EQMOD - 3-STAR Alignment GOTO ACCURACY

EQMOD 3Star Alignment use AFFINE/TAKI coordinate transformation matrix operations to compute for the apparent location of an object based on three reference stars and the coordinate of the target object. The process is done by converting the equatorial coordinate space of a given object to its mechanical mount coordinate space.

Figure 1 is a simple block diagram of the coordinate tranformation matrix as implemented on the eqmod driver

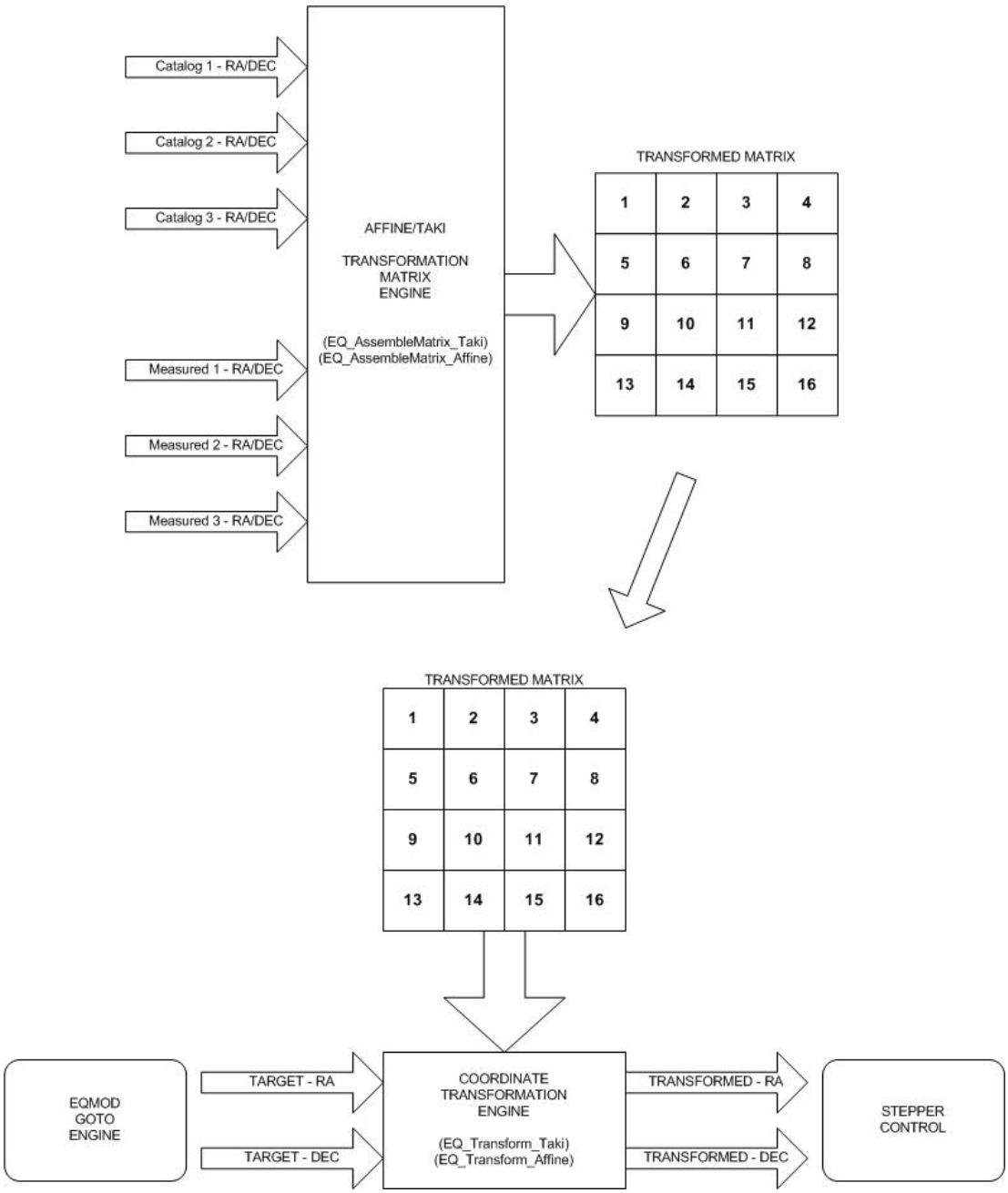
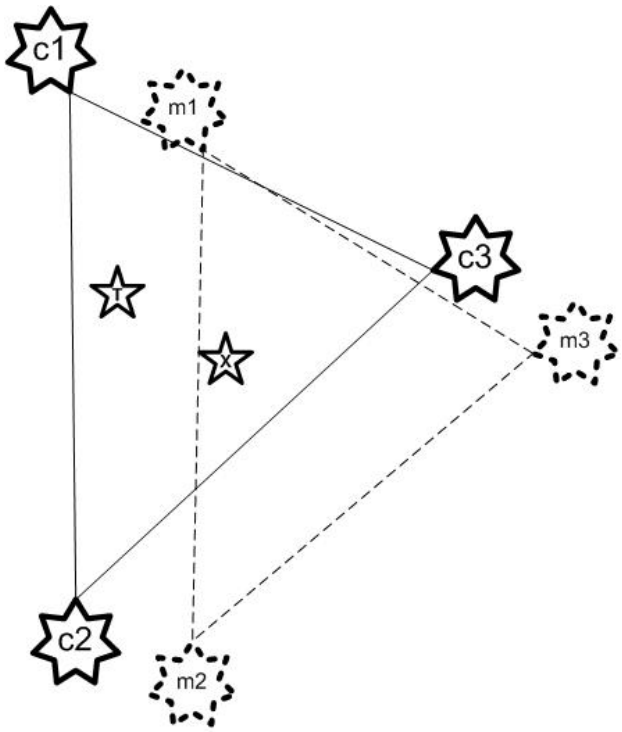
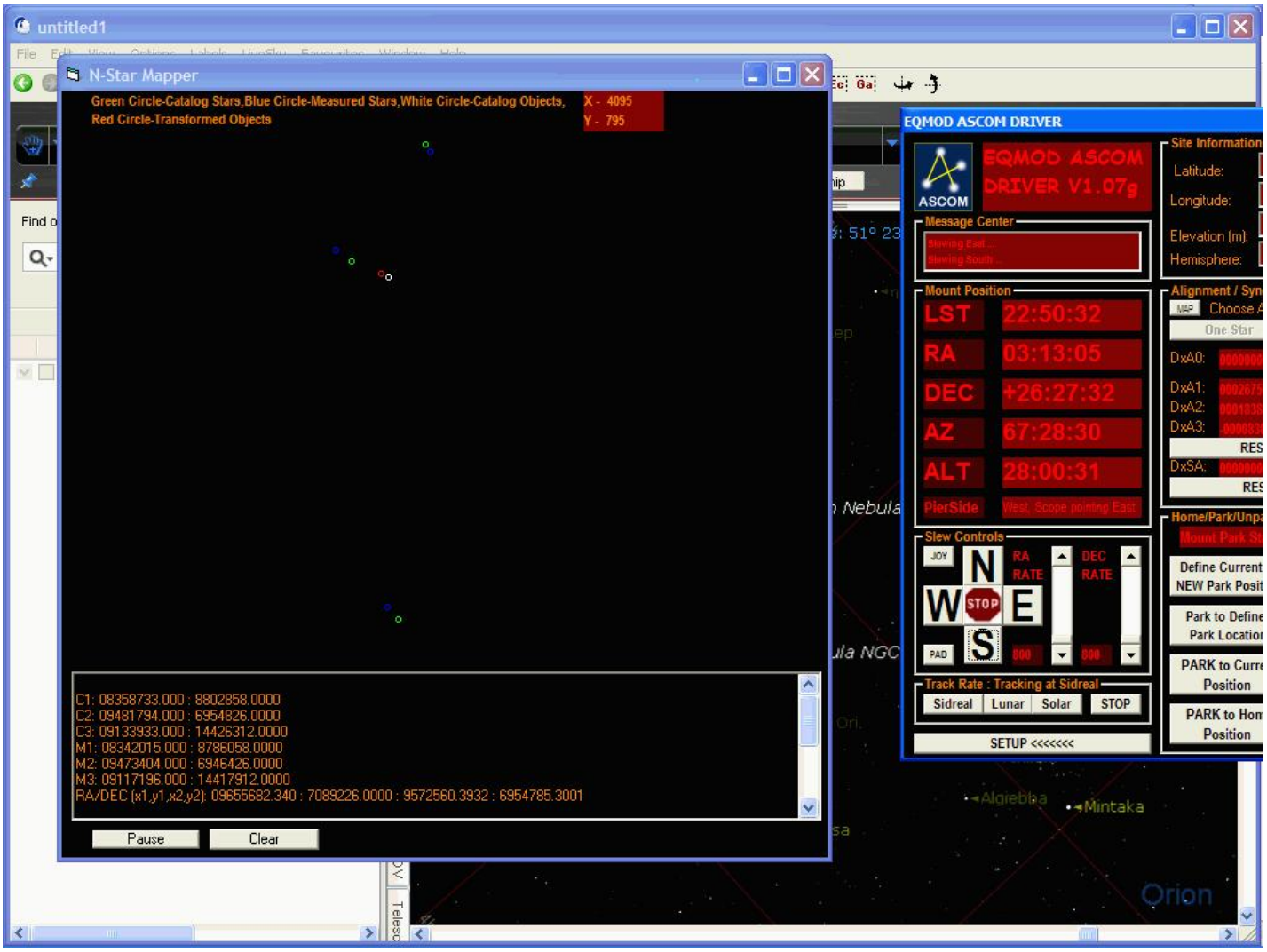


Figure 2 shows a simple plot of Catalog, Measured, Target, and Transformed stars.



Basically these are the coordinate space specified by the stepper positional values of the mount. Each part of the sky is tagged with a ra/dec stepper coordinate and its position varies as the earth rotates. Because of these changes, the ra and dec values, plus the third value which is the time the alignment star position was measured. These values are converted to stepper data and are transformed using AFFINE/TAKI transformation matrix algorithms.

Figure 3 shows a screen shot of EQMOD's N-STAR mapper window. This allows you to visualize the transformation process.



For each GOTO, the target coordinate of an object is transformed using the AFFINE/TAKI matrix. These new coordinates are then used to compute for the new GOTO target location.

The transformation matrix method is pretty much accurate for computing coordinates. However, care should considered when alignment stars are measured as any discrepancy in the measurement process could cause significant errors on the transformed data as explained below

We use the 'triangle' formed by the three reference stars as a starting point in the explanation.

Figure 4: The region within the triangle formed by the three alignment stars is usually where the GOTOs are accurate. The region outside the triangle will still be accurate only if the the alignment stars are properly centered.

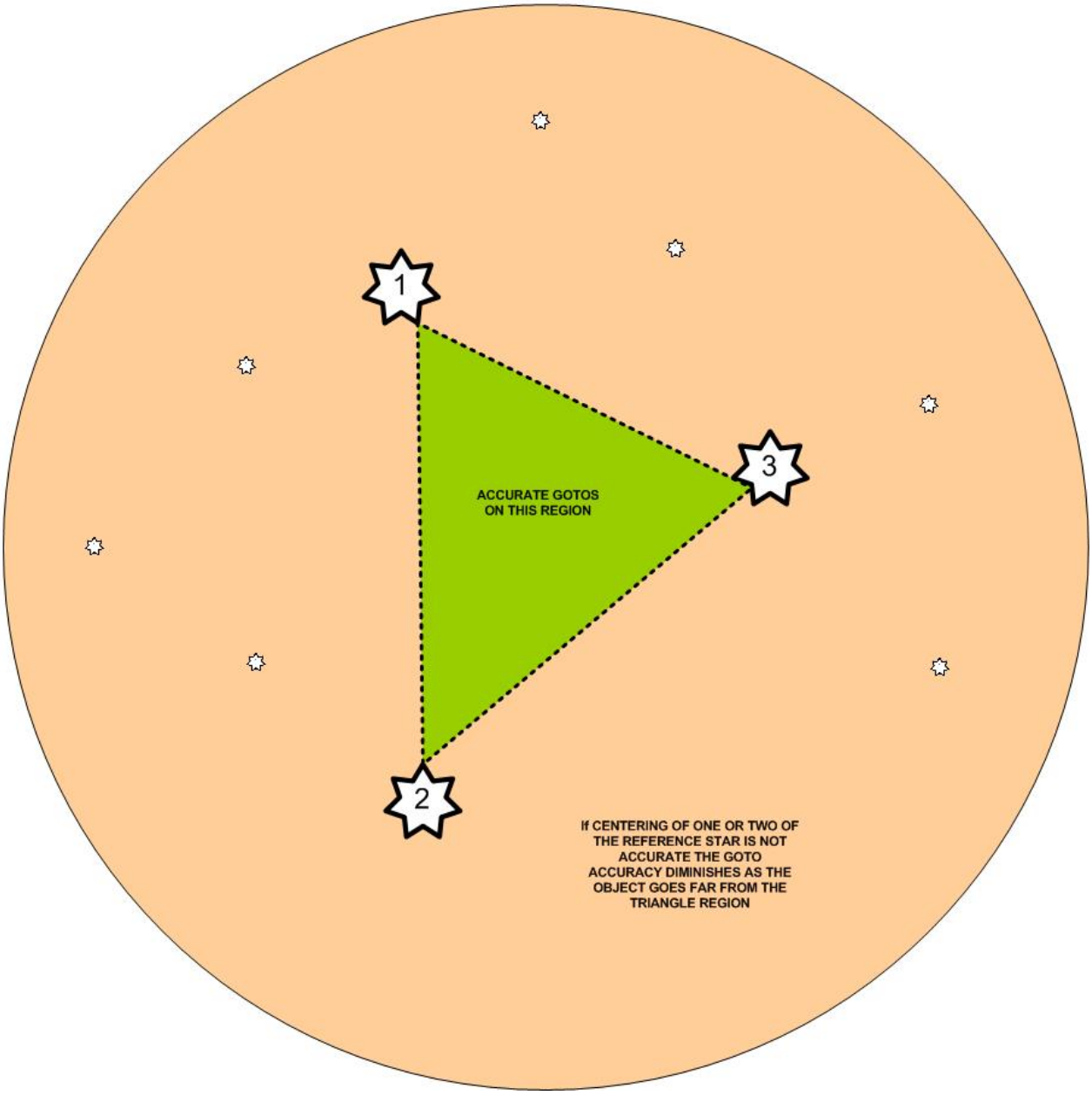


Figure 5: Here is a screen shot of the Affine Simulator showing stars inside and outside of the 3-star triangle. Green Circles represent the Catalog Alignment Stars. The blue circles represent the measured alignment stars after the Three-Star calibration process. The white circles are the catalog GOTO stars. The Red Circles represent the transformed coordinates of the GOTO stars. This is where the mount is placed after a goto command with respect to the white circle target object. Simulator available at the eqmod yahoo groups file section: Files > EQAlign > AlignmentMethods

Figure 6: Here is a screen shot of the Affine Simulator showing the three stars evenly measured.
If the alignment stars are accurately centered, objects even outside the triangle are accurately transformed

Figure 7: Here is a screen shot of the Affine Simulator showing the three stars with an alignment star (blue circle) not accurately measured (A)

GOTOs within the triangle region will still be accurate (B) as the two other alignment stars will still help in locking down the transformed coordinates of the target star.

However, target stars outside the triangle will float outwards (C) due to the error created by (A) and this error increases as the target star increase its distance from the edge of the triangle.

As a summary, to avoid any discrepancy created by the mis-aligned reference stars, choose stars that will paint one big triangle in the sky. Both the RA and DEC motors should move with greater distances from 1 reference star to the next reference stars. Best is to force a meredian flip from alignment star to the next alignment star. Distributing your alignment stars accross the sky would put your target objects mostly within the triangle area.

Choosing the alignment stars that will create a very small triangle will only give you a higher probability of having erroneous gotos specially if the alignmented stars are not properly centered The area outside the triangle is bigger than the one being covered by the triangle itself. If this is the case, it would be best to use a high magnification cross-haired eyepiece reticle for alignment star centering.

N-STAR

N-Star basically uses multiple 3-star alignment regions. Basically plotting multiple triangle points across the sky. With N-star, the eqmod driver will choose the nearest 3-star reference points from a pool of multiple alignment stars for a given target object.

OTHER USES OF THE 3-STAR ALIGNMENT ALGORITHM

Using 3-star alignment for Polar alignment checking: http://eq-mod.sourceforge.net/eqmod_polaralign.html

EQMOD 3-STAR 1ST LIGHT REPORTS:

--- In EQMOD@yahoogroups.com, "Gary Honis" wrote:

I used the 3-Star Test Version 107g with logging on Tuesday night. As others are reporting here, the 3-star version worked perfectly. I did not experience the first errant slew that I would experience after polar aligning using Version 1.7e. I followed the same routine for the new version as the old, so I don't know why I had the problem with the previous version, but am glad that the new version is working without problems.

I used the polar aligning scope to align the mount. The three alignment stars I used for EQMOD were in order: Aldeberan,

Sirius and Regulus. I was using THE SKY version 6 and all slews to these three stars were very close. The stars appeared in the frame of my DSLR finder on the ED80 refractor with an .8X reducer. I centered the alignment stars in the crosshairs of a 10mm reticle eyepiece in the Short Tube 80 guidescope with a 3X barlow. After aligning, I slewed to the Horsehead Nebula and it was nicely placed near the center of the DSLR frame. Never did I do a SYNC command in THE SKY. I then slewed to galaxies in Leo and Virgo and slews were right-on, perfectly placed for imging. With previous EQMOD versions I would slew to a bright star near an object to be imaged first, but with the new 3-star version, I skipped that step. Posted Images taken of the Horsehead and galaxies in Leo and Virgo here:

http://ghonis2.ho8.com/032007modrebel.html

I did do a screen print of "N-star Mapper" if it is useful to anyone.

Great work guys in making the 3-star alignment happen!

Gary Honis

--- In EQMOD@yahoogroups.com, "Mike Broussard" wrote:

I tested this version tonight (Tuesday, Mar 20, 2007) and I had some really great results. I used Aldebaran as my first star, then crossed the meridian and flipped to the next star, which was Castor. For my third star, I crossed the meridian again and went to Rigel.

I had my camera attached, so after doing the 3-star alignment, I did a goto to the Pleiades, snapped a pic and it was dead on. After the second goto I got a perfectly centered M36 image. Then a goto to the Horsehead, a 30 sec exposure later and I could just see it dead center. These were all on the same side of the meridian.

I crossed the meridian and flipped for the next test shot, which was M44 in Cancer and looked centered to me, although I could not fit all of it in one frame. Then I did a goto to NGC 2903 and it was dead center for the test image there as well. Last,I moved the scope to a cursor position right in the middle of M95 and M96. It looked pretty good in the test image.

I had a crash in PHD at this point. It was not a EQASCOM problem, but just a PHD issue. (I tried to guide with a star way too close to the top of the frame.) So, that was the end of the goto tests, since when I restarted PHD and CDC I lost the sync and I would have had to do another 3-star alignment. It was late, so I called it a night.

But, guys! I've never had that kind of goto accuracy before, especially with the meridian flips. It pays to always do a 3-star alignment from now on if it is this accurate!

Mike