CO-ORDINATION OF IMAGES FROM MULTIPLE SENSORS INTO ONE COMMON DATA SPACE

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Abstract. This paper outlines an investigation into combining multiple images of a selected scene into one image data space using digital image processing techniques. Due to the rapid development of image processing technology, electro-optic devices, and other related systems, the modern battlefield is becoming densely populated with different imaging platforms. Currently no process exists by which multiple images of the same scene, taken from various platforms, are integrated into one image data space. If various image formats, taken from different perspectives are fused into one common data space, then intercommunications between the imaging platforms can be achieved. A technique known as geometric transformation has been used. This utilises the collection of control points from all image sets, which are matched appropriately so that a second order polynomial equations can be fitted, this then enables the construction of a common image domain. Such a technique can be used for pre-selecting targets for submunitions or can allow submunitions to select and allocate targets when delivered in a salvo to target a common area. This paper outlines the process required to extract and match common features from a number of similar images and then uses these points to fit such a second order polynomial which links the images together. The paper concludes with an outline of the types of operations where this process can be employed.

INTRODUCTION

On the modern battlefield, the use of multiple imaging sensors has a number of significant advantages including the ability to decrease the effect of camouflage and an enemy's ability to deceive. These images may have been obtained from different platforms, operating at varying orbits or flight profiles, and usually have been taken with a degree of temporal variation. Accurate pixel correlation must therefore be obtained before the images can be fused and credible analysis can be initiated.

To achieve inter-image pixel correlation, subsequent images are geometrically transformed until they match a reference image. This process is sometimes called *rubber-sheet transformation*, because it may be viewed as a process where an image is "printed" on to a sheet of rubber and then this sheet is stretched and pulled according to some predefined set of rules [1]. The reference points are commonly referred to as control points, which are usually selected around the area of interest to ensure a high level of correlation and accuracy [2]. This is because a rubber-sheet transformation tends to introduce large errors the further away one moves from a control point.

Traditionally, geometric transformations are used on images that have been obtained by looking directly down on the earth. As a result, the polynomial that performs the transformation is of the first order, only altering the rotation, translational shift, and magnification of the image. Higher order polynomials can take into account other imaging variations like tilt, but due to their higher orders, errors occur rapidly as one moves away from a control point.

With the advances in technology in recent years, imaging systems are playing a greater part in all areas of surveillance and reconnaissance. To be detected, an object has to be in contrast with the background. With imaging radar, corner reflections will produce strong returns, while in the 8-12 μm band, vehicles and equipment will contrast against the cooler background of vegetation. If multiple imaging systems are looking at the same area of interest, then these contrasting targets can be used as control points, and a very accurate transformation can be obtained. It can then be possible to link each imaging system such that a point in space in one field of view can be accurately located in another field of view.

If this process can be performed accurately, and automated, then applications like passive target selection and allocation for weapons systems and submunitions could be achieved. Navigation, using key features and a digitised map, could also be accomplished. Tank commanders could know where each gun system is aimed, and all sensor systems could be integrated into a common imaging battle space.

This paper outlines the operation and demonstrates the utility of automated geometric transformation to develop a common imaging data space.

IMAGE TRANSFORMATIONS

First Order Transformations

To understand how a geometric transformation works it is first necessary to investigate the fundamentals of a polynomial transformation. Figure 1 illustrates two sets of four points creating two quadrangles. These two quadrangles are geometrically equal. The one on the left was sketched first, and then it was copied. The copy was then rotated (anticlockwise), reduced in size and then shifted to the right.

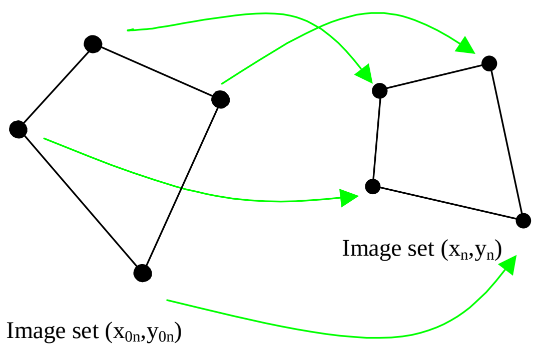

Figure 1. Simple Image Transformation.