3-D IMAGING AND ANIMATION APPLIED TO FOOT STRUCTURES IN WALKING AND RUNNING: PHASE TWO: SOFT TISSUES AND USER INTERFACE

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INTRODUCTION

In physical education and in biomechanics it is very important to develop a sound knowledge of the locomotor system structures and of the mechanisms and interactions responsible for movements. This learning process requires a realistic 3-D representation of structures in static as well as in dynamic situations.

Pedagogic literature has demonstrated that learning difficulties are frequently related to inadequate representations of structures and movements. However visualisation and mental imaging can be facilitated with computer assisted teaching and the use of 3-D images (Guy & Frisby, 1992; Michael & Revick, 1986; Richards, Sawyer & Roark, 1987).

In order to counteract learning and training difficulties encountered by physical education students, coaches and athletes, due to poor or inadequate 3-D visual representation of human body structures and movements, a low cost computer platform capable of 3-D objects generation and animation has been developed. The first phase of the project was dealing with 3-D imaging of bone structures of the ankle-foot complex and animation of these structures in walking (Therrien, Farrar & Cuemer, 1993).

The second phase of the study, presented hereafter, was pursuing three main objectives:

1) generation of 3-D representations of the main soft tissues of the ankle-foot complex (ligaments, tendons, muscles and retinaculum);

2) animation of the ankle-foot bone structures in running;

3) development of a user interface easily accessible with the mouse or the keyboard.

METHODOLOGY

The main elements of the methodology used have already been presented before (Therrien et al., 1993). It included:

1) the development of a computer platform, using a Commodore Amiga 3000T computer together with preparation software and presentation software;

2) selection of the "structured drawing" imaging techique;

3) selection of anatomical structures

4) selection of anatomical and kinematic data on "objects" and their movements, from anatomical and biomechanical literature (Czernieki, 1988; Root, Orien & Weed, 1977; Winter, 1991);

5) creation of "objects" of the ankle-foot complex;

6) animation of movements;

7) integration and synchronisation of animated movements of bone structures with animated human manikin and relative time code, in walking and in running;

8) the development of a very "friendly" user interface including functions and options easily accessible either with the mouse or with the keyboard.

RESULTS AND DISCUSSION

The final product enables the user to have access, through selection of menus, functions and options, to the following 3-D illustrations:

1) multiple views, from any selected angle, of the bony structures of the lower leg and foot;

2) multiple views, from any selected angle, of muscles, tendons. ligaments and retinaculum involved in ankle and foot movements

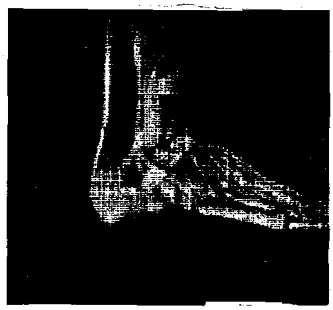

Figure I. Illustration of ligaments, tendons, muscles and retinaculum of ankle-foot complex.

3) multiple views of lower leg and foot articular surfaces, with a transparency option, in order to better locate hidden surfaces;

4) animation of opening of talus-calcaneum joint in order to better locate corresponding articular surfaces;

5) identification, with a pointer, of any individual structure of the ankle-foot complex.

In addition, the user can also select to view 3-D animations of any of the following movement sequences:

1) basic ankle-foot movements: plantarflexion, dorsiflexion, pronation, supination;

2) talus-calcaneum interaction, in order to reproduce the rotation taking place at their interface when loading the joint;

3) movements of lower leg and foot structures in walking or running (side view or rearview) synchronized with a reference manikin and a relative time code (Figure 2)

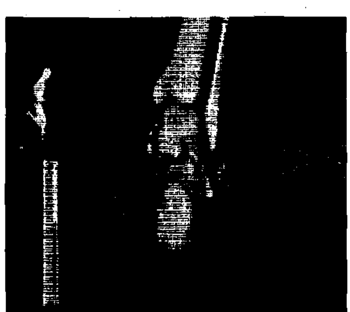

Figure 2. Illustration of running animation mode synchronized with manikin movements and relative time code.

Comparative evaluation under controlled conditions, of teaching a structural **kinesiology** course with and without the use of this tool has demonstrated that retention of knowledge is 10% higher when using this computer-assisted teaching technique.

CONCLUSION

The teaching tool developed offers adequate 3-D representation of structures and movements of the ankle-foot complex and the user interface is very easy and time efficient to use. Results demonstrate that this 3-D representation tool can be used to improve visualisation and comprehension of walking and running activities.

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