BIOMECHANICAL INTEGRATION OF ESSENTIAL HUMAN MOVEMENT PARAMETERS

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INTRODUCTION: This project consisted of the development and application of the Ariel APASview software to dynamically view simultaneous EMG, kinematic, kinetic, forceplate data, graphs, AVI video and 3-D StickFigures for clinical, sport and ergonomic applications. Visual observation and cinematographic records are typically utilized to perform biomechanical analyses of sports techniques, clinical evaluations of pathological movement, and ergonomic analysis. The use of permanent cine and more recently videographic records permit the observer to increase the frequency of the visually freezing the motion and replaying the movement for subsequent analysis. However, these earlier procedures did not allow for simultaneous integration of multiple views and the display of the numerical/graphical data for the observed human movement. Technological developments in hardware and software currently facilitate the integration of video, force plate, and EMG data. This dynamic integration of video, 3-D stick figures, numerical and graphical data Provide a powerful tool for visually syn-chronized analysis of sport, clinical, and ergonomic movements.

METHODS: The purposes of this project were two-fold: 1) develop software that could dynamically integrate video, EMG, force plate, kinematic and kinetic data; and 2) demonstrate the usefulness of simultaneous data integration in performing biomechanical analyses for ergonomic, sports, and clinical applications.

RESULTS AND DISCUSSION: Integrated viewing tool. The viewing option permits the user to examine the kinematic / kinetic data of the human movement simultaneously with the data point trajectory and the corresponding video frame from multiple cameras (see Figure 1). This feature of creating dynamic outputs may be used in performing simultaneously qualitative and quantitative analyses for sport performance.

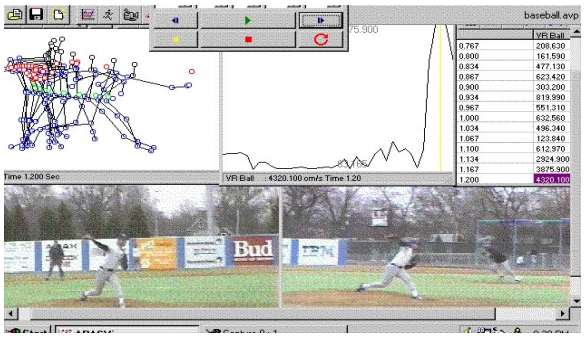

Figure 1 - View option for simultaneous views of pitching with integrated kinematic data.

Video viewing option. The video viewing function permits the biomechanist to observe a sport or functional movement from multiple perspectives, simultaneously. This allows the coach or clinical to perform sport or clinical evaluations at sampling rates that may be 2-10 times faster than visual observations depending on the video cameras transport rate (see Figure 2).

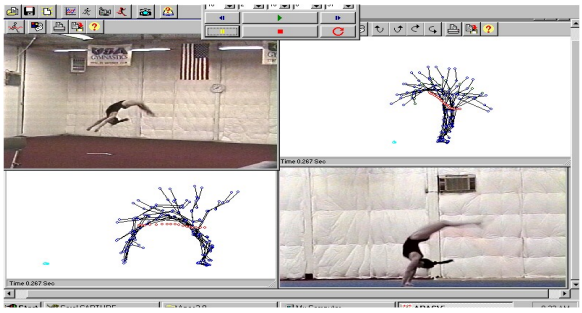

Figure 2 – Video and sync views for comparative views of gymnastics skills.

Sync view. The synchronization function provides the capability of performing a comparative study of two separate trials or different movement techniques in a side –by-side analysis format (see Figure 2).

Integrated data option. This option provides the analyst with the ability to simultaneously synchronize force plate, EMG, and video derived kinetic and kinetic data. These dynamic outputs can be synchronized with maximum misalignment of 16 msec for NTSC for the video and the alignment error for the analog data will be dependent on the data sampling rate. Utilization of the data integration capabilities has been found to be extremely useful when performing clinical gait evaluations, ergonomic analyses of the EMG activity of the abdomen and low back while wearing back belts during lifting (see Figures 3 & 4).

Stick figure option. This function permits the superimposition of the ground reaction force vectors on the digitized video images which may be rotated in 3-D space. A global fiducial point must be digitized in order to define the force plate's referential frame and the numerical data may be dynamically integrated with the matching video images (see Figure 4).

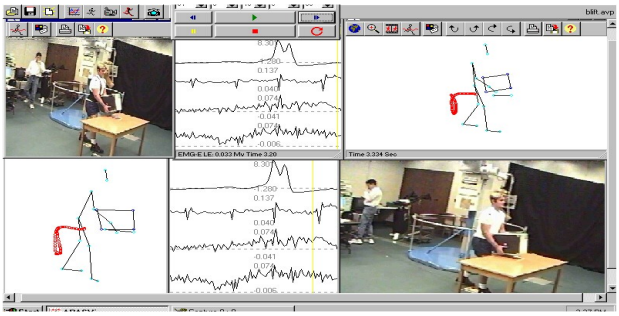

Figure 3 - Integrated analog data while lifting.

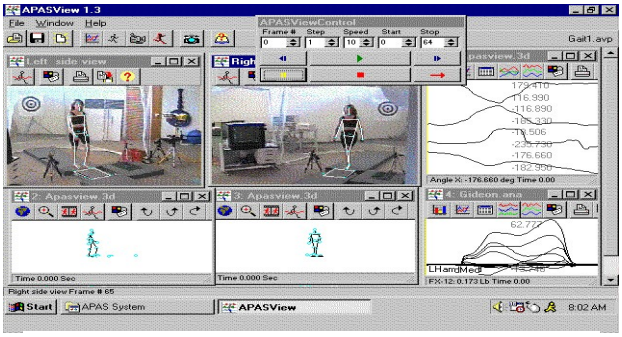

Figure 4 - Superimposed GRF vectors on clinical gait video with force plate data.

CONCLUSION: Synchronization of individual views with kinematic, kinetic, and analog data may be accomplished by adjusting the time offset. By synchronizing the separate views or trials, it is possible to produce comparative studies such as the 1996 Atlanta Olympic project conducted by Finch, Ariel & Penny (1998), which evaluated discus throwing performance variances observed for best and worst attempts. Dynamic integration of video records, kinetic, kinematic, EMG, and force plate data can produce multimedia presentations of human movement that facilitate effective qualitative and quantitative biomechanical analyses.

REFERENCES:

Finch, A.E., Ariel, G.A., & Penny, A.M. (1998). *International Symposium on Biomechanics in Sports XVI, 93-96.*