Gait Analysis of Stair Ascending and Descending

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***Abstract*— Stair ascent and decent is a common functional and challenging task for several populations. Older adults are at a greater risk for a stairs-related fall due to biomechanical, perception-action or environmental constraints and exhibit altered stair-gait characteristics. [1[1]] During the stance phase of stair ascent, the hip and the knee joints undergo extension while the ankle joint undergoes plantar flexion. Staircase slope proves to be an important characteristic affecting temporal and kinematic gait parameters. Our study is a broader attempt to analyze that how staircase inclination affects the kinematic patterns of stair climbing. [2] It can be used to investigate stair climbing of patients with knee and hip implants [3]. This knowledge can serve as a reference for the imitation of natural motor control strategies in intelligent prostheses. For this purpose we are using FSR and EMG sensor to get output response to analyze the difference between ascending and descending. To get smooth response apply different filtration techniques for noise removal.**

Keywords—FSR, EMG, Planter flexion

I. INTRODUCTION

he climbing a stair is very important movement because of its relevance to the daily activities, and the cooperation of the human with the machine can be analyzed in phases where higher support from the exoskeleton can be contributed, as well as smaller forces have to be applied to allow positioning the foot over the next step [4].

Jonathan et al (2002) [5] evaluate weighted stair climbing exercise as a means of increasing lower extremity muscle power in mobility-limited older people. They suggest that stair climbing exercise be a useful component of a home exercise program designed to enhance lower extremity muscle power, aerobic capacity and functional performance. Wells et al [6] studied a functional comparison of biomechanical outcomes during gait and stair climbing was carried out for younger individuals with these two alternative hip arthroplasties. They conclude that reduction in the abduction and flexion moments appear to be the most significant outcomes effecting function. Resurfaced hips may function slightly better.

The purpose of the study is to show a biomechanical study for stair climbing in order to get measurement values that can be depended on in the hospitals of rehabilitation, the centers of physical therapy and the clinical of medical sports, instead of depending on the measurement values that are dependent on the development countries for the same movement. The analysis investigated the biomechanics and motor co-ordination in humans during stair climbing at different stair height.

It is observed that upward movement is against the gravity stair ascent shown to be the more demanding biomechanical task when compared to stair descent for healthy young subjects. [7]. It is found that greater hip and knee angles, hip and knee moments are found in stair ascent compared to stair descent. Greater dorsi and plantar flexion are observed in stair descent than stair ascent. The maximum value of hip, knee, and ankle joints are rising in accordance with the increases of subject heights and different inclination [8].

There are two main phases during stair ascending and descending. First one is stance phase and second one is swing phase. In ascending during stance phase weight acceptance (WA) phase in which the body moves into optimal position in order to lift the body in next phase. In pull-up (PU) phase in which the one leg and whole body is pulled up to the next step. Forward Continuance (FCN) phase in which the subject has ascended the step and moving forward to the next step. During swing phase foot clearance (FCL) in which the whole foot takes off the previous step. Foot Placement (FP) in which the foot is ready to touch the next step as shown in **Fig.1. 1.** For descending the stance and swing phases properties are shown in **Fig.1. 2.**

Stair ascent and descent have similar patterns to those described for walking and running. However, the hip muscles generally contribute less than the muscles acting on the knee and ankle joints. Going upstairs, or ascent, is first initiated with a limb lift via vigorous contraction of the iliopsoas, which pulls the limb up against gravity to the next stair. The rectus femoris becomes active in this phase as it assists in the thigh flexion and eccentrically slows the knee flexion.

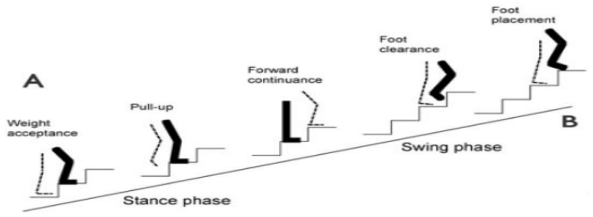

Fig.1. 1: Stance and swing phase during ascending

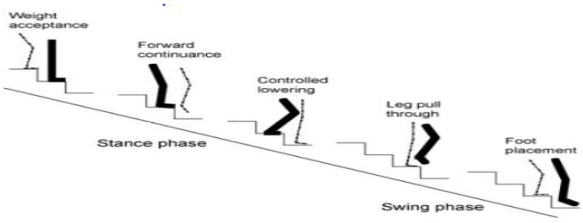

Fig.1. 2: stance and swing phase during descending.

II. METHODOLOGY

A. *Objectives*

The main objectives of this to differentiate between the output responses of selous muscle for stair ascending and descending. The purpose methodology is shown in **Fig. 2. 1**

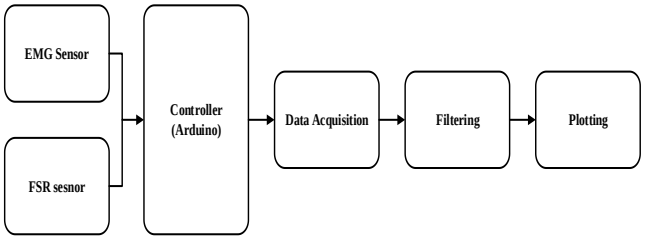

Fig. 2. 1: Methodology Block diagram

B. *Description*

For the objectives defined above, we are using two type of sensors first one is Electromyography sensor (EMG) and Force resistance sensor (FSR). This EMG is type of non-invasive. These sensors are used as for input. For data acquisition we are using Arduino Uno as micro-controller. When muscle extent or contract EMG gives measure some millivolts due to potential difference between electrodes of sensor. After this signal is amplified and rectified then goes to controller. Controller read the data extract the valuable information then plot the output response. The FSR is lies behind the toe for force and pressure measurement. As EMG electrodes are connected at Soleous muscle which is located at as shown in **Fig. 2. 2.** Circuit diagram and sesors location as shown in **Fig. 2. 3.**

Fig. 2. 2: Soleous Muscle Location

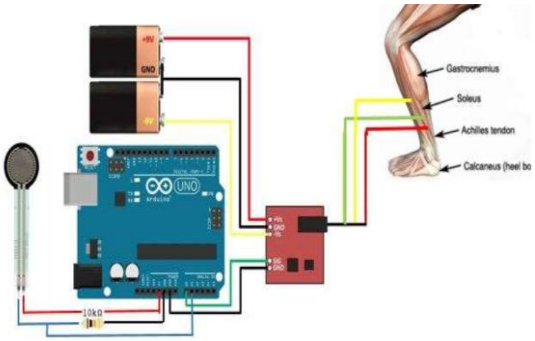

Fig. 2. 3: FSR and EMG location and Circuit diagram

III. RESULTS AND OUTPUT

C. Stairs ascending response

From experiment stair climbing time is 13.4 second and gait cycle is 6. As subject climb with the speed of 0.215 m/s. the step length will be 48cm. The output results plot is shown in **Fig. 2. 4.**

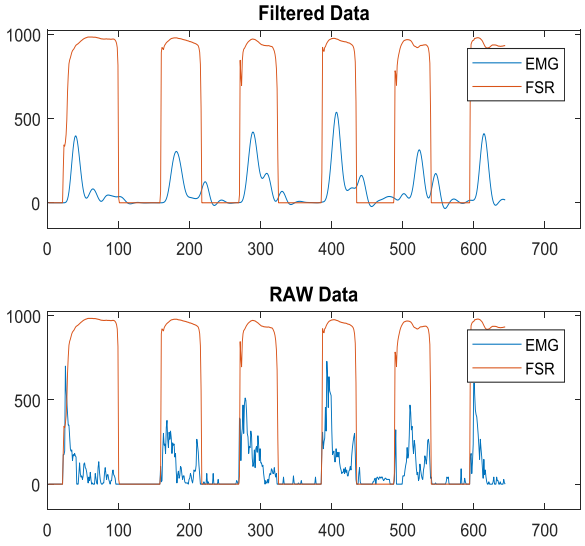

Fig. 2. 4: stair ascending response

Phase terminologies during ascending is given as shown in **Fig. 2. 5**

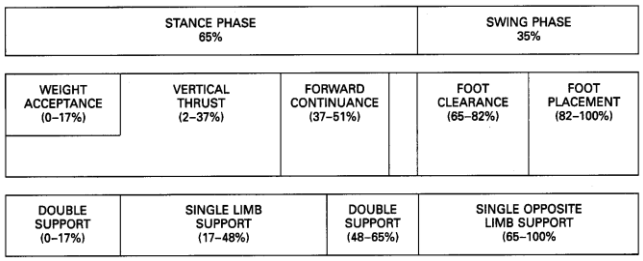

Fig. 2. 5: Phase terminologies during stairs ascending

D. Stairs descending response

From experiment stair climbing time is 11.4 second and gait cycle is 6. As subject climb with the speed of 0.25 m/s. the step length will be 48cm. The output results plot is shown in **Fig. 2. 7.**

Phase terminologies during descending is shown in

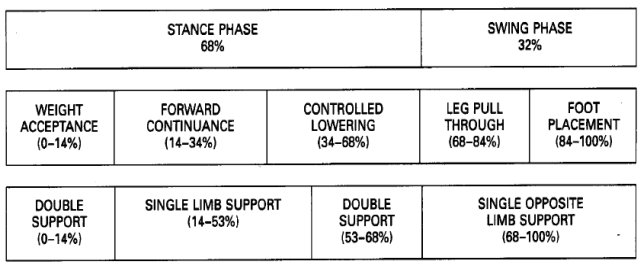

Fig. 2. 6: stairs Descending terminologies

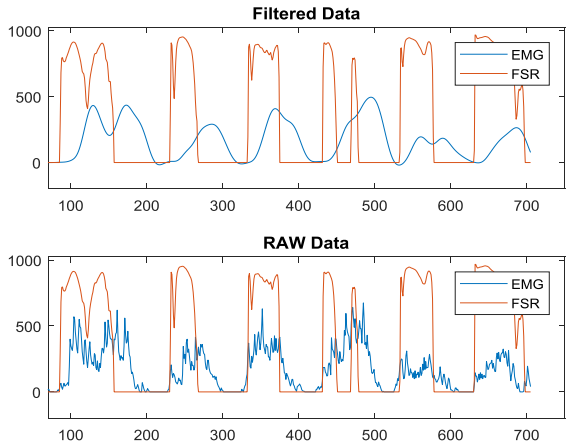

Fig. 2. 7: Stairs descending response

IV. CONCLUSION

According to our filtered graphs, stance phase 64.3% and swing phase 35.7% in case of ascending stairs. And stance phase 66.67% and swing phase 33.33% in case of descending. Our results are very close to theoretical values

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