Tracking targets through a sequence of imagery is only the first step in understanding target dynamics. In order to utilize the basic position versus time data generated through tracking, you need the suite of advanced motion analysis tools built into every copy of VISUAL FUSION.

Advanced Analysis features include track editing to fix broken tracks, plots of position or intensity versus time, and plots of separation distance between two targets. From position plots you can take derivatives or fit to functions to obtain estimates of velocity or acceleration. With position or intensity plots you can analyze vibrations using FFTs to find fundamental frequencies. With any of the plots you can import data from external sources to create informative, multi-source plots.

**Track Editing**

Even the best tracker will sometimes have trouble generating a complete time history of an object. A typical example is a head disappearing into an airbag and then rebounding. This usually results in two separate targets: one going in, one coming out. VISUAL FUSION contains several track editing tools, allowing you to solve this and other problems. Simply select the two targets, and click a button to combine these two targets into a single target having a complete time history.

**Position, Velocity, & Acceleration**

Position, velocity, and acceleration versus time are among the most important results of motion analysis. A simple click of the button on the target, produces a plot of position versus time (upper graph in the figure). Often the motion exhibits different behavior during different time periods, which need to be analyzed separately. The figure shows an example in which the initial constant velocity region is selected and plotted (lower graph). Another button click fits this to a straight line, giving a least squares estimate of the velocity.

Acceleration can be computed from the data, by taking the second derivative of position versus time. Alternatively, external data from an accelerometer can be imported from an ascii file. The upper graph shows acceleration plotted on the same graph as the position.

VISUAL FUSION can import time series data from ascii files. A number of scaling functions are available to match data from different sources (e.g. data recorded in IRIG msec and data recorded in sec from an event). Up to 20 data sets can be plotted on a single graph.

Any of the graphical data can also be exported as ascii files for use in other programs. To support report generation, graphs and imagery can also be cut and pasted into other programs such as Word.

**Target Separations**

VISUAL FUSION provides plots of separation distance between two targets with a couple of button clicks. Simply select the two targets and with a single button click the separation distance (x,y, and magnitude) as a function of time is plotted. This is useful for understanding separation dynamics, or plotting motion relative to a moving reference.

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Frequency Analysis

Frequency analysis allows you to determine the oscillation modes of an object, whether using position or intensity data. The example at the right demonstrates determination of the rotation frequency of a fan. Simply click on the desired target to get the position versus time plot. From the plot, a simple click produces the power spectrum of the target motion. In this example, another button click fits a gaussian function to the spectrum in order to determine the center frequency, 30 Hz.

Scaling / calibration

For motion calibration with a single camera, VISUAL FUSION allows you to calibrate the motion of each target independently, using known scale factors. Simply select an object of known dimensions in the image at the same distance from the camera as the target, and enter the dimensions of the object. VISUAL FUSION will now scale any or all objects to that scale factor. You can repeat this for each object or use one scale factor for each object. Also note that VISUAL FUSION supports independent x and y scaling, for cameras with rectangular pixels, or digital cameras which skip lines at higher frame rates.

Signature Analysis

Analysis of intensity versus time signatures of objects, even when unresolved, can yield a wealth of information concerning dynamics. The signature in the bottom diagram shows intensity of an unresolved object. A simple button click gives the power spectrum, from which we can clearly see a 1 Hz spin and a 5.7 Hz nutation component of the motion.

Other Analysis Options

Blast or fragmentation events produce many pieces of debris moving at various speeds and angles. A simple button click produces a histogram of particle speeds and another histogram of trajectory angle.

Other types of advanced analysis are described in separate application notes. These include multi-sensor 3D position determination of arbitrary objects, single sensor 6DOF determination of known objects, airbag deployment analysis, and radiometric calibration.

This application note describes advanced analysis features of the VISUAL FUSION motion analysis software package. Basic tracking capability and various extensions available for VISUAL FUSION are described in the general brochure.

Developed by analysts, for analysts.

For more information contact:

Dr. Jack Sanders-Reed
IVET, LLC
26 Meadow View Rd
Sandia Park, NM 87047
505-450-1851
Jack.SandersReed@gmail.com