Roke Manor Research Ltd
a Siemens company

# Visual MTI for UAVs

## EMRS DTC Project 4/105

### What we are doing and why

Visual Moving Target Indication (MTI) is the detection of moving objects with a video camera. Our project objectives are to:

- Develop visual MTI algorithms for a down-looking UAV-mounted camera
  - All objects appear to move in the video because of the platform motion
  - In scenes with pronounced 3D structure the relative motion of moving and stationary objects can be complex
- Develop algorithms to exploit visual MTI by a higher-level analysis of movement patterns
  - A technical problem is how to relate targets detected in well separated fields of view to a common coordinate system.

UAVs are going to be used increasingly for reconnaissance and surveillance purposes. Visual MTI techniques will:

- Support deep, pervasive surveillance
- Reduce operator workload
- Combined with higher-level analysis identify
  - Co-ordinated movements – e.g. convoys not just individual targets
  - Unusual movement patterns
  - Movement in sterile zones

### What we have achieved

To date we've developed prototype visual MTI algorithms and exercised them with civilian airborne video

- Feature detection, tracking and motion analysis
  - More robust to 3D effects in hilly/urban terrain than pixel-based image-registration methods
- Developed a means of assessing how consistent a feature, seen from different viewpoints, is with the assumption that it is part of a static scene
  - Based on the fundamental matrix
  - Accommodates 3D effects
  - Can be applied in urban/hilly situations
- Staged processing approach,
  - Progressively improving target detection/false alarm rate.

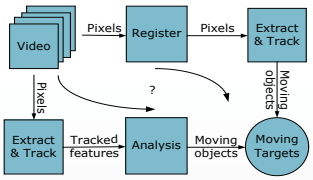
### Where we are going

We plan refinements to prototype visual MTI processing chain

- Geometric calibration
- Special cases of viewing geometry
  - Narrow angle – wide angle
  - Flat ground – hilly/urban

High-level mapping – initial considerations

- Choice of platform-based or homography-based solution
- Viewing geometry and scene structure
- Integration drift
- Recognition and exploitation of revisits
- Synergy with other DTC projects.

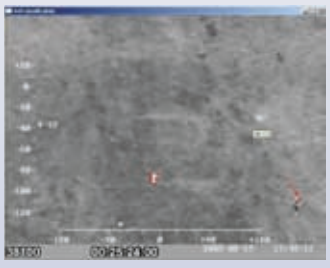



*Roke's visual MTI solution is based on feature extraction and track analysis, rather than the more common approach of image registration followed by analysis of image differences to detect moving objects.*

*Stage 1: An initial classification of targets is obtained by analysis of consistency with respect to a fundamental matrix calculated using an estimation technique known as RANSAC. The coloured trails show tracks classified as moving and the blue crosses mark the preferred randomly selected stationary set.*

*Stage 2: A 2nd classification of targets is obtained by analysing initial classification histories to identify a high-confidence stationary set (small blue crosses). This set is used for a further iteration of fundamental matrix calculation and consistency analysis..*

*Stage 3: Further analysis of 2nd stage classification histories gives final detection at reduced false alarm rate.*



*Further example outputs from the 3rd visual MTI processing stage.*

### Find out more

See EMRS DTC conference paper "Visual MTI for UAVs" by Richard Evans & Esin Turkbeyler.

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