Design and Development of Post Knee Arthroscopy Assist Device

Rajeshwari Rengarajan, Department of Biomedical Engineering, Sri Ramakrishna Engineering College, Coimbatore, Tamil Nadu, India

ABSTRACT

Designing and developing a device which provides a solution for knee spasms for the people who underwent surgery in the knee due to injury by enhancing the ability of motion in the knee joint and also strengthening the weak muscles. After operative procedures the patient remains in bed rest which results in passiveness in the lower limb and Range of Motion (ROM) will be reduced due to the impact of the injury. Thus, the Continuous Passive Motion (CPM) device is designed to lessen edema and swelling of the knee followed by injuries or surgeries. This device replaces the all time presence of physiotherapist and can accomplish such routine physical movements without the guidance and assistance of physiotherapist. The key feature in constructing a CPM is in the establishment of an accurate alignment with the human knee joint enabling the device to deliver similar movements as the actual body. Emergency switch is employed to the patients and they can stop the system in case of emergency or discomfort. This system comprises of Mechanical and Electronic components to fulfill the necessity of the device requirements.

Keywords: Continuous Passive Motion (CPM), Movement, Muscles, Range of Motion (ROM), Swelling

INTRODUCTION

Skeletal system gives a definite framework to the human body in which joints and muscular system together play the vital role by providing freedom of locomotion. Therefore, reduction or loss of the degrees of freedom will decrease the quality of life. Muscle weaknesses occur due to old ages, labor accidents or injuries are the main reasons for human movement disabilities. To recover the ability of motion, the weak muscles could be strengthened by using rehabilitation training devices or orthopedic treatment. Normally, people who have problems in arm or leg movements need to undergo periods of physiotherapy session, which involves a series of repeated and routine physical movements with the assistance of physiotherapist on a daily basis for several days or several weeks. Continuous Passive motion (CPM) (Ho, H.J. et.al (2006), Miyaguchi, S.,et al.(2009) is an intelligent device, which is able to replace the duty of the physiotherapist and can accomplish such routine physical movements without the guidance and assistance of a physiotherapist. It is also widely used for knee rehabilitation by helping the joints move gradually in order to recover the ROM or to lessen edema and swell-
ing of the knee following injuries or surgeries associated with knee joint diseases such as knee replacement arthroplasty or reconstruction of the cruciate ligament as stated in early literatures. The paper aims to recover the ability of motion and strengthening the weak muscles. The device has been developed to produce cost effective, easier way of physiotherapy (Saputra, M.K., et al., (2011)).

**OVERVIEW OF POST KNEE ARTHROSCOPIC ASSIST DEVICE**

The device consists of Microcontroller, Driver circuit, DC motor, Limit switch, Emergency switch, Position feedback circuit, Level converter, software (LabVIEW) and other associated circuits as shown in the Figure 1. The PC has LabVIEW application to handle the user demands. It controls the range of the movement from 30 degrees/minute to 180 degrees/minute. The speed and number of movements can also be set through the LabVIEW. Level converter (MAX 232) is used to convert signals from RS-232 serial port to signal suitable for TTL compatible digital logic circuits. PIC16F877A controller is used, which has programmable memory of 8K bytes. Relay allows the motor to switch ON for the mechanical movement of the limb. Motor is a rotary actuator that allows for precise control of angular position. Limit switch will be interfaced to shut down the motor power under any malfunction situation. Emergency switch will be incorporated to pause /stop the device anytime, if the patient feels uncomfortable.

The flow of the project is explained in such a way that the personal computer through the software LabVIEW controls the angle, speed, number of times. The microcontroller interfaced with the personal computer provides the processed input to the motor. The motor action provides rotation to the shaft and the shaft in turn provides movement of the mechanical device. The flowchart of Post Knee Arthroscopy Assist Device is shown in Figure 2.

*Figure 1. Block diagram of post knee arthroscopic assist device*
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