Design and Development of a Test-Phantom for LegFit

Degree programme: BSc in Mechatronics and Systems Engineering (Medical technology | Robotics)
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Industrial partner: ICU tech GmbH, Signau

In order to treat various venous problems and prevent deep vein thrombosis, ICU tech GmbH has developed LegFit, a new device allowing intermittent pneumatic compression therapy to be performed at home, typically after hospital discharge. The aim of this bachelor's thesis is to design, develop and realize a test-phantom that can be used to measure and quantify the LegFit device.

Introduction

Intermittent pneumatic compression (IPC) is a therapy that prevents venous stasis and consequently the formation of blood clots. However, this treatment is usually carried out in hospitals and cannot be continued after hospital discharge, which is problematic. LegFit, a new wearable system, has therefore been developed by ICU tech GmbH to allow the treatment to be carried out at home.

Goals

To better understand their product and improve the development of their new type of cuff, ICU tech GmbH needs a test-phantom for the LegFit device. It must be able to reproduce anatomical features similar to those of a human lower leg, with the option of adapting to different leg physiologies to test various models in different situations. The pressure curve must be measured at different points along the cuff using suitable pressure sensors. Finally, a user interface must be provided to control the measurement sequence and transfer the recorded data to a laptop.

Methods

The concept was developed iteratively, in close collaboration with the industrial partner. Using evaluation criteria, the most appropriate sensors for this application were chosen from a wide range of possible techniques. An iterative process was then used to develop the mechanical design to best meet a wide range of situations. Finally, measurement control has been programmed to be performed from the laptop.

Results / Outlook

The capacitive thin-film sensors chosen (Fig. 1, Nr. 1) are positioned on a plastic film for easy installation and adaptation on different lower leg models. They are laid out in a straight line along the calf in order to reconstruct the pressure gradient in the cuff. The highly adaptative test-phantom can be positioned horizontally or vertically and can accommodate different leg models using quick release clamps (Fig. 1, Nr. 2). A microcontroller (Fig. 1, Nr. 3) acts as an interface between the sensors and the computer, sending sensor data to the laptop (Fig. 2) and receiving information from the user interface. The user interface could be improved by implementing new features such as measurement analysis. The accuracy of the pressure measurement could be improved by enhancing the calibration of each sensor.

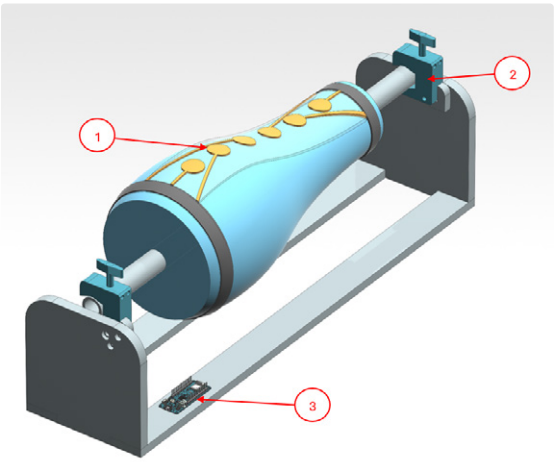

Fig. 1. Design illustration of the overall system.

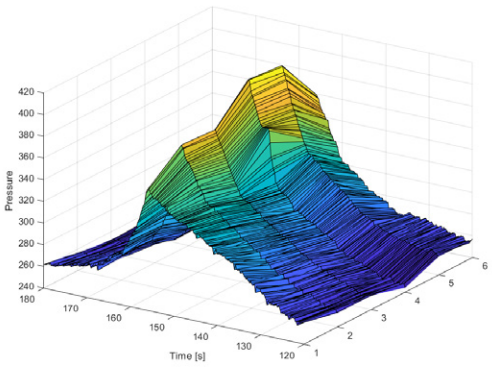

Fig. 2. Measurement of the pressure gradient produced by the LegFit device over time.

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