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SCHOLA LUDUS ONLINE INTERACTIVE VIDEOS – ACTIVE AND PLAYFUL OBSERVATION VIA RECORDED PROCESSES

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Abstract
A new educational form of online interactive videos is presented. Interactive videos introduce a new streaming solution with the details - a whole interactivity enabling a user to focus on running complex physical processes in their details with respect to the whole system behaviour. In this sense, SCHOLA LUDUS online interactive videos seem to be a high-quality complement/alternative to real observation of real physical objects/processes. With the possibility of using different capturing techniques, interactive videos are perfect for incorporation into any physics learning/teaching environment.

1. Introduction
Many Internet environments with physics content take advantage of video materials for different aims, e.g. the portal for non-formal education (Exploratorium, 2009), the portal providing video lectures for serious learning (Princeton University, 2009) or Time Warp TV show bringing "the truly never-before-seen" process details (Discovery Channel, 2009). Some of their video content employs the latest in high technology of video recording combining with the latest in multimedia processing to get the video as interactive as possible – e.g. the technology of high-speed photography with the output scenes controlled by a user frame by frame (Discovery Channel, 2009) or technology of 360° Interactivity for Live Events (Immersive Media, 2009).

In this paper, a new usage of video records for authentic learning and teaching shifting the educational video users from passive watching to active observing is presented.

2. SCHOLA LUDUS interactive videos
The importance of complex dynamic systems approach in educational process is often underestimated. To understand complexity of dynamic processes, the process details need to be recognized and taken into account in a way of linear-causal thinking approach to a system thinking approach shift characterized by the "recognition of the mutual interactions of system components, the ability to distinguish between micro and macro levels of analysis and the understanding of system's emergent property" (Raia, 2005).

In the frame of SCHOLA LUDUS approach to physics education via attractive complex processes and many years of experience with interactive, live exhibitions[1] as our stimulating-strategy-activity to later serious physics learning and teaching (Matejka, 2009), an idea of bringing the real, interactive exhibits online together with the possibility of playing with them (or at least a solid alternative to playing with them) to study the running physical processes in their complexity and their details arose. And so, the user's interaction with the real content of, otherwise, an online interactive video, has been, to a great extent, ensured.

SCHOLA LUDUS online interactive videos (SLOIV) - specially designed objects taking advantage of flash format as a widespread streaming multimedia format – enable a user to gain an experience similar to that gained by direct observation of real objects by, e.g., changing the observation distance of the running processes in any time along with perceiving them in context of the whole system. This possibility alone supports recognition of physical process details as well as their relation to the whole, complex system behaviour, which is usually not achieved during direct observation without any instructions. In this sense, the interactive videos seem to be a high quality alternative to real observation of real objects and processes.

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[1] E.g. "Liquids Surprisingly", "Scientific Toy", "Dynamic Parallels"

2.1. SLOIV for active learning and teaching

In accordance with SCHOLA LUDUS widely experienced approach to physics learning and teaching via complex dynamic processes, SLOIV supply active recognition of the complexity in/of the real processes online. With the possibility of zoom function in running video, the concrete physical processes determining the behaviour of a system as a whole can be recognized. Zoom in/zoom out function unveils a user important details which, otherwise, can be missed by a human eye distracted by many details and processes running around simultaneously. Moreover - a view of the whole object - a frame marking currently zoomed part - functions support understanding of the whole system behaviour in its complexity (Fig.1, 2).

SLOIV enable, to a great extent, active visual interaction with a recorded object/process. SLOIV handling, in addition, gives user a possibility to treat the object or process in a way, the real playing does not allow/provide necessarily, namely to:

- watch the same process repeatedly
- stop the running process randomly
- move back and forth in the running process randomly
- to watch the speed-up process in case of time-lapse video recording
- to watch the slow-down process in case of high speed video recording
- have the time and size scale information.

Seeing the basic functionality of SLOIV, the educational content for interactive videos may vary. In general, we distinguish two main types of objects for SLOIV content:

- objects/processes that are unique and otherwise hardly accessible – the goal is to get them accessed as much as possible (Fig. 1),
- objects/processes that are accessible and realized easily, but interactive handling by making use of all SLOIV functionalities (see above) is required/suitable – the goal may be, e.g., to observe the same process/object repeatedly, etc. (Fig.2).

Of course, an active user of SLOIV is expected not to learn only via SLOIV. At SLOIV, there is no possibility of handling the object as if it was for real (in contradiction with real playing with real objects).

SLOIV are useful everywhere where real playing with a real object needs to be substituted by a remote recording of the object while maintaining as much real observation as possible, e.g. in web-environments, Internet portals, Internet online services for physics teaching and learning etc.

2.2. Designing SLOIV

Recording

Objects/processes for SLOIV are best to be recorded with HD camcorders providing lossless recording in progressive mode (however, we used SONY HDR-FX7E, 1080i camcorder with mpeg-2 encoding interlaced mode) to achieve the best possible available resulting picture quality, mainly at zooming of the video scenes. And, how did we process the recordings?

Encoding

Used encoding procedure is as follows:

1. Original, mpeg-2 format recording transcoding to avi format using Avidemux 2.4 Qt4[2] with Huffyuv Lossless Codec[3]
2. Applying Smart deinterlace filter[4] in version 2.8b1 followed by the Flip vertically filter in VirtualDub 1.9.5[5]
3. Encoding to avi format applying VP6[6] codec in VirtualDub 1.9.5

[2] http://www.avidemux.org/
[3] A very fast, mathematically lossless video codec, free, with source code (GPL), http://neuron2.net/www.math.berkeley.edu/benrg/huffyuv.html
[4] http://neuron2.net/smart/smart.html
[5] http://www.virtualdub.org/

4. Transcoding avi format to flv format using Avidemux 2.4 Qt4
5. Applying flash format using Macromedia Flash 8[7]

To obtain a fast moving back and forth in the running video, it was necessary to set the key frame (I-frame) value to 25. We, also, applied a quite huge bitrate of 10 Mb and the two-pass encoding method to get the best picture results.

Using SLOIV - software requirements

To enjoy SLOIV, only:

- a web browser, and
- a flash player implemented in the web browser

are needed. Zoom in/ zoom out functions as well as all other functions are accessed directly in the flash player so there is no need to install additional software or download the video (the preloader function enabled, the average size of a 1 minute video is approx. 75 MB).

Using SLOIV - hardware requirements/optimal configuration

To enjoy SLOIV smoothly, the following requirements should be granted:

- processor Core™2 Duo 2.0 GHz equivalent or faster,
- 200 MB free available RAM or more, and
- display resolution at least 1024x768.

Using SLOIV - functions

SLOIV enable a user (Fig.1, 2) to:

- zoom in/zoom out any video scenes while running, in steps of 0.5 up to 3 x (maximal) zoom,
- move between different parts of the video scene,
- stop the running video randomly,
- watch the video repeatedly,
- move back and forth in the running video randomly,
- have the time and size scale information,
- have a view of the whole object in the video frame corner including marked zoomed part.

However, there are some limitations of SLOIV, mainly of technical character (see below).

2.3. Beyond SLOIV

The resulting SLOIV quality depends on more factors given by technology limitations (recording device limitations: resolution, fps, shutter speed, scanning, data compression, loss encoding; flv size limitation etc.) resulting in certain restrictions regarding the possible SLOIV content. Also in general, if the optimal technology is not available, it is problematic to get the perfect results with e.g. fast moving objects, moving water and water-solid object-boundaries or tiny objects (for instance the sand grains).

3. Conclusion

Considering the modern educational trends combined with the latest technology, an advancement of interactive content for physics learning and teaching heading to a high-quality, uncommon and attractive content can be made. We are confident that SCHOLA LUDUS online interactive videos provide, to a great extent, such an opportunity.

Interactions with SCHOLA LUDUS online interactive videos enable a user to gain the experience not only similar but significantly enhanced with respect to those gained by direct observation of real objects and processes in their complexity. In this sense, SCHOLA LUDUS online interactive videos provide the playful and meaningful science learning. With the possibility of using different capturing techniques such as real-time, slow-motion and speed-up technique providing the recording of

[6] http://www.on2.com/index.php?565

[7] Now integrated into Adobe Systems, Inc., http://www.adobe.com/products/flash/

different processes, SCHOLA LUDUS online interactive videos are perfect for incorporation into any online science, especially physics, learning and/or teaching environment, Internet edutainment portals etc.

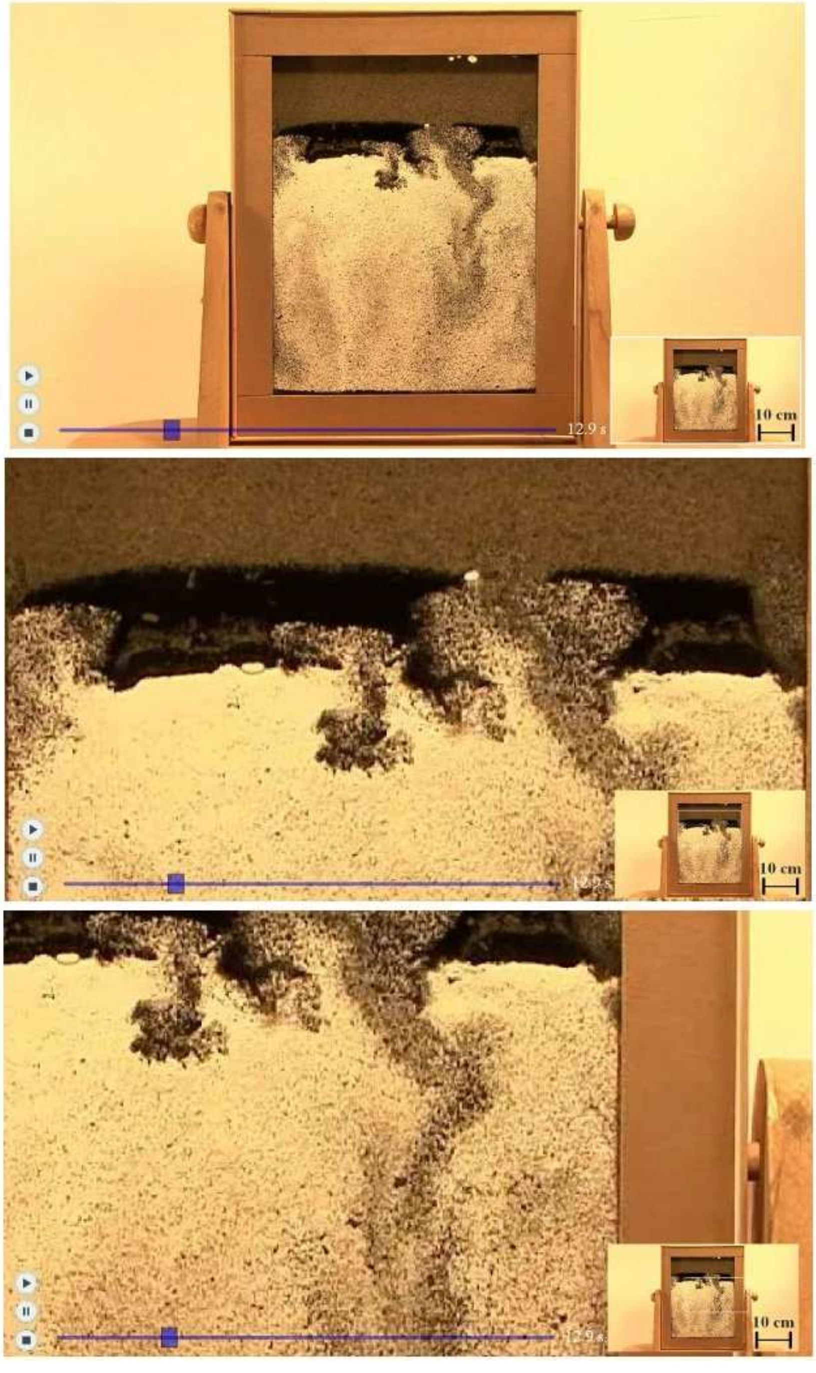

Figure 1: SLOIV screenshot of "Window with sand, water and air mixture after turning upside down"
http://www.scholaludus.sk/udine/window_with_sand_water.html
Capturing setup: 25 fps, F3.4, shutter speed 1/300 s.
From top to bottom: no zoom, 2 x zoom, 3 x (maximal) zoom.
Besides the observation of the whole physical process dynamics, one can zoom in the different parts of the video scenes in order to focus on different local processes and conditions determining the behaviour of the whole dynamic system (e.g. individual sand grain motion vs. their collective motion, air bodies and their interaction with sand, vortices, etc.).

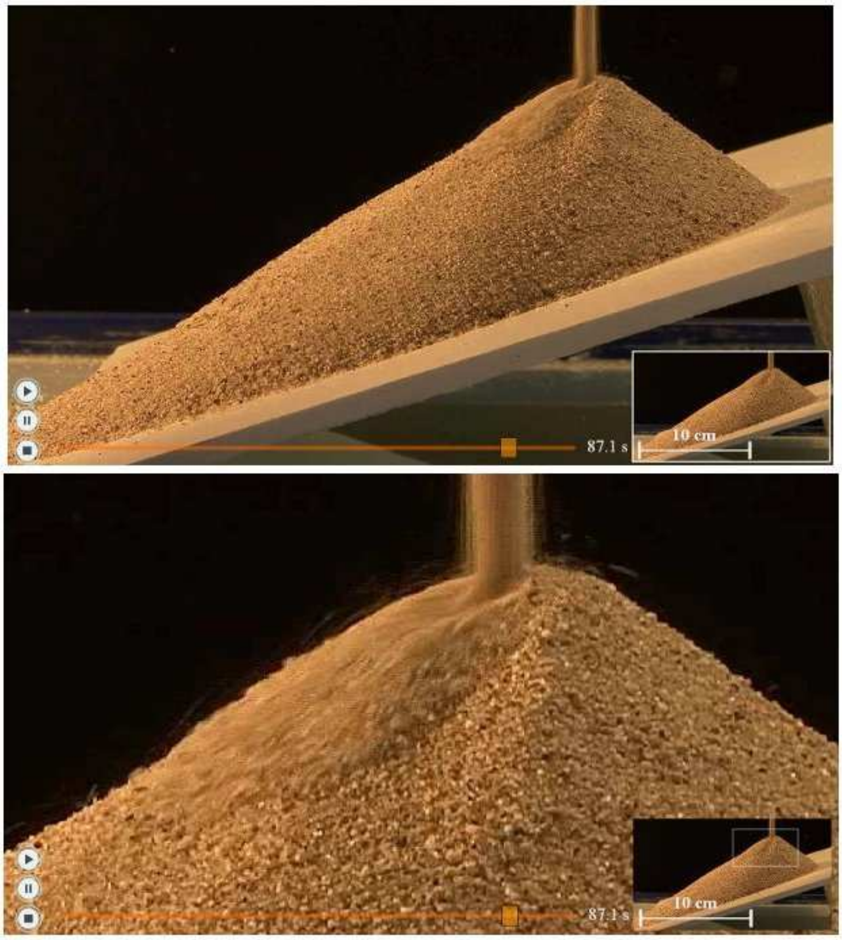

Figure 2: SLOIV screenshot of "Sand dripping on an inclined plane".
http://www.scholaludus.sk/udine/sand_dripping_on_an_inclined_plane.html
Capturing setup: 25 fps, F5.2, shutter speed 1/100 s.
The top figure at no zoom, the bottom one at 3 x (maximal) zoom.
The physical system is simple to be prepared but much more difficult to be understood in its complexity: At the beginning of the process, individual grain motion prevails (individual trajectories of the bouncing grains can be recognized), later collective grain motion is dominant (sand mounds, avalanches, waves) – "Does the sand mound shape depend on the base position?

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