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KRĀJUMA ZINĀTNISKĀS REDAKCIJAS PADOMES PRIEKŠSĒDĒTĀJA

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PREPARING VIDEO-BASED TEACHING AIDS FOR ELITE ATHLETES: SOFTWARE CHOICE

SUMMARY

Introduction. Motion analysis is a common approach in preparation of elite athletes. A good practice is presenting materials of analysis in a CD or DVD format; special software is required to create CD/DVD projects from recorded data.

The Aim of the Study. The aim of this work is development of a step-by-step procedure for creation of user-friendly video-based teaching aids for athletes, and review of required software types.

Materials and method. In order to make video-based teaching materials available even for small sport federations various free-of-charge software solutions, opposite to expensive payware, were tested and evaluated. Verbal communication with main users of processed video materials - athletes and their coaches - gave a better understanding of end-user needs in terms of videos. Although there are numerous software packages for processing of video records, to develop a quality and user-friendly video-based teaching aids a combination of different software is required.

Results. A range of software products was evaluated; there are available quite a few quality free-of-charge software solutions, still it was possible to find products with sufficient functionality and user-friendly interface. A stepwise procedure of video-based teaching aids' creation had been developed, and new user-friendly materials were distributed among athletes and coaches.

Conclusions. Given all necessary hardware, video-based teaching materials of acceptable quality can be created using free-of-charge software. Commercial products offer more effective solutions, and in most cases creation of video-based teaching aids is a compromise between quality, time consumption and spending of resources.

Key words: elite athletes, motion analysis, freeware, teaching aids, video editing

INTRODUCTION

Video recording is a popular practice in preparation of athletes in many sports, including elite athletes competing at Olympic Games. Analysis of video materials assists athletes in examination of their technique, focusing on mistakes, comparing own technique with performance of most successful athletes, track performance changes during exercises with growing fatigue, and follow changes in technique during training cycles or periods. For coaches video materials are a useful tool when explaining technical details to the athletes, putting a stress on the mistakes, or, in contrary, demonstrating examples of correct technique and forming visual patterns of good performance in athletes. Scientists started using means of film recording for analysis of human movements shortly after invention of motion pictures. J. Marey (1830–1904) was one of the first researchers who used medium of film in his works upon locomotion and invented that what nowadays is called a “stroboscopic picture”. Works of N. A. Bernstein (1896–1966) gave a further development to motion capture methods. (Бернштейн, 1990) Nowadays video materials in sports are analysed not only by athletes or their coaches. Significant scientific groups are concerned about motion analysis via video records; within the scope of research are kinematic characteristics of motions, and in some cases efforts are made to develop a “perfect”

technique. Many sport organizations create video-based teaching aids in order to help mastering the art of movements to the students (e. g. National Skating Association of the UK with UK Sports Institute had published a DVD for Short Track Skating, named “Basic Skating Positions”). (Knudson et al., 2002; Федоров, Кружков, 2004; Лысенко и др., 2004)

Athletes and coaches of Latvian Olympic Team have a growing interest to video-aided motion analysis; however, quality of video materials shall be improved in order to make analysis more efficient.

THE AIM OF THE STUDY

The aim of this work is development of a step-by-step procedure for creation of quality video-based teaching aids for athletes and review of required software types. The goal was set to find ways of processing video materials in a cost-effective manner.

MATERIALS AND METHODS

To accomplish the goal analysis of literature and internet resources and practical testing of selected software were performed. In the present work we have analysed software that is suitable for Microsoft Windows operating systems (OS), since these OS dominate on the personal computer (PC) market. Only software that is available free of charge was tested, we have also tried to avoid simplified versions of commercial software and shareware. Terms “freeware”, “free software” and “open source software” are used in accordance with suggestions of Free Software Foundation campaign GNU Operating System.

After analysis of available literature (Gura, 2009; Романов, Лысенко, 2004) and personal experience in video recording we have determined principal stages for creation of video-based teaching aids; the stages are presented at Figure 1 (see Figure 1).

To complete these stages various types of software are required; necessary software groups are listed in Figure 2 (see Figure 2).

We will now consider the software requirements to complete steps 1 to 5.

There are available numerous manuals of video recording, and more detailed examination of this issue is out of the scope of the present work; specifics of videotaping depend on an object being recorded and goals that are set. The way the recorded data are transferred to the PC depends on a media that is used for video shooting. In a new generation cameras data are recorded on a solid state drive, and recorded files (usually in form of Audio Video Interleave (AVI) containers) can be transferred to the PC in a simple copying procedure without additional video capture software. In this type of cameras video files are formed after pressing a record button and are discontinued after interrupting video recording. Discontinued files might be a general drawback of cameras with solid state drives, because it is often useful to have all recorded data in one file despite interruption in video shooting.

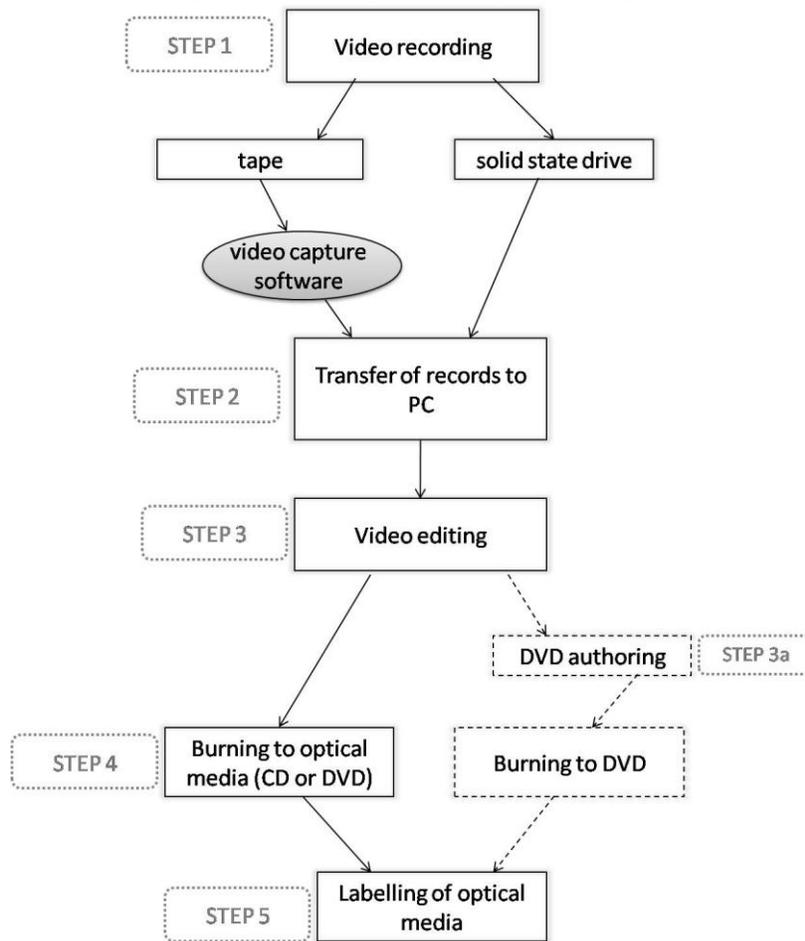
In case video is recorded directly to the PC (videostreaming), there is no need to spend additional time to file transfer; however, usage of videostreaming has limitations: not all the cameras support it, during videostreaming mobility is reduced due to wired connection to the computer, etc.

that users face is copying recorded data from the tape to the PC; special video capturing software is required.

Essential features of video capturing software are the following:

- camera recognition through IEEE 1394 interface;
- keeping audio track when transferring the captured data;
- capturing of selected video fragments, not all of the tape.

Figure 1. Principal development stages of video-based teaching aids



With cameras using DV (digital video) tapes as the recording media the first problem

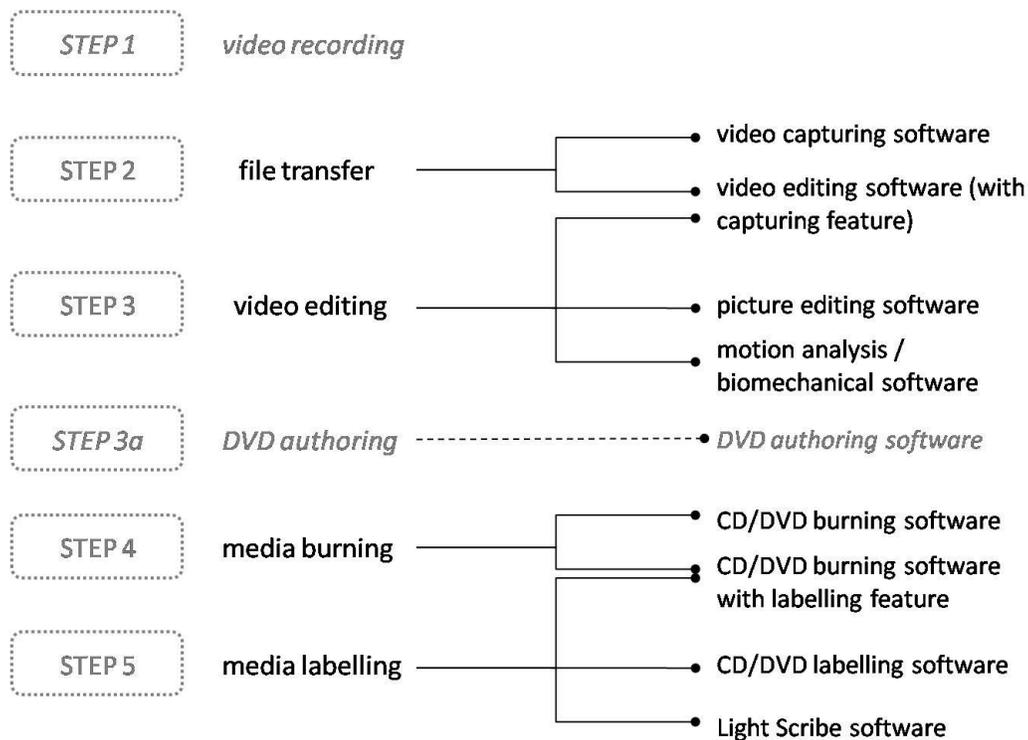
Camera recognition through IEEE 1394 interface is an important feature. Although video transferring via USB (Universal Serial Bus) is also possible, this leads to a significant loss of video quality due to insufficient USB bit rate. IEEE 1394 interface has also lower CPU usage of the PC comparing to USB.

Optional features of video capturing software that would make video processing more convenient might be:

- easy installation process;
- low usage of PC resources;
- easy operation (intuitively clear interface);
- stable performance;
- video playback during capturing process;
- video camera operation via program tools;
- video playback without recording video to the PC;
- muting of video during its playback and capturing to the PC;
- full screen and part of the screen program window;
- easy access to folders storing captured files.

Most of video editing software solutions have a built-in feature of video capturing from a source (camera); in order to skip usage of multiple programs one can use this feature – generally it meets all essential requirements; another advantage of using video editing software for video capturing from the source is guaranteed compatibility of video formats. From the practical point of view usage of stand-alone software for video capturing is reasonable in case only transfer of videos to the PC is needed, and further editing is scheduled later. If this is the case, loading of rather resource-intensive video editing software can be avoided by using capturing software only.

Figure 2. Software groups for development of video-based teaching aids



Many of the current versions of video cameras already come with a software package that allows transferring video to the PC and meets requirements mentioned above. A strong advantage of the camera-enclosed software is that it is already available with the camera. Still, in case when this software cannot be used or its usage is impractical, there are available alternative solutions. There is quite a few free-of-charge video capturing software that has a licence allowing more than just a “personal use”; Table 1 presents examples of such software on a freeware licence. Video capture payware offers much wider range of functions comparing with mentioned freeware, but for needs of teaching aids programs indicated in Table 1 are sufficient (See Table 1).

Table 1. Video capturing freeware

Freeware	OS	Installation file size	User interface	Functionality
DVIO	Win 98/2K/ME/XP	32 KB, does not require installation	poor	poor
STOIK	Win 98/2K/ME/XP/Vista	483 KB	good	good

The next step after video had been transferred to the PC is preparation of the teaching aid itself. At this stage appropriate tools are required to perform general actions:

- cutting and combining video fragments;
- editing poorly recorded materials in terms of brightness and contrast;
- cutting single frames out of video stream;
- editing single frames, adding graphical information (positions of body parts, angles, trajectories, etc.);
- editing video fragments (creating overlays, etc.);
- assembling the final version of movie clip, including adding separate frames with graphics, edited video fragments, audio and text, animated transitions between fragments, slowing down playback speed where needed, etc.

During verbal communication athletes and coaches who often use video analysis of technique indicated most important features of edited video materials that make the materials useful for the audience:

- splitting of video material into separate frames, frame-by-frame playback;
- playback of videos in slow motion;
- preparing individual videos for athletes;
- overlay of video fragments;
- zooming into selected fragments of video;
- information text before or on video fragments;
- graphical information on selected video fragments;
- audio information added to video;
- good visibility of movement details;
- playback of prepared videos on most common video players.

Taking this information into account and also considering details mentioned about video capturing software, we have created a comparison chart for free-of-charge video editing software. Results of software comparison are presented in Table 2 (see Table 2). It can be seen from this table that analysed software does not meet all essential requirements. Unfortunately free-of-charge software does not allow overlaying video fragments – function that is available in many payware solutions and is appreciated by athletes and coaches. Scripts, written in AviSynth program, allow extending functionality of the software if needed, but this requires intensive familiarizing with additional documentation. Despite missing some features, free-of-charge software operates quite sufficient for needs of teaching aids creation, although in some aspects it is less convenient than payware. VirtualDub and Windows Movie Maker have more user-friendly interface, and therefore development of video-based teaching aids is less complicated than with two other programs.

Table 2. Evaluation of free-of-charge video processing software

Software	AVIDEMUX	JAHSKA	VIRTUALDUB	WINDOWS MOVIE MAKER
Licence	GPL	GPL	GPL	EULA
OS	Win	Win XP	Win 98 and higher	Win ME and higher
Installation file size	15 MB	53 MB	3 MB	approx. 7 MB
Video capturing tool	No	No	Yes	Yes
Single frame grab	No*	Yes	Yes	Yes
Inserting pictures into a video flow	Yes**	Yes	Yes	Yes
Brightness/contrast adjustment	Yes	Yes	Yes	Yes
Playback slowdown	No*	Yes	Yes	Yes
Video overlay	No	No	No	No
Adding graphics over video stream	No	Yes	No	No
Adding text	Yes	Yes	Yes	Yes
Adding, muting, adjusting audio	Yes	Yes	Yes	Yes
Animated transitions	Yes	Yes	Yes	Yes
Versatility of supported video formats	good	Input of uncompressed files only	sufficient	sufficient
User interface	Poor	Poor	Good	Good

* is possible using scripting in AviSynth program

** picture size in pixels shall correspond to video fragment size

With free-of-charge software it is not enough to use only video editing package to create teaching aids with overlaid graphics, additional software is required (however, even using special motion analysis payware does not necessarily spare additional video editing with movie creation

software). Some authors (АКТОВ, materials available at homepage of Ukrainian shooting federation) indicate that combination of picture editing and spreadsheet software can be used for basic video analysis – visualization of movement trajectories and comparison of activity phases. Suggested method is time consuming, but with moderate amount of video materials, it is an affordable alternative to simple versions of motion analysis software. An example of functional freeware image editing is Paint.NET, it is suitable for Windows XP and higher OS. Open Office Calc is open source spreadsheet software for Windows OS, alternative to Microsoft Office payware products.

Another image editing freeware, PicPick for Windows OS with 1,44 MB of installation file solves a problem for calculating joint angles, as it has a built-in angle measuring tool. If there is no need to overlay pictures, this freeware is enough for basic analysis of technique.

The next step after video records have been processed and teaching aids have been designed is burning the data on a media. In this work we have not considered an option of DVD authoring, because the survey among the athletes and coaches about DVD format efficiency is not completed yet. Therefore we skip step 3a (Figure 1) and proceed to transfer of video files to the optical media. In a simple case there is needed nothing more but optical disc burning, and this operation can be successfully completed by means of Microsoft Windows OS built-in function. There are also available some free-of-charge software options (e. g. InfraRecorder free software, or Free Create-Burn freeware suitable for all Windows OS), a few of them would also complete step 5 and create labels for compact discs (e. g. free application CD Burner XP).

There are not too many requirements for CD/DVD labelling software in a simple case of teaching aids development. It is sufficient that this software allows creating titles on a compact disc label, adding pictures to the labels is more than enough; therefore it is not necessary to use functional all-in-one software that allows both CD burning and label creation. Steps 4 and 5 can be completed by combination of OS built-in function for data burning and some non resource-intensive software for labelling (e. g. CD&DVD Label Maker freeware with 0,61 MB installation file). Often CD/DVD writing hardware supporting LightScribe technology is integrated into modern computers. If this is the case, it is another simple solution for compact disc labelling; LightScribe manufacturer features a free-of-charge software support for its hardware.

Step 5 of development procedure can be easily skipped, but that would leave the created material unfinished. Labelled optical media is easily cognizable and more attractive to the end-user, therefore adding more efficiency to video analysis.

RESULTS

During this work many software products were evaluated. It is obvious that payware solutions can offer much more comfortable operation and wider range of functions; still free-of-charge software is a cost-effective alternative. Although there are available quite a few quality free-of-charge software solutions, it was possible to find products with sufficient functionality and user-friendly interface.

A step-by-step procedure of preparation of video-based teaching aids had been developed. Given all necessary hardware, video-based teaching materials of acceptable quality can be created using the following free-of-charge software:

- video capturing freeware STOIK (optional);
- video editing free software VirtualDub, or freeware Windows Movie Maker;
- image editing freeware PicPick and optional image editing freeware PaintNET;
- open source software Open Office Calc (optional) alternative to Microsoft Office Excel payware;

- Microsoft Window OS built-in optical disc burning function (or alternative freeware and free software for disc burning);
- Labelling software (CD&DVD Label Maker freeware) or LightScribe technology.

Development of teaching aids with proposed software solutions will be more time consuming comparing to usage of professional software, and processed video materials would lack some features required by elite athletes, but procedure of development is accessible to wider range of users. In case teaching aids are prepared for one occasion, shareware with just a few limitations comparing to payware is an optional solution. On the basis of performed study we began development of more user-friendly video teaching aids for athletes of Latvian Olympic Team. Teaching-aids of a new type were distributed among the athletes and coaches. There is an ongoing research about usage of DVD-format for video-based teaching aids. The next step will be development of a video creation manual for usage in the Olympic Team.

CONCLUSIONS

Development of video-based teaching aids for elite athletes by means of software available free of charge still remains a challenge. Commercial products allow solving many video editing tasks much more effective, but accepting some limitations, free-of-charge software is a competitive alternative to payware. In most cases creation of video-based teaching aids is a compromise between quality, time consumption and spending of resources.

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