



## Motion analysis in the clinic: There's an app for that

Motion analysis has proven to be a useful tool for physiotherapists to assess movement patterns during functional tasks. Motion analysis provides both the clinician and researcher the potential to gain insight into the pathomechanical changes in movement, as well as the possibility of tracking functional rehabilitation. Traditional motion analysis relies on the use of expensive and bulky equipment; however, there has been increasing development of motion-analysis apps available for iPad, iPhone and android devices that require less time and equipment.

There are over 15 general motion-analysis apps for various hand-held devices. If a clinician is interested in a specific sport, then there are over 250 apps available. This review critiques seven motion-analysis apps: Ubersense (Ubersense Inc. USA); Dartfish Express (Version 3.0.2 Dartfish, Switzerland); Coach's Eye (Tech-Smith Corporation, USA); PostureScreen (PostureCo, Inc, USA.); Motion Analyzer for Rehab (Pokapoka Lifecare Co., Ltd, Japan); VStrator (Improve Your Game, LLC, USA); and KCapture (Spark Motion LLC, USA). The latter four have been designed with specific features that are useful for medicine and healthcare, including: password-protected patient files, posture grids and Borg Scales. However, some of these features in Motion Analyzer for Rehab are in Japanese. All of these apps offer gross motion analysis. Similar to any two-dimensional or three-dimensional analysis technology, there are several factors that need to be controlled in order to make data reliable and valid. These can be classified into the program, the device and assessor skill.

### Program

Ubersense and VStrator are both free to download and use. All the other apps have a download fee ranging from AUD6.49 to AUD329.99. In addition to its download fee, Coach's Eye requires in-app purchases (AUD6.49) to access vital tools, such as drawing vectors and angles.

There are many similar features between the apps: all have the ability to record video and capture stills; however, the ability to do these tasks is not always intuitive and may be limited. For example, VStrator only records 15 seconds of video in each take, which makes capturing motion from longer tasks or slower patients more difficult. Further, while VStrator is usable in any hand-held device, its display was designed for iPhone and, therefore, the image is small and grainy when captured using an iPad or tablet. PostureScreen advertises that it is capable of motion capture; however, this is only available on iPad and there are few details on how to access this feature from the home screen. All programs also offer slow motion and zoom features. Slow-motion speeds vary from program to program: Ubersense offers three slow-motion speeds; Dartfish Express has two slow-motion options; and the remaining apps have a single slow motion. Furthermore, all of the apps have the ability to compare two videos side by side – this tool is particularly useful if tracking participants over time; however, its clinical utility is highly dependent on the assessor's motion-capture skills, as is discussed later.

Differences between the programs include the filing systems and import/export ability. Ubersense, Coach's Eye, VStrator and KCapture are all able to import and export to third-party programs such as Dropbox or Twitter, whereas the other apps require files to be shared using their program extensions. Ubersense and PostureScreen also offer in-app tutorials and exercise prescription, whereas the others have access to blogs for user tips and patient demonstrations. These features are relatively small differences and depend primarily on user preference. In contrast, the number of frames captured per second and the range of tools offered are more important considerations when choosing programs.

The frequency at which consecutive unique images are produced is 'frames per second' (FPS). Shooting at 30 FPS gives no artifact at slow speed, but can result in blurring on movements faster than walking at comfortable speeds. A frequency of 50 to 60 FPS is equivalent to high-end high-definition TV systems; 120 to 250 FPS is typically used to capture three-dimensional running gait. Only Ubersense, Dartfish Express and Coach's Eye are capable of shooting  $\geq 60$  FPS; the remainder capture at 30 FPS. In these three apps, the FPS is automatically set to the maximum that the device being used is capable of.

The second difference between programs is the tools available – particularly the ability to draw angles and vectors. In addition to the above three apps, KCapture offers the ability to draw angles that are automatically calculated. KCapture also has a unique ruler function. The remaining apps permit circles and lines to be drawn but offer no way of quantifying the angle or distance of these circles/lines.

### Device

Frequency (FPS) is also a primary consideration when discussing the device to be utilised during motion capture. Despite some apps being capable of capturing at  $\geq 60$  FPS, it is ultimately dependent on the camera in the device. According to Apple's website ([www.Apple.com/au/](http://www.Apple.com/au/)), iPad mini and air, iPhone 5S and 5C, iPhone 6 and iPod touch are the only devices capable of recording at 60 FPS, provided they have IOS 7. This implies that any app run on iPad or iPad 2 is going to capture at 30 FPS, resulting in image blurring during faster motions.

A second consideration of the device is the frame of reference. For changes over time (including between takes) to be reliably compared, the frame of reference needs to be identical. This includes noting the distance from the patient, height of the lens and position of the camera, which cannot be moved between takes and must be kept orthogonal to the plane of movement. A change in 1 deg in the reference frame can result in up to 2 deg in kinematic error.<sup>1</sup> Without identical frames of reference, side-by-side comparisons are invalid.

### Assessor skill

The largest source of error in motion analysis results from marker placement. Marker placement error accounts for up to 14 deg

difference in kinematic data.<sup>2</sup> While in-app drawing tools have not been assessed for reliability, the lack of pre-placed joint markers possibly increases this error further. A recent study reported that training examiners in marker placement led to improved reliability of three-dimensional kinematic data.<sup>3</sup> This suggests that practising marker placement prior to capturing data, such that joint centres can be easily identified, may improve the utility of the drawing tools.

In summary, motion analysis is now cheaper and more accessible than at any previous point in clinical practice. Numerous apps exist that may be of value to the clinician. Ubersense, Dartfish Express and Coach's Eye offer the greatest utility at the lowest price. However, even with the capabilities of these apps,

their validity and reliability is highly dependent on the device they are loaded on and the skill of the practitioner using them.

**Kathryn Mills**

*Discipline of Physiotherapy, Macquarie University, Australia*

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#### References

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<http://dx.doi.org/10.1016/j.jphys.2014.11.014>

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## Statement regarding registration of clinical studies and systematic reviews from the Editorial Board of *Journal of Physiotherapy*

The Editorial Board of *Journal of Physiotherapy* reminds readers of our policy that prospective registration is mandatory for randomised trials that began participant recruitment after 1 January 2006. Prospective registration means that the protocol for a trial is registered on a publicly accessible register before data collection begins on the first participant. Also, the submitted trial report must be consistent with the registered protocol. We will accept registration in any register that satisfies the International Committee of Medical Journal Editors requirements. Registers that meet these requirements can be found here: <http://www.who.int/ictrp/network/primary/en/>. Some of these registers now allow the registration of protocols for other clinical studies, such as

observational studies. While registration of these other study types is not yet mandatory, it is encouraged. Similarly, we encourage the registration of systematic reviews, which is possible at [www.crd.york.ac.uk/PROSPERO/](http://www.crd.york.ac.uk/PROSPERO/). Authors should provide the name and address of the register and the trial registration number on submission. Readers can find out more about our policy here: <http://www.sciencedirect.com/science/article/pii/S1836955312701224>.

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