Algorithms for all - sky image astrometric calibration
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Introduction

WILLIAM - Wide-field all-sky image analyzing monitoring system
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Astrometric solution?

Astrometry.net:

Q: Would your code work on all-sky images?

A: Not very well … We assume a TAN projection, so all-sky images typically don’t work …
Pole searching algorithm

**Hough transform**

\[ r = x \sin \theta + y \cos \theta \]
\[ r = a \sin (b \theta + c) \]
\[ x_0 = a \sin (c), y_0 = a \cos (c) \]
Utilization of Generalized Hough transform

$R$ – table for storage of vectors of searched pattern relative to reference point

Accumulator matrix to store information about number of stars that lay on the $R$ – table pattern
Result of GHT
Result of GHT

Information about:
- Rotation
- Scale
- Position

Problematic of fish – eye lenses:
- distortion caused by projection
Improvement of GHT

Two size parameters
Binning of accumulator
Generalization of pattern
### Projections

<table>
<thead>
<tr>
<th>Projection</th>
<th>(perspective)</th>
<th>$r = f \tan(\theta)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectilinear</td>
<td>(perspective)</td>
<td>$r = f \tan(\theta)$</td>
</tr>
<tr>
<td>Stereographic</td>
<td>(panoramic)</td>
<td>$r = 2f \tan(\theta/2)$</td>
</tr>
<tr>
<td>Equidistant</td>
<td>(linear)</td>
<td>$r = f \cdot \theta$</td>
</tr>
<tr>
<td><strong>Equisolid Angle</strong></td>
<td>(equal – area)</td>
<td>$r = 2f \sin(\theta/2)$</td>
</tr>
<tr>
<td>Orthographic</td>
<td>(orthogonal)</td>
<td>$r = f \sin(\theta)$</td>
</tr>
</tbody>
</table>
Projections (equal – area)

\[ r = k_1 \cdot f \sin \frac{\theta}{k_2} , \quad \text{where} \quad k_1 = k_2 = 2. \]
Catalog fitting

To fine tune coefficients
Near future

- FITS header
  - Possible to use ZEA projection
- Fine tuning of projection parameters
- Implementation of system projection analyser
- Testing on other systems
Thank you for your attention

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