



AFRL-RH-WP-SR-2010-0004

**Point-Light Visualization Developer, Version 1.0
User Guide**

**Adam M. Fullenkamp
Biosciences and Performance Division
Vulnerability Analysis Branch**

August 2009

Interim Report for May 2008 to August 2009

**Approved for public release;
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**Air Force Research Laboratory
711th Human Performance Wing
Human Effectiveness Directorate
Biosciences and Performance Division
Vulnerability Analysis Branch
Wright-Patterson AFB OH 45433**

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// SIGNED//

Julia Parakkat, Work Unit Manager
Vulnerability Analysis Branch

// SIGNED//

Mark M. Hoffman, Deputy
Biosciences and Performance Division
Human Effectiveness Directorate
711th Human Performance Wing
Air Force Research Laboratory

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE (DD-MM-YYYY) 06-08-2009		2. REPORT TYPE Interim		3. DATES COVERED (From - To) May 2008 – August 2009	
4. TITLE AND SUBTITLE Point-Light Visualization Developer, Version 1.0 User Guide				5a. CONTRACT NUMBER In-House	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER 63231F	
6. AUTHOR(S) Adam M. Fullenkamp				5d. PROJECT NUMBER 7184	
				5e. TASK NUMBER 02	
				5f. WORK UNIT NUMBER 71840226	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) 711 HPW/RHPA 2800 Q Street, Bldg 824 WPAFB OH 45433				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Materiel Command Air Force Research Laboratory 711th Human Performance Wing Human Effectiveness Directorate Biosciences and Performance Division Vulnerability Analysis Branch Wright-Patterson AFB OH 45433-7947				10. SPONSOR/MONITOR'S ACRONYM(S) 711 HPW/RHPA	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-RH-WP-SR-2010-0004	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release, distribution is unlimited					
13. SUPPLEMENTARY NOTES 88 ABW/PA cleared 23Mar10, 88ABW-2010-1411.					
14. ABSTRACT This report is a user guide for the Point-Light Visualization Developer, ver1.0 (PLVD1.0), a software utility developed by 711 HPW/RHPA to enable the hand digitization of point-light imagery from 2D video sequences. Although there are model-based algorithms capable of automatically digitizing human point-light walkers from 2D video imagery, such algorithms are often limited by camera perspective, object occlusion, and clothing coverage. Furthermore, users may wish to develop point-light representations of objects in a video sequence other than humans. While manually intensive, PLVD1.0 allows the user the flexibility to create point-light video images from a diverse range of 2D video sequences for purposes of human perception/cognition studies and time series analysis of fiducial motion. Ultimately, this software is intended to facilitate the analysis of human and object motion.					
15. SUBJECT TERMS Point-Light; Perception; Video; Walker; Digitization					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (include area code)
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ACKNOWLEDGEMENT

The author would like to thank Kathleen M. Robinette and Julia Parakkat of 711 HPW/RHPA for their feedback and support in the development of the Point-Light Visualization Developer, ver1.0 (PLVD1.0) software. The author would also like to thank Frank Morelli of the U.S. Army Research Laboratory (AMSRD-ARL-HR-SE) with whom PLVD1.0 was developed in accordance with a memorandum of understanding (MOU) between 711 HPW/RHPA and AMSRD-ARL-HR-SE.

SUMMARY

This report provides detailed instructions for the operation and utility of the Point-Light Visualization Developer, ver1.0 (PLVD1.0). Specifically, PLVD1.0 allows the user to import standard AVI video files, create marker/fiducial definitions, hand digitize marker locations over a series of video frames, and export point-light videos. The software also creates an ASCII file for each point-light analysis with the corresponding 2D marker locations so that time-series analyses can be performed. Strengths of PLVD1.0 include flexible marker definition, automatic frame incrimination, frame-by-frame saving of marker locations, marker track filtering options, and marker track inspection options.

1.0 INTRODUCTION

Point-light video imagery has been used consistently since the early 1970's to evaluate human perceptions of biological motion.^[1-4] Specifically, point-light imagery allows for presentation of biological motion without the potentially distracting and confounding visual data that often accompanies standard 2D video (e.g. background clutter, scene lighting, clothing, hair, etc). While newer technologies, such as marker-based 3D motion capture systems, have simplified and improved the accuracy of point-light images, there are instances where scientists may wish to develop point-light sequences from preexistent 2D video data. In such cases, there are generally two options for obtaining point-light representations. First, there have been a number of technical reports describing methods for the automated tracking and modeling of human movements from 2D video.^[5-7] Although model-based algorithms may facilitate the automation of point-light images, they may also be limited by variations in clothing and human-background contrast. Additionally, scientists may wish to develop point-light representations of non-human objects which require more robust modeling to accomplish. The alternative to modeling is to develop point-light imagery by means of hand-digitization. While manually intensive and prone to high-frequency noise, hand digitization provides a more practical method for creating point-light images in the absence of a robust, automated modeling solution. For this reason, the Point-Light Visualization Developer, ver1.0 (PLVD1.0) software tool was developed.

PLVD1.0 is a software tool, written in National Instruments LabVIEW 8.5, that allows a user to read in AVI video files and hand-digitize multiple points in each frame of video footage. The PLVD1.0 software then uses the hand-digitized point information to create a point-light video. The software also saves the 2D point locations in an ASCII spreadsheet for further analysis. What follows is a brief description of the different functions and user options provided in PLVD1.0.

2.0 PLVD1.0 USER INSTRUCTIONS

2.1 Reading AVI Files

PLVD1.0 is capable of reading AVI video files. Other digital video formats will need to undergo conversation before they can be read by PLVD1.0. Also, AVI files may be compressed using different compression filters. Not all compressed AVI files can be read into PLVD1.0. If the user has chosen to convert other files into a particular AVI format, they must confirm that the compressed AVI's can be read into PLVD1.0.

Upon opening PLVD1.0, the software will search for a video file to be opened. As a matter of convenience, the user may wish to create a "start.txt" file in the 'C:\Program Files\PLVD' directory. This will allow the user to designate a specific start path for PLVD1.0. Otherwise, the open file option will start on the desktop each time PLVD1.0 is run. To create this start path file, create a text file named "start.txt" in the 'C:\Program Files\PLVD' directory. Within this file, paste the path to the directory location that will serve as the start directory. There is a sample "start.txt" file in the "temp" folder that accompanies the PLVD1.0 software. NOTE: Remember

that text files already have a '.txt' extension and that naming the file "start.txt" may be redundant.

When a video file has been selected, PLVD1.0 will automatically search within the directory that the video is contained to see if any prior digitized points exist for that video. If such a file does not exist, the video will be loaded. If such a file does exist, the user will be prompted with the option to "Load existing points data for this video file?" If the user wishes to continue with digitization that had begun at a prior time, they may select "yes" and select the corresponding *_pts* file. If the user wishes to create a new points file for the video, they may select "no" and start fresh. A user may create as many *_pts* files for a given video as they choose. PLVD1.0 will auto-increment each new *_pts* so that old files are not overwritten. This function may be useful if a user wishes to hand digitize multiple portions of one longer video file.

2.2 Preparing for Digitization: Options and User Settings

In preparation for digitization, users may wish to address a number of settings that will facilitate the digitization process. After a video has been loaded, the user may toggle the "Options" tab at the top left of the PLVD1.0 window. The "Options" page (Figure 1) will allow the user to customize the marker and video options. The "Marker Options" allow the user to identify the amount and names of the points that will be identified in each frame. These options allow the user to add, delete, and reorder the markers to be digitized. Note that the points must be digitized in the order set in the "Marker Options." Creating a list of markers will allow PLVD1.0 to indicate which marker is next to be identified on the front or "Interface" page of the software (Figure 2-A). The "Video Options" in the "Options" tab allow the user to define the attributes of the markers for both the digitization and video creation. The marker color and marker size can be adjusted to control the points that are displayed during digitization. These same options and the background, frame rate, and filtering options are then used to create the point-light video. Users are advised to set all options prior to digitization, although only the marker options are required to be set ahead of time. Users can change the "Video Options" at any point in the digitization process.

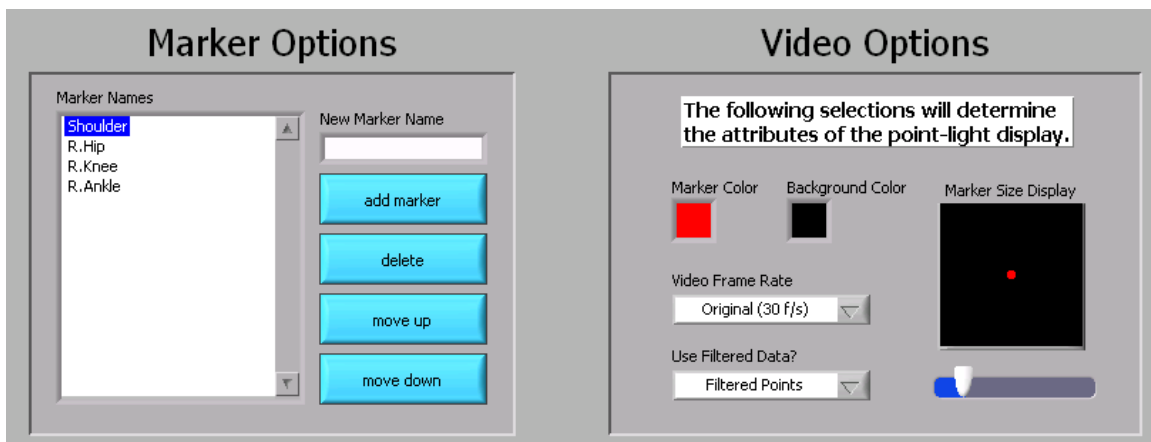


Figure 1. The Options Tab in PLVD1.0 for marker and video options

2.3 Digitization

PLVD1.0 provides users with the ability to zoom in and out of videos of different resolution to obtain the desired view of each video image. Figure 2-C shows the “zoom multiplier” control and the “image scroll” options. Once the user has scaled the image to the desired size, they may use the two scroll sliders to adjust the horizontal and vertical view of the frame.

If the user selects a video frame that has already been digitized, the buttons in Figure 2-B will appear. These buttons allow the user to “show points” that have already been digitized and also to “hide points.” Even though, a frame has been digitized, the user may re-digitize the frame. If the user re-digitizes a frame with existing points data, they will be given the option to overwrite the existing points, or to leave the original points in place.

After the user has set the user options PLVD 1.0 is ready to begin digitizing points. PLVD1.0 will always start each video at frame 0. This corresponds with the first frame in the video sequence and can be considered frame 1 based on the numbering scheme used for the AVI file. Based on the frame numbering system that PLVD1.0 uses, a 200 frame video sequence will actually range from 0 to 199. Depending on the marker names chosen, the user will see the marker that is next to be identified in the top-right of the image (Figure 2-A). This indicator will help if the user ever loses track of which marker was digitized last. Points are identified by placing the mouse arrow over the point of interest and left-clicking. When the user has selected a point, a marker will appear over the selected point and the “next marker” indicator will advance to the next marker in the list. After all markers have been identified in a frame, PLVD1.0 will automatically advance to the next frame. When the user is digitizing a given frame, they always have the options to “delete last point” and “delete all points in this frame” (Figure 2-H).

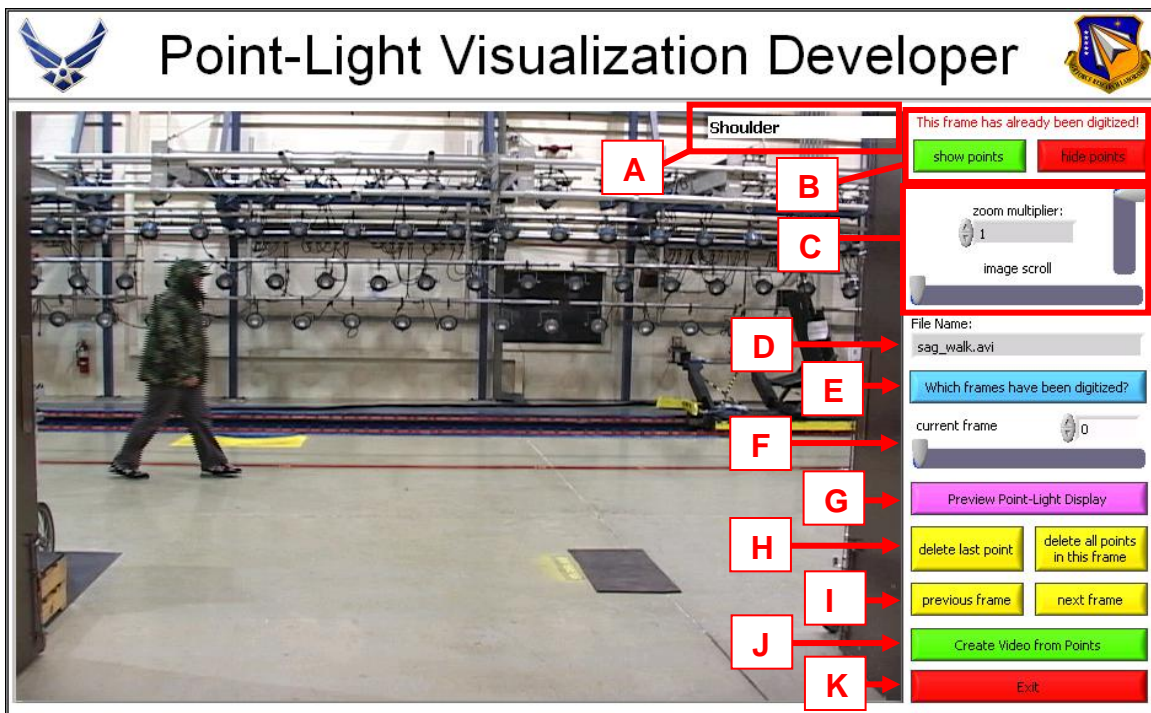


Figure 2. The Interface Tab of PLVD1.0 for hand digitization

Users may choose to analyze only sections of a video and/or digitize frames in different orders. There are several methods for manually changing the frame that is in view. First, users may select the “previous frame” and “next frame” buttons to jump backward and forward one frame, respectively (Figure 2-I). Subjects may also change the frame manually by moving the “current frame” slider or by directly changing the value in the “current frame” digital display (Figure 2-F).

After digitizing all or a number of frames, the user may wish to check the status of the frames that have been digitized. This is especially useful if the user has only digitized a portion of the video or if they have been required to jump to different frames. To check for the presence of undigitized frames, the user may select “Which frames have been digitized?” (Figure 2-E). This will show the lowest and highest digitized frames, along with any gaps between them. This function will also be useful if the user is forced to begin digitization in one session and continue the digitization at another time.

One very important function to be aware of is the frame-by-frame auto-save and update of point locations. From the very first frame that a user digitizes, PLVD1.0 will create a spreadsheet of the 2D point locations. This spreadsheet is updated with each frame that is digitized. Accordingly, the user may exit PLVD1.0 at any time and all point digitization work will be saved. This function is very helpful for allowing the user to breakup digitization sessions, digitizing different portions of a given video, and for the ability to perform post hoc analyses on the saved 2D point data. The spreadsheets that are automatically created will be named according to the following convention: video file name_ pts_increment number.xls

2.4 Previewing the Point-Light Display

Once the user has digitized all relevant frames, they may qualitatively inspect the accuracy of the point-light display. To do so the user can select the “Preview Point-Light Display” button (Figure 2-G). Toggling this button will open a new window to display the “preview_pl” viewer. The “preview_pl” viewer will allow the user to both view and filter the digitized points. First, the user may observe the motion of the raw (unfiltered) points by toggling the “Play” button (Figure 3-A). The user may also view the video at double and half speed by selecting the appropriate “Video Frame Rate” option (Figure 3-B). Because the user will be selecting the location of each marker in each frame without any guidance, it is expected that the raw point-light display will demonstrate a modest amount of high frequency noise. This noise may be filtered out by utilizing the low-pass filter options (Figure 3C-F). First, the user may select the appropriate “Lowpass Filter Cutoff (Hz)” frequency (Note: The filter is a 2nd order Butterworth filter). Then, the user must select “Apply Filter” for the data to be processed. Once the data has been filtered, the user may “Play” the point-light display to view the filter changes. If unsatisfied with the filter results, the user may select a different filter cutoff value and “Apply Filter” again or they may select “Restore Raw Data” to use the raw data. Note: each time the “Apply Filter” button is toggled, the software will filter the raw data. The software will never filter previously filtered data.

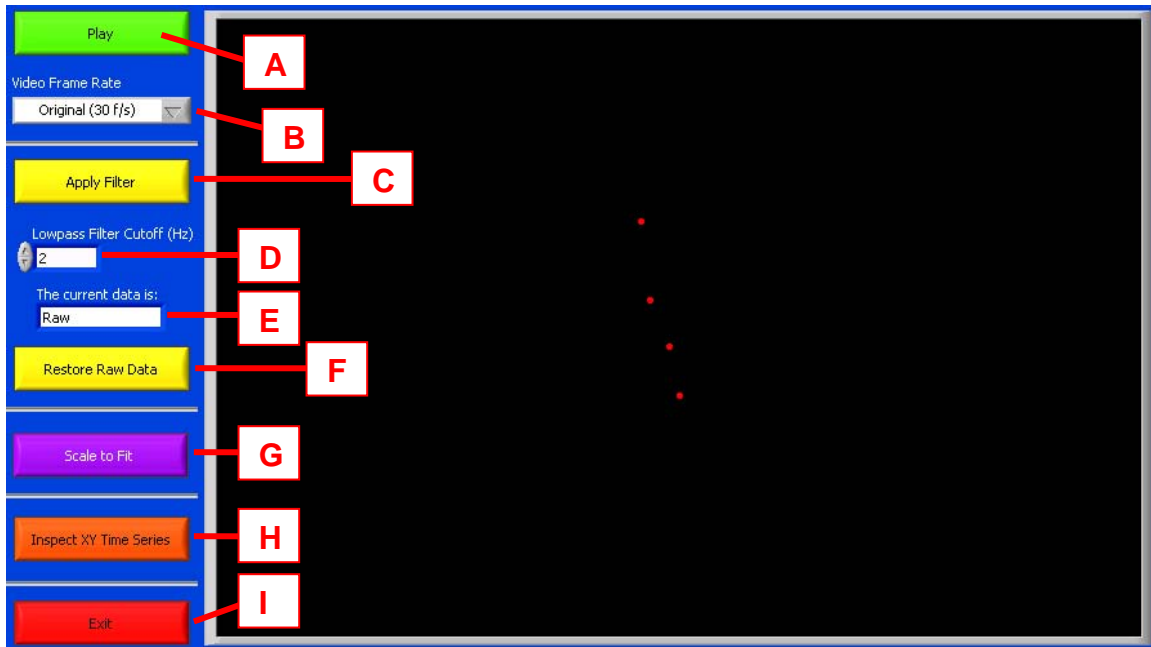


Figure 3. The “preview_pl” viewer for processing digitized points

Another useful option in the “preview_pl” viewer is the ability to fit the point-light display to the image window. The user may wish to digitize an image within a video sequence that only falls in one small corner of each frame. However, to present such a point-light display may be inappropriate. Accordingly, the user may select the “Scale to Fit” button after the filtering options have been selected (Figure 3-G). This will expand the point light display to fit the image window.

The “preview_pl” viewer provides one more very important function. Specifically, the viewer allows the user to inspect the 2D XY time series information for each of the markers. If a user accidentally identified the markers in one frame in the incorrect order, they would not be able to tell from the point-light display alone. This is because all of the markers are presented in the same color. Such an issue is irrelevant for the development of a point-light display. However, an error of this sort could substantially affect any post hoc analyses to be performed on the 2D point location spreadsheets. To ensure that markers have not been inadvertently switched at any point, the user may select the “Inspect XY Time Series” button (Figure 3- H). This will open yet another window that will allow the user to select each marker and view the 2D coordinates over time (Figure 4). The user will notice any frame containing switched markers because there will be an obvious spike or anomaly in the position data.

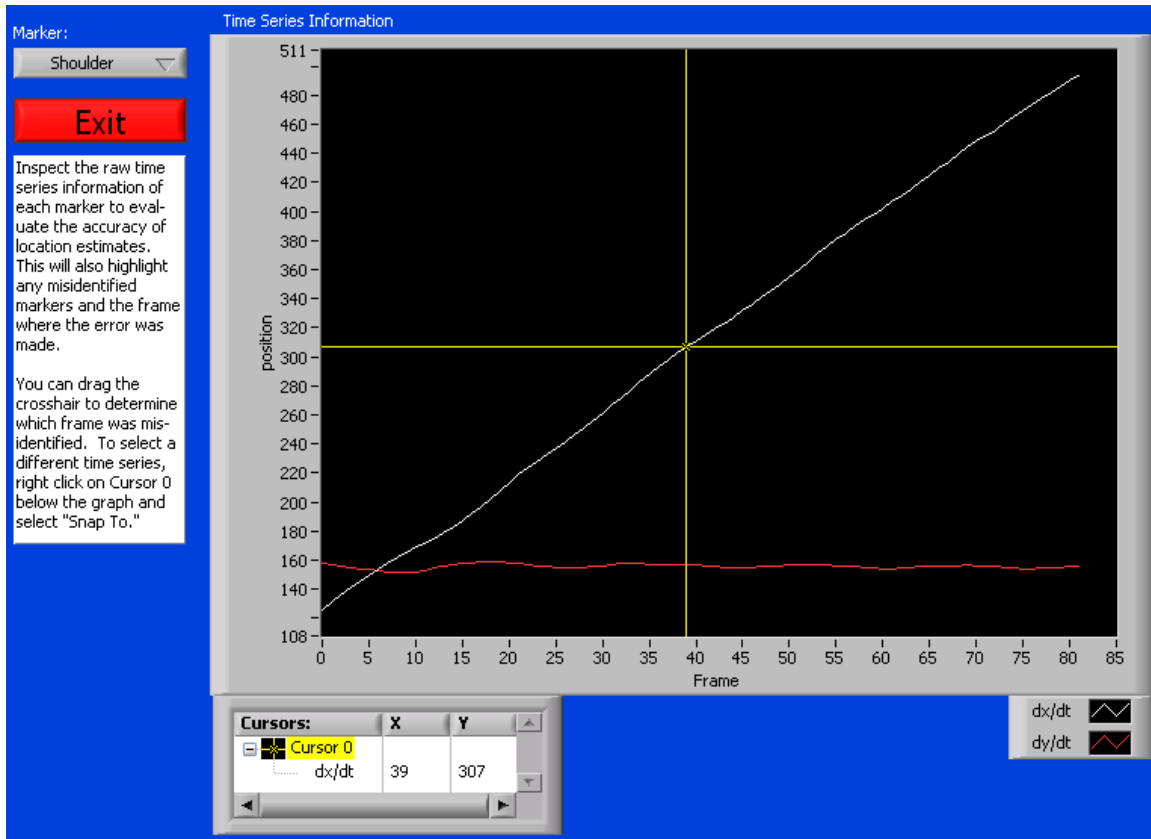


Figure 4. The “xy_time_series” window for inspection of marker trajectories

If, during the inspection of the marker time series, the user notices a frame that contains an anomaly in the data, the user can slide the yellow crosshair along the waveform until the frame of interest is identified. The user can then go back and re-digitize that frame to correct the problem. Again, if two markers were simply switched in one frame, this will not affect the appearance of the point-light walker. However, such an error will confound any analyses of the *_pts* spreadsheet.

2.5 Creating the Point-Light Video

Once the time series information has been inspected, the user may “Exit” the “xy_time_series” window. Similarly, when the user has finished filtering, resizing, and viewing the point-light display they may “Exit” the “preview_pl” viewer. It is critical to close both the “xy_time_series” and “preview_pl” windows by toggling the “Exit” buttons instead of closing the window at the top right.

With the point-light display inspected and processed, it’s time to create the point-light video. The user should again select the “Options” tab at the top left to view the “Video Options.” As previously mentioned, the user may select the “Marker Color,” “Background Color,” and the marker size using the slider beneath the “Marker Size Display.” The user also has two other video options at their disposal. First, the user may choose to have the video play at original-speed, half-speed, or double-speed. The final video option involves presenting either the raw or

the filtered points. Note that the filtered points will only be used to create the video if the user has first processed the point data in the “preview_pl” viewer. Selecting the option to use the filtered points, without taking the step of filtering, will cause PLVD1.0 to use the raw points instead. As matter of practicality, the user is strongly encouraged to inspect each point-light display in the “preview_pl” viewer before creating a point-light video.

Once all video options have been adjusted, the user should select the “Interface” tab and toggle the “Create Video from Points” button (Figure 2-J). The user will see a progress bar in the middle of the “Interface” viewing window as the video file is created (Figure 5). The video that is created will be an uncompressed AVI file and will be named according to the following convention: video file name_pl.avi. Unlike the *_pts* files, the point-light videos that are created in PLVD1.0 do not auto-increment. Instead, each point-light video that is created from a given video file will be overwritten each time the “Create Video from Points” button is toggled. Users are advised to rename or move each point-light video that is created from a file where multiple point-light videos are to be made.

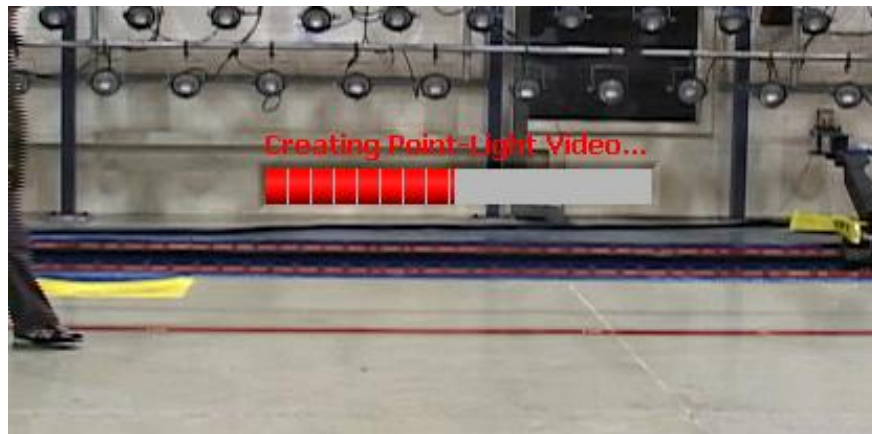


Figure 5. The “Creating Point-Light Video...” progress bar

3.0 FINAL COMMENTS

After all work in PLVD1.0 has been completed, the user can select “Exit” to stop the program and then close the main window (Figure 2-K). Remember that PLVD1.0 allows the user to complete a portion of the digitization and return to complete the process. Also note that the *_pts* data should be easy to read into other analysis software since it is saved in an ASCII format. Finally, if the user wishes to create multiple point-light videos from a single video file, it is important to create a separate *_pts* file for each analysis. PLVD is programmed to create a video from all digitized frames in a given *_pts* file. Therefore, if the user has digitized two subsets of a video within the same analysis, those two subsets will be combined in the point-light video.

As a final note, the author of this user guide wishes to reinforce that PLVD1.0 was designed with a specific research project and application in mind and was not intended to be developed for commercial distribution. Where PLVD1.0 may serve future research applications, this user guide has been developed to detail the use and function of the custom software.

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