# BIOSIST - TWO DIMENSIONAL KINEMATICS PERFORMANCE ANALYSIS

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## INTRODUCTION

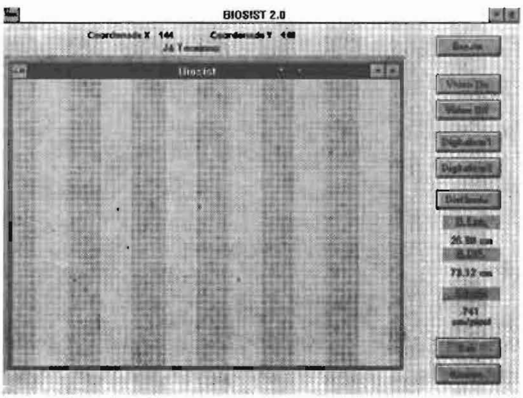
The visual observation process is the most used to analyze the mechanics of the performance. The accuracy of this process, is essentially based on observer experience, which is subjected to many errors, because it depends on its capacity to focus attention in this aspects, and the used criterion in this observation among many others. It's possible that even to the most experienced observer some important data might been forgotten. The video record and the later analysis of the task can be helpful, but the performance must be quantify, if we want to optimize the task.

The observer has many means available, but most of then are very expensive (time and money consumption) not only in the collection of images but also on in its later computation.

The purpose of this study is offer, to the observer, a quantitative and qualitative analysis tool, not expensive and easily accessed. Its a qualitative analysis instrument because makes possible the visualization of the realized task, and a quantitative tool because it gives the numeric values of the realized task.

## MATERIAL AND METHODS

The system uses any video camera and video recorder and it works in any Windows 3.1 or later version environment. A Videoblaster SE 100 board allows



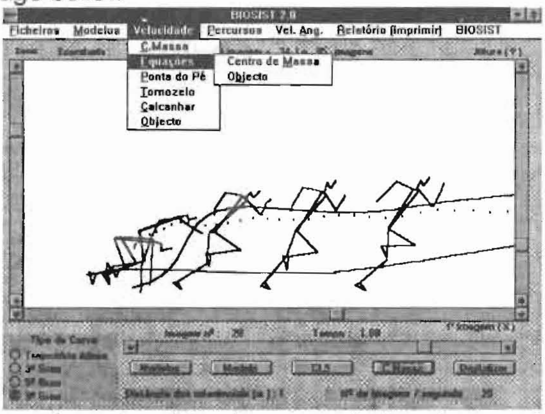

the video image transfer to the computer video board. The BIOSIST image digitalization module supplies the bidimensional spatial coordinates of the anatomical or objects data for the reconstruction of the performer graphic model.

The BIOSIST it uses 21 anatomical coordinates $( x , y )$, of the joint centers and extremities, and 2 coordinates, to compute the scale factor. This coordinates are save in a file to posterior analyses. Its also possible in this module, to digitize an object, for exempla a ball flight phase.

It's also possible to compute the real distance from a point to one fixed line, as Hay and Koh (1988). The image created by a camera represents a deformation. A three-dimensional object is project onto a view plane using a perspective transformation. Two parallel lines in the object that are not parallel to the plane are projected into converging lines ( vanishing point ). From the vanishing point, Rogers and Adams (1990), we can compute the distance from a point to one fixed line.

The second module, the data prosecution module, makes possible to figure out suitable kinematics parameters for the study.

It's possible visualize the stick figures all together, or frame by frame using the graphic model ; image bellow




The center of mass data is computed using an adaptation of the Dempster, Clauser, Hay tables. The center of mass velocity is the first derivative of a fitting curve which one is computed from the center of mass positions and the BIOSIST user can choose the least square fitting, order, Miller(1993 ).

The Gauss-Jordan method, was used to solve the equations system in which *x* are the coefficients to be compute and *b* the center of mass points i.e. the

$$Ax = b \; ; \; A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \; ; \; x = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} \quad \text{e} \quad b = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{bmatrix}$$

solution of the system.

The intersegmental angles are computed using the dot product. The intersegmental angular velocity are compute from the least square fitting It's also possible to print the results or save it in text mode for posterior analysis.

The BIOSIST image digitalization module supplies the bidimensional spatial coordinates of the anatomical or objects data for the reconstruction of the performer graphic model: occupancy 200 bites. As an example, a 35 frames performance occupies 18,2 KB. A 3,5" diskette of 1.4 MB accumulate the BIOSIST.EXE and about 2000 frames.

For the validation of the system we used numerical theoretical analysis to compare the second derivative of a parabolic ball trajectory, the gravitational acceleration (g).The throwing ball release conditions was ($h_o$, $v_o$ e $\alpha_o$ ). The trajectory of 13 balls have been digitized in order to analyze the second derivative of equation found using the fitting method ( fig 1 ).
The values of *x* and *y* were compute from the equations well know, of projectiles under the gravitational force. These values have been read by the BIOSIST, and the obtained values were compared ( fig 2 ); the acceleration value also been analyzed in function of the number of collected images. Later on, for new initial conditions we have analyzed the acceleration value in relation to the scale value alteration ( fig. 3 )

## DISCUSSION AND RESULTS

The results obtained by the digitalization of the balls show some variations around the g value ( 9.81 $ms^{-2}$), with standard deviation of 0,48 ( fig.1).

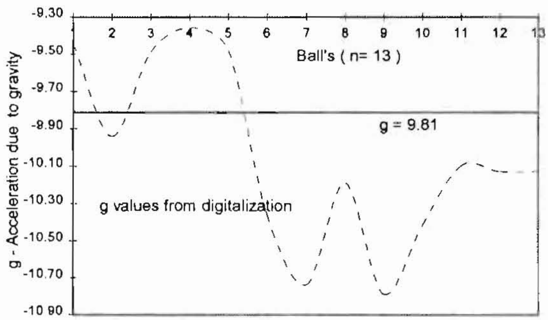



Fig.1- The acceleration due to gravity computed from the values of the 13 trajectories

But in a situation where *x* and *y* were calculated from the projectile equation of the motion ( $x = v_{xo}.t$ ; $y = y_o + v_{yo}.t - \frac{1}{2}gt^2$ ), and read by BIOSIST.

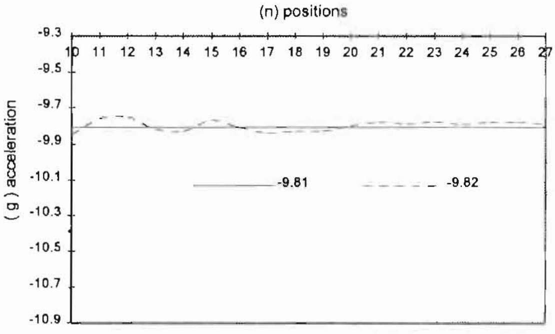



Fig. - The acceleration due to gravity computed from the values of the projectile equations of the motion

The results obtained for the gravitational acceleration, present major differences when the number of points computed decrease. The two ( fig.; 2).are on the same range of values for easier visual orientation. The *g* values computed by BIOSIST between 9 and 27 trajectory points ( -9.80± 0.0285) average difference between the simulated and the values of ( *g* ).

I It is then pertinent to ask what is the importance of the scale factor in the computation of *g* . We do find a very large correlation ( -1.00) between g values de values of scale factor. its was possible to find a minor oscillation of simulated g (2.47 E-5 m ) of the scale values ruffle alterations in the *g* values ( -7.40E-2) (fig.3).

Those results show a new calibration process for the 2D kinematics performance analysis process.

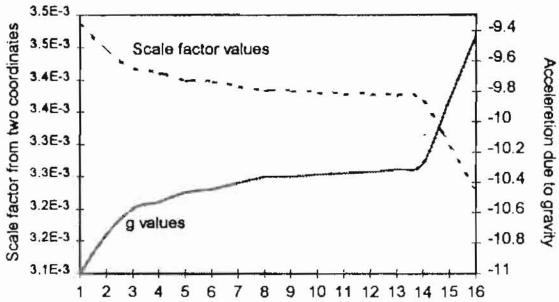



Fig.3 - The correlation between the scale factor and the acceleration due to gravity computed

## CONCLUSION

The present data seems to show the evidence that BIOSIST uses accessible means and guarantee the computer memory saving on digitalization. The numerical methods used to smooth a set of points behaves well. The results show a big careful on collecting the points which settle the scale to use ( the two first coordinates to collect).The scale factor is crucial to the success of BIOSIST obtained data and therefore the of coordinates collect process of points which settle the scale factor is determinant on investigator's work.

## REFERENCES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