COMPUTER AIDED BIOMECWANICAL FLLM ANALYSIS PROGRAM

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INTRODUCTION

One of the most important methods of sportbiomechanics is the analysis of film records. To understand sport movements it is necessary to make high speed films and video records. We use a high speed 16 mm camera to record any movements but we have a lot of problems for the analysis of these films. My program wants to help anybody to analyse films. The program calculates velocities, accelerations, forces and moments of human body and of some parts of human body.

METHODOLOGY

Everybody knows how hard is the work to analyse high speed video films and films that we used to study sport movements. We know that many programs were written by researchers for help this work but these programs were written by universities' members for themselves and we met this programs only at conferences but never in a shop. We have not seen any big softwarehouse make program like these but we need this kind of program for our students, researchers and teachers. I started to write this on Turbo Pascal 3.0 in 1989 and now I use TP 6.0 and I think that I never will finish my work.

The program needs the following configuration:

- IBM compatible computer (8088,80286,80386,80486) with minimum 1 MB RAM;
- floppy or Winchester;
- graphic card and monitor (Hercules, CGA, EGA, VGA, SVGA, etc)
- Epson compatible matrix printer;
- plotter that knows HPGL;
- table for digitalisation.

When we start to run the program we can see the main menu on the screen. It has six menu points:

1) Enter data
2) Graphics
3) Fourier series
4) Compare Fourier series
5) Calculate angles
6) Centre of gravity
0) Exit

First we must use data entry because without data the program does not work (and it will appear an error message). We have a lot of way for data entry:

1) Table
2) Keyboard
3) Files

The most important way to collect data is to use a digitaliser. This part of the program firstly asks the start and end point of the"X Axis" . If we use special films where "X Axis" is not vertical it will be not problem. The program after the co-ordinates of the start and end point of "X Axis" will calculate every time the correct co-ordinates by using elementary geometric equations. The system of equations is:

$x' = x * \cos(\alpha) + y * \sin(\alpha) + x0$

$y' = -x * \sin(\alpha) + y * \cos(\alpha) + y0$

Then the program asks about the normal distance that we want to use than an etalon. (We use many times a one meter long bar). It is necessary to convert co-ordinates to 'm' (or 'mm'). After this data we can add the co-ordinates of important points. The program suggests 18 points on a human body but we have chance to modifying this. The human body model that the program uses was made by DEMPSTER.

After data we can print on a printer or on the screen co-ordinates of the points and the velocity and acceleration of points. If we use etalon bar everything will calculates mm, mm/sec and mm/sec^2.

When we collect data we can save them on a file. This file is an ordinary ASCII text file that we can read and modify by means of any word processor program (if it is necessary).

We can make various graphics with data on the screen or any HPGL compatible plotter. The types of graphs are:

I. Picture of phases and centre of gravity
2. X-Y covering curves
3. or Y(t) covering curves
4. Fourier series and derives
5. Angles
6. Forces
7. Torques

We have to calculate some exact and very important functions that are necessary to understand what is the most thing under the movements. Because the digitaliser and the film techniques give a discrete group of points it is necessary to make any fitting to analyse functions. We use Fourier series because it is good to make exact functions from discrete data and its first and second derives is the velocity and acceleration of the function.

We use to calculate differences between two Fourier series a special mathematical model:

$$\Delta = \sqrt{\quad (f(x) - g(x))^2}$$

This means that we have an absolute number that we can use to analyse differences. Sometimes it will be important for example compare two functions that we calculated between two different athletes who makes good and bad movements and then to know what was wrong.

The next important point of the biomechanical analysis is the angles. The program can calculate about 25 different angles from every picture. If we want to see this function (angle/sec or angle/frame) we can make draws on the screen or on the plotter. If we want to see angle-functions of two different movements or two different athletes we have to load their data and after we can

see everything on the screen or on the plotter.
If we know some anthropometric data of athletes the program can calculate centre of gravity of human body segments and the centre of gravity of the total body. Here the program uses the model of DEMPSTER. We can see how this point is moving under the exercises.
Every time we can save any data that the program calculated before. Perhaps we can Ioad this saved data when we need them. The file system is very simple. Every file is a normal ASCII file but the type of file has some differences. (For example the file type of the original data is DAT, the file type of Fourier coefficients is FOU, etc.). When we make any modification with a file the old file type will be a BAK file and the new one will be the original.