# Human Lower Extremity Motion Analysis introducing Kinovea

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## *Abstract:*

*Human Motion is the most effective and fundamental functionality utilizing the lower extremities or legs. The replication of human movement is possible in the humanoid robots with simulation related prerequisites. The forward and backward motion simulation of the normal left and right leg is the primary requirement which has been demonstrated in this research paper. The balancing of body is feasible with the leg motion simulation in different conditions such as vertical acceleration and horizontal velocity. The leg motion video of 8secs with forward and backward movement has been taken into consideration for the simulation purpose to check the activity level of the legs. The similar movements can be mimicked in the autonomous bio-robotic systems.*

***Keywords: Leg movement, Robotics, Kinovea, Motion simulation***.

## 1. INTRODUCTION

Human movement represents an entity moving from one location to another location. The movement is performed through a fixed axis and has a direction. Anatomical movements involve body parts moving around fixed joints relative to the main anatomical axes such as sagittal, coronal, frontal, etc. or planes parallel to them. The anatomical movements consists of the anatomical structures involved in the movement. Reference axes around which the movement happens and direction which is usually related to a standard plane, such as the median, medial, sagittal, frontal, etc are the important factors to define movements. The movements of flexion and extension take place in sagittal directions around a frontal/coronal axis. Flexion or bending involves decreasing the angle between the two entities taking part in the movement (bones or body parts). In contrast, extension, or straightening, involves increasing the respective angle. Flexion and extension of the knee consist of the tibia of the leg moves relative to the femur of the thigh. The movement is in the sagittal plane. The fulcrum is provided by the knee joint, through which the frontal/coronal axis passes. During flexion, the leg moves backwards (posteriorly). During extension, it moves forwards (anteriorly) [1]. Kinovea software is a platform where the human movements can be analyzed using video images. Through the images the acceleration and velocity of the lower limb are depicted with information regarding the different phases of the gait cycle.

## 2. REVIEW WORK

In this research methodological approach of prosthetic leg rehabilitation with the measurement of limb movements using Kinovea software in different conditions is the most untraveled path [2]. The utilization of Kinovea software with 2D motion video analysis has been incorporated to show the validity and angular movements of different joints of human body parts [3]. The motion capture system incorporation has been done using the kinect sensor and the MATLAB software to represent the body part movements to analyse the model design [4]. The reliability factor to quantify the angular measurement between knee and hip at the footstrike during running is observed [5]. A study was conducted to investigate the reliability of the Kinovea program to measure the cervical range of motion of the healthy subjects [6]. The most feasible way to develop a cost effective gait analyzer using markers on the subject with motion capturing is presented in the paper [7]. The lower limb movement analysis with different muscular activities are shown here [8]. The design of the system identification and the control law are discussed regarding the gait analysis using Vicon software [9]. The robotic movement of human body parts are shown to be implemented in the replication with reconfiguarable shapes [10].

## 3. METHODOLOGY

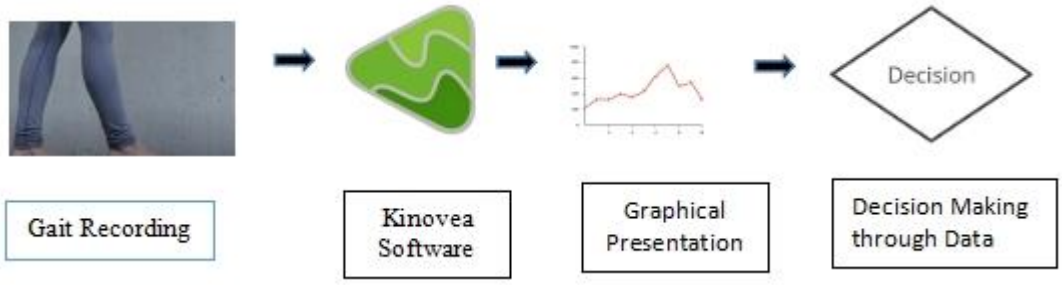



Fig. 1: Schematic Diagram of Human Gait Analysis through Kinovea

The human lower limb movements are captured using video recording where each and every steps during a gait cycle is measured with respect to the images in pixel values. Through this video of the healthy subject who has both the legs in normal condition , all the movement steps are shown. By utilizing the video recording and Kinovea software [11] the motion analysis has been performed to gather information regarding motion pattern. In this research work, the vertical acceleration and horizontal velocity of the leg movement are considered. Through the observation of the gait pattern the structural design of the lower limb can be recognized. The limb movements are showing the different phases of gait cycle of a human being through graphical presentations using kinovea software.
The velocity and acceleration are presented in terms of pixels of the images captured in the video. The velocity is presented as px/sec and the acceleration is presented as $px/sec^2$.

## 4. RESULTS and DISCUSSIONS

The utilization of Kinovea software is presented in this research work through the graphical presentation of the human lower limb movement. The two particular conditions are vertical acceleration. horizontal velocity. Through these mentioned conditions the lower extremity motions can be recognized within the movement duration shown in the recorded video used to analyze for the subject.

The balancing of body is possible during motion through the forward and backward motion of the left and right leg respectively and simultaneously. According to these motion pattern, the graphical presentations are shown here from Fig. 2 to Fig. 9 for a full gait cycle.

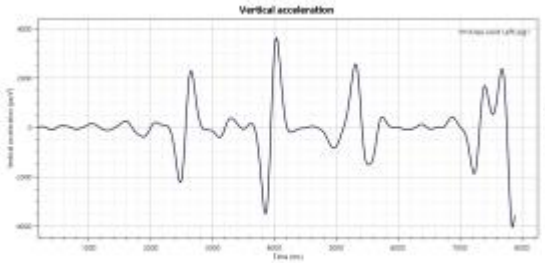



Fig. 3: Horizontal Velocity of Left Knee in Forward direction

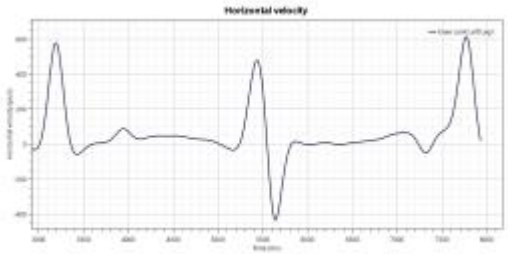



Fig. 2: Vertical Acceleration of Left Knee in Forward direction

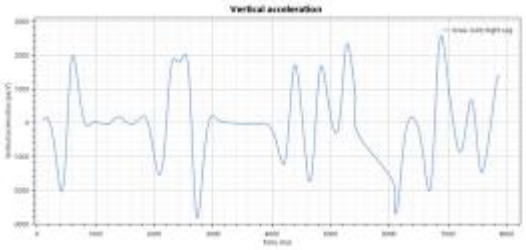



Fig. 4: Vertical Acceleration of Right Knee in Backward direction

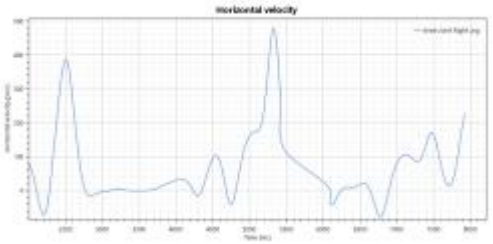
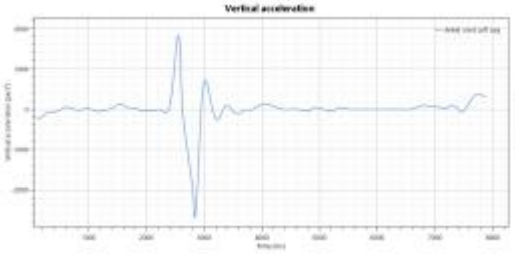



Fig. 5: Horizontal Velocity of Right Knee in Backward direction



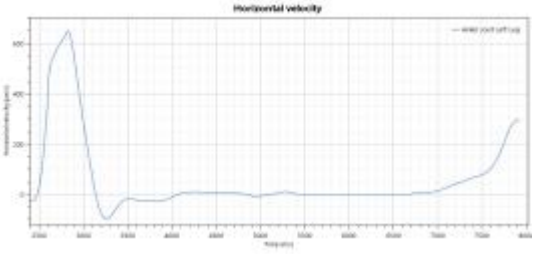
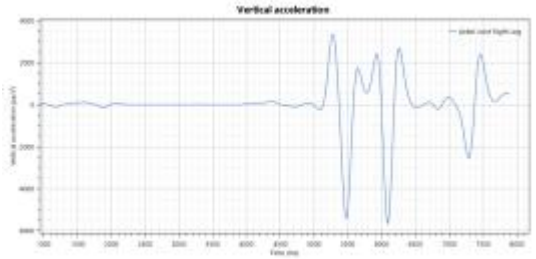



Fig. 7: Horizontal Velocity of Left Ankle in Forward direction

Fig. 6: Vertical Acceleration of Left Ankle in Forward direction



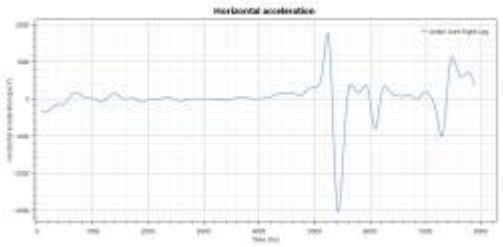




Fig. 8: Vertical Acceleration of Right Ankle in Backward direction

Fig. 9: Horizontal velocity of Right Ankle in Backward direction

All the movement variations are presented during 0-8000 milliseconds for acceleration and 2000-8000 milliseconds for velocity. The time duration is related to the recorded video of the motion where the leg movements are shown within the mentioned time duration. Within the particular time region, the acceleration and velocity in both the horizontal and vertical direction are observed where the motions are distributed throughout the region with different amplitude values.

## 5. CONCLUSIONS

The current research work depicts the idea of human lower limb motion presentation in pixel form with respect to time as the resource of the analysis is a recorded video of leg motion. The detailed information about the whole time period during gait cycle is conveyed with the motion pattern. Different patterns are clearly shown for different types of considered conditions. For prosthetic lower extremity rehabilitation purpose, this approach of velocity and acceleration measurements are necessary.

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