image
SYSTEMS
MOTION ANALYSIS

MOTION ANALYSIS

Presentation Beijing

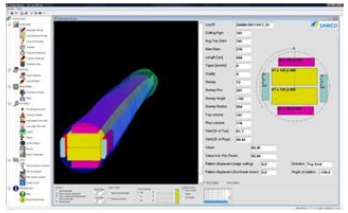
COMPANY INFORMATION

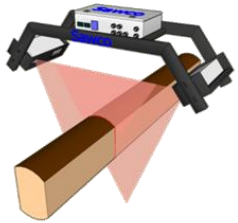
IMAGE SYSTEMS GROUP

DigitalVision

Optimisation of image quality and output in broadcast and movie industry

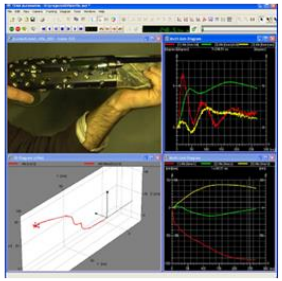
RemaSawco





Optimisation by image analysis of sawmill industry

image SYSTEMS MOTION ANALYSIS



Creation of scientific data output from images

Turnover: 25 MEUR

Employees: 96

Offices:

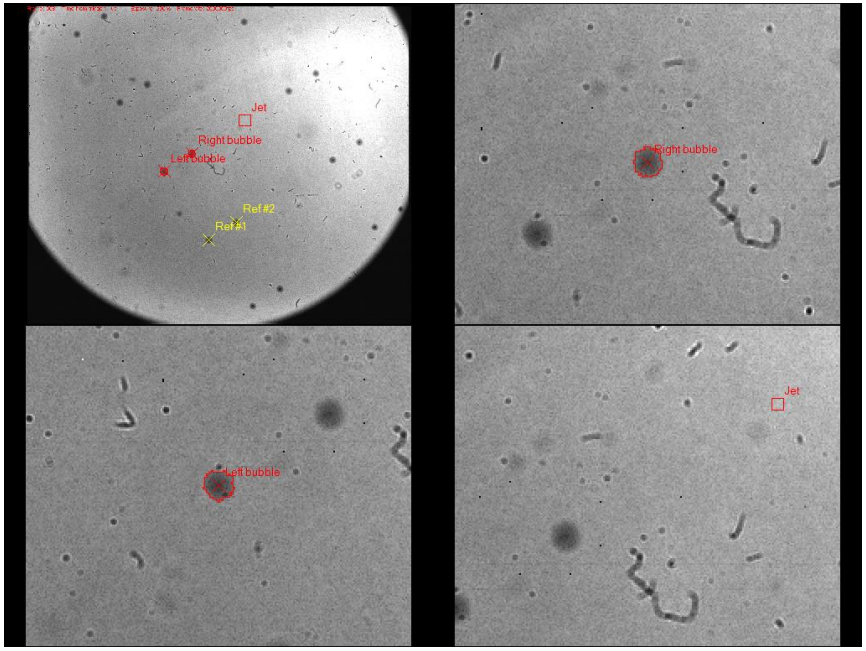
- HQ in Linköping, Sweden,
- Stockholm, Sweden
- London, UK,
- Los Angeles, USA

Image Systems is listed on the Swedish stock exchange (Nasdaq OMX)

3 companies having world leading products on niched markets

image SYSTEMS

MOTION ANALYSIS



- Non contact, non-intrusive and high accuracy out-put data

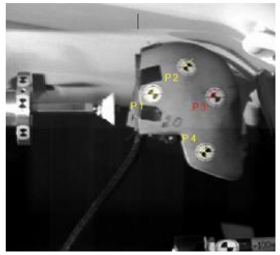
- Founded 1985 in Linköping, Sweden and has ever since developed tools for image analysis

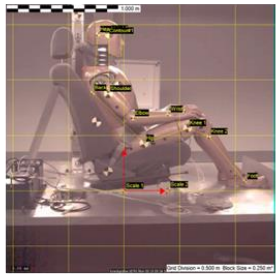
- Image Systems is the market leader in all segments for high-end post motion analysis solutions.

image SYSTEMS

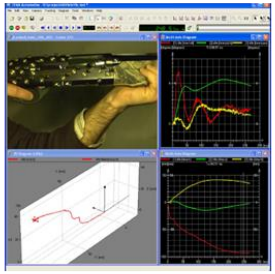
MOTION ANALYSIS

AUTOMOTIVE

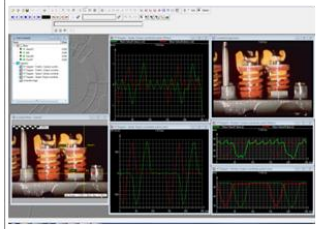




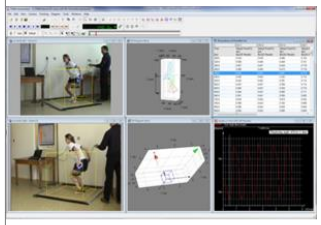
DEFENCE



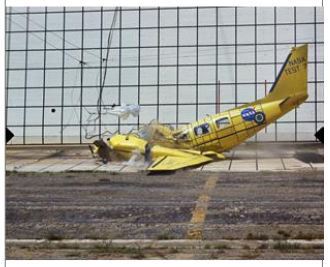
MANUFACTURING



BIOMECHANICS



AERONAUTICS

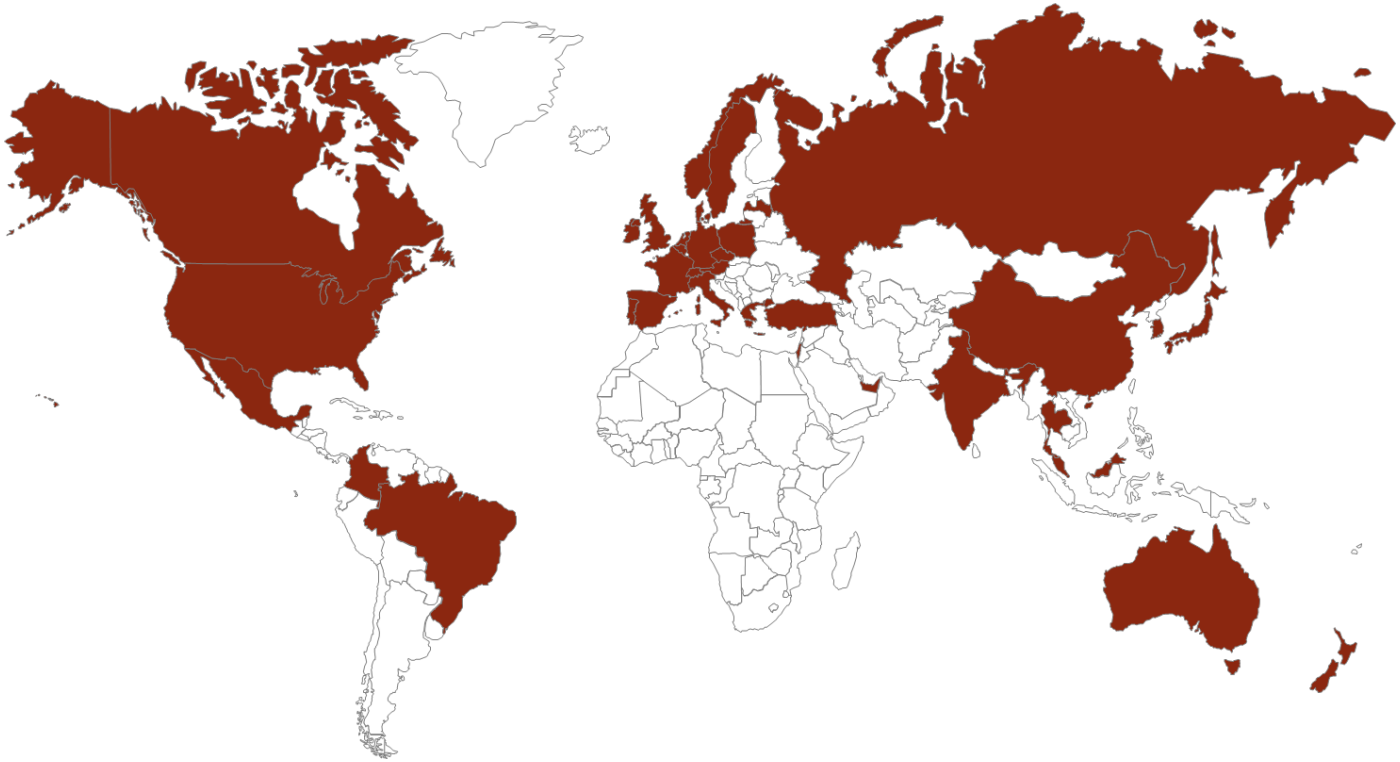


ONE TECHNIQUE – MILLIONS OF APPLICATIONS

MOTION ANALYSIS

INSTALLED BASE

- +1 500 software licenses installed an in operation
- +50 scanners in operation
- +Users in more than 40 countries
- Used globally by most military forces and weapons testing ranges

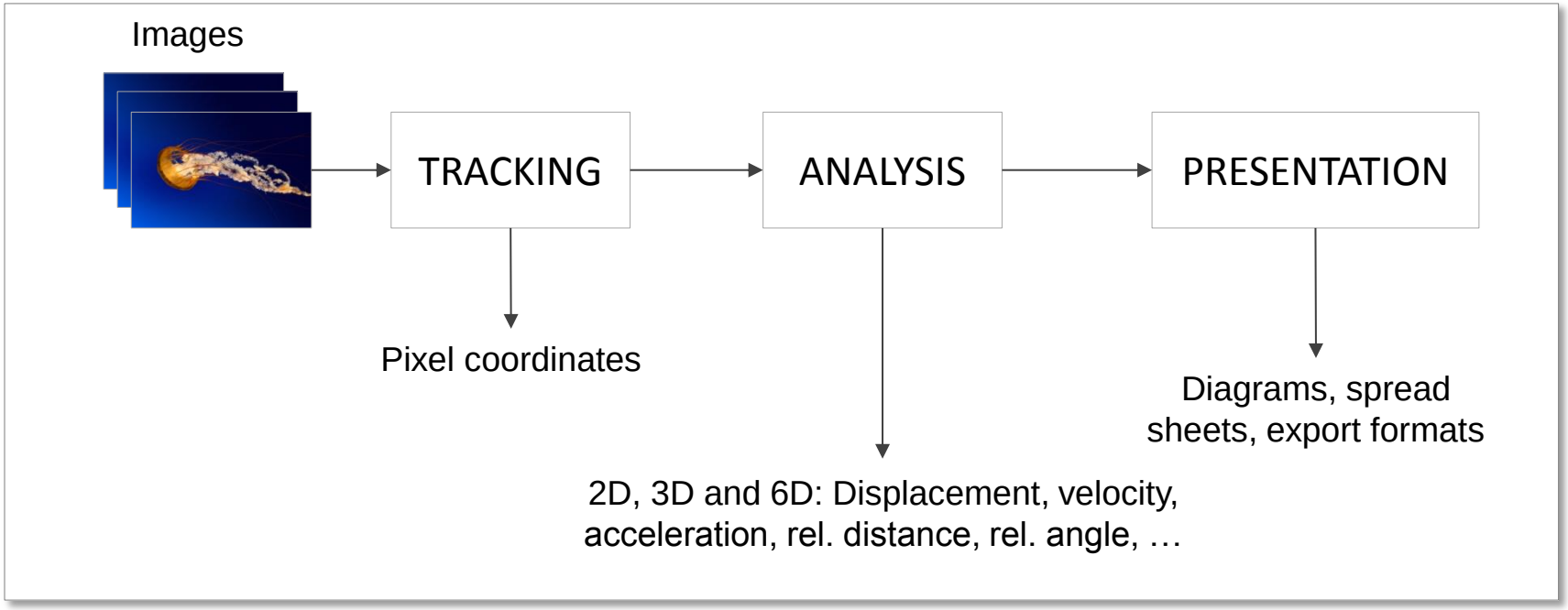


ANALYZING MOTION WITHIN IMAGES

MOTION ANALYSIS

THEORY BEHIND

- Using specific algorithms to locate any point in an image, we can track such points in a sequence of images at 0.1 pixels accuracy.
- Knowing the time lap between each image together with a referenced point in the image, we can calculate displacement, velocity, acceleration, rel. distance, rel. angle, etc of the point.



MOTION ANALYSIS

TRACKING & TRACKERS

CORRELATION

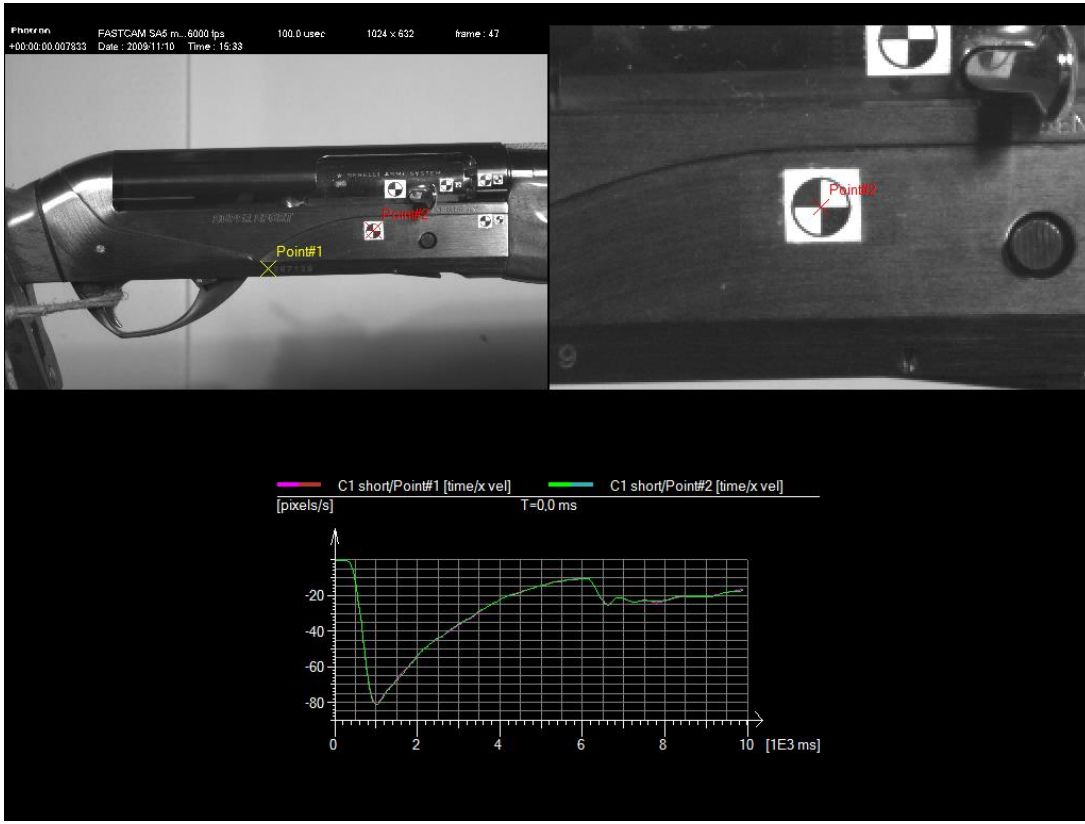
- Can track anything having a contrast, but is sensitive to rotation and change of luminance.
- The operator defines the correct position of what is to be tracked.

MOTION ANALYSIS

TRACKING & TRACKERS

QUADRANT SYMMETRY

- A tracker that knows how the marker should look.
- Locks mathematically to the centre of the marker.
- Not sensitive to rotation nor to luminance changes.
- Output is coordinate and angle.

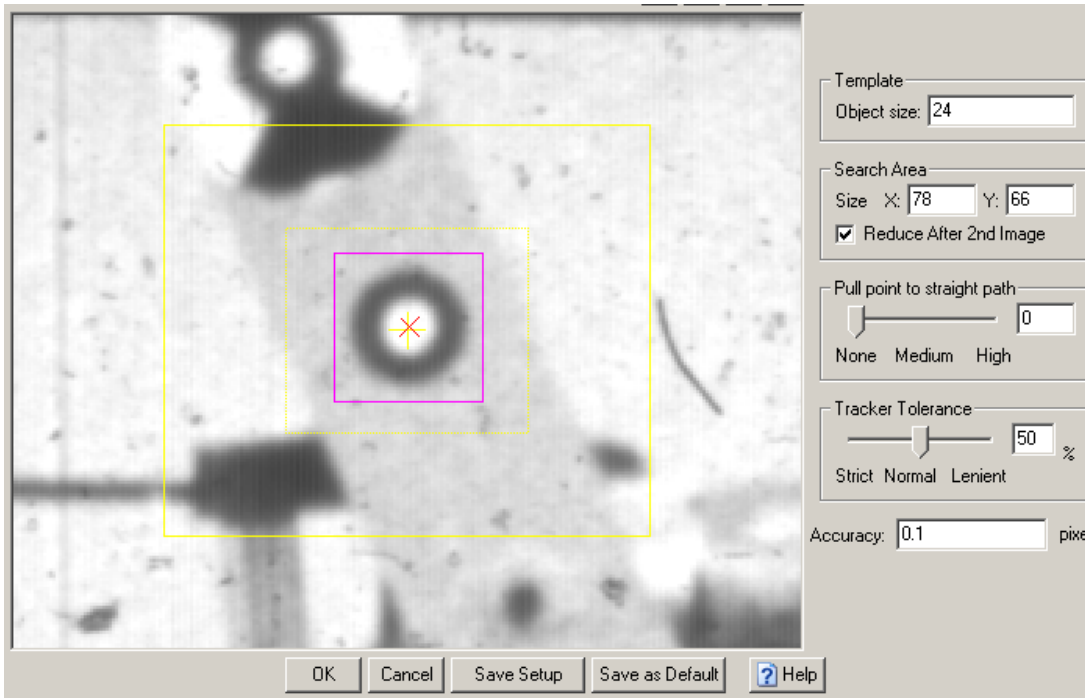


MOTION ANALYSIS

TRACKING & TRACKERS

CIRCULAR SYMMETRY

- A tracker that knows how the marker should look.
- Locks mathematically to the centre of the marker.
- Not sensitive to rotation nor to luminance changes.
- Output is coordinate.

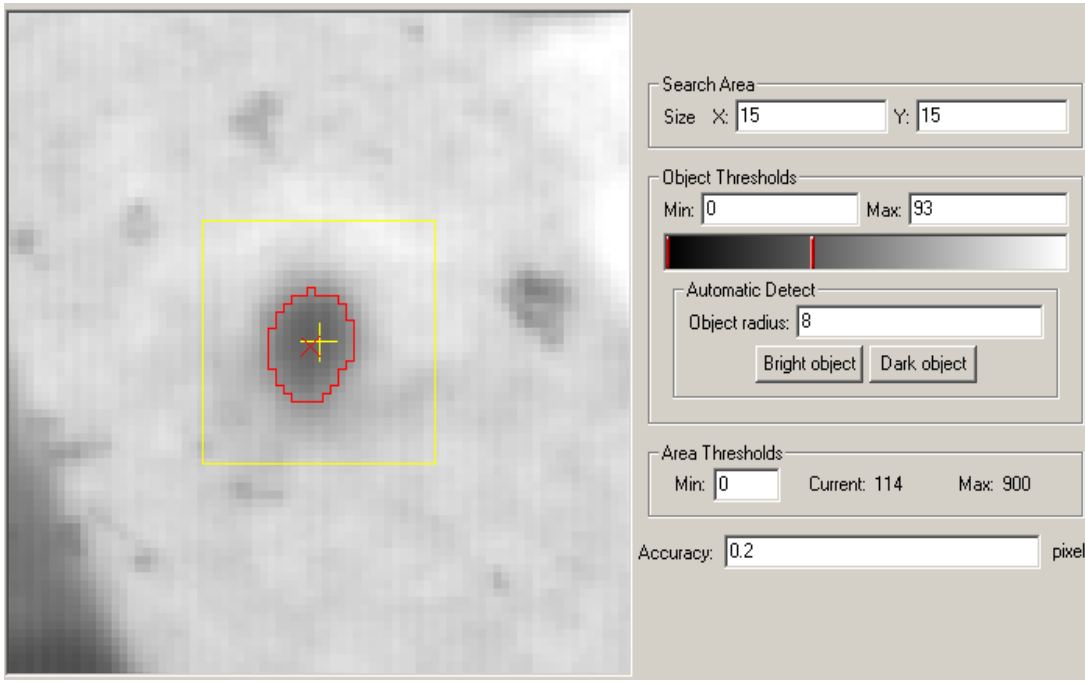


MOTION ANALYSIS

TRACKING & TRACKERS

CENTRE OF GRAVITY

- Using two static greyscale thresholds, this tracker identifies an area.
- Output is area centre coordinate.

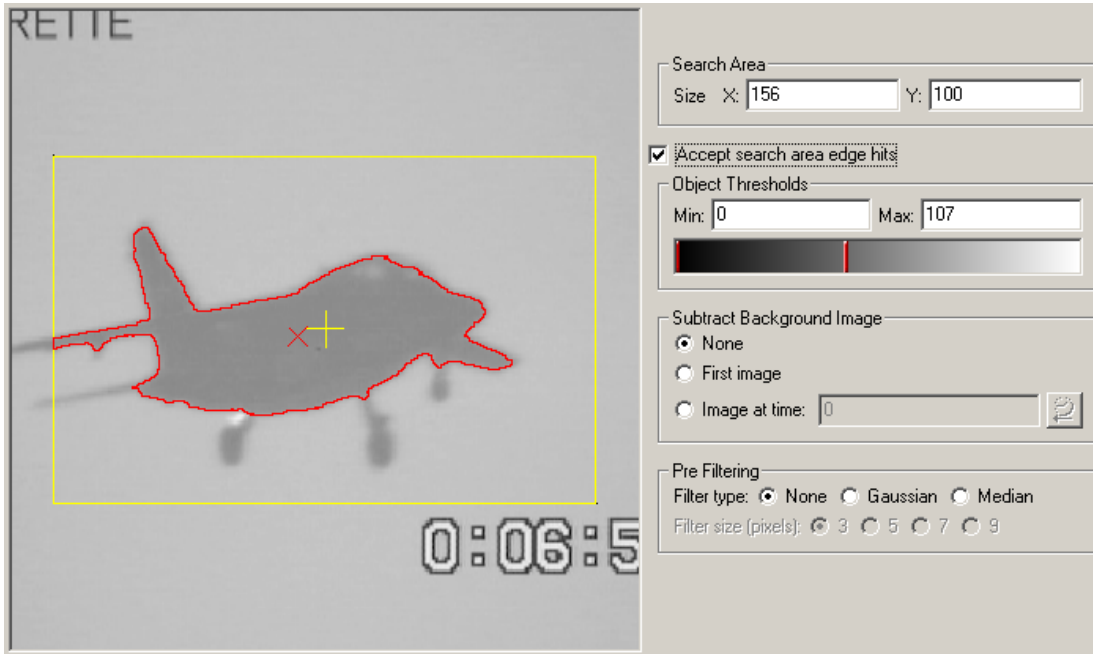


MOTION ANALYSIS

TRACKING & TRACKERS

OUTLINE

- Using two static greyscale thresholds, this tracker identifies an contour, all values between threshold values will inside the contour.
- Output is centre coordinate and contour.

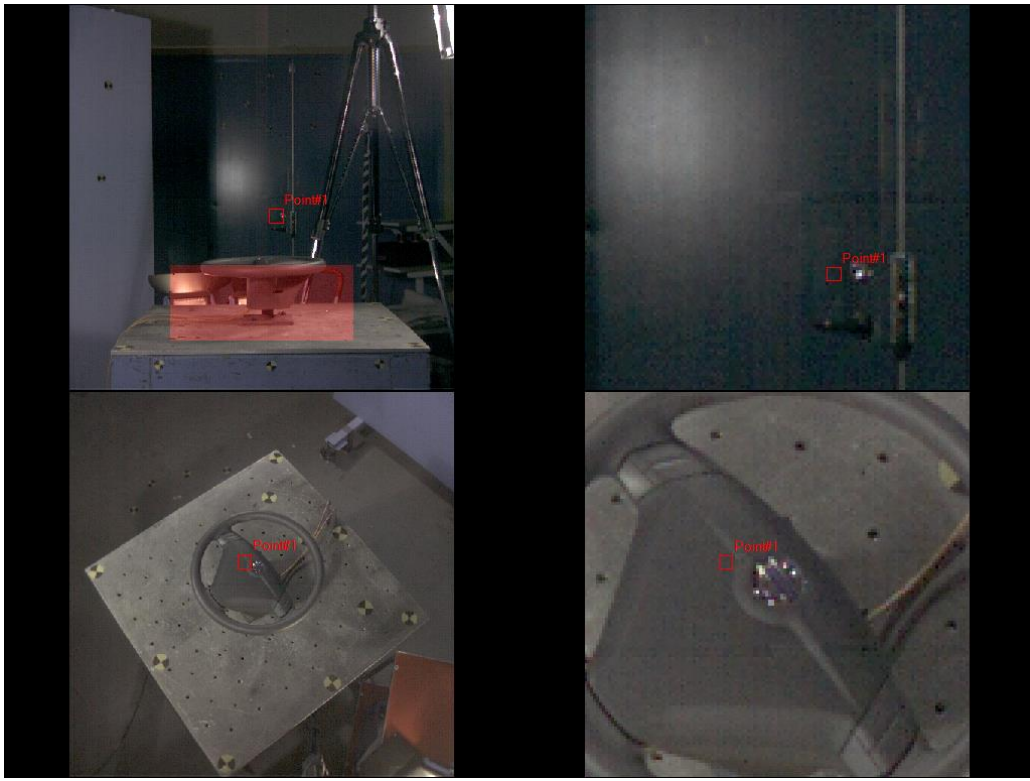


MOTION ANALYSIS

TRACKING & TRACKERS

ADVANCED OUTLINE

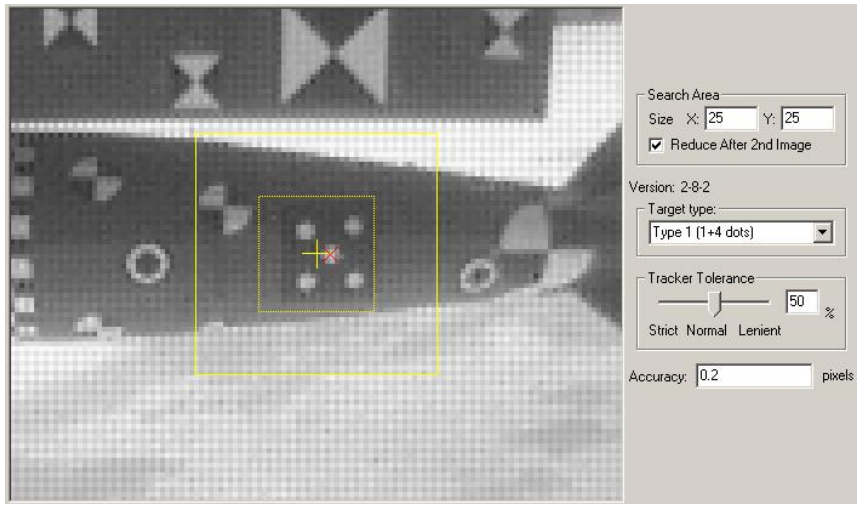
- This tracker is an advanced ‘Outline’ tracker which gives the operator special tools for operations on contours/outlines.
- Output is centre coordinate and contour.

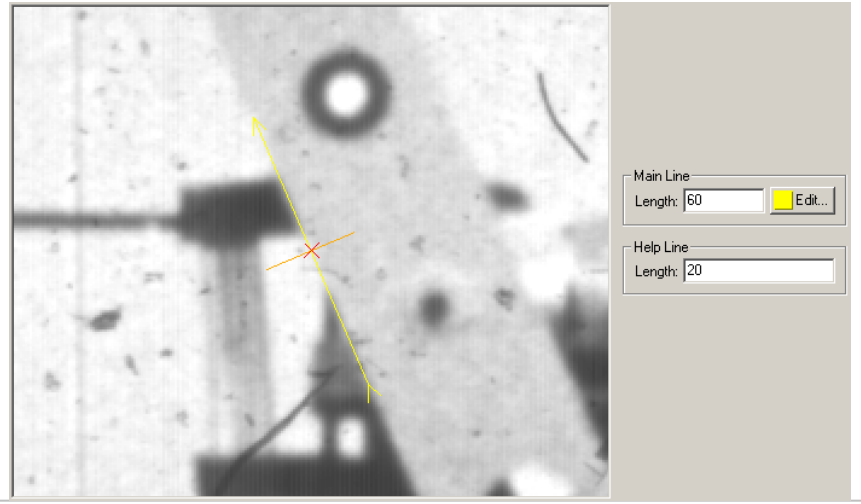


MOTION ANALYSIS

TRACKING & TRACKERS

MANUAL LINE
MXT TARGET
VIRTUAL
CONSTANT
INTERSECTION
CORNER CONTOUR





MOTION ANALYSIS

TRACKING AACCURACY

Algorithm	Uncertainty [px]
Correlation	0.5
QUAD	0.1
MXT	0.2
COG	0.2

- By using the difference in gray scale of different pixels, the software can manage to go below 1/10 of a pixel's accuracy

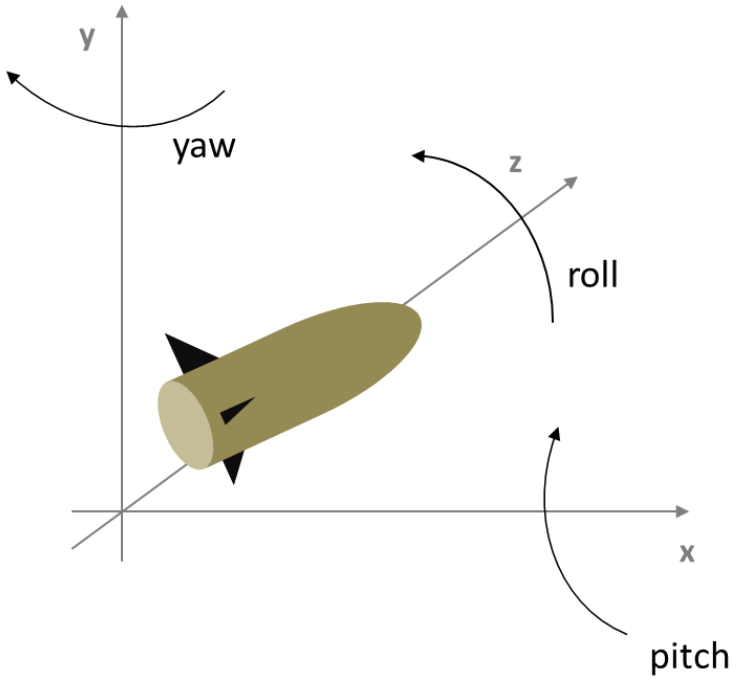
MOTION ANALYSIS

ANALYSIS

- Tracking means to follow a specific object/feature in an image sequence. We measure parameters such as
  - Displacements
  - Speed
  - Acceleration
  - Angles
- We can scale based on depth, chose to scale in pixels or meters and decide where we want to set the coordinate system

TRACKING 6 DIMENSIONS

- X Y Z
- ROLL PITCH YAW

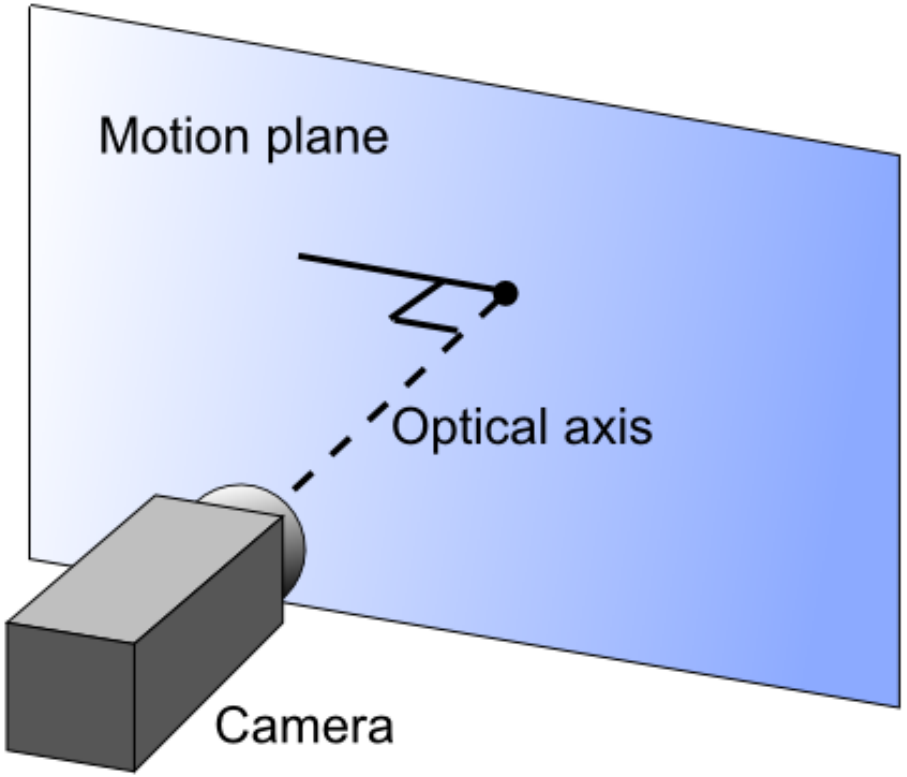


2D TRACKING

MOTION ANALYSIS

2D ANALYSIS

- Concept:
  - The camera is positioned at a 90º angle to the observed motion plane.
  - Transform pixels to meters using a scale factor.
  - The scale factor is constant for all objects in the motion plane.

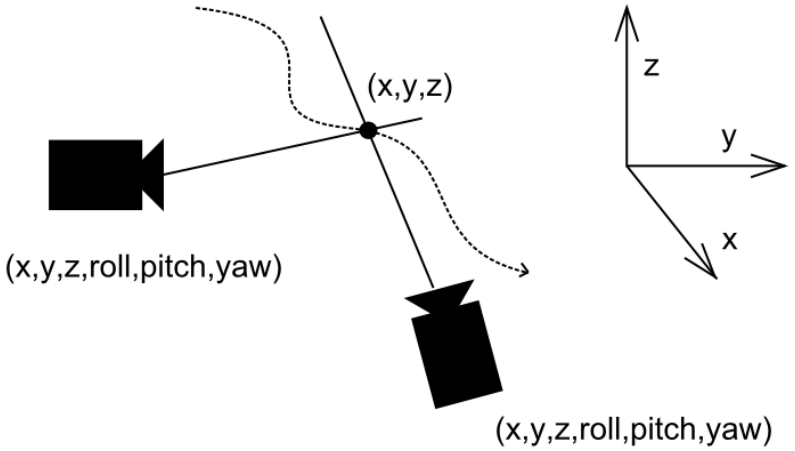


3D TRACKING

MOTION ANALYSIS

3D ANALYSIS

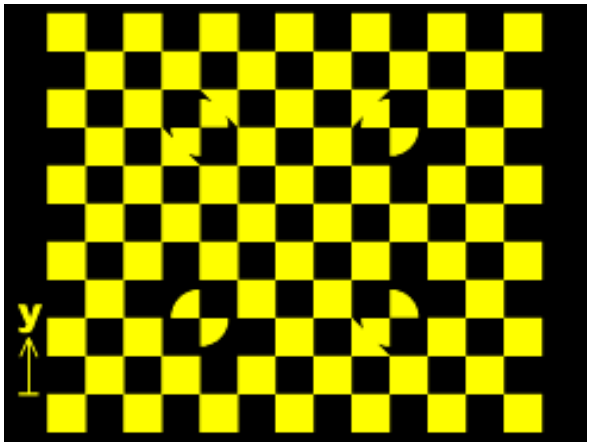
- Triangulation/intersection
  - Track an object from multiple camera views.
  - A tracked 2D position in the image corresponds to a 3D line of sight.
  - By intersecting multiple lines of sight, the 3D position is computed as the intersection point.
  - The cameras must have an orientation (x, y, z, roll, pitch, yaw) in a common coordinate system, and the images must include timing information.



MOTION ANALYSIS

LENS CALIBRATION

- Calibrating camera & lens combination for:
  - Focal length
  - Principal point
  - Aspect ratio
  - Lens Distortion
- Two methods:
  - Calibration board
  - Wand calibration

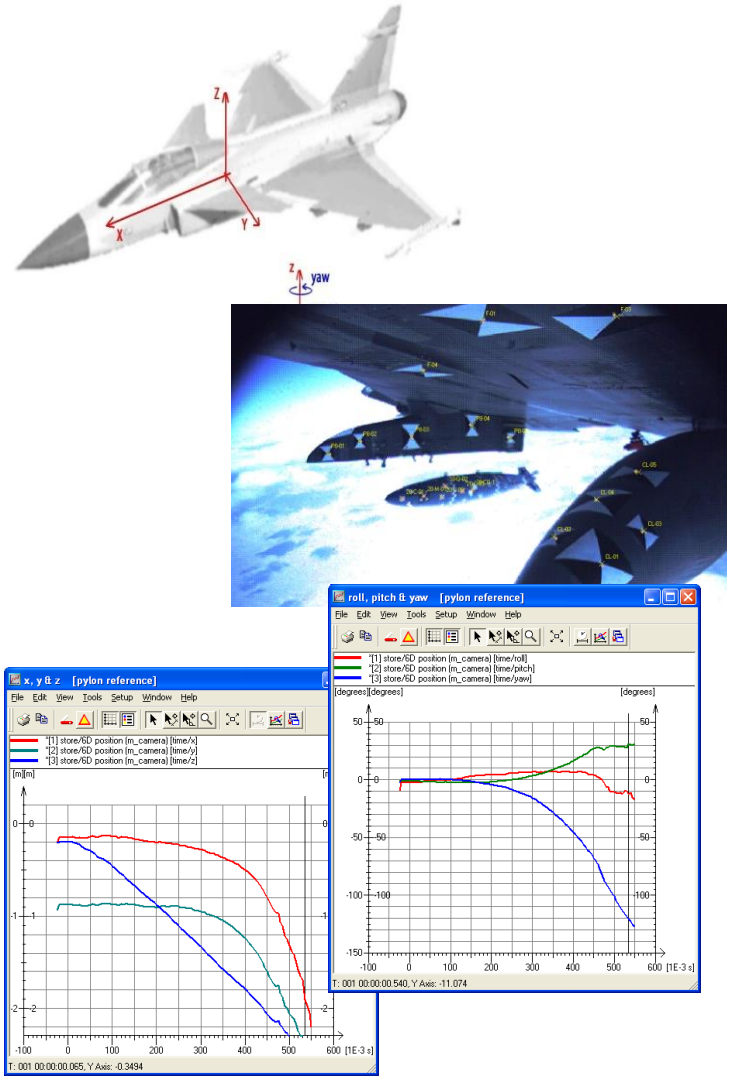


6D TRACKING

MOTION ANALYSIS

6D ANALYSIS

- TrackEye can compute the 6D solution from one or multiple camera views. The rigid body must have multiple visible targets at any point in time. The motion of the rigid body can be described with six parameters: three position coordinates (x, y and z), which gives the position of a specific point on the body, and three attitude angles (roll, pitch and yaw), which gives its orientation in space.



ARENA TESTING

MOTION ANALYSIS

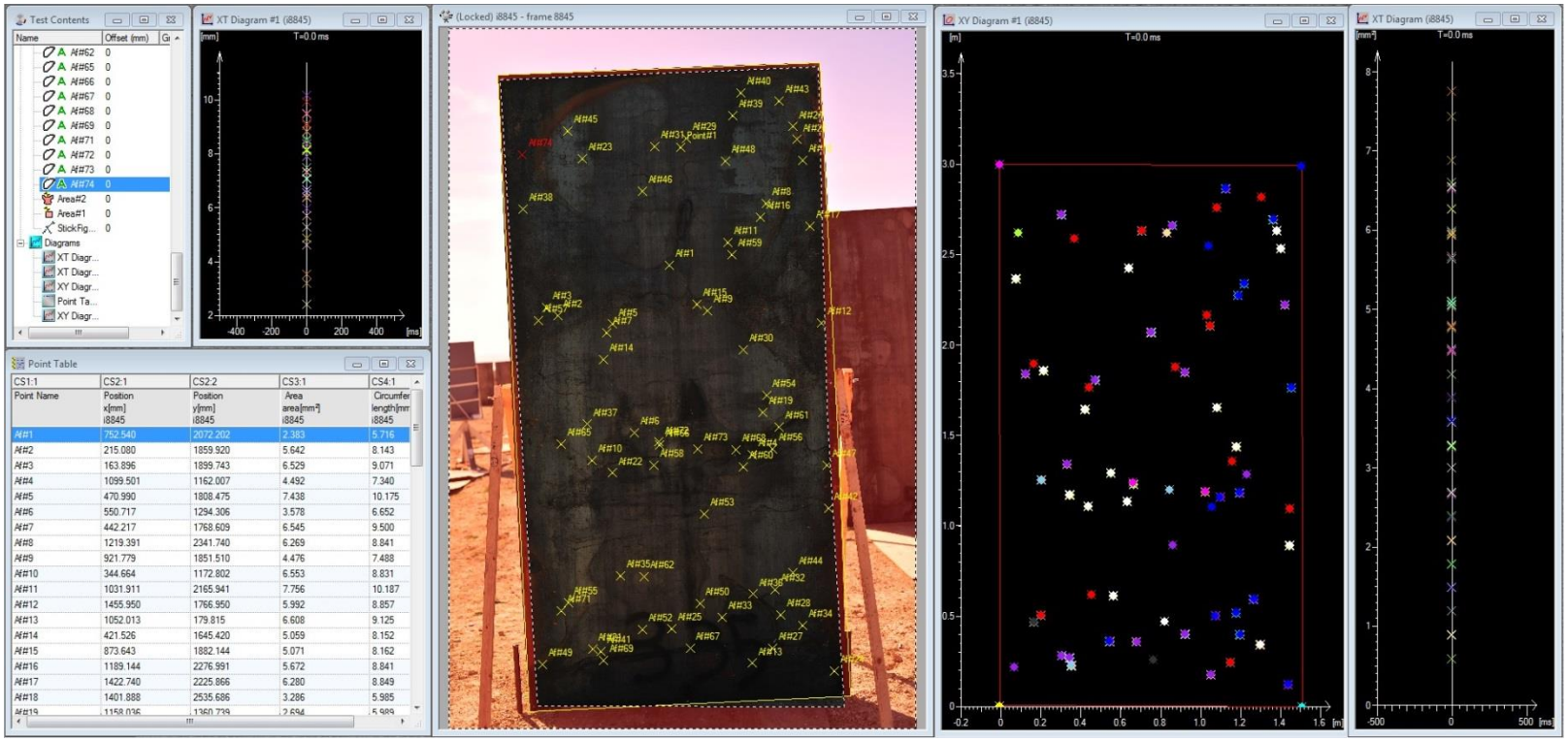
ARENA TESTING

- Traces of an explosion are detected using screens monitored by one or several cameras.
- Each screen has reference markers with a measured 3D position.
- Output is 3D position of objects together with certain object trace characteristics like speed, angle, area, etc.
- We also automatically can detect position, number and area of penetration holes in each plate.

MOTION ANALYSIS

ARENA TESTING - AUTODETECT

- The results of each plate is calculated within minutes…
- Quantity – x, y Location - Area

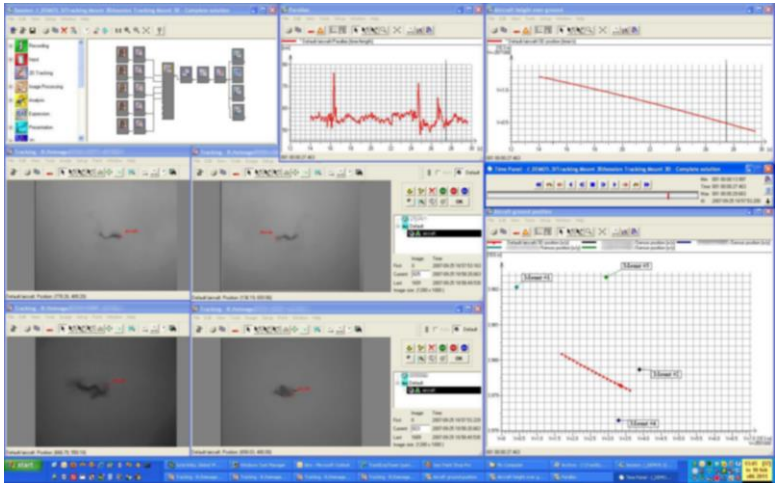


TRACKING MOUNTS

MOTION ANALYSIS

TRACKING MOUNTS

- Generates 3D position data using images & data from tracking mounts. Objects at large distances.
- Calibration & correction, integration with customer procedures.
- Coordinate transformations & refraction



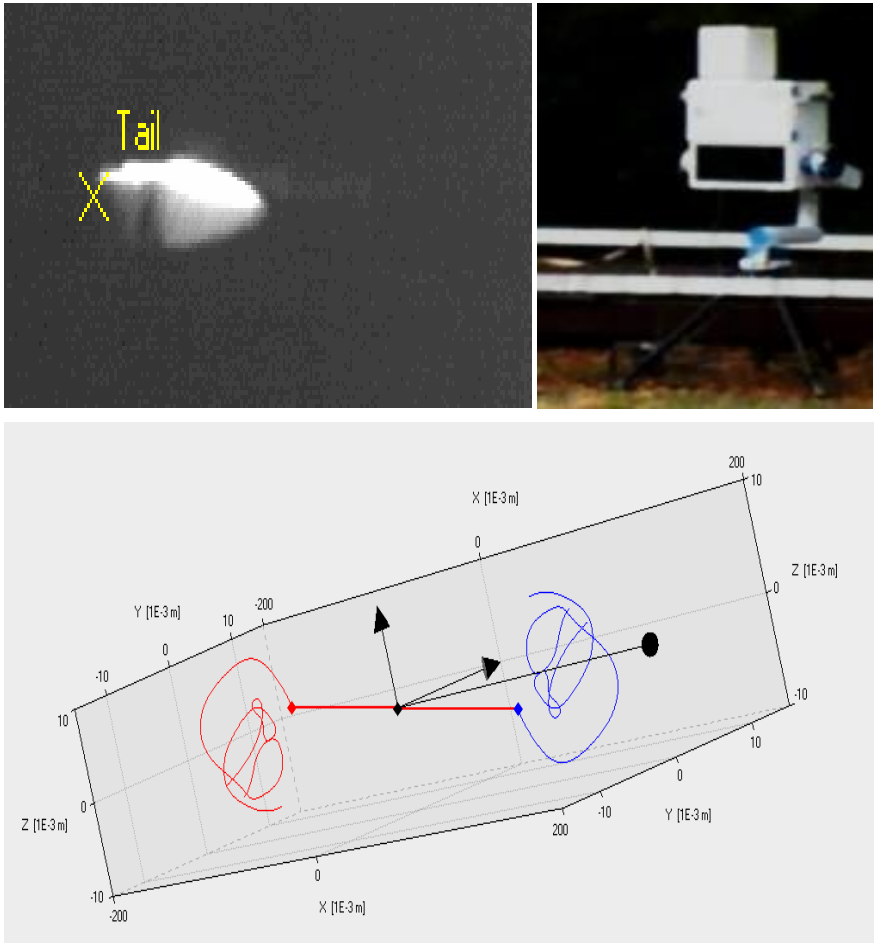
MIRROR TRACKER

MOTION ANALYSIS

MIRROR TRACKER

- Computing the 2D/3D coordinates & characteristica of a moving object from one/two trajectory trackers and optional fixed cameras.
- The 3D module computes the objects position (x, y, z) when the position of each fixed camera is known.

  For the mirror tracker the camera positions are fixed but the image is transferred by a rotating mirror. This requires special calibration procedures

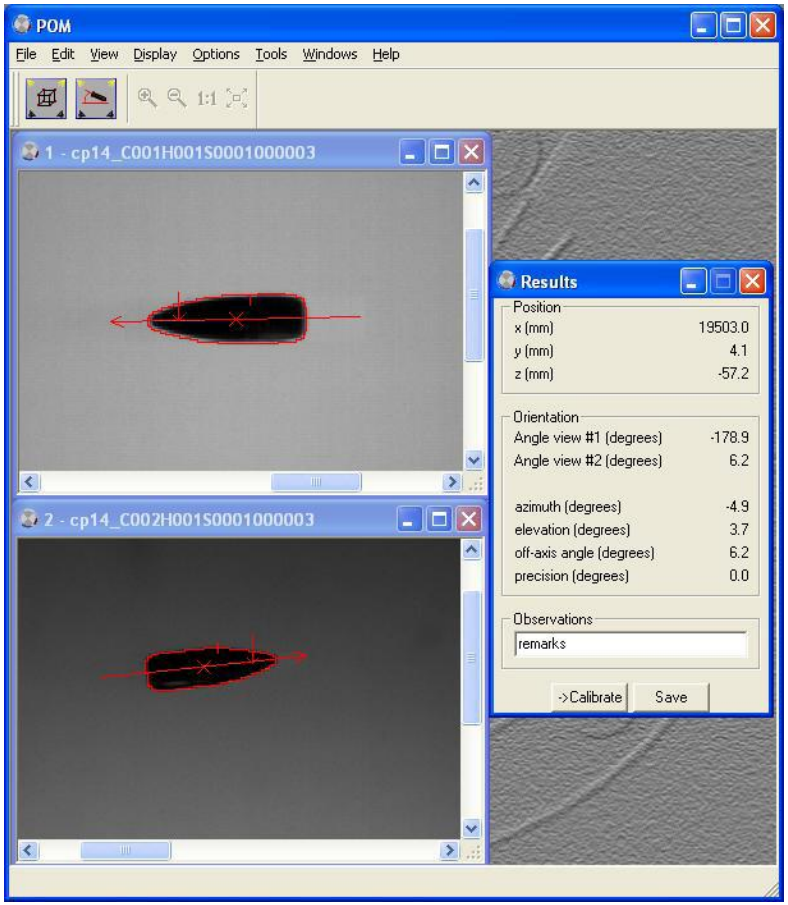


PROJECTILE ORIENTATION MEASUREMENTS

MOTION ANALYSIS

POM

- A dedicated stand-alone module to measure impact angles and 3D position of a bullet.
- Two cameras and two x-ray flashes create shadow images.
- Optimized for easy-of-use & short turn-around.
- A two-step procedure:
  - calibration
  - measurement

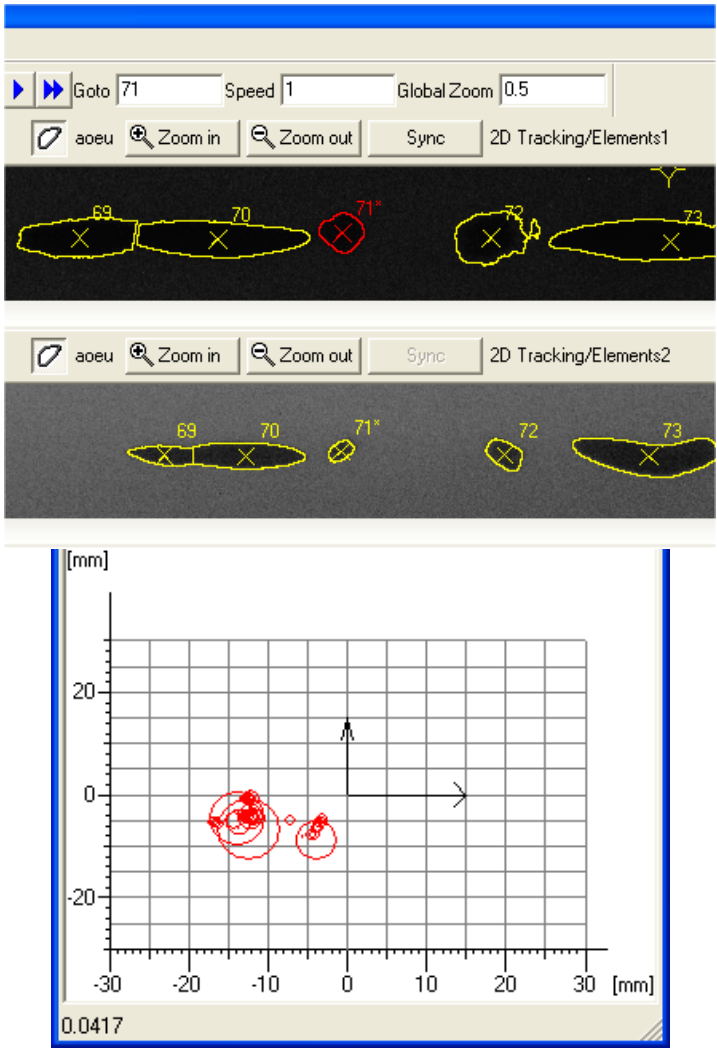


X-RAY MEASUREMENTS

MOTION ANALYSIS

X-RAY

- Analyzing 3D characteristics for plasma string droplets
- A series of X-ray flashes are used to create droplet shadows in 2D.
- Calibration to define geometry.
- Typical output data for droplets:
  - volume
  - velocity, rotation angle
  - estimated impact position



PRODUCTS

2 SOFTWARES – SAME CODE

TEMA & TRACKEYE

TRACKEYE

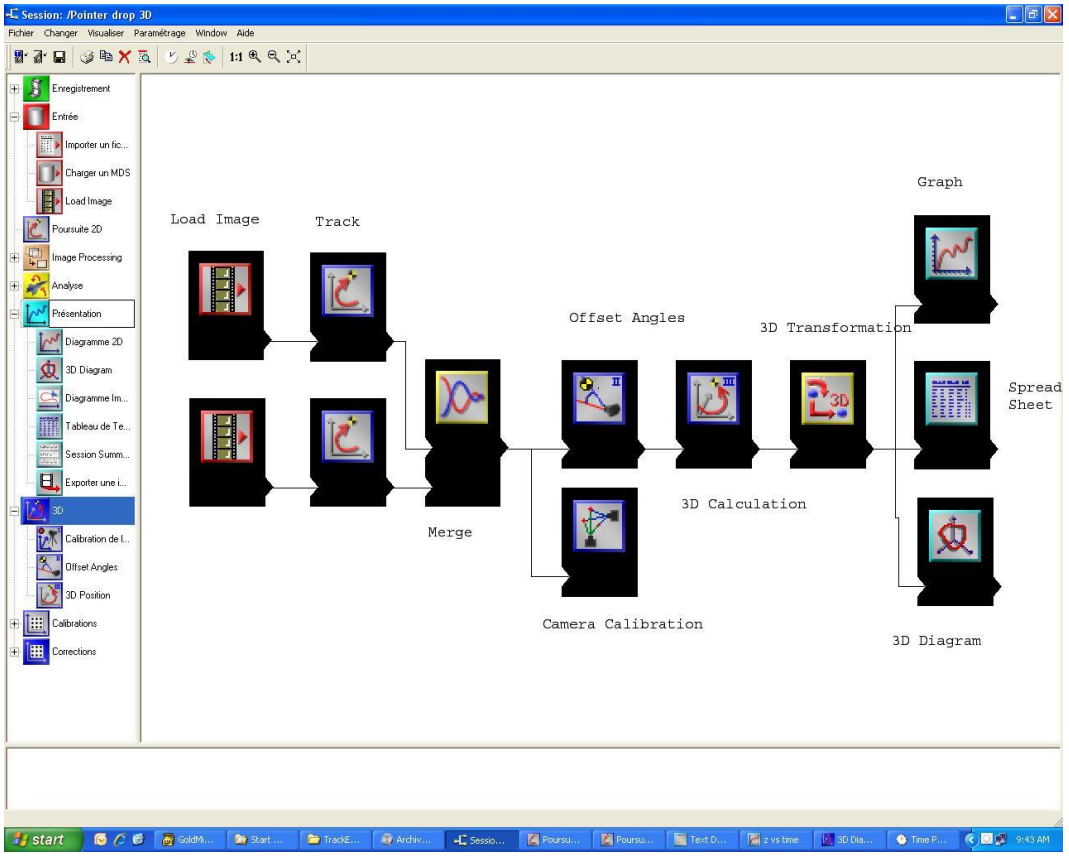
- Most powerful motion analysis software on the market
- Requires understanding of process of tracking by the user
- Modular features – user creates his specific test
- Includes 6 DOF Stores release, Tracking Mounts, Mirror Tracker, ARENA features and SDK

TEMA

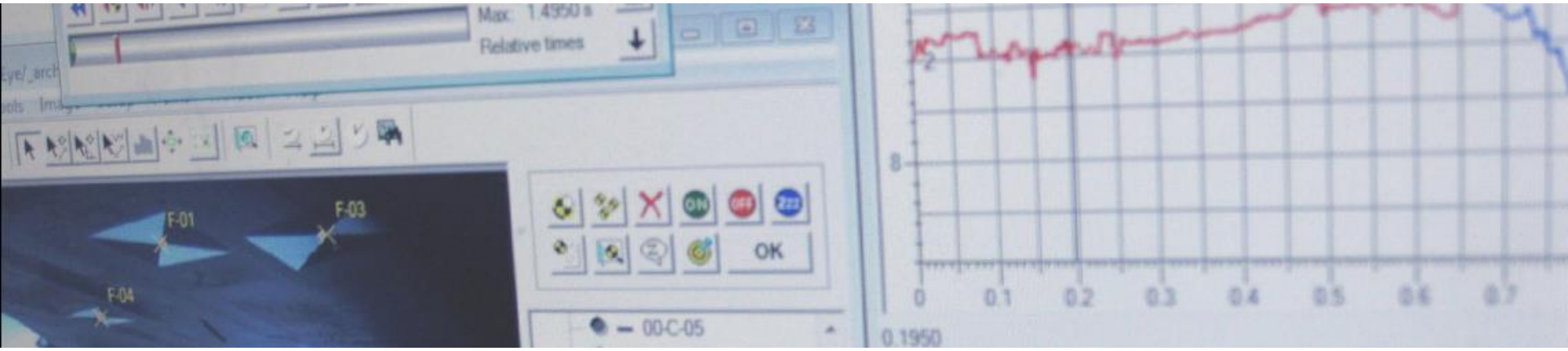
- Dedicated for simplified use
- Uses the same tracking algorithms as TrackEye
- “Locked” features – user creates pre-defined tests

TRACKEYE

- Icon based build up of test implies complete flexibility
- Each icon can then be set up with the appropriate parameters
- The session can be saved as a template for repeated use with new image files
- Ability to insert your own functions and algorithms



TRACKEYE



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- Korean Defense
- Italian Defense
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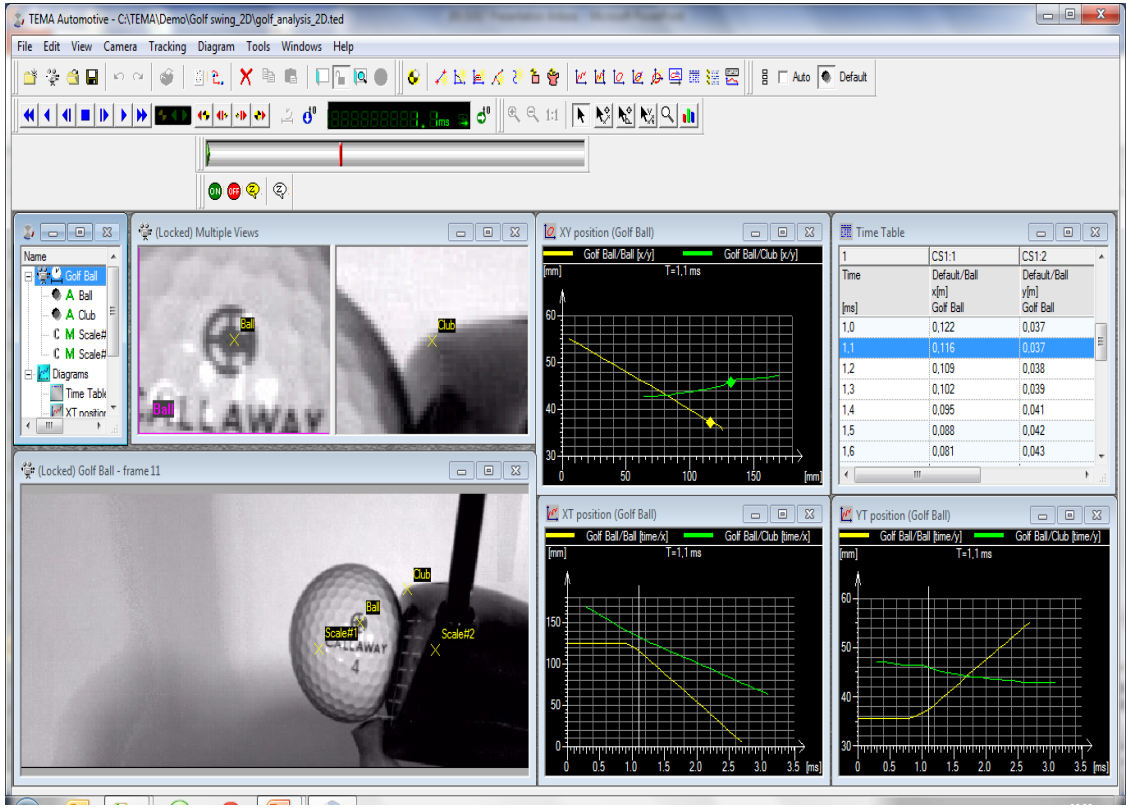
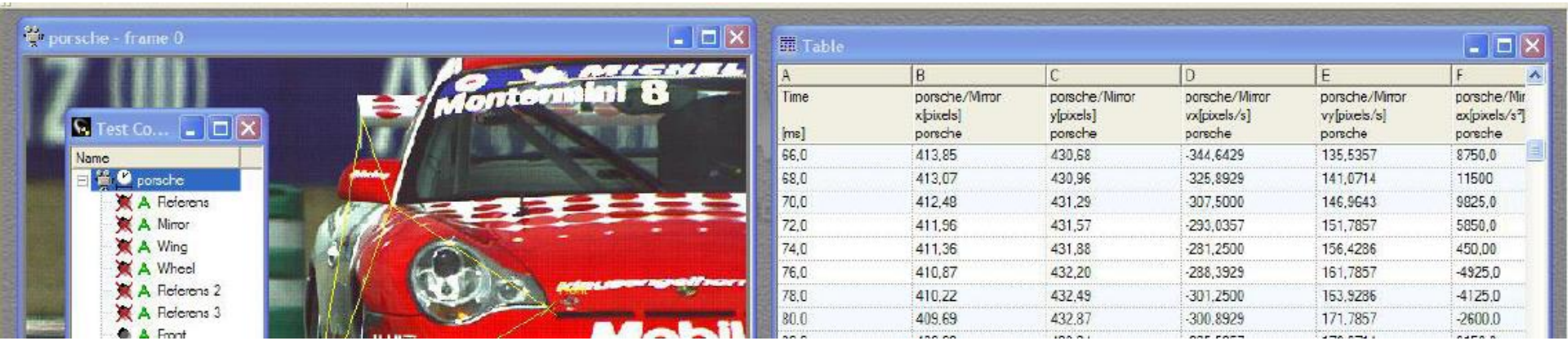
- Boeing, USA
- Lockheed Martin, USA
- MOD, UK
- BWB, Germany
- DGA, France
- Dassault, France
- Dutch Army Test Range
- Embraer, Brazil
- Israeli Air Force
- MIAT, Poland,
- MHI, Japan
- JDF, Japan
- INTA, Spain
- Air Force Test Range, Spain
- Brazil Air force
- NASA, USA
- Rafael, Israel
- Raytheon
- Saab, Sweden
- Swedish MoD
- *and others…*

TEMA

- Predefined functions
- Quick build-up of test scenarios



TEMA



A	B	C	D	E	F
Time [ms]	porsche/Mirror x[pixels] porsche	porsche/Mirror y[pixels] porsche	porsche/Mirror vx[pixels/s] porsche	porsche/Mirror vy[pixels/s] porsche	porsche/Mir ax[pixels/s²] porsche
66,0	413,85	430,68	-344,6429	135,5357	8750,0
68,0	413,07	430,96	-325,8929	141,0714	11500
70,0	412,48	431,29	-307,5000	146,9643	9825,0
72,0	411,96	431,57	-293,0357	151,7857	5850,0
74,0	411,36	431,88	-281,2500	156,4286	450,00
76,0	410,87	432,20	-288,3929	161,7857	-4925,0
78,0	410,22	432,49	-301,2500	163,9286	-4125,0
80,0	409,69	432,87	-300,8929	171,7857	-2600,0

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- Claas, Germany
- Coca Cola, Japan
- Daiwa Seiko, Japan
- NASA, USA
- Drev, Canada
- U.S Army
- Federal Aviation Administration, USA
- Sharp, Japan
- Fuji Electric, Japan
- Fujitsu, Japan
- Hofstra University, USA
- Indian Head, USA
- HSVA, Germany
- Nikon, Japan
- Citroën, France
- Volvo, Sweden
- DaimlerChrysler, USA
- Alstom, France
- KIA Motors, Korea
- AutoLiv, global
- Lear Seating, USA
- Mitsubishi, Japan
- Nissan, Japan
- Peugeot, France
- Bridgestone, Japan
- Volkswagen, Germany
- CEAGA, Spain
- DaimlerChrysler, Germany
- *and many more…*

QUESTIONS ?

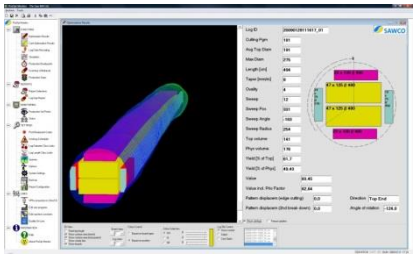
image
SYSTEMS
MOTION ANALYSIS

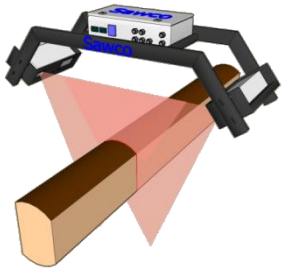
IMAGE SYSTEMS GROUP

DigitalVision

Optimisation of image quality and output in broadcast and movie industry

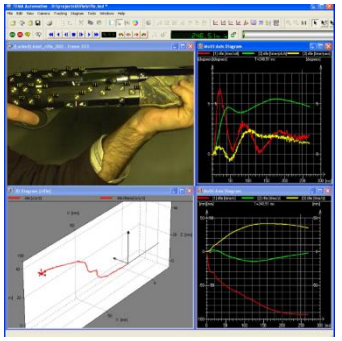
RemaSawco





Optimisation by image analysis of sawmill industry

image SYSTEMS MOTION ANALYSIS

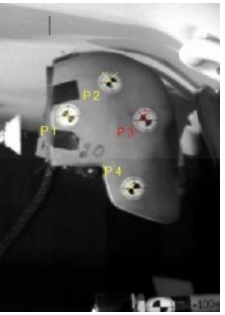


Creation of scientific data output from images

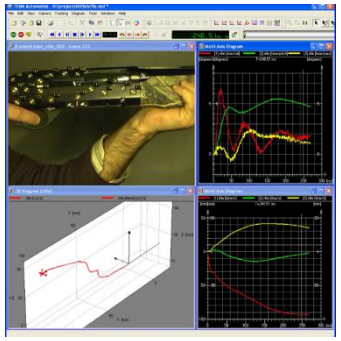
MOTION ANALYSIS

WIDE VARIETY OF APPLICATIONS AND SEGMENTS

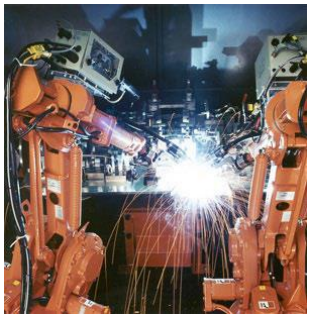
OMOTIVE

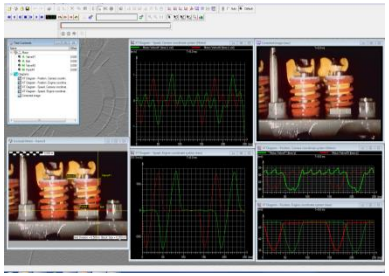


DEFENCE

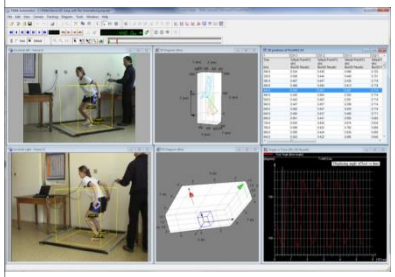


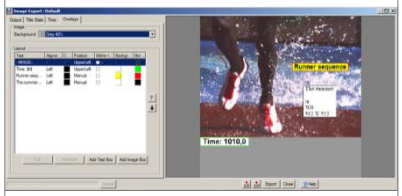
MANUFACTURING





BIOMECHANICS





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