OPTIMAL CONTROL STRATEGY FOR ABOVE KNEE PROSTHETIC CONTROL USING SEMG AND FLEXION ANGLE

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INTRODUCTION

Development of an advanced and intelligent prosthetic for a transfemoral amputee patient is a challenging task. This requires complex sensor mechanisms feeding real-time dynamic data [1] to a controller which in-turn generates a control signal for hydraulic or pneumatic actuation system. In this paper, the authors aim at developing a control strategy for control of knee flexion rate of the prosthesis and governing the walking speed of the amputee for slow, normal and fast [2]. Electro-myograph (EMG) signals and knee flexion angle acquired through electro-goniometer are used for prosthetic control by many researchers. There are several limitations while using surface SEMG, fixing of surface electrode to the residual limb, variation of signal due to muscle atrophy and other environmental and engineering factors [3, 4]. The authors attempt a novel method to control the prosthetic using SEMG. The EMG electrodes are placed on the non-amputed (healthy) limb of the patient to minimize the effects on quality of EMG signals due to amputation.

METHOD AND MATERIALS

Biometrics twin axis goniometer SG150 is placed on the prosthetic knee joint. Biometrics EMG electrodes SX 230 were placed on Vastus lateralis, Medial hamstring, Gastrocnemius and Soleus muscles of the patients healthy limb. Experiments were done to generate knowledge-base of EMG patterns to categorize walking speed in to slow, normal and fast based on the self selected pace of different individuals. Similarly by analyzing experimental data, linear - angular knee flexion angle is mapped in terms of walking speed. Control priority of these parameters is evaluated and fed into the embedded software. The real time controller generates control for the pneumatic actuation system based on the level of the signal.

RESULTS

The Gastrocnemius and Soleus muscles showed a change in RMS value of EMG signal from 0.050(mV) and 0.040(mV) for slow walk to 0.066(mV) and 0.058(mV) respectively. The knee flexion range during these experimentations varied from 7° to 54° indicating a flexion range of 47°.

CONCLUSIONS

By adjusting the pressure of pneumatic cylinder walking speed was controlled. EMG signals were used to activate a flexion lock. Further improvement of the system can be achieved by introducing a neuro-Fuzzy based controller thus making it more intelligent.

REFERENCES

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SYSTEM BLOCK DIAGRAM

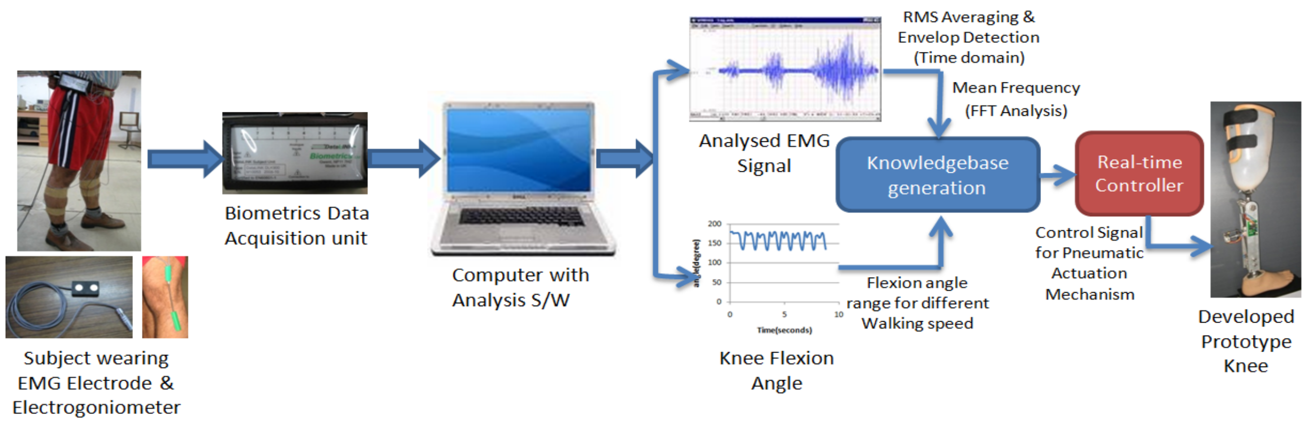

Fig.1: System block Diagram of the control mechanism