

Rotational Scanning Techniques for Hyperspectral Imaging

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Since hyperspectral images form three dimensional data structures, data acquisition usually requires that two of the dimensions remain constant, whilst the third is varied. A popular method for capturing hyperspectral data is pushbroom scanning. This technique builds an image by incrementally capturing all available wavelengths on a spatial line scan over time. One drawback of this technique is that an accurate way of linearly moving the camera or the object is required. Rotational movement is often easier to achieve or naturally available, hence the work presented here investigates an alternative approach to the traditional pushbroom method.

If the rotation of the object is perfectly aligned (i.e. the axis of rotation is coincident with the leftmost pixel for anti-clockwise rotation) the acquired hypercube is, in fact, a polar representation of the scanned object. This ideal polar representation can be easily converted to Cartesian form using existing toolboxes [1] to produce a conventional hypercube.

While rotational movement is often easier to achieve than the translational motion required by pushbroom, near perfect rotation is often not possible. There are two main sources of error when using rotational scanning: horizontal offset and vertical offset. These offsets occur when the axis of rotation does not precisely coincide with the desired pixel as described above.

This paper explains, using examples, a method to compute these two parameters such that they can be used to compensate for the errors caused by these offsets. Although polar to Cartesian conversion can be calculated, there is no guarantee that each pixel stored in polar form can be mapped to a unique point in Cartesian space. As such, a suitable interpolation method is required to compensate for this. A number of such techniques are discussed and evaluated in this paper.

This work will lead to the development of a tool which will be capable of automatically estimating the offset parameters. Further investigation into other forms of error in rotational scanning will also be carried out (e.g. non-circular rotation).

References

- [1] P. Manandhar, (2007) "Polar To/From Rectangular Transform of Images", <http://www.mathworks.com/matlabcentral/fileexchange/17933-polar-tofrom-rectangular-transform-of-images>