Repeatability

Repeatability testing will be done using a laser diode attached along the axis of the telescope. Setting the mount a known distance from a whiteboard, the mount will be commanded to move to various altitude and azimuth positions. Image rotation will be held constant at theta3 = 0. After each move, the location of the laser on the whiteboard will be marked.

Three sets of motions will be tested:

1. Azimuth only – Move back and forth between two azimuth positions holding altitude and image rotation constant
2. Altitude only – Move back and forth between two altitude positions holding azimuth and image rotation constant
3. Altitude and Azimuth – Move between four points multiple times
   1. Test function “testRepeatability”
      1. No current method for knowing when actuators stop moving so uses a delay system
      2. Tests wide range of angles
         1. Alt 20° Az 0°
         2. Alt 30° Az -10°
         3. Alt 40° Az -20°
         4. Alt 50° Az -10°
         5. Alt 50° Az 10°
         6. Alt 45° Az 20°
         7. Alt 30° Az 10°
      3. Keeps rotation constant 0°
4. Measure the distance between dots for each test.
5. Use statistical analysis
6. Find approximate angular drift
   1. May need to set up a scale for this somehow.

Tracking Rate

1. Command telescope to an angular position and mark it
2. Command telescope to a second position and mark it
3. Command a tracking move such that it should move from that second position back to the first
4. Time how long it takes to get back to the first position
5. Calculate the speed it actually moved vs the commanded speed

Point Rotation

1. Mount two laser diodes on the front of the mount
   1. Might want to tilt the base so the functional altitude is 0 degrees to correct for skewing on the whiteboard (whiteboard perpendicular to the two lasers)
2. Command to a known alt (~15deg) and az = 0.
3. Command to rot = 0. Mark board
4. Command to various other rot angles.
5. Measure the angle created with each command. Will likely need to correct for alt != 0

Tests:

* Repeatability
  + Altitude
  + Complex
  + Long Run
* Relative Positions
  + Altitude
  + Image Rotation
* Velocity
  + Azimuth
  + Altitude
* “wobble” testing
  + Use grid of points

Test apparatus set up

All tests are performed using laser diodes mounted to the front of the telescope stand in frame. Three lasers are required to perform all the tests.

The primary laser is used for repeatability tests and relative angular motion tests. This laser is mounted on an axis parallel to the telescope optical axis and goes through the center of the pivot point. The alignment of this laser is not critical for repeatability tests but is vital for relative motions tests. Deviation from the described positioning can have a major impact on comparative measurements.  
  
The second and third lasers are used for measuring relative image rotation angle. They are also mounted parallel to the telescope optical axis but they do not need to go through the center of the pivot point. These two lasers should be on the same level such that if the telescope were pointed at a wall with all angles at 0, the two marks would be horizontal.

The apparatus should be oriented relative to a vertical surface (wall) with the X-Y plane parallel to the wall and the X-Z plane perpendicular to the wall. The origin of the apparatus should be as far as possible from the wall but the optical axis laser must remain on the wall at the extremes of the desired testing area.

Point Rotation Results

As the system does not currently have any form of feedback to the actual accuracy of its image rotation, and such feedback is required for actual usage of the system, relative accuracy of the image rotation will be measured and tested. This also helps to account for issues arising from manufacturing and system level.

The point rotation test is designed to test the relative accuracy of commanded image rotations. This test utilizes two laser diodes mounted on the front of the telescope. The telescope is commanded to a position with zero image rotation angle, then the two lasers are marked on the wall this will be the reference angle. Without moving the telescope base, it is commanded to another position with the same altitude and azimuth but different image rotation. The lasers are again marked on the wall. These sets of points are connected to create two lines which should be at the commanded image rotation angles relative to the horizontal. A photograph of these lines is then taken to be analyzed.

Using matlab (see appendix XXX for code), the angle of the reference angle and the angle of the second position are measured. Subtracting the reference angle from the angle of the second position, a relative angle is calculated. Comparing this to the expected angle results in a measure of the relative accuracy.

Commanded to -0.1rad, 0rad, 0.1rad

corrected negative line is

  -0.0908

corrected positive line is

   0.1036