

Visual Moving Target Indicator

There is an increasing use of unmanned aerial vehicles (UAVs) that use video cameras for viewing action and events occurring on the ground. Roke Manor Research has developed the Visual MTI video analysis system which automatically detects and quantifies the movement of vehicles and people from the continuously moving video taken from an air vehicle. Visual MTI can additionally provide image stabilisation; perform image mosaicing to provide a wider visual context; and align the mosaic to existing maps. Visual MTI can be used in a ground station to increase operator efficiency, or else be deployed onboard a UAV for increased autonomy.



Blue crosses – stationary features
Coloured trails – tracks of moving features

The challenge of dealing with video from UAVs

Unmanned Aerial Vehicles (UAVs) are increasingly used in military and civil applications. A video camera is often the primary sensor on a UAV, providing a torrent of imagery of the overflown ground. From this imagery, it is possible to detect the presence of moving objects on the ground, such as vehicles and people, which can be of strategic importance.

Currently, the assessment of UAV video is overwhelmingly performed by human operators. This requires that the video is first transmitted to a ground station over a high bandwidth link, and then carefully examined by the operator. The rapid and unceasing movement of the video footprint over the ground makes this an exceedingly expert and demanding task. The operator's memory is relied upon to place in context events occurring on different images, which can be separated either in space as well as time – perhaps hours or days later. If a number of UAVs are operating over an area, then human operators may struggle to coordinate the information obtained from each separately.

How Visual MTI works

Visual MTI can operate on any video stream of the ground that has sufficient continuity, from either a visible band or infrared camera. From each image are extracted hundreds of so-called feature-points, which are persistently present in regions of distinctive visual texture. These features-points are tracked across images. A geometric analysis is performed on these tracks, which allows them to be categorized into those that are moving in ground coordinates, and those that are stationary on the ground (though moving on the images).

Blue crosses – stationary features
Coloured trails – tracks of moving features



Mosaic image constructed by stitching together individual video frames

What can Visual MTI do?

The stationary tracks can be used to automatically construct an image mosaic (see left), which provides a wider visual context. The mosaic is constructed from individual video images, each of them being perspective-warped so that they are in correct geometric alignment. The mosaicing can be extended to a larger area by detecting and acting on so-called loop-closure events, where regions of the ground are revisited in the camera view. The mosaic can be aligned to a pre-supplied ground map, and overlaid on it. This can be performed automatically if suitable MetaTag positional information is provided along with the imagery.

The stationary tracks can also be used to provide image stabilisation, by performing a perspective warping that keeps stationary tracks locally immobile on the image.

The mosaic image provides a wide-area, but static, depiction of the viewed ground from an overhead viewpoint. By itself this will show an up-to-date view of the material on the ground, irrespective of whether it is moving or stationary. A facility is provided for overlaying the moving tracks onto the mosaic, so that movement can be seen in context, and the source video shown alongside. The user can then view the video source and classify the tracked object as either threat, friendly or unknown.

Future

Research is ongoing to analyse the tracks of moving objects. By regularly monitoring a region from overflying UAVs, a statistical map of normal movement can be built. Movements will be associated with roads and paths, perhaps with the aid of an aligned symbolic map, and labelled according to attributes such as direction, speed and time. Automatic detection will occur on unusual movement events, or the occasion of trigger events pre-specified by the operator. This could result in the UAV automatically responding by changing course to follow the unusual moving object, and acquiring imagery of it at higher resolution.



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