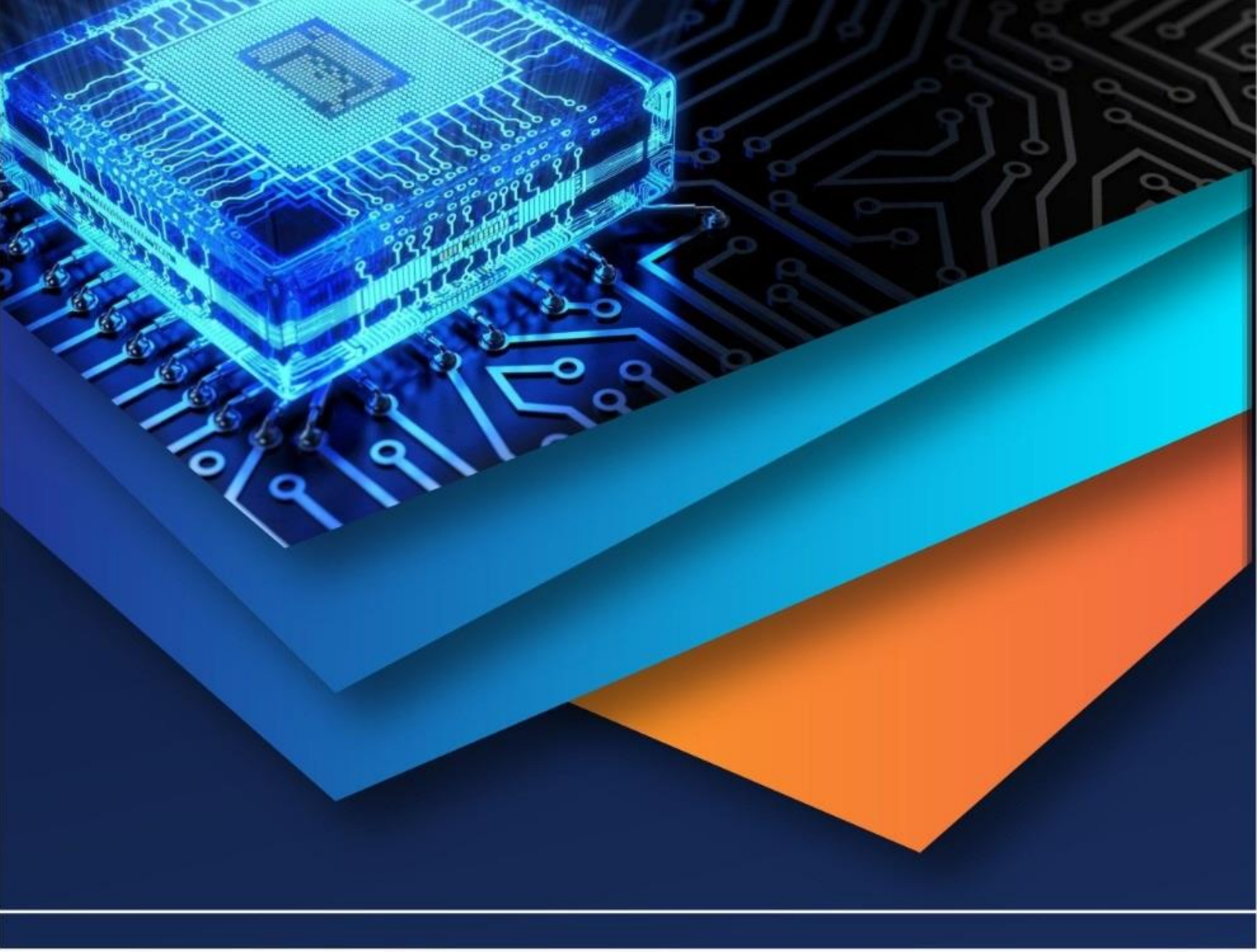

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