* INTRODUCTION
  + STATEMENT OF PURPOSE
    - Is what I have about correct?
  + SCOPE OF THESIS PROJECT
    - Description of the overall goals. Include quantitative goals?
      * What slew rate do I need for celestial tracking? 1rot/day->.0042 degrees/sec. Garrett got 0.67 deg/s but doesn’t say what his target is. Seems like at his speed going slow enough would be a concern
  + Theory - brief
    - Celestial coordinate systems
      * RA/Dec vs alt/az
      * Include simple formula
    - Transformations – “we will use these types of coordinate transformations. The details are shown in section blah”
* BACKGROUND
  + STATE OF THE ART
    - Traditional telescope mounts
    - AMiBA
      * “The AMiBA Hexapod Telescope Mount” – Koch et al
    - [Hexapod Telescopes](https://en.wikipedia.org/wiki/Hexapod-Telescope) / sterwart-gogh platforms in other usages
    - Gudgel’s work (should this be here or up in the intro?)
      * Description of system
    - How should I cite these? Reading Gudgel’s paper was a large portion of my experience with how these work and celestial coordinate systems. Should I go find other sources for this information?
* THEORY
  + TRANSFORMATIONS
    - How basic should the math be? Derivation of rotation matrices? Discussion of applying multiple rotation matrices? Talk about how I choose the order to apply the rotations?
      * Senior project level
  + ANGULAR VELOCITIES
    - Tried to do time derivatives of rotation matrices but ended up not working. Should I discuss this here as well as how I ended up doing it?
      * Yes talk about it. Include the work done and what I ended up needing to have to make it work
    - Should I discuss here how without feedback this is a problematic approach because it basically assumes infinite acceleration and I don’t actually know where each actuator ends up without feedback? I’m guessing this should be later in discussing results?
      * Assume the motors accelerate sufficiently fast such that acceleration time can be neglegated
* DESIGN
  + State of PREVIOUS SYSTEM
    - Results from Gudgel
  + HARDWARE DESIGN
    - Stepper motors because:
    - Is this a good place to talk about changing to a frame instead of the actual telescope? This was a necessary step because my stepper motors aren’t strong enough. Not a desired change.
  + ELECTRICAL DESIGN
    - Nucleo
      * why
    - L6470 STEPPER MOTOR DRIVERS
      * Include l6470 driver code in appendix
      * Why did I choose this driver.
  + SOFTWARE DESIGN
    - uPy
      * advantages and disadvantages
* TESTING AND VERIFICATION
  + TESTING
    - Omni-trac test with results
      * :-/ not happy with vibration but proof of concept it should be okay
    - Laser testing (still need to do)
    - Copy Gudgel ch 5 testing?
      * Repeatability testing shouldn’t be hard. Laser pointer mounted along OTA axis, Camera in fixed position behind Mount. Command to point A, then B, back and forth?
      * Slew rate
      * Point rotation (image rotation angle)
  + FUTURE REFINEMENT
    - Causes of error
      * Stack up of error with velocity model
        + No feedback so I don’t know if the actuators are getting to the instructed position

Assumes infinitely acceleration

* + - * Slop in joints
      * Not-straight rods
    - Improvements
      * Bearings on all joints
      * Pairs of bearings to take moment and thrust load instead of putting it on the motor
      * Stronger/faster motors
      * Higher resolution
      * Encoders
    - Future possibilities
      * Interface with external astronomy software
        + Meade Telescope Serial Command Protocol
      * Servo Motors with Ball screws
  + SUMMARY
* BIBLIOGRAPHY
  + I don’t have much right now beyond gudgel, st manual
  + How extensive should this be.