ISSN 1750-9823 (print)
International Journal of Sports Science and Engineering
Vol. 06 (2012) No. 01, pp. 003-008

Visual Simulation for Learning in Kinesiology- Developing the Volleyball Smash Feet Tracks Visualization System

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(*Received June 10, 2011, accepted September 9, 2011*)

Abstract. To meet the needs of the learner, simplifying new skills for learners at their beginning stages of learning is critical. Novice learners benefit from simplifying motor skills to be taught greatly. Not only does simplification reduces the amount of information novice learners need to deal with, assisting with their limited focus of attention capacity, simplification also gives students a sense of successful accomplishment. Such benefits make learning a bit more fun to enjoy. How is simplifying motor skills done through computer simulation? Combining computer design and knowledge from Kinesiology, current study proposed simulating a real-world sport skill, 3-step volleyball spiking approach, through a computer assisted visualization system.

Key Words: Computer assisted simulation system, visualization, volleyball spiking approach, modeling, feedback

1. Introduction

The amount of information needs to be processed by learners tackling a new sport skill can be overwhelming [1]. Such demand is even more substantial if a novice learner is exposed to the new skill without directions [2]. To meet the needs of the learner, simplifying new skills for learners at their beginning stages of learning is critical [3].

Most coaches and instructors adopt a teaching system that demonstrates the skill to be learned first, and then invite students to practice. Feedback to the performance of the skill is provided to accompany practice. Although a visual representation of the skill to be learned leaves students a direct perception of the execution of the movement, such original visual representation is often information over-loading [1]. Providing excessive amount of the information to a learner defeats the purpose of effective teaching especially for novices.

Similar issues hold true for providing feedback. Effective feedback providing on motor skills, complex or simple, is essential to its acquisition, however difficult to accomplish [4]. Moreover, successful execution of a simple skill (i.e. setting and bumping volleyball) does not guarantee success on a more complex one (i.e. volleyball spike approach). Looking in detail, the two simple individual skills belong to the discrete skill category due to the easy identification of a definite beginning and ending [5]. Serial skills such as butterfly flutter kick, fielding a ground ball in baseball, or volleyball spiking approach, on the other hand, are classified due to its multiple components. Beginner learners are often frustrated by the unsuccessful transition experience. Motivation, that only enhanced by initial successful experience, is challenged [6]. The inclusion of the different discrete parts makes serial skills harder to grasp. Simplification of the skill, when possible, comes in handy.

Novice learners benefit from simplifying motor skills to be taught greatly. Not only does simplification reduces the amount of information novice learners need to deal with, assisting with their limited focus of attention capacity, simplification also gives students a sense of successful accomplishment. Such benefits make learning a bit more fun to enjoy.

Simulation, one form of simplification, has been studied extensively in areas with safety caution and

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high-cost equipment (i.e. training astronaut). Aid regular sport skill learning with computer simulation is scarce [7]. How is simplifying motor skills done through computer simulation? Here is a proposal with a real-world sport skill, 3-step volleyball spiking approach, as the basic skill for the model.

2. Methods

Similar to our previous project on presenting color-coded 3-D visual representations of rhythm [4], two components were also used to design the volleyball smash feet tracks visualization system. Specifically, one of the components used is the sound capture program, developed by Sun Microsystems, Inc. (http://www.java.sun.com). This component is used for its capture/playback function only. Extension of such compatible file is .wav. Original sounds for the Volleyball Smash Feet Tracks can be obtained through two approaches. First of which is to connect a microphone to the computer that is running the sound capture program, Procedures involved include putting the microphone on the floor near the net, then use the computer to record the sound, and save it as a wave file; Second of which is to record with a digital recorder on the floor near the net, and export the sound as a wave file. For the purpose of developing model and feedback clearly, player foot-work in volleyball spike approach needs to be practiced and recorded without balls.

Due to the fact that recorded sound will be analyzed at the second component, a data output function was added to the sound capture system from Sun Microsystems, Inc. (http://www.java.sun.com). After a recorded sound track or loaded wave file to the sound capture system, the sound capture system finds the actual sound data from the wave file and output the data to a text file.

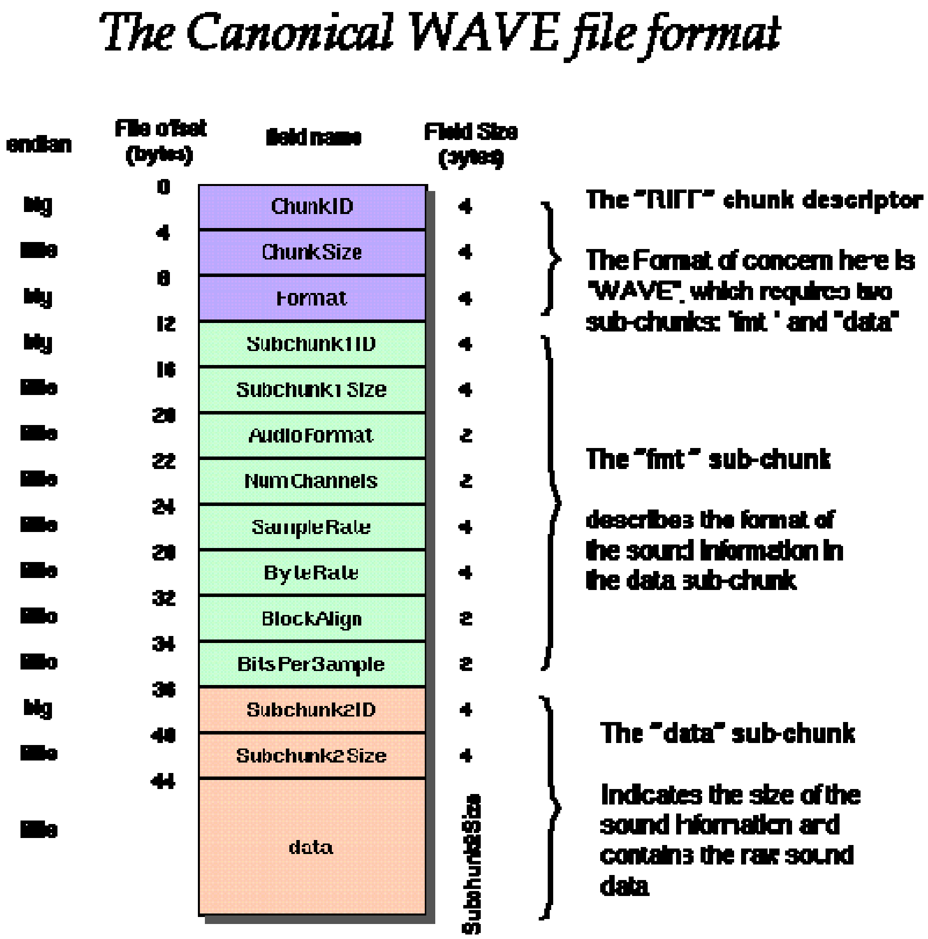

Figure 1

According to the format of the wave file (shown in Figure 1) [8], format information was acquired from the first 12 bytes. For example, if this wave exhibits an endian form, regardless of the size (big or small), data points between the 13th byte to the 35th byte will be used. This section of data includes the information about the data sub-chunk. From the same section, the BitsPerSample data is obtained, which is located between 34th -35th bytes. The BitsPerSample data determines the single sample size. Begin from the 44th byte is the actual sound data. First of all, sound data will be divided by the sample size. Then, in each sample, data is reordered by either big-endian form or little-endian form depending on the format of the file received. At the end, data will be converted to decimal number and output to the text file.

The second component is the image generation – developing the visualization part. After text file was segmented from part one, generated text file was used to process associated images - volley ball smash feet tracks generating. This system contains four modules: a) importing file; b) noise reduction; c) peaks finding, and d) image generating (will be introduced in the next section in detail). Specifications of each module are as below:

(1) Importing file: importing text file generated from the component one - captured sound. Although the file input is a text file, it still can be considered as an image due to the fact that the data is from the wave file. Curve of the sound wave can be drawn from a Microsoft Excel file. For example, Figure 2 demonstrates the sound wave from a saved text file. This is also the rationale for launching the image processing idea.

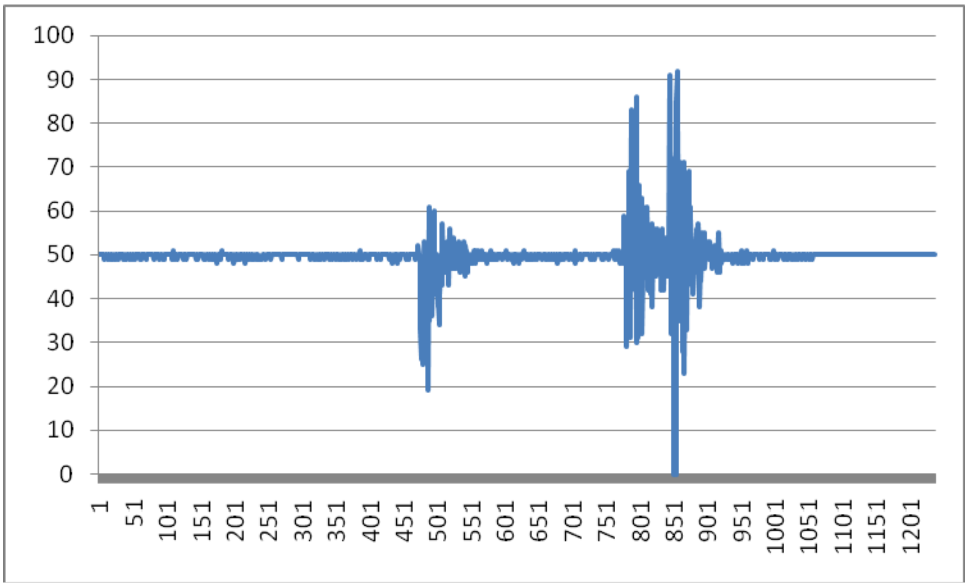

Figure 2

(2) Noise reduction: Because the data received from component one is raw data, it contains so many noises that it is impossible to be done any analysis directly. A 2-stage filter pre-processing was applied for de-noising purpose.

a. Median filter

Median filter is a common non-linear filter being used a lot in image processing applications. Before applying the median filter, a filter, also known as window size, needs to be chosen. Figure 3 illustrates the window size.

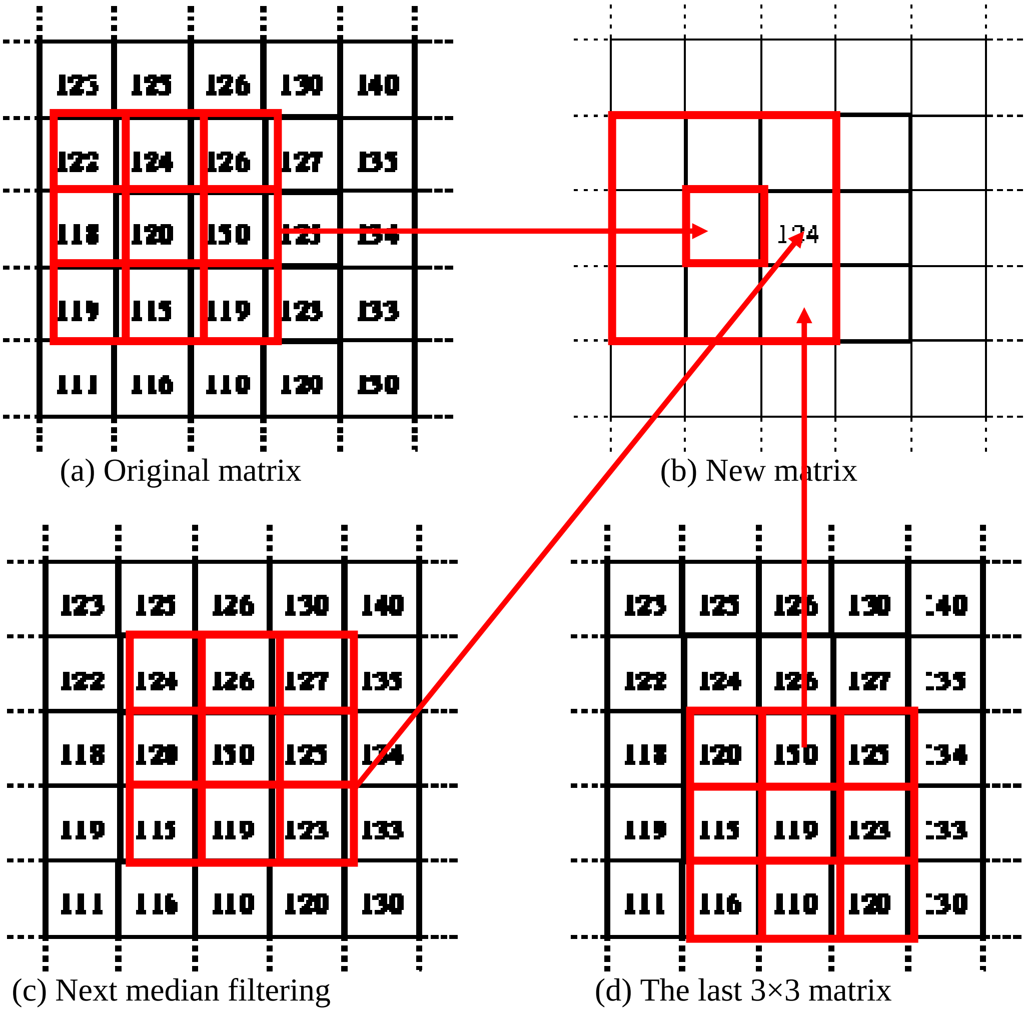

Figure 3. An example of median filtering with window size of 3: How to get the median value [8, 9]. Original matrix (b) New Matrix (c) Next median filtering (d) The last 3×3 matrix

The red matrices in the Figure 3 are the filter windows. If the window size is 3, the matrices should be 3×3. Values were sorted from one matrix and the median value was used to substitute the center value. Specifically, the values from the matrix in the Figure3.a are 124, 126, 127, 120, 150, 125, 115, 119, and 123. After sorting those values, the result is 115, 119, 120, 123, 124, 125, 126, 127, and 150 and 124 is found to be the median value. So 124 will be used as the value of the center blank of the matrix and saved to a new matrix. [5] The bigger is the window size, the dimmer is the picture, and more time is needed for calculation. After extensive testing, number 3 was chosen as the window size due to its image quality generated and reasonable speed of calculation.

b. Gaussian filter

After median filter, the sound wave became smoother, but it is still not satisfactory for the next steps. So this second filter, which is named Gaussian filter, was applied. The Gaussian filter will instantly control the curve of the sound wave, neither too high nor too low. Figure 4 is the shape of a typical Gaussian filter.

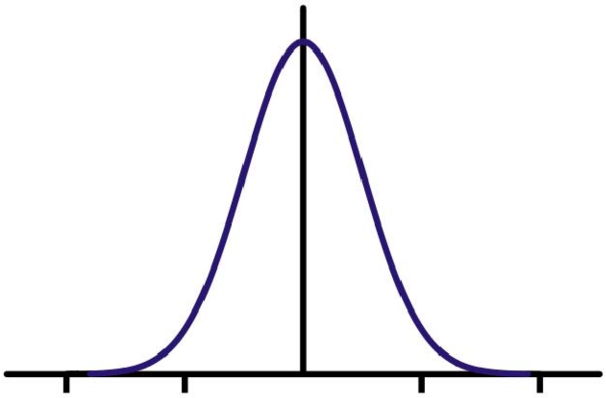

Figure 4 [10]

For convenience, we used {0.398942, 0.241971, 0.053991, 0.004432, 0.053991, 0.241971, 0.398942} as the mask of the Gaussian filter. Figure 5 shows the differences between the curve of the sound wave (red) from the plain data and the curve of the sound wave (blue) from the data after image pre-processing.

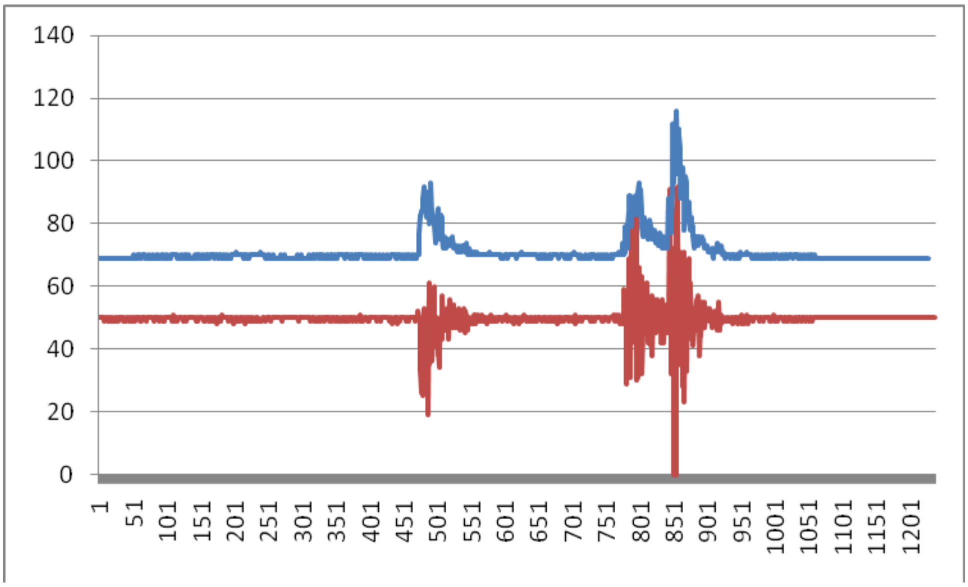

Figure 5

The red curve was generated from the raw data. The blue one is after noise reduction. It is satisfactory enough for us to find the peaks from the blue curve.

(3) Peaks finding:

The peaks are defined as the highest points in the sound wave in a reasonable range, and should be significantly higher than the average value. After several experiments, we found those thresholds for our system. The peaks should be the highest values between (-30, 30) range, and higher than 1.05×average.

3. Results

Image generating

In this part, the system will generate the image file for the result. At the beginning, a standard data from an experienced volleyball player displaying the sound pattern of the 3-step volleyball spike approach was loaded and image of which is generated as shown as Figure 6.

Figure 6

Figure 7

Then a recorded data was used to generate the comparison image file, so the trainee can figure out the differences between theirs footwork and the standard data in a visual format that is much easier to comprehend. A serious problem occurred when effort was put in trying to generate the comparison images. How do we define the start point? It is hard to leave the computer to make this decision. After some observation and exploring, we did find a solution. The trick is that the end point for our case is very intuitional - the last peak value is the end point. Comparison images generated was in reverse direction to avoid the starting point problem. Figure 7 is one of our final result images.

4. Discussion

By giving students a simplified visual demonstration on where their feet should be, (an external focus of attention), learners' attention is concentrated on the critical component on the motor skill – rhythm. External focus of attention facilitates learning especially for beginners [11]. Moreover, providing students a comparison of their approach performance and the one from the model, self-directed evaluation is administered. As a result, self-initiated feedback seeking, another principle for effective learning is implemented with the assistance of this proposed direct visual representation. Effectiveness of such program in teaching and coaching practice needs further exploration.

5. References

[1] Honeybourne, J. *Acquiring skill in sports: An introduction.* New York, NY: Taylor & Francis Group, 2006.

[2] Ploetzner R., & Lowe, R. Dynamic visualizations and learning. *Learning and Instruction*. 2004, **14**(3): 235-240.

[3] Coker, C. A. *Motor learning control for practitioners(2nd ed.)*. Boston: McGraw Hill, 2009.

[4] Wang, L. Guo, RK, Lu, P., & Tsai, PS. Color of rhythm- a 3-D visual representation. *International Journal of Sports Science and Engineering*. 2010, **4**(4): 246-250.

[5] Schmidt, R., & Wrisberg, CA. *Motor Learning and Performance* (4th ed.). Champaign, IL:Human Kinetics.

[6] Borich, GD. *Educational psychology: A contemporary approach* (2nd ed.). Boston: Addison Wesley Publishing Company, 1997.

[7] Heynen,C. Viewing and visual representation in the physical education classroom. *Strategies.* 2008, **22**(1): 25-30.

[8] Open source from https://ccrma.stanford.edu/courses/422/projects/WaveFormat/

[9] Guo, RK. *Robust spots finding in microarray images with distortions*. Master Thesis at University of Texas-Pan American, 2008.

[10] Open source from http://en.wikipedia.org/wiki/Gaussian_filter

[11] Wulf, G., Shea, C.H., & Lewthwaite, R. Motor skill learning and performance: A review of influential factors. *Medical Education*. 2010, **44**: 75-84.