

Metody nauczania elektronicznego ruchu w zastosowaniu do treningu Wu-Shu

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Streszczenie

Zastosowanie zaawansowanych metod nauczania wspomaganego elektronicznie (ang. *e-learning*) do nauki ruchu (tańca, różnych rodzajów sportu, sztuk walki lub rehabilitacji) nie było dotychczas rozważane w literaturze poświęconej e-learning. Tymczasem e-learning może mieć wiele zastosowań jako materiał do nauki w domu lub uzupełniający dla różnych form ćwiczeń ruchowych, które ćwiczone są z trenerem. Zapotrzebowanie na tego typu materiały jest dobrze ukazane poprzez obfitość literatury na temat nauki sztuk walki, tańca, i innych rodzajów ćwiczeń fizycznych.

Oprócz materiałów dodatkowych, zawierających historię dziedziny, terminologię, bądź inne informacje dające się przedstawić w formie tekstowej, materiał dydaktyczny służący do nauki ruchu może zawierać informacje potrzebne do nauki wykonywania ćwiczeń fizycznych. Tego typu materiały dostępne obecnie to zwykle filmy instruktażowe. Jednakże taki rodzaj informacji jest zwykle niewystarczający. Potrzebne są nowe metody strukturalizacji i opisu informacji o ruchu ciała ludzkiego, mające wspomagać naukę ćwiczeń fizycznych. Te metody powinny wykorzystywać wiedzę anatomiczną. Nauczanie wspomaganie elektronicznie powinno być zindywidualizowane dla różnych uczniów. W zastosowaniu do nauki ruchu, zmiennymi służącymi do indywidualizacji materiału mogą być: zdrowie fizyczne (historia przebytych urazów i chorób), wymiary fizyczne (waga, wzrost), wiek, płeć, poziom kondycji fizycznej i umiejętności ucznia. Indywidualizacja materiału może polegać na sugerowaniu różnych ćwiczeń rozgrzewki i rozciągających oraz różnego sposobu wykonania ćwiczonego ruchu. Ważnym elementem metodologii nauczania jest ocena postępów ucznia. W nauczaniu ruchu wspomaganym elektronicznie jest to element bardzo trudny do przeprowadzenia. Poprzez zastosowanie zaawansowanych metod grafiki komputerowej możliwa staje się ocena statycznych pozycji wspomagana przez komputer. Ocena ta odbywa się poprzez dopasowanie trójwymiarowego modelu szkieletu człowieka do zdjęć pozycji studenta. Instruktor może określić własności modelu (kąty pomiędzy elementami szkieletu i wzajemne położenie punktów szkieletu), które charakteryzują poprawną pozycję. Na tej podstawie można oceniać poprawność pozycji ucznia. Jednakże ocena dynamiki wykonania ćwiczeń jest bardzo trudna. Jedną z możliwych metod przeprowadzenia takiej oceny jest filmowanie studenta i trenera z synchronizacją czasową za pomocą dźwięku, a następnie porównanie obu filmów przez studenta lub trenera.

Badania nad zastosowaniem metod e-learning do nauki ruchu zostały przeprowadzone przy pomocy studium przypadku nauki formy Wu-shu (chińskiej sztuki walki). Ta dyscyplina została wybrana ze względu na nawiązaną współpracę z trenerem kadry polskiej Wu-shu. Materiał instruktażowy został stworzony w oparciu o filmy formy (sekwencji ćwiczeń) wu-shu. Filmy zostały wykonane z 4 kątów i w trzech trybach: widok całego ciała, zbliżenie na korpus oraz zbliżenie na nogi trenera. Forma została podzielona na sceny (podział jest uzależniony od poziomu zaawansowania studenta). Poziom zaawansowania

studenta decydował także, czy była wyświetlana forma ćwiczona powoli, czy z zachowaniem właściwej dynamiki ruchu. Aplikacja e-learning daje studentowi możliwość nawigacji pomiędzy scenami, wyboru kątów oraz zbliżeń. Dodatkowo, każda scena zaczynała się i kończyła statyczną pozycją, która mogła zostać przedstawiona w osobnym oknie z nałożonym modelem szkieletu człowieka. Model ten służył do strukturalnego opisu pozycji – przy każdym z punktów modelu trener mógł umieścić objaśnienie, które opisywało prawidłowe położenie tej części ciała.

Aplikacja e-learning zawierała dodatkowe informacje, dotyczące historii wu-shu, terminologii formy oraz jej prawidłowej wymowy. Interfejs użytkownika został zaprojektowany przy użyciu znaków chińskich, popularnych symboli i wzorów dekoracyjnych związanych ze sztuką chińską i Wu-shu. Miało to służyć stworzeniu odpowiedniego nastroju, co jest także praktykowane przez trenerów sztuk walki podczas normalnych zajęć. Dodatkowo, aplikacja została wyposażona w muzykę tła dla poszczególnych ćwiczeń. Aplikacja jest w trakcie testowania przez studentów oraz instruktora, a ocena aplikacji przez studentów jest bardzo pozytywna. Planowane jest przeprowadzenie eksperymentu pozwalającego na ocenę skuteczności aplikacji w nauczaniu ruchu poprzez porównanie z grupą kontrolną. Planowane są także prace nad zapewnieniem możliwości oceny postępów ucznia przez porównanie filmów ucznia i trenera.

E-learning Methods For Teaching of Movement Applied For Wu-shu Training

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Abstract

The use of advanced e-learning methods for the teaching of movement (dance, different forms of sport or martial arts) has not been considered before in the e-learning literature. E-learning could have many applications in the teaching of movement as supplementary or reviewing material for a classroom course, or as material that is fitted to the individual student profile (student physical health and fitness, age, sex). In this respect, the instructional material for teaching of movement could be considerably different (for instance, teaching children would be very different from teaching adults). Finally, using advanced computer graphics and computer vision tools, it could be possible to introduced limited forms of feedback that evaluates the student's execution of movement.

Keywords

e-learning, student profile, computer vision, martial arts, dance, physical exercises

Introduction

Among many contemporary applications of e-learning technology, there are a few examples of the teaching of movement: dance, different forms of sport or martial arts. These applications [2, 3] usually focus on two aspects of teaching of movement: theoretical information about movement (for instance, teaching of traditions and behavior related to the dance styles or martial arts forms) and teaching of practical movement execution (for instance, steps and figures of a dance or positions and forms of a martial art). In the teaching of theoretical information about movement, simpler forms of e-learning (hypertext presentations) are usually used. In the teaching of movement execution, diagrams (figures), photographs and instructor films are usually used. To date, there has been no attempt to apply advanced e-learning methodology to the subject of teaching movement. Yet, we consider that in this area e-learning can be very useful.

Applications of e-learning for the teaching of movement would allow to create instructional materials that are more individualized and student-centered than traditional lessons. E-learning material for the teaching of movement can often be very useful for reviewing purposes. If a student wishes to exercise learned material at home between lessons with an instructor, e-learning can help him remember and exercise the movements learned during previous lessons. Also, e-learning material could include and use information that is not utilized during traditional lessons due to lack of time. Last but not

least, e-learning material for the teaching of movement can be individually adapted to the needs of the student that depend on his physical fitness.

The following table [1] summarizes the advantages and disadvantages of using e-learning methods for teaching:

	Traditional Classroom Learning	E-Learning
Advantages	<ul style="list-style-type: none"> • Immediate feedback • Familiarity to instructors and students • Motivating students • Cultivation of a social community 	<ul style="list-style-type: none"> • Learner-centered and self-paced • Time and location flexibility • Cost-effective for learners • Unlimited access to knowledge • Archival capability for knowledge reuse and sharing
Disadvantages	<ul style="list-style-type: none"> • Instructor-centered • Time and location constraints • More expense to deliver 	<ul style="list-style-type: none"> • Lack of immediate feedback • Increased preparation time for the instructor • Not comfortable to some people • Potentially more frustration, anxiety, and confusion

Table 1 A comparison of e-learning and traditional classroom learning

Advanced e-learning methodology for teaching of movement

One of the most important drawbacks of traditional, class-room methods for the teaching of movement is that instructors rarely have the time to adapt their teaching to the physical fitness of individual students. This can make it difficult for some students to follow the rest of the group, or, in extreme cases, cause physical injury. On the other hand, e-learning material can easily be adapted to the individual profile of a student. The following characteristics can be used for such adaptation:

1. physical health (the record of previous or current diseases)
2. physical dimensions (weight, size)
3. age
4. sex
5. time of day, temperature, etc.
6. student expertise and physical fitness

The adaptation can be carried out by suggesting additional exercises or different ways of performing the movement, depending on the characteristics of the student. The adaptation of the material should be consulted with specialist (physicians). In particular, certain students may be advised not to proceed with certain exercises or parts of the material that exceed their physical capabilities, in order to increase the safety of exercising.

Supporting the exercising of movement using anatomical knowledge

Most forms of movement require certain preparations, such as warm-up exercises or exercises that increase the strength of certain muscles. In a classroom, the instructor will typically suggest certain exercises and carry out a warm-up phase before proceeding. However, once again this phase is usually not individually adapted to student capabilities and needs. Students may also be able to recognize certain weaknesses during exercises that need to be corrected in order to improve their performance.

E-learning instructional material can include a set of stretching, body-building and aerobic exercises that are used in the warm-up phase and can be used to improve the fitness of a student in specific ways. These exercises could be structured using an interactive, 3D anatomical model of the human body. The student could select certain body parts, and the system would suggest a sequence of exercises for that body part; the exercises could be adapted to the fitness profile of a student.

Creating feedback in the e-learning of movement

From a methodological point of view, the use of photographs or films for the teaching of movement execution has a limited value. In a direct contact with the instructor, the student is able to copy the instructor's movement and compare his movement to the movement of the instructor. The study is simplified also because the student can observe the instructor from an arbitrary direction. Using a computer that displays an instructor film, the student can have difficulty to copy the instructor's movements, since the instructor is visible on a monitor and the student has no possibility of directly comparing his movement to the movement of the instructor. A film can also be insufficient if the student requires to observe the movement from a different direction than the direction of the camera.

To increase the efficiency of methods for computer-aided teaching of movement execution, it is possible to use an additional camera that films the student during movement execution. Such a film, or pictures of the student in certain positions, can be used (under certain conditions) to analyze the movement of the student and compare it to the movement of the instructor.

One of the methods of such an analysis would be overlaying the film of the student and the film of the instructor. This would enable the student to compare his movement to the

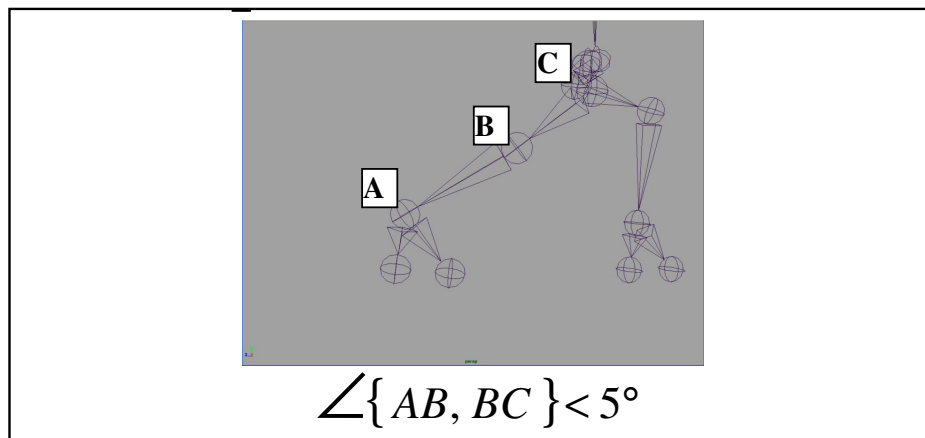


Figure 1 Example of expert rules to evaluate static positions

movement of the instructor. In order to overlay the films, it becomes necessary to synchronize the movement of the student and of the instructor. This can be achieved by the previous exercise of movement speed and by synchronizing the student's movement using sound signals (a voice that describes the stages of movement of the instructor). Additionally, the two films should be made on a similar space. This additional requirement may not be necessary if the two films are used to create animations that can be scaled and moved before overlaying.

The use of 3D animation instead of an instructor film has an additional merit. The student will be able to observe the instructor's movement from any direction. However, it is necessary to use a very good model for human body animation, in order to eliminate the possibility of errors in the animated movement of the instructor.

The use of motion tracking could allow the extraction of information about the movement from films or photographs. Efficient methods of motion tracking exist that could be used for this purpose [4]. The information about the position of bending points in the body of the student and the instructor could make it possible to extend the e-learning system with an additional element. This element is the use of expert rules that have been

Position or movement	Example description	Scene of instruction material
1. Bing Bu (Attention position)	Legs straight and together. Stand straight and push out chest. Look left.	First scene
2. Ding Bu (T stance)		
3. Ban Ma Bu		
4. Gong Bu (Bow stance)	Keep distance between feet so that position is stable. Hips slightly to the side. Head up, look ahead.	
1. Dan Tui (kick)		Second scene
2. Ma bu (Horse stance)	Feet parallel (can have 15 degrees deviation). Knees must not extend beyond toes. Knees must point to the side, not to the front. Thighs parallel to the ground.	
1. Cha Bu (Back-cross step)		Third scene
2. Xie Bu (Crossed leg stance)		
1. Du Li Bu (Standing position on one leg)		Fourth scene
2. Pu Bu (Drop stance)		
1. Xu Bu (Empty stance)		Fifth scene
2. Bing Bu		

Table 2 Division of wu-shu form into instructional scenes

prepared by the instructor, to correct the body position of the student. The proposed mechanism can be decomposed into the following stages:

1. Prepare a film or pictures of the student
2. Extract information about the location and position of the student
3. Fit a 3D or 2D model of the human body to the extracted information
4. Use expert rules prepared by the instructor to evaluate the students' position, and suggest improvements

For example, during the execution of a dance movement the student can be bending down instead of keeping a straight position of the upper body. On the basis of the information extracted from the films of the student and the expert rules prepared by the instructor, the system can use a rule that recognizes the incorrect position of the upper body and specifies a way to correct it.

To prepare the rules that evaluate student positions, the sequence of evaluating a position can be carried out using films or photographs of the instructor. The instructor could prepare material about correct and incorrect execution of the movement. These materials can be used to prepare an initial set of rules that would be later evaluated by the instructor. Note that the rules should not produce binary evaluations, but rather an evaluation on a certain scale, as well as suggesting a way to improve the position or movement.

A case study of using e-learning methods for teaching wu-shu

The aim of this research project is the use of the methods described above on an example case study of teaching movement, and the development of interactive e-learning methods for the teaching of movement execution. As a case study, the teaching of basic forms of Chinese martial arts (wu-shu) has been chosen. The main reason for this choice was the availability of an instructor, and the large complexity of the movement in wu-shu exercises. A cooperation has been started with the trainers of the Polish national sports team in this discipline. This cooperation consists of joint preparation of instruction material, training program, and the use of established e-learning methodology (for instance, interactive adaptation of the training material to the knowledge of the student). This basic material will be gradually extended by some of the experimental solutions described above. The created training materials are being tested by volunteer students and evaluated by instructors. Another aim of the research project is the study of methods for preparing instructional materials for e-learning of movement.

Wu-shu, as other martial arts, has much in common with dance. The knowledge of the sequence of movements and positions is not enough to exercise a form (a fixed sequence of movements in a martial art). Timing and dynamics of movement play a critical part. Of course, a beginner should perhaps start by exercising positions and learning the sequence of movements; however, intermediate and advanced students who are preparing for competitions or learning self-defense applications must learn to exercise the movement with appropriate timing and speed.

The teaching material for a wu-shu form consists of a set of films that present the execution of the form by the instructor. The form has been divided into five scenes, each of which consists of a few positions and movements. The scenes have been filmed from four angles (front, back, and both sides) and in three modes: capturing the whole body, a close-up of the upper body and a close-up the legs of the instructor. The instructor exercised the form slowly, thus creating teaching material for basic students.

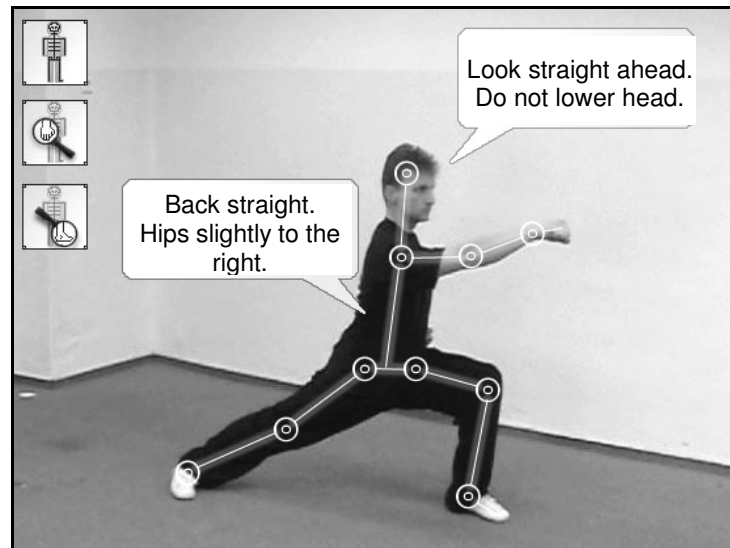


Figure 2 Example interactive diagram for description of a wu-shu position

For advanced students, the form has been divided into two scenes. The instructor exercised the form more quickly, allowing to evaluate the required dynamics of movement. The entire form has also been filmed as one scene, exercised at top speed; these films have also been made from four angles and in three modes.

The e-learning application created on the basis of the instructional material allows a student to choose his level of expertise. A beginner will be able to choose from the 5 scenes. Each scene can be viewed from one of the 4 angles. The student may also choose if he wishes to view the entire body of the instructor, a close-up of the upper body or of the legs. An advanced student will be able to choose to view one of the 2 longer scenes or the entire form, exercised at higher speed.

At the beginning and end of each of the 5 short scenes, the instructor is standing in a position. Wu-shu has a number of positions that have very specific requirements. The description of the position should allow students to learn how to exercise it correctly. Therefore, apart from films, pictures of the positions have been prepared that serve as a basis for instructional diagrams. The e-learning application allows to click on the positions in a scene and opens a window where the picture of the position is shown as an interactive image map. A schematic skeleton is superimposed on the picture, as shown on Figure 1. The skeleton is controlled by icons that allow to show parts of the skeleton superimposed over the upper body or the legs of the instructor. This facilitates the observation of the position of arms and legs, and reduces the amount of space used by the descriptions.

Each of the points of the skeleton has a text description of the proper position of the body part marked by the point of the skeleton. This description should allow a student to correct his position during exercises.

Warm-up exercises

The application includes a module for warm-up and stretching exercises. The student is encouraged to start his exercises by the warm-up phase that should not be shorter than 20 minutes. The student is guided through a set of warm-up exercises typical for wu-shu training. An extension of the warm-up exercises to allow fitting the exercises to the age and health of individual students is planned.



Figure 3 Visual design of the user interface

Additional background information

The developed e-learning application contains additional background information about wu-shu history, terminology and about the exercised form. This information can serve to increase the interest of students, allow them to learn proper pronunciation of the Chinese terms and increase their general knowledge of wu-shu. The acquired knowledge can be tested by a student through a simple quiz that is included in the application.

Visual design of the user interface

The user interface of the e-learning application has been designed to match the subject of the e-learning material. The interface includes patterns of Chinese characters, of symbols and decorations related to the Chinese martial arts. This design of the user interface is intended to create a setting and mood that is suitable for a student of Chinese martial arts. The same approach is usually taken by martial art schools that decorate their training halls with Chinese paintings and banners with Chinese writing (quotations or sayings). During wu-shu training in a martial arts school, the students typically listen to music that helps to create a mood – slow Chinese music for exercises that require concentration, fast music for dynamic exercises. The same approach is being followed in the developed e-learning application, which is fitted with music that is played in the background during some exercises.

Conclusions and future work

The case study of wu-shu training has allowed to apply some of the e-learning methodology developed for the teaching of movement, and to verify the proposed methods in practice. The prepared instructional material has been evaluated by students, who found it helpful as a supplement to the normal training. Among future work, we are planning to design an experiment that would allow to evaluate the effectiveness of the created training material.

The presentation of fast and dynamic movement on film is not a sufficient method for the students to learn the required dynamics of movement. We are planning to develop new methods of processing the film that would allow to demonstrate the dynamics of movement and to better describe the transitions between positions.

The development of warm-up and stretching exercises is an important area of future work that is related to another planned application domain: physical rehabilitation. This is a broad area of exercises that are usually done at home by people with injuries or after operations. The exercises must usually be supervised by an instructor that can fit the exercises to the health and age of the patient. Here, as well as in sports, e-learning of movement can be of use.

The elements of the visual interface and music that have supported a creation of mood will be developed further. This type of work should allow to partially overcome one of the limitations of e-learning material: the lack of community. Since the used symbols and patterns are familiar to all students of wu-shu, the application will have a role in community building.

An important part of future work will be the extension of the wu-shu training application with an interactive evaluation module. This module will base on a film of the student and allow the student to compare his movement with the instructor's movement.

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