CHAPTER 19
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KNEE REHABILITATOR

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INTRODUCTION

Knee surgery is an intensive endeavor that is very expensive and requires therapist support. In many cases, such support is needed long after the initial injury. Unfortunately for people that suffer from knee surgery, hospital discharge is necessitated by economics long before the patient has had adequate therapy. This means that the person must continually revisit a therapist on an outpatient basis. For those who live long distances from a therapist, this is costly and time-consuming.

SUMMARY OF IMPACT

An electro-mechanical device to assist in this process may alleviate some of the burdens of knee surgery rehabilitation. While not eliminating the need for a qualified therapist, this device will make patient visits to a therapist less frequent. Since the device is intended to be sent home with patients for use during their recovery process, it will allow patients to take a more active role in their own recovery. Because it will provide a virtual reality graphical interface, recovery may actually be more enjoyable.

TECHNICAL DESCRIPTION

The Knee Rehabilitator is a commercially available knee brace that has electrical and mechanical components mounted to it, enabling it to be interfaced to a personal computer. Components of the device are summarized in Figure 19.1. The leg brace has metal splints that run the length of the leg. A pneumatic cylinder is attached to these metal supports. Resistance to movement of the leg is monitored by controlling the flow of air into and out of the cylinder. The amount of resistance can be set by the user via software on the computer. The computer can also monitor the force exerted on the brace by using the air pressure sensors to measure the air pressure at the ports of the cylinder. These measurements can be utilized to monitor increase in strength. The flex sensor at the joint of the leg brace tells the computer how far the knee is bent. This can be used to monitor range of motion and provide the computer with an exact measurement of the knee's angle.

In Figure 19.2, the connection to the computer is shown. The sensors and air valves connect to the analog control circuitry which conditions the signals to go into the printer port interface hardware. The printer port interface hardware turns the analog signal into a digital signal that can be read by the printer port of the computer. Once the information is in the computer, it is used to show an on-screen animation of the leg bending and extending. This animation is a portion of a user interface that allows the user to increase and decrease the amount of resistance in the Knee Rehabilitator. The user interface also allows users to interact with virtual objects such as boxes. When the user lifts his or her leg as if to step on the virtual box, the resistance of the rehabilitator increases to simulate stepping up.

While this simulation is not perfect, as more programming is done on the user interface, interesting workout routines could be developed. With some more work, the Knee Rehabilitator could become a valuable rehabilitation tool.

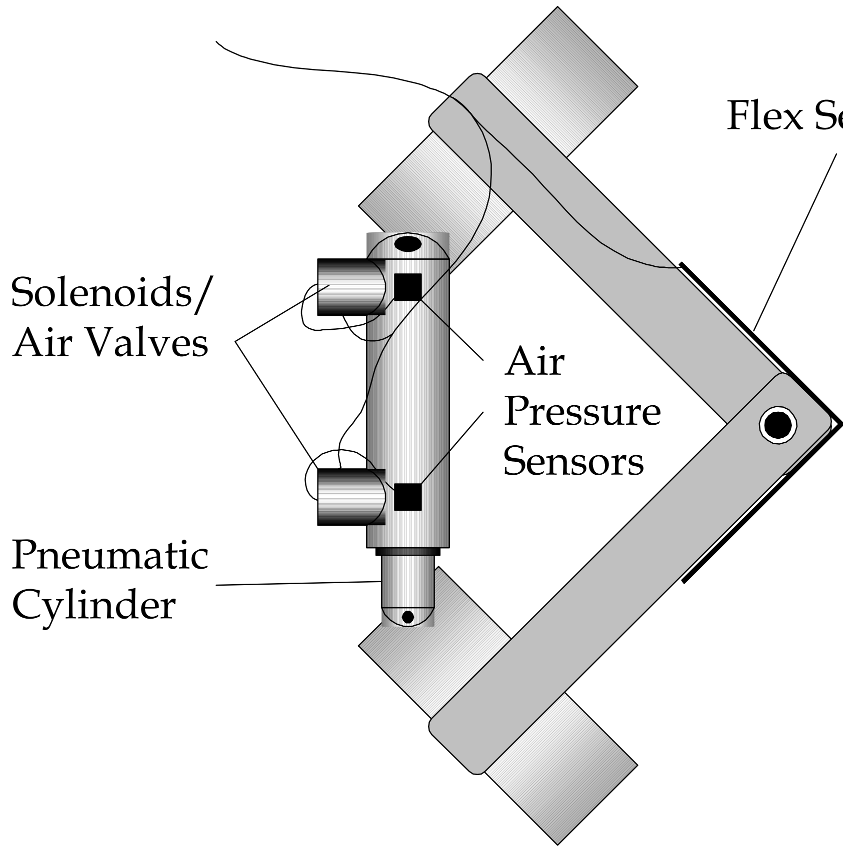

Figure 19.1. Knee Rehabilitator.

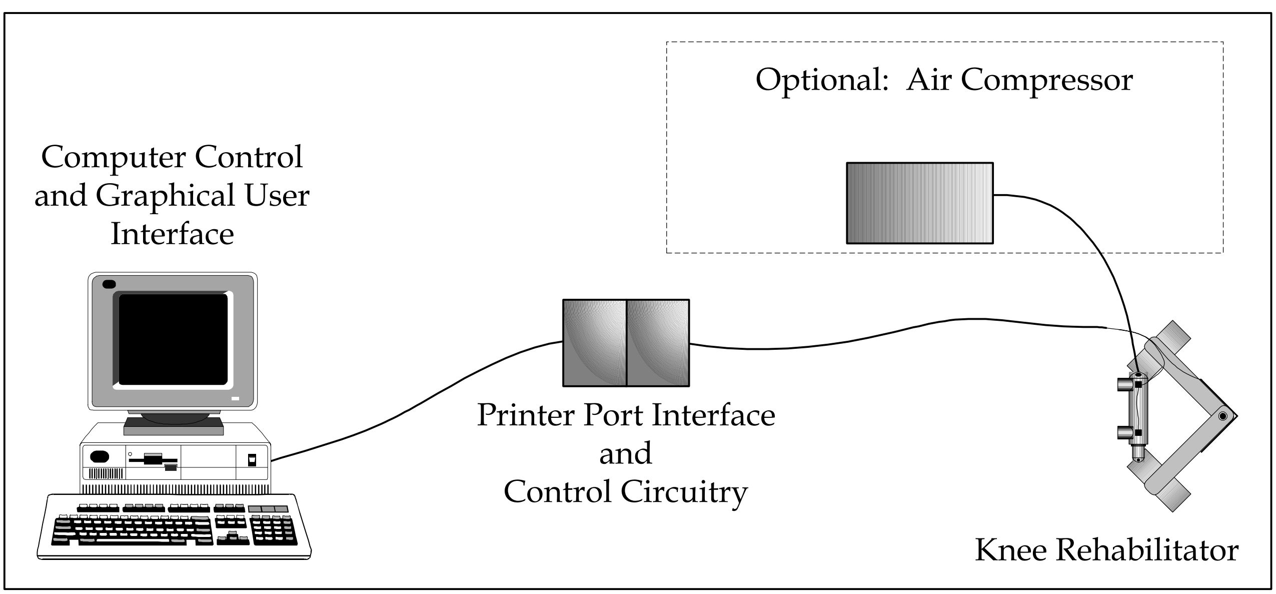

Figure 19.2. System Overview.

WHEELCHAIR-BASED DYNAMIC SEATING SYSTEM RESEARCH PLATFORM

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INTRODUCTION

The current project is a continuation of work carried out during the past three years toward the development of a wheelchair-based dynamic seating system to prevent or aid in the prevention of pressure sores. During the first year, extensive research was conducted in finding out the causes of pressure sores and current devices on the market used to prevent them. It was apparent from the research that there were no wheelchair-based dynamic seating systems commercially available used in preventing pressure sores.

During the initial design phase, it became apparent that no device was available to study the effects of modifying the frequency, intensity, and direction of shifting operations. Physicians and seat manufacturers had no clinical evidence on which to base their evaluations or designs. It was thus important to design a dynamic seat that is versatile enough to not only perform any desired shifting operation, but also to serve as a research platform to gather the vital clinical data needed for its own validation. This element of research capability added significant complexity to the design of the Dynamic Seating System Research Platform (DSSRP).

During the second year, the chief student engineer successfully completed the user interface program, which allowed users to program the DSSRP using a PC to perform any shifting pattern for any length of time. The user interface also had provisions for recording shifting patterns for future clinical trials.

SUMMARY OF IMPACT

The DSSRP will provide medical personnel with a powerful tool to determine which shifting patterns and frequencies are to be used in successfully treating pressure sores in people who spend significant amounts of time in their wheelchairs. Once this information is known, more inexpensive and less complex dynamic seating systems can be built and made commercially available to those persons susceptible to pressure sores.

TECHNICAL DESCRIPTION

The DSSRP is built using a modified Roho cushion consisting of multiple independent manifolds. Independent clinical studies found that the Roho cushion had the lowest pressure differential between the person’s seat and the cushion. Upon seat initialization, the seat is configured just as a normal Roho cushion is. Once the user has been fitted to the seat, the pressure levels in the individual compartments are recorded as baseline pressure and stored in the onboard computer. The user or clinician then uses the PC based user interface program to create a shifting cycle. This cycle is uploaded into the DSSRP computer. Upon user command, the DSSRP performs the specific shifting operations and when finished, returns the user to the initial baseline pressure.

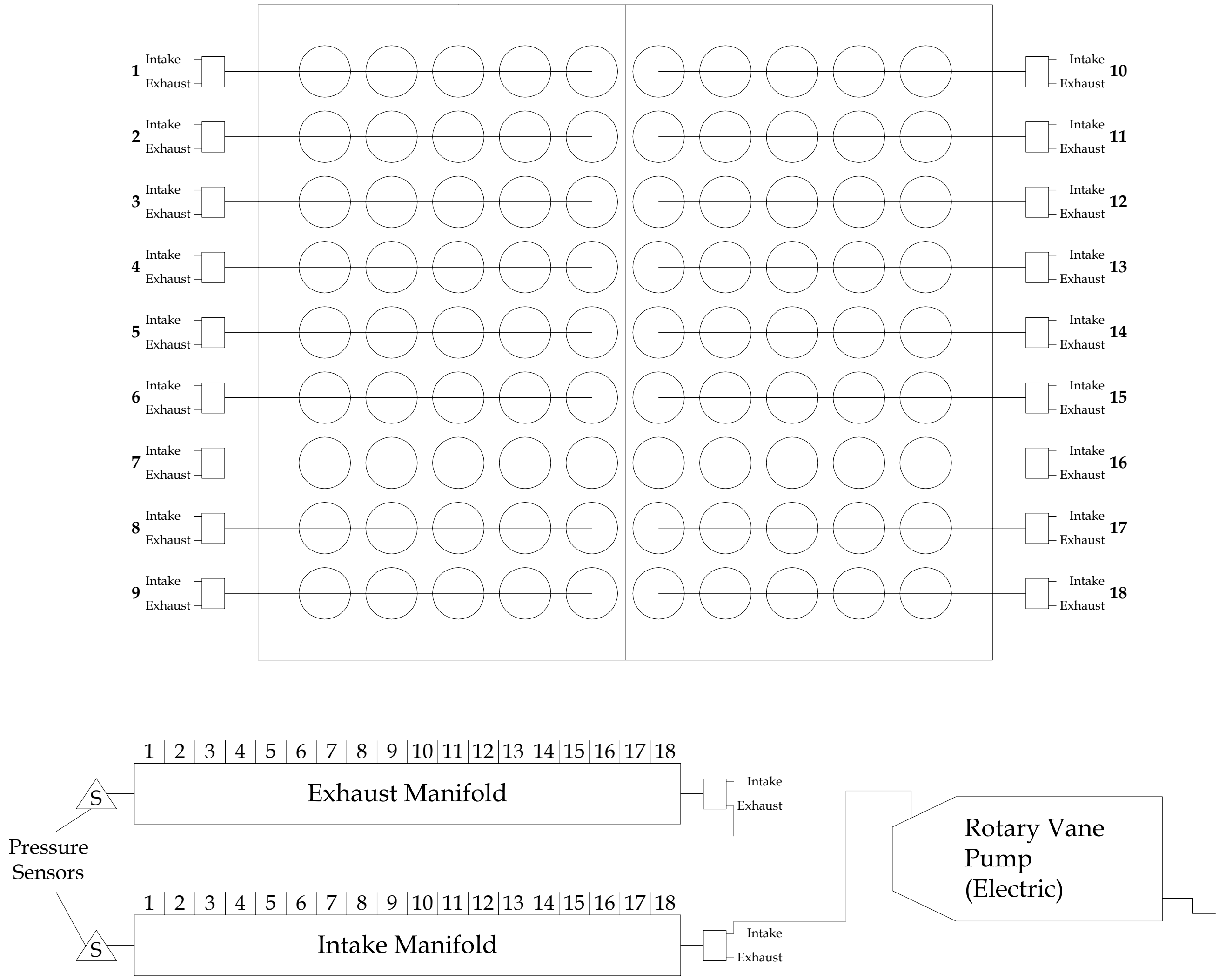

Figure 19.3. Wheelchair-Based Dynamic Seating System Research Platform.