Analyzing the Capability and Utility of Open Source Motion Tracking Software Kinovea and Blender for Research Application

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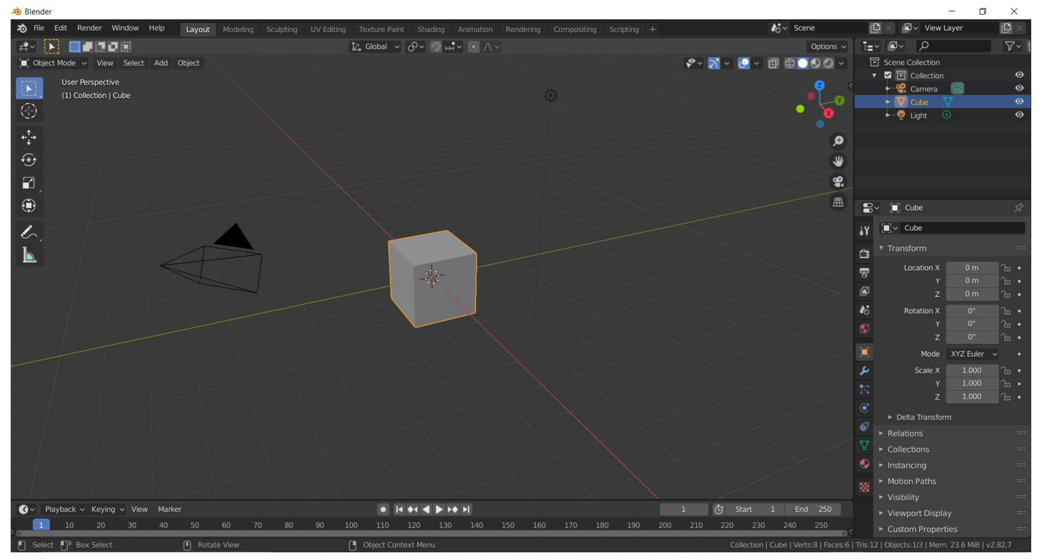
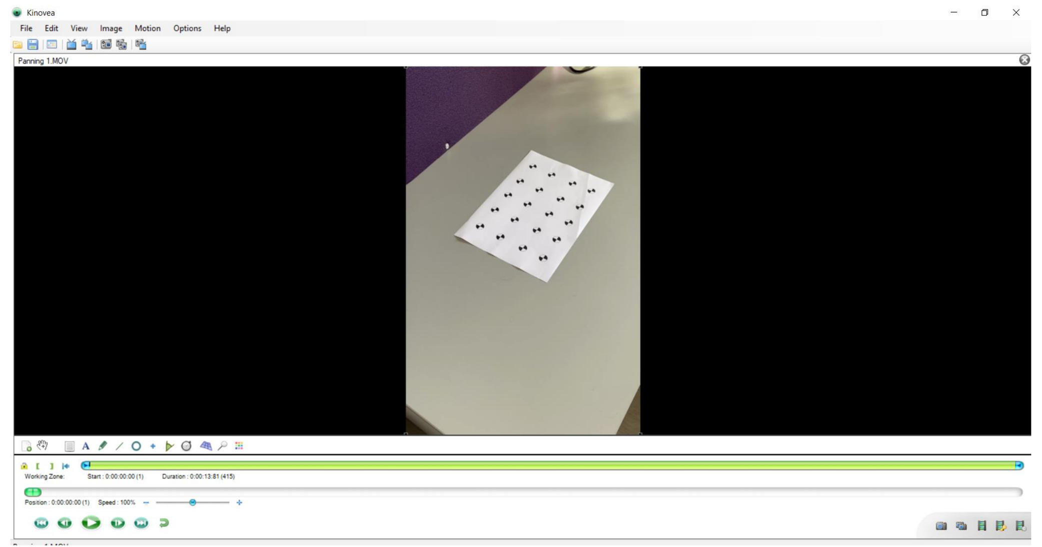
Introduction

My work was motivated by a desire to find a suitable and capable motion tracking and modeling software that was offered opensource. The goal was to find something robust that people could gain access to for free and could learn during schooling and it would still be practical for them after in research. I also wanted to analyze not just the strength of the software but the utility and "user-friendliness", so to speak, as well as how they stacked up to more commonly used tracking software. First, I looked into real applications of the software and found "Design of a Low Cost 3D Scanner for Taking Anthropometric Measurements" showing that Blender is a practical and cost-effective alternative to current motion tracking methods (Dávila, Pablo, et al). Kinovea I found was mostly used in simpler tracking such as fixed arm, vertical wrist movement in a boxer (Gatt, Ian T., et al) but was found not to be comprehensive enough for more high-level assessment (Beulens, Alexander J. W., et al).
Looking into real research cases, many different forms of motion tracking are utilized. Some examples are combinations of trackers and video capture (balancing), electromagnetic tracking (boxing), and tracking apps on phones (Balsalobre-Fernández, Carlos, et al).
Each of these different methods are used to accurately track motion and convert it to 3-D space for analysis. Many of the times very expensive equipment is needed for this to happen, namely a 3-D camera and some other type of tracker to gain kinetic information. For example (balancing article) used a combination of high contrast, reflective markers and eight cameras to track the motion of the participants. This camera system cost upwards of $10,000 or £7,500 (Vicon Hardware).



Blender Start Screen



Kinovea Start Screen

Methodology

My approach to this problem was to test the software each with different qualities of video designed for motion tracking. I began with high quality top down video of a man rowing, who had both high and low contrast trackers on him. I then moved on to simple motion tracking of a sheet of markers (seen in figure 1) shot with an iPhone 11. These videos were to test how well the software handled basic lateral movement, rotation, and scale changes in the tracking. I made these videos with different lighting conditions a well as combinations of these movements in order to further test accuracy

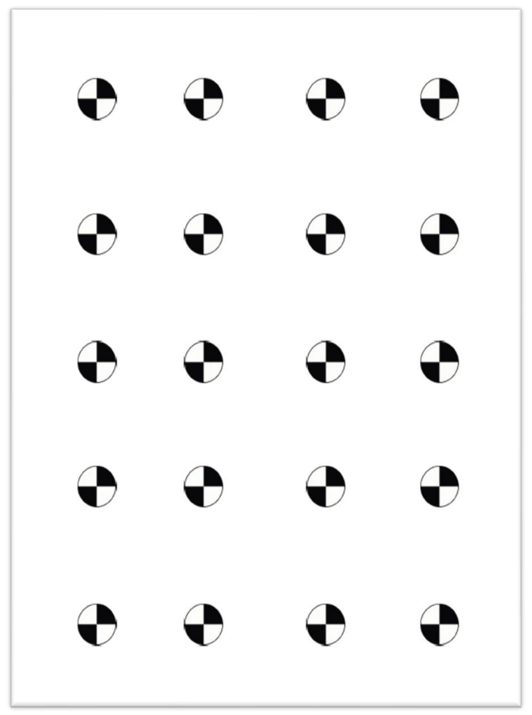


Figure 1

Using this sheet I tested the software for how they handled translational movement, rotation and scale changes, plus combinations of them. This would show real world application as when tracking one or more likely two of these types of movement are occurring. If the software was unable to handle one of these alone in more or less ideal conditions, it would most likely struggle to handle a combination in a real world scenario. It also allowed me to test how well the software could handle points leaving and rejoining the field of view; was it able to pick it back up or not? Did the software confuse the point that left for another one on the sheet?

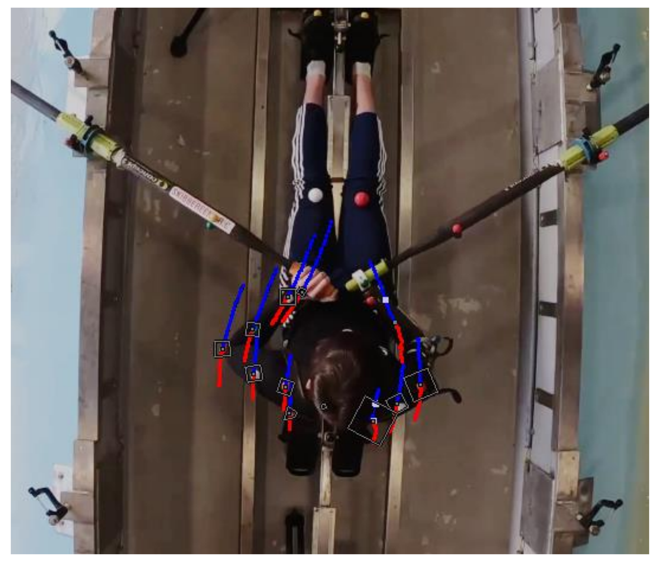


Figure 2

The high-quality rowing video was used to get a base line for real research applications. Though there were issues with the video, such as some slight fisheye distortion and imperfect lighting, these were the kind of conditions that would be used in real research. On top of that the person being tracked was also outfitted with a combination of different size and color markers in order to test the software's capability of handling non-ideal conditions. (Figure 2 shows a keyframe in Blender)

Results and Conclusions

Kinovea did not perform as well as I expected in my tests and after looking into some research that utilized it such as "Analysis of the Video Motion Tracking System 'Kinovea' to Assess Surgical Movements during Robot-Assisted Radical Prostatectomy" and "Accuracy and Repeatability of Wrist Joint Angles in Boxing Using an Electromagnetic Tracking System" I came to the conclusion that Kinovea is powerful but more niche. It is capable of calculating changing angles and tracking points but need a relatively clean source. When testing with my tracking sheet there were too many identical points close together and with the rowing video there was too much clutter. As shown in those two articles it is used by professionals and provides adequate utility assuming the video you are using isn't too cluttered and has a clear tracking point. Figure 3a is a utilization from Gatt, Ian T., et al and 3b is another example of the angle feature from Charmant, Joan

Figure 3a

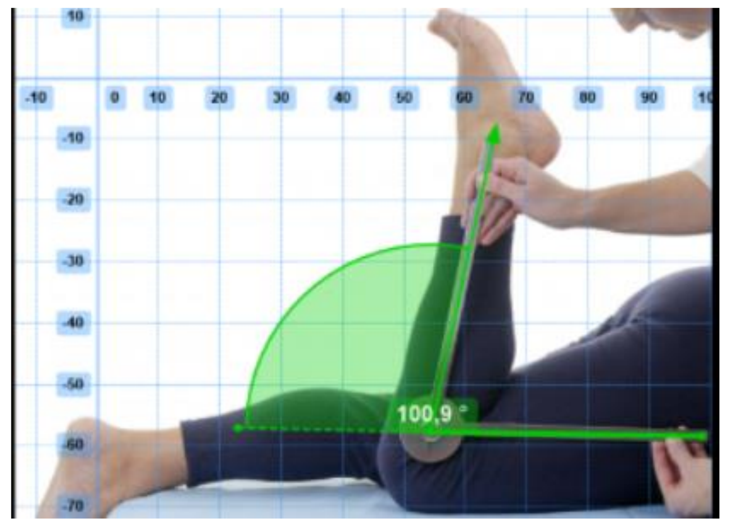


Figure 3b

Blender was able to handle the video of the rower quite well. The high contrast markers were able to be tracked with no manual assistance needed and for the most part the red ones, which I would consider medium contrast on the black outfit, could also be tracked without assistance. When tracking green markers, which were also smaller, I needed to manually reset the keyframe being tracked from time to time. Blender was also able to effectively track multiple of the markers at once and only seemed to struggle when tracking upwards of 5 depending on the color of the markers. If the marker left the page it was also able to stop the tracking and when manually told the marker came back, would pick the track back up as one single track. This helps for rendering it into 3D, a feature that Blender is fully capable of doing.
Blender was able to handle each of the other tests with relative ease. It has built in features where the user can specify if the marker is expected to change size or rotate. This allowed it to track nearly every point on the page at once without any issues. This means that the tool is, in more ideal conditions, powerful enough to accurately track many points moving in all three axes. Most likely in real world conditions some manual fixes would need to be done, but these are quite easy to do in blender as you can go to the frame where the mistake started, fix what it being tracked and have it re-track the whole video based on your new keyframe.
In my testing for Blender I found it to be a reliable and cost-effective way to track and model video. It lacks the ability to internally calculate kinetics, but can graph and output all the tracking information is such a fashion that plugging it into MATLAB and finding kinetics information is possible. It is also capable of 3D modeling with 2 or 3 views of an experiment, meaning only 2 or 3 cameras would be needed rather than the 8 mentioned in the experiment above. This leads me to believe that it is an adequate tracking and modeling software that is capable of being used in real world research.

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