Sports Analysis in the New Millennium

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MOVEMENT ANALYSIS CAN BE APPLIED TO:

Athletics

Industry

Medicine

Space
Ariel Performance Analysis System

Video Capturing

APAS

General Biomechanics
Functional Capacity
Gait Analysis
Jobsite Analysis

Functional Capacity

Sports Analysis
Post Injury Evaluation
Job Qualification Testing

Kinematic Studies

Lifting
Standing
Sitting
Ladder Climbing

Squatting
Backload
Stairclimbing
Hand Evaluation

Carpal Tunnel Syndrome

Analog A/D Option

Gait Analysis
Balance Analysis
Impact Studies
Prosthetic Design
Neurological Studies

Spine

c.p.
m.d.
m.s.

Pre & Post Surgery
Hip Replacements
Knee Replacements
Amputee Gait
Walking Aids
Stroke Patients
ALL APPLICATIONS UTILIZED SIMILAR QUANTIFICATION TECHNIQUES
Basic Components of Motion Analysis System

- Notebook computer
- Video cameras
- Portable VCR
- External monitor
- Portable printer
- Optional A/D devices
- Force plate
- EMG
The Early 70's

use of high speed cinematography
NEW TECHNOLOGIES
For Your Professional Toolbox

- Computerized Video Analysis [Kinematics]
- Force Plate [Kinetic Ground Reaction] 3D
- Dynamic EMG
- Internet Interface
Athletic performances can be divided into a wide spectrum of activities.
The Spectrum of Athletic Performances

• **Explosive Events**
  – *Throwing*
  – *Sprinting*
  – *Jumping*

• **Endurance Events**
  – *Long Distance Run*
  – *Swimming*
  – *Cycling*

• **Accuracy Events**
  – *Golf*
  – *Archery*

• **Team Sports**
  – *Soccer*
  – *Basketball*
  – *Hockey*

• **Esthetic Events**
  – *Figure Skating*
  – *Gymnastics*
  – *Diving*

• **Multi Events**
  – *Decathlon*
  – *Pentathlon*
Analysis of Performance Require:

**Video Recording**

**Digitizing the Data**
- Manual
- Automatic

**Transformation of the Data**
- 2D - Two Dimensional
- 3D - Three Dimensional
High Speed Camera at 240 Hz
Video Recording
Video Capturing

[Image of a computer screen displaying a video analysis tool with graphs and diagrams related to video capturing.]
Video Capturing System
Video Capturing Software Packages
Reidel Gold Medal
Hardware

- **Main Computer System**
- **Workstations**
- **Capture Card**
- **Network**
  - Intranet
  - Internet
    - Renderer
    - Presentations
Software Integration
Software Modules

APAS System

Ulead VideoStudio 4.0.Ink

Shortcut

Modified:
3/18/00 3:47 PM

Size: 595 bytes
Software Integration

- Capturing
- Digitizing
  - Locally
  - Net Digitizing
- Transformation
- Filtering
- Kinematic Results Display
- Kinetic Results Display
Digitizing

- Manually
- Automatically
# Transformation

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Data Transformation

VIEWING Module C.B.A. Inc.

Pvault.avi
Filtering/Smoothing
Smoothing of the Data

Filtering Algorithms

- Cubic Spline
- Digital Filter
- Quintic Spline
- Fast Fourier Filter
- Segment Constraint
PHOTOGRAMMETRIC TRANSFORMATION WITH PANNING

K.A. Stivers, G.B. Ariel, J. Wise, M.A. Penny, A. Vorobiev, A. Gouskov, N. Yakunin
Panning Head

- Optical angular encoder
- Selection of the bar width and position within the frame
- Transformation of the encoder impulses to the video signal - the bar with proportional to the panning angle length
- Video output to the camera’s EVF/Character Generator Terminal
- View finder
Real-time rendering

Traditional stick figure

Real-time rendering
What is Rendering anyway?

Definition of:
- Graphic objects
- Lighting
- Environmental effects
- Behavior
- Physical characteristics

Calculate views:
- Computer screens
- Immersive workbench
- Head-tracked glasses
Technological advances have made it possible to integrate, synchronize, and simultaneously display video records, kinematic, kinetic, EMG, and force plate data of human movement.
Display and Analysis
Calculating the Velocities of the lower limb revealed acceleration and deceleration patterns in a unique sequence.
Observing the upper extremities reveals a pattern as well.
Dubrovshchik BLR 66.6m Vel 2718 cm/sec

△ = VEL_MAG_R.EXT1
CBA Graphing module

\[ \text{Time: } -0.046 \rightarrow 2126.684 \]

\[ \Delta = \text{VEL_MAG_R.EXT1} \]

Washington 65.42m

\[ 2484.85 \text{ Cm/S} \]
THE CASE OF THE LONG JUMP:

CARL LEWIS

MIKE POWELL
Velocity of the Center of Mass

Mike Powell 8.95m - World Record
Height of the Center of Mass

Mike Powell 8.95m - World Record
Angular Displacement in Hip Joints

Mike Powell 8.95m - World Record
Angular Velocity in Hip Joints

Mike Powell 8.95m - World Record
Angular Displacement in Knee Joints

Mike Powell 8.95m - World Record
KINETIC FORCE PLATE
GROUND REACTION FORCES
Analog Data Input

- Force Plates
  - Horizontal force
  - Lateral force
  - Vertical force

- EMG Data
  - Muscle Activity
  - Timing of Muscular firing
NORMAL GROUND REACTION

Lb

A=FX-1
B=FY-1
C=FZ-1

Y=64.382
Y=-63.068

Sec

0
.5
1.0
1.5
History was made at the Atlanta Games by utilizing the Internet to provide Biomechanical data immediately for use at remote sites.
The purpose of the research conducted at the XXVI Olympiad in Atlanta was to expand the biomechanical applications and the interactive capabilities of the Internet to make sport performances rapidly available to everyone.
Under the auspices of the International Track and Field Coaches Association, the track and field events which were performed at the Atlanta Olympics in 1996, were selected to illustrate these procedures because these activities uniquely captivate an enthusiastic world-wide audience.
Because of the strict accessibility to the field for security reasons, special locations had to be chosen and guarantee for setting video cameras.

The main goal in the present study was to be able to load the data into the Internet at the fastest time, so scientists, students and any interest group will be able to download the video and other data immediately from the Internet.

The purpose of the present study was to analyze Track and Field performances in the Atlanta 1996 Olympic Games.
This was a new and innovative procedure that allows immediate sending of video information all around the world for immediate analysis at different locations.
The Internet has opened a new frontier for research and international cooperation on multifaceted studies.
Essentially, in Internet terms, the entire process consists of the following steps:

- Analog video data is captured off-site and off-line through the use of a frame-by-frame advance VCR.
- Analog video data is converted off-site and off-line to digital video data in AVI format.
- Digital video data in AVI format is transmitted via FTP from a remote PC (browser) to a web server.
The web server, converts the AVI frames into individual GIF files.

The web server, through CGI, superimposes the x,y,z coordinates on the video images.

The web server sends back the processed (digitized) image frames back to the remote PC (browser) with all pertinent mathematical and physical observations, analysis, and conclusions.
Utilizing the tools available in Cyberspace, the Biomechanist, The Coach and the Sport Scientist can retrieve and display data as well as documents from virtually anywhere on the planet. Studies can be conducted at multiple locations and data rapidly exchanged among these sites.
A BIOMECHANICAL STEP ONTO THE INTERNET

It is a window on the ever-expanding world of on-line information. The new communication links afforded by rapid satellite/computer exchanges bringing together hypertext multimedia and global networking. The Web is growing at an astounding rate and is changing the scientific world by making it possible for anyone to transmit and receive information around the world.
PROVIDE SIMULTANEOUS INTEGRATION OF:

- Video Images,
- 3-D Stick Figures,
- Kinematic & Kinetic Data in graphic/tabular format,
- Analog information from force plate & EMG data

Applications

- COACHING
- SPORT PERFORMANCE ANALYSIS
- OPTIMIZATION OF PERFORMANCE
Program Integration and Synchronization
The Cyber Coach