

Visual3D Philosophy

Motion capture technology and the techniques of quantitative analysis are relatively new and still evolving. This work is detailed, and rife with opportunities to make mistakes. Software tools like Visual3D help, by eliminating common computation errors and making the processing history of all data available for inspection and double-checking, but there is little any automated system can do to protect against incorrect input data or unwarranted assumptions — **that is up to you.**

For example, you need to be aware of any pre-processing done by your camera or analog equipment manufacturer. Some vendors interpolate and/or filter data prior to creating an output file for analysis. They do this in order to make their output “look better”, for commercial reasons. At HAS-Motion, we believe that this practice has potentially damaging effects on research assessment outcomes. Physical disabilities and patient problems can be completely hidden or minimized in this manner. Researchers using these systems will not be able to create reproducible results without fully documenting the pre-processing assumptions, algorithms, and results prior to any analysis. Feel free to contact HAS-Motion if you are unsure about how your system generates and provides its data. In some cases, the pre-processing activity can be turned off.

Additionally, we advise that motion capture experiments should be designed with the desired analysis and modelling approach determined before attempting to capture any data. For example, the type of analysis you plan to do will usually have implications on which sensors you will use, how they should be calibrated, etc. For marker-based motion capture, Visual3D can interpret a variety of target-marker configurations so you can place markers as you have always done, try out alternative methods, and devise new configurations which are optimized for specific situations. For markerless motion capture, Visual3D can automatically build models for many different vendors so you can get right to verifying and analysing your data. Data from other sensors such as IMUs, EMG, and force plates can all be read into Visual3D as well, giving you the flexibility to analyse movement in many different ways.

Finally, we believe that tools like Visual3D help labs become more effective by providing a common analytical framework for modelling and analysing motion capture data. When all members of a lab use Visual3D over multiple “generations”, all of the lab's research is available to a user to build on. Time that used to be spent on building custom software solutions or retracing analytical decisions from a previous researcher can now be spent making progress on today's projects.

Through working with a great many researchers, we have developed a significant body of experience in motion-capture and data-analysis techniques, and sharing this knowledge has become an important part of the service we provide to Visual3D users. We firmly believe that the principles just described are indispensable, and we are committed to help you to understand and apply them in your own work.

Need for Transparency in Analysis and Presentation of Data

The article [Many analysts, one dataset: Making transparent how variations in analytical choices affect results](#) presents a fascinating look at the impact of different, reasonable analytical decisions for the same data set. The authors concluded that:

“The observed results from a complex dataset can be highly contingent on justifiable, but subjective, analytic decisions. Uncertainty in interpreting research results is therefore not just a

function of statistical power or the presence of questionable research practices, it is also a function of the many reasonable decisions that researchers must make in order to conduct the research. This does not mean that data analysis and drawing research conclusions is a subjective enterprise with no connection to reality. It does mean that many subjective decisions are part of the research process and can affect the outcomes. The best defense against subjectivity in science is to expose it. Transparency in data, methods, and process gives the rest of the community opportunity to see the decisions, question them, offer alternatives, and test these alternatives in further research.”

Original and Processed Data

Some of the guiding principles of Visual3D are:

1. Original data should be preserved unchanged
2. Processed data should contain the entire history of processing steps. The processing history should be sufficient to allow the precise re-processing of the signals.

With Visual3D, your original data is never changed or modified except under exceptional circumstances, such as an identifiable error in the data file. Original data is copied into a repository called a workspace, which also contains your model(s), report, and all calculations. Data-conversion plug-ins read your original data and send their output directly into the workspace. New data computed during analysis is stored into the workspace, along with a detailed history of the computations and their inputs. The entire workspace is saved into a special file, with the extension **.cmz**; these files are suitable for sharing between researchers, maintaining historical archives, and for distribution as part of advanced course work.

Being wary of unwarranted assumptions is also why we advocate storing data in as “raw” a form as possible, though there are limitations to this criterion because Visual3D doesn't actually interpret the original 3D motion capture camera data. For example, if all we have is pre-computed ground reaction data from a force plate as input, we have to make the (possibly unwarranted) assumption that all the force plate properties, calibrations, and processing were perfect, because there is no way to validate the data. In designing Visual3D, and in our attempts to improve it incrementally over time, we have tried to make working with “raw” input data as painless as possible, in order to encourage you to do so.

Know your data

Ideally, motion-capture experiments should be designed with the intended data processing and analysis methods in mind. You may not always have this luxury, e.g., when performing retrospective analysis of old data sets, but most of the time you can and should design your studies from beginning (physical setup, procedures, and data capture) to end (reports and possible conclusions).

To get valid, reproducible results, you must know your data — where it comes from, its specific nature and characteristics. Even more important, you must know the assumptions you make about your data, and have evidence / confidence that these assumptions are warranted. A corollary of this principle is that your analyses should always begin with input data which is as “raw” (unprocessed) as possible.

Proper equipment calibration and quality control procedures are indispensable concrete embodiments of the “know your data” principle. HAS-Motion can help with these critical technical issues.

Data Quality Assurance

Visual3D is a data-analysis tool, not a data-collection tool, and certainly not a calibration or quality-control tool. Visual3D cannot tell you if your motion-capture equipment is not accurate, synchronized, or calibrated. Incorrectly calibrated force plates or capture volumes result in suspect data, with the attendant risk of misinterpretation. HAS-Motion has a set of quality assurance tools, such as Visual3D's [CalTester](#) add-on, to help in validate lab capture data.

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