

AUGMENTED VIDEO COACHING, QUALITATIVE ANALYSIS AND POST-PRODUCTION USING OPEN SOURCE SOFTWARE

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This study investigated the feasibility of using open source software (OSS) to provide augmented video coaching, qualitative analysis and media post-production which are tasks associated with professional coaching/scholarly activities. Utilised test equipment consisted of two video cameras, iPad, Mac-mini, two PC laptops and two desktops of various specifications. Free OSS were selected based on the possibility they could achieve the tasks. Testing occurred over a period of seven years. Critical analysis included OSS functionality mapping to the selected tasks and surrounding activities associated with media post-production. Instructional guidelines and their on-line links for the target audience were developed with the use of OSS VirtualDub, LongoMatch, Kinovea, VLC media player. The utilisation of OSS is feasible for coaching/scholarly activities.

KEY WORDS: coaching technology, video capture, coaching tools.

INTRODUCTION: Video analysis, as a form of augmented coaching, is evident in the examples of learning by observing the replays of others or yourself at various skill levels from beginner (including sport enthusiasts, recreational/amateur participants) to expert. Some reasons for rejection of technology supported augmented coaching include users' attitude, associated costs and the perception of how utilisation of technology can advance coaching practice. While an operating system typically allows a form of video capture and replay (e.g. iMovie in Apple's Mac OS X), the utility of such approaches is typically time consuming, lacking specific functionality for video analysis/coaching and requires a degree of computer literacy. In contrast, specialist commercial software is generally designed to address such functionality and usability gaps associated with the tasks of video coaching, analysis and content management. Motivated by factors such as commercial software licensing, time consuming migration/reinstallation (e.g. when upgrading a computer or the operating system) and overall associated costs, this study starts to answer the question whether a common set of augmented video coaching tasks can be solved with free, available, open source software (OSS) alternatives.

The OSS initiative (e.g. www.fsf.org and www.gnu.org/licenses/gpl.html, accessed 28 Jan. 2012) was established to allow free dissemination and software modifications as opposed to commercial software restrictions. The examples of OSS initiatives include: sports oriented and universal purpose tools (Table 2) as well as free operating systems (Unix/Linux variations multi-boot installation tested in Table 1), whose performance is optimised without computational overheads of licensing or other forms of digital content validation. Such on-line community driven software development (typically linked to active discussion forums and published repositories of previous software versions), is designed to complement and integrate with existing software, information/communication infrastructures and to work on both new and older hardware, found in coaching scenarios. The OSS investigated in this initial study is supporting coaching, academic and video content management user activities. The primary focus of this study was the task of video capture (Alderson & Elliott, 2006) taking into account observation rigor and requirements for qualitative analysis of human movements and video post-editing (Knudson & Morrison, 2002). In summary, the purpose of this study was to the feasibility of using OSS to provide augmented video coaching, qualitative analysis

and media post-production which are tasks associated with professional coaching/scholarly activities.

METHODS: The selection of tasks was aimed to cover common activities for the target audience (coaches/scholars). The list of user tasks with associated activities were:

1. **Live capture with delayed replay** for the purpose of *in-vivo* self-coaching, single or group coaching.
2. **Real-time and post-match analysis**, including video segment annotation/tagging for direct access replay, game analysis and overlay drawing.
3. **Video presentation and replay**, communicating instruction and feedback. Additional functions may include comparisons, annotations and intervention instruction.
4. **Video overlay drawing** and annotations for analysis, video presentation and replay.
5. **Video content post-production**, including video transcoding, segmentation, cropping, filtering (deinterlacing, rotation, etc), adding logos and resizing.

Test equipment (see Table 1) was selected based on the range of electronic devices currently easily accessible to coaches and consisted of two video cameras, iPad, Mac-mini, 2 laptops and two PCs (for post-editing purposes). All computers had 7200 rpm hard disks and firewire port(s). In addition to established coaching practice, an on-line search was made for the most recent OSS that were likely to enable the completion of the user tasks. Personal experience as an elite tennis coach, combined with the literature review search and studies for the first authors' PhD, shaped the search strategies for OSS. Tests (task, OSS and incremental equipment additions) started in 2005, by the authors and acknowledged contributors with more concentrated revisions and updates in 2012.

Table 1
Utilised test equipment

#. Item	Characteristics / Properties
1. SONY DCR-TRV110E-PAL; with firewire cables	PAL/NTSC Digital Video Recording; Connectivity: i.Link/firewire; Night vision; Lenses: Ø37mm 20x zoom.
2. CASIO Exilim EX-FH25	PAL/NTSC DHTV File transfer: USB or SD card (30 MB/s); High-speed video (30,120,240, 420 and 1000 fps and 30- 120, 30-240 fps); File Formats: AVI, JPEG; Lenses: Ø35mm 20x zoom; Battery: 4x AA (Ni-MH or Alkaline).
3. iPad 2; with USB / SD Card reader	iPad storage capacity: 32GB, Direct file transfer: iPad Camera Connection Kit (www.apple.com).
4. Mac Mini (model 2010)	CPU 2.26 GHz Intel Core Duo; DDR3/1067 MHz 8 GB; (P< 85 W); SD Card reader; OS-X, Win-XP, Ubuntu 11.04, Fedora 14.
5. Laptop #1 CLEVO	Pentium 4, 32-bit, 2GB SODIMM (P<120 W), Win XP, Ubuntu 9.10 and Ubuntu 9.04 /32-bit.
6. Laptop #2 ASUS	64-bit AMD Dual Core, 3GB SODIMM, (P<90 W); Removeable battery, Win Vista, Win XP, Ubuntu 9.04/32-bit, Ubuntu 10.4/64-bit.
7. PC #1	Single Core AMD 64-bit 2.4 GHz, 2GB DDR; Win XP.
8. PC #2	Intel i7 (8-core hyper-threading) 64-bit 2.67 GHZ, 12 GB DDR3; Win XP, Win 7, Ubuntu: 9.04/64-bit, 9.10/64 bit, and 0.10/64-bit.
9. Portable USB card reader	Formats: SD, MicroSD, SONY MS, MS Duo, Micro M2.

P = Power consumption [Watts], information provided by a manufacturer.

RESULTS: VirtualDub, LongoMatch, Kinovea, VLC media player (see Table 2) were selected for task review based on user acceptance and functionality/utility testing matched with the task(s) requirements.

The tasks that were able to be achieved using the available equipment, the specifics of how the tasks were achieved, and observations and recommendations for the OSS tested are shown in Table 2.

Table 2

Tasks achieved, the specifics of how they were achieved, and observations and recommendations for the open source software tested.

#. OSS - Task # and how tasks were achieved	Observations and recommendations
<p>1. VirtualDub (Lee, 2010) - Tasks: 1,3,5</p> <p>Single click, direct capture program preset activation (via Command-line), e.g. for DV Camera (Table 1, Item #1): "C:\Program Files\VirtualDub-1.9.11\VirtualDub.exe" /capture /capdevice "Microsoft DV Camera and VCR (DirectShow)" /capfile "%HOMEPATH%\My Documents\DVCam_capture_.AVI"; Capture file using name-auto-index (for athlete performance video recording) using the shortcut sequence: F5...capture, ESC ...stop, J ... next name-auto-indexed file; The shortcuts for creation / navigation-selection of name-auto-indexed files, allowing new or unconditional overwriting of existing file: [,];</p> <p>Single click, direct replay mode program activation and fast direct video segmentation (via command-line pre-loaded processing settings), e.g.:"C:\Program Files\VirtualDub-1.9.11\VirtualDub.exe" /s "Video_DirectStreamCopy.vcf"; Replay and selection fast saving (via Video > Direct stream copy); Shortcuts: Home, End ... mark selection; [.] ... go to start, end selection; Space-bar ... play/pause, ←,→ ... single frame reverse/forward play;</p> <p>In default start-up, e.g. apply 90° video rotation: Video > Filters [Add]: Rotation;</p> <p>Save repetitive menu-settings/tasks to VCF file: File > Save processing settings.</p>	<p>MS Windows only. General media editing and capturing purpose. Well-documented help and insights. Fast navigation function for task #3. Advanced integration flexibility: command line interface, external software integration, text-based instruction scripting, generating unattended job queue and its task list management. Flexible start-up configuration via VCF file for different user scenarios. Limited in native media formats (as well as opening media files). Designed to support installation of external filters and add-on media codecs for extending functionality and available media file formats. Before video replay feedback, coaches should practice first post-editing using the shortcuts for fast selection, replay and apply preconfigured settings for "Direct stream copy".</p>
<p>2. LongoMatch (Alastruey, 2012) - Tasks: 1,2,3,4,5</p> <p>On-line capture (tested in ver. 0.16.9 for MS Windows, not available in ver. 0.15.7 for Ubuntu 64-bit) and annotate/tag motion events:</p> <p>File > New Project > Live project using a capture device;</p> <p>On-line and off-line review and game pattern analysis by annotation/tagging into user defined categories;</p> <p>Video segment adjustment (View > Analyze Mode), annotation/review per player, time-line or user-defined categories.</p> <p>Basics single frame (per annotation) overlay drawing capability.</p> <p>CSV project export includes information for annotated/tagged e.g. for external viewers' command-line parameters replay of project's video A-B sequences.</p>	<p>Cross-platform tool (Windows and Linux distributions - Ubuntu, Debian, Fedora and OpenSUSE). Generic, flexible strategy analysis (team and individual) and video annotation capabilities. Universal tool covering all coaching tasks. Relatively longer time to learn compared to tools # 1 and 3. Game pattern annotation can be viewed in timeline. Basic overlay drawing tools. Saved projects keep all users' data while preserving the original video. Help documentation not included in installation.</p>
<p>3. Kinovea ("Kinovea," 2011) - Tasks: 1,3,4,5</p> <p>Usability focus on coaching tasks (1, 3 and 4) was evident by intuitive task completion with a minimal number of steps required.</p> <p>Advanced annotation capability over video segments (real-time stop watch, perspective grid, translucent fade-in/out drawing elements) and export flexibility (e.g. slow motion MKV or standard speed AVI, MPG4, MKV).</p>	<p>The most intuitive user interface for coaching tasks that are also well documented. Advanced overlay drawing and analysis tools. MS Windows only. Separate Microsoft's .NET framework ver. 2 or higher (23 MB or > 237MB separate download for higher .NET versions) required.</p>
<p>4. VLC media player ("VLC media player," 2011) - Task: 3</p> <p>Tests (MS Windows, Linux and Mac OS X): Playing a range of commonly used media formats, without additional codec libraries installation;</p> <p>Configuring shortcut keys: Tools > Preferences [Hotkeys] ; or VLC > Preferences ...</p> <p>Default shortcut keys e.g: e ... single frame play; l ... loop play; Space-bar ... play/pause;</p> <p>A-B loop button added to user interface View > Customise</p>	<p>Cross-platform tool, which can play a range of commonly used media formats, without additional codec libraries installation. While video-streaming capture was achieved, for its complexity, it is not recommended as practical solution for e.g. coaching task #1. For video replay/coaching</p>

Interface ... (user interface modification is not available in ver. 1.0.1 for Mac OS X).

purpose user should: (1) install the latest version of VLC and (2) consider alternative players.

DISCUSSION: The increasing presence of OSS represents alternatives for users to try and opt for free software, which may not offer the same level of usability and support compared to commercial software, while the OSS is often accompanied with discussion forums. Regarding preserving data, security and potential installation challenges, it is recommended that Linux installation and configuration for novices should be supervised or assisted by at least an intermediate or expert Linux user. Re/installation of Linux and basic security configuration may take less than 45 minutes. Typical CD installation includes PDF, archiving (ZIP) and device driver operation capability as well as an open office software suite. Linux distributions can read/write in partitions native to Windows. While this is convenient for sharing videos and salvaging (virus-infected/lost password) data, it is also possible to corrupt a portion of the Windows file system by creating files using Linux/Mac OS file naming conventions. To protect athletes' privacy users should create (Linux) user accounts with encrypted file system for storing and reviewing data or use the third party encryption or secure network attached storage devices (typically based on Linux kernel).

For the coaches, athletes and scientists the following suggestions are associated with the VirtualDub tasks. (1) Use filter combination pipeline, compress or transcode video in post-production rather than during the capture (minimising cognitive load and allowing focus to coaching tasks). Decide if convenient to segment video as early as possible or at a later stage. Use external codecs and storage devices (relatively inexpensive) and off-load transcoding to another computer (e.g. low-power Mac-mini or less frequently used PC). Using the task queue function, it is possible for a computer to filter, transcode (in unattended fashion) and shut-down when complete. (2) Apply filters first and then transcode at the final stage (to minimise quality loss).

CONCLUSION: The feasibility of OSS application was achieved for the tasks associated with video coaching, qualitative analysis and post-production or digital content management. In response to system upgrades, reinstallation or migration as well as anti-piracy and privacy concerns, the utilisation of free software represents a viable alternative.

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