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Novel Approach in Design of Dynamic Knee Brace

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ABSTRACT

A self-contained electronically controlled dynamic knee-brace system (DKBS) has been designed and tested which allows knee flexion during swing phase, but restricts flexion during the stance phase of gait. This project focuses on creating an electronic knee wrap for humans to wear in order to monitor the motion of their knees to reduce the risk of suffering any injury or re-injury. While significant research has been conducted for identifying the factors responsible for injuries, there is a need to quantitatively determine a person's risk of suffering the injury in order to decide if a person is fit to return to the movement of knees. To this end, this research explores the opportunity to mount a high performance, small area circuit on a knee wrap.

I INTRODUCTION

The knee is the largest joint and one of the most important joints in the body. It plays an essential role in movement related to carrying the body weight in horizontal (running and walking) and vertical (jumping) directions. At birth, the kneecap is just formed from cartilage, and this will ossify (change to bone) between the ages of three and five years. Because it is the largest bone in the human body.

Stability of knee is required whenever a person has injured his knee or is undergoing a recovery. The stability is also required in old-age. Muscle and ligament injuries require recovery time and a knee brace can provide with the stability required while the process of physiotherapy is going on.

1.1 PREVIOUS WORK

The late 60s were important for the evolution of knee braces. In 1967, a professor of physiology, Dr. Robert F. McDavid, invented the first lateral knee brace designed to prevent injury or reinjury. His brace provided lateral protection of the knee. Then during the 1967 season and Super Bowl III, Hall of Fame New York Jets' Quarterback Joe Namath played with a now-famous knee brace. Jack Castiglia of the Lenox Hill Brace Shop with along with noted sports physician Dr. James Nicholas designed the brace. This allowed Namath to keep playing despite being plagued by knee problems.

The first DJO products were simple sleeves made of sewn-together neoprene that were pulled over the knee as well as the ankle and elbow joints for support. Fast forward to today where knee braces come in a variety of shapes and sizes, designed for all manner of knee injuries and prevention. Whether you suffer from knee osteoarthritis or you're looking to keep your ACL protected during a football game, there's a knee brace that's right for you.

1.2 PURPOSE

The objective of our project is to develop a knee brace which provides stability based on muscle movement.

1.3 CONTRIBUTION OF THE PAPER

The paper explains about how this project provides the user with a lighter and more reliable alternative to what is present in the market. The adaptability of the project adds more flexibility to its user hence providing case specific solutions.

1.4 PROCESSING AND IMPLEMENTATION

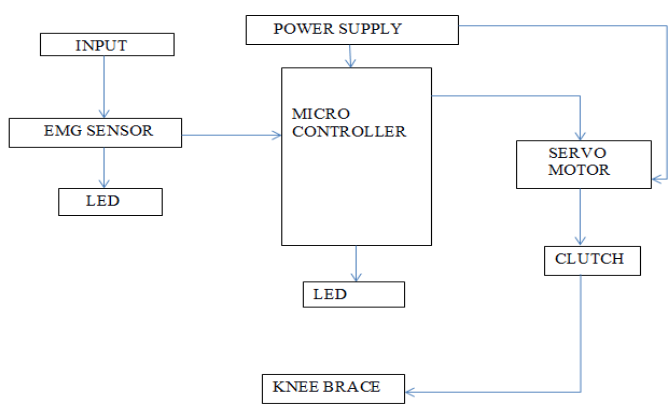

Fig. Block Diagram

The block wise flow chart of the processing of our project is shown in the fig.7.shown above. The description of each and every block is given as below.

Input (muscles): The EMG Sensors are to be mounted on the specific location on the muscles, so that the muscle flexion can be read.

EMG Sensors: The EMG sensors act as transducers which convert the input obtained via the electrodes placed on the muscles into electrical signals and provides the output to the Microcontroller.

Microcontroller: The microcontroller being used is ATmega 328 based Arduino Nano which takes the Input from the EMG sensors and provides the output to the stepper motor.

LED display: The LED display is used to show the degree of flexion of the specific muscle.

Stepper Motor Driver: It takes the input from the microcontroller and operates the stepper motor based on the given input.

Stepper Motor: It is mounted on the clutch of the knee brace and decides its activation.

Clutch: It restricts the motion of the knee.

The stepwise implementation of the process can be explained as:

Place the electrode for the EMG reading on the muscles taking part in knee flexion.

Getting the live reading from the EMG and comparing the output with the clustered data.

Processing the output derived from clustering and providing it to the stepper motor.

Use the stepper motor to move the mechanical clutch present in the knee brace.

The clutch decides the flexion of the knee at that very instant hence providing support.

Fig. Rehabilitative knee brace

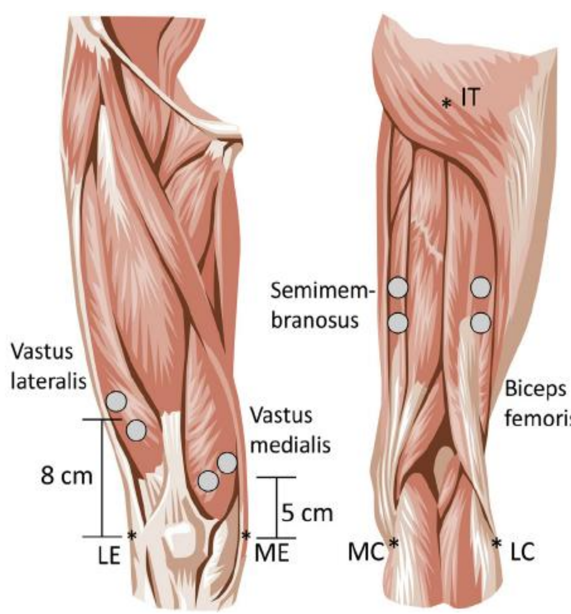

Fig. EMG Electrode Placement

IV. CONCLUSION

We implemented a system in which we controlled the knee movement by giving the support by the clutches. The sensors were mounted around the knee. The muscle movement was noted by the sensors and the outputs are drawn in the form of graphs. Hence, we noted the movement of the knee muscles and set the movement of our clutches accordingly. This prevents knee from having unnecessary movements.

4.1 ADVANTAGES

- Help with designing of products to increase efficiency.
- The electronic system will compensate the mechanical constraints of the braces.
- The instrument can be deployed in hospitals.
- The cost of project is quite low, which will help us reach to the people.

4.2 APPLICATIONS

The project can be used for rehabilitation in regeneration of torn muscles. It can also be used for adaptive knee support system.

V. ACKNOWLEDGEMENTS

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REFERENCES

Proceeding papers:

[1]The application of inertial and magnetic sensors to the monitoring of calf muscle pump activity Karol J. O'Donovan a, Alan K. Bourke a, Derek T. O'Keeffe a, Gearóid ÓLaighin b, Medical Engineering & Physics 31 (2009) 55–60

[2] IEEE/ASME transactions on mechatronics, vol. 11, no. 4, August 2006" Design and Control of an Exoskeleton for the Elderly and Patients"

[3] Ferrari E, Morgan G. Travel as a risk factor for venous thromboembolic disease. Eur J Med Res 2004;9:146–9.

[4]"Automatic Control Design for a Dynamic Knee-Brace System" Steven E. Irby, Kenton R. Kaufman, James W. Mathewson, and David H. Sutherland ,IEEE Transactions on rehabilitation engineering, vol. 7, no. 2, June 1999

Books:

[5]http://www.ottobockus.com/orthotics/solution-overview/orthotronic-mobility-system-c-brace/

[6]https://www.iworx.com/research/muscle-physiology/biox-recorder/?gclid=EAIaIQobChMIqff2s_q1QIV1R2PCh1A_QhuEAAYAiAAEgIm2PD_BwE