VISUAL FUSION supports two different types of 3D motion analysis. The general case of unknown targets is solved using multi-sensor triangulation to obtain true 3D position and estimations of orientation. The more restrictive case of known, rigid targets, allows a single sensor to perform 6 Degree Of Freedom (6DOF) analysis in which the object position and orientation are measured.

**Multi-sensor 3D Analysis**

3D target position is computed using triangulation of the Line Of Site (LOS) from 2 or more sensors, as shown in the diagram below. The minimum number of required sensors is 2. However, if more than 2 sensors are used, VISUAL FUSION will use all sensors to obtain a least squares estimate of the target location, thus improving the position estimate.

The 3D position calculation requires knowledge of the sensor location (x,y,z), LOS pointing (azimuth and elevation), and the optical characteristics, specifically the angular Field Of View (FOV) of an individual pixel. This may be computed knowing the FOV of the sensor and the number of pixels.

VISUAL FUSION can use image data from sensors which are not gen-locked, and in fact from sensors running at different frame rates, as long as accurate timing information is available for each frame.

**Orientation Estimation**

Target orientation, in the form of pitch and yaw, can be measured in two different manners. If one can place two tracking patterns on the target, the two patterns can be tracked separately, and their orientation can be computed.

In the more common case, where tracking patterns are not available, VISUAL FUSION can automatically create “virtual” targets. The software computes the second moments of an object (as shown in the missile image) and uses this to generate a virtual target in front of and behind the target centroid location. These two virtual targets are then used to compute the pitch and yaw.

**Applications**

Originally developed as a real-time, 3D position and orientation estimation application for White Sands Missile Range (WSMR), under a Small Business Innovative Research (SBIR) effort, the multi-sensor 3D module is in use worldwide for applications ranging from defense to biological motion studies. It is used to measure velocity and angle of attack, 3D bird trajectories, and 3D miss distances between multiple objects.

Data collection geometry varies from 2 sensors on a common tracking mount providing short baseline stereo viewing, to widely separated but fixed cameras, to tracking mounts separated by several kilometers.

**Technical References**


www.ivetllc.com/VisualFusion
VISUAL FUSION 3D / 6DOF Analysis

Single Sensor 6DOF Analysis

When your target is a rigid body of known dimensions, it is possible to use a single sensor to perform 6 Degree Of Freedom (6DOF) analysis. This gives the target location (x,y,z) and the target orientation (pitch, yaw, roll).

In a typical scenario, the user prepares the target by placing at least 4 track markers on the target at carefully measured locations. These markers are automatically tracked with the VISUAL FUSION software.

Knowing the focal length of the camera, and the relative positions of the markers, it is possible to compute the position and orientation of the target.

6DOF analysis can be performed relative to the camera, for a single object, or relative to a second object, if 6DOF analysis can be performed on both objects.

Applications include stores separation from aircraft and occupant orientation in crash test.

This application note describes the multi-sensor 3D and single sensor 6DOF 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.

Single sensor 6DOF stores separation analysis

Technical Reference


Developed by analysts, for analysts.

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Multi-Sensor, 3D analysis

- 2 or more sensors used to triangulate location (x,y,z) of unknown objects.
- Minimum of 2 sensors required. More sensors used in least squares method reduces error.
- Provides pitch and yaw estimates by generating “virtual” targets using target shape information
- Sensors do not need to be gen-locked and can even run at different frame rates

Single Sensor, 6DOF

- Only 1 sensor required
- Target must be a rigid body with 4 known track points
- Target location (x,y,z) and orientation (pitch, yaw, roll) computed by measuring apparent target locations.

www.ivetllc.com/VisualFusion