Design and Development of Pressure Sensing Bandage

Pudhumozhi Subramanian
Department of Textile Engineering
Kumaraguru College of Technology

Aarthy Sekar
Department of Textile Engineering
Kumaraguru College of Technology

Abstract

Compression bandages are specially designed to apply pressure, helping to maintain blood flow and reduce discomfort and swelling. Compression bandages are a simple non-invasive treatment for varicose veins, chronic venous insufficiency and lymph edema. The treatment compresses superficial veins to promote the flow of blood through the body veins. The main objective is to design pressure sensing bandage using suitable method and to measure different level of pressure intensity. Compression bandages come in a variety of sizes, length, and colors. They are also available with different strengths of compression. Stockings and compression bandages with successive sensors are available in the market but there provide least comfort and hence make them difficult to be worn. Further, these sensors often have contact with skin which makes them undesirable. In order to overcome this level we have to design the bandages with using compressed air concepts. The main objective is to design pressure sensing fabric using suitable method and to measure different level of pressure. These different readings of pressure will be sent through wireless Bluetooth device which connects the patients' device to the concerned.

Keywords- Apply Pressure, Compressed, Blood Flow, Sensors, Compressed Air

I. INTRODUCTION

Materials used for compression such as stockings, compression bandage, elbow bands and knee bands impart pressure on the worn region to reduce blood clots. The successful management of venous leg ulcers, golfer's elbow, tennis elbow, bronchitis etc. represents a significant clinical problem and a major drain on limited financial resources. Research has shown that the majority of ulcers can be induced to heal by the application of adequate levels of sustained graduated compression. Bandages vary greatly in their ability to provide sustained content of elastomeric yarns. Elbow band or sleeves how they commonly called are designed to squeeze blood vessels are designed to squeeze blood vessels causing them to open forcefully. This allows more oxygenated blood to reach compressed muscles which helps lower your heart rate. Thus compression bandages have versatile application. But the working of compression bands is limited because the pressure applied is never constant. Researchers say that a compression band maintains optimum pressure for only eight hours.

There is a specified pressure that has to be imparted in regions of blood clots ranging from 80 Hg.mm to 240 mm Hg. But the pressure imparted gradually decreases thereby providing to no effective diagnosis for the inflammation. Therefore it is mandatory to check pressure regularly to know the effect of compression bandage on the inflammation. So we have designed a compression band that will sense pressure using compressed air.

II. OBJECTIVE

The objective of the project is to design and fabricate a compression bandage to sense pressure using compressed air.

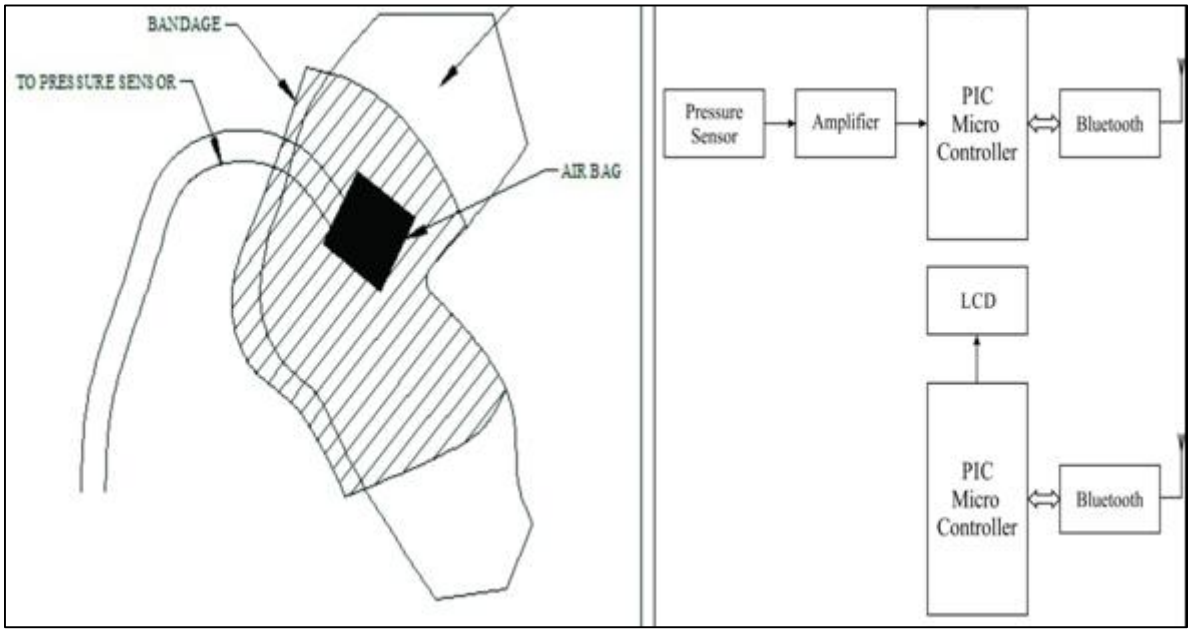
- To design a compression band that senses pressure
- To sense the pressure using compressed air principle
- To measure the different levels of pressure imparted by the bandage on the specified region of the body

The key features of this module are:

- Removable air bag which can be inserted whenever needed.
- PIC micro controller
- Inverting amplifier for increasing the power of signal.
- Attached with a Bluetooth device that transfers data between two devices.
- By using LCD display that measure pressure.

III. BLOCK DIAGRAM OF PRESSURE SENSING COMPRESSION BANDAGE

Given below is the block diagram for pressure sensing compression bandage



IV. WORKING DESCRIPTION

A. Air Bag and Compression Bandage

The air bag is placed inside the compression bandage by means sleeve stitched inside the bandage. Initially air inside the air bag is in Free State. Now the bandage is worn over the elbow. The air bag consists of a tube which is inserted over the pressure sensor.

The compressed air rushes out through the tube and applies pressure on the pressure sensor. The pressure sensor is generally a transducer; it converts the applied pressure (which is a physical quantity) and converts it into a digital quantity (mm.Hg). There is a strain gauge that is connected to the Wheatstone bridge to maximize the output.

B. Receiving the Inputs

The pressure read by the sensor is feeble so to read the accurate pressure; the reading must be amplified. Here we use inverting amplifier as a gain amplifier. We can change the gain by adjusting the value of feedback resistance value. As the open loop DC gain of an operational amplifier is extremely high we can afford to lose some of this gain by connecting a suitable resistor across the amplifier from the output terminal back to the inverting input terminal to both reduce and control the overall gain of the amplifier. By this method the pressure is amplified.

C. Processing of the Output

The amplified signal transmits the output to the PIC micro controller. The PIC microcontroller is a mini computer which has an in built CPU. This combines various components of devices into a single chip. The whole coding is coded inside the CPU. And the output is displayed on the display.

V. TRANSMITTING OUTPUT VIA BLUETOOTH

This displayed pressure has to be transferred to another device (mobile) via a Bluetooth device. But to transfer the output the two devices has to be paired. So a code common to both devices must be written to the Bluetooth device. A common code appears on the connecting devices and the devices get paired. Now the output pressure displayed on the LCD can be transferred to any number of devices but one at a time. This helps to keep track of the pressure changes of the bandage on day to day basis.

VI. HARDWARE DESCRIPTION

A. Compression Band and Air Bag

To sense the pressure of compression bandage we have used the principle of 'compressed air'. A small air bag is placed inside a compression bandage which is the air filled medium. The air bag is inserted into the compression band by means of a sleeve stitched inside the band. Initially, the air inside the medium is not compressed and is in 'Free State' i.e.; there is no pressure. But when the band is worn over the body, the air inside the air bag gets compressed thereby developing pressure which will be equal to the pressure that is applied on the particular region. This pressure causes the compressed air to rush through the outlet. This outlet ends on the pressure sensor that senses the pressure applied on the knee or elbow by the compression bandage.

B. Pressure Sensor

A pressure sensor measures pressure, typically of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed.

1) Piezo Resistive Sensor

Uses the piezoresistive effect of bonded or formed strain gages to detect strain due to applied pressure. Common technology types are Silicon (Monocrystalline), Polysilicon Thin Film, Bonded Metal Foil, Thick Film, and Sputtered Thin Film. Generally, the strain gauges are connected to form a Wheatstone bridge circuit to maximize the output of the sensor.

This is the most commonly employed sensing technology for general purpose pressure measurement. Generally, these technologies are suited to measure absolute, gauge, vacuum, and differential pressures.

C. Amplifier

An ELECTRONIC AMPLIFIER is a device for increasing the power of a signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with larger amplitude. In this sense, an amplifier may be considered as modulating the output of the power supply.

Here we use inverting amplifier as a gain amplifier. We can change the gain by adjusting the value of feedback resistance value. As the open loop DC gain of an operational amplifier is extremely high we can afford to lose some of this gain by connecting a suitable resistor across the amplifier from the output terminal back to the inverting input terminal to both reduce and control the overall gain of the amplifier. This then produces and effect known commonly as Negative Feedback, and thus produces a very stable Operational Amplifier system.

Negative Feedback is the process of "feeding back" some of the output signal back to the input, but to make the feedback negative we must feed it back to the "Negative input" terminal using an external Feedback Resistor called Rf. This feedback connection between the output and the inverting input terminal produces a closed loop circuit to the amplifier resulting in the gain of the amplifier now being called its Closed-loop Gain.

D. Micro Controller

Microcontroller is a general purpose device, which integrates a number of the components of a microprocessor system on to single chip. It has inbuilt CPU, memory and peripherals to make it as a mini computer. A microcontroller combines on to the same microchip:

- The CPU core
- Memory(both ROM and RAM)
- Some parallel digital I/O

PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory.

VII. SIMULATION AND HARDWARE RESULTS

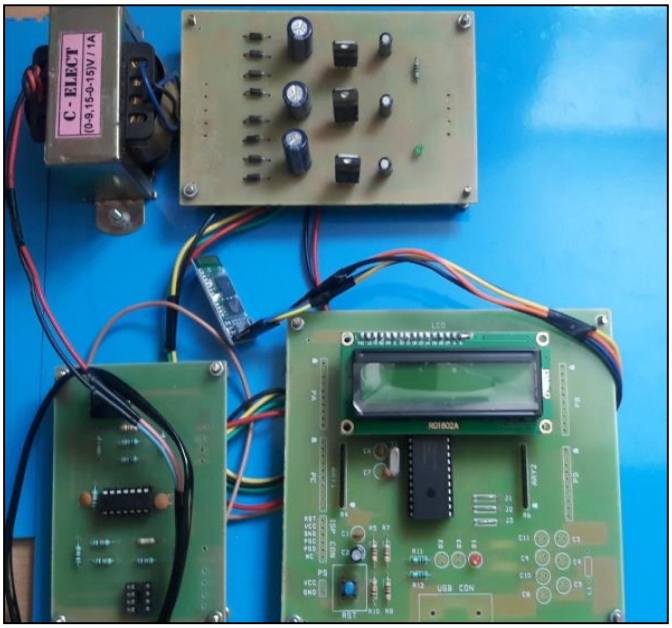


Fig. 4.1: Image Showing Circuit of Pressure Sensing Compression Bandage

Fig. 4.2: Image Showing Piezo Resistive Pressure Sensor

Fig. 4.3: Image Showing Amplifier in the Circuit

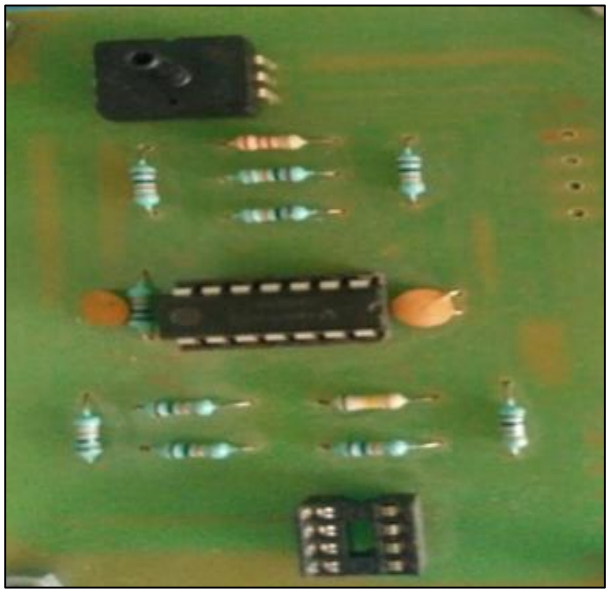
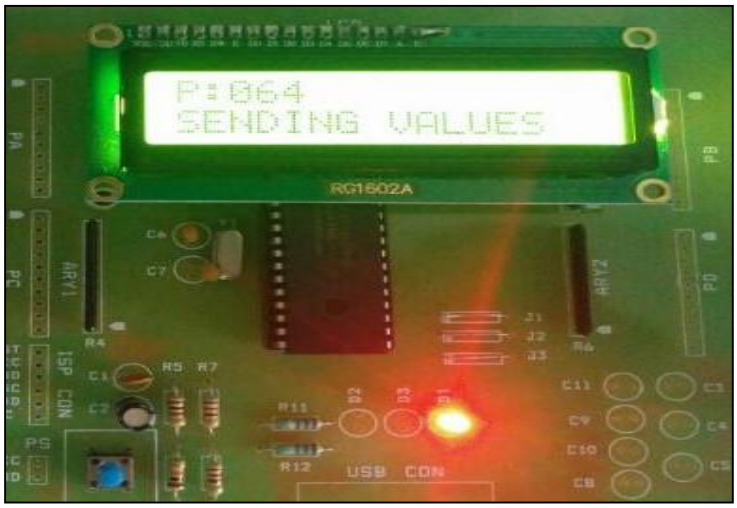


Fig. 4.4: Image Showing the Air Bag of Pressure Sensing Compression Bandage

Fig. 4.5: Images Showing the Display on the Liquid Crystal Display



VIII. CONCLUSION

A pressure sensing compression bandage has been developed by means of compressed air principal and the result has been transferred to required device via Bluetooth. The designed pressure sensing compression bandage has been used for testing the pressure applied by the bandage. The results show that pressure applied by the compression bandages reduces exponentially on usage and a graph has been developed. This setup can be used in hospitals to check the pressure applied by the bandage; to ensure proper diagnosis of the inflammation or clot. The results can be transferred and stored in a main computer.

IX. FUTURE ENHANCEMENTS

- use the same set up in compression stockings and check the pressure
- To make the set up compact

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