Atmospheric Doppler Lidar Scanner

NOAA/CSL | University of Colorado Boulder | Design Center Colorado

Sam Feig, Ben Fonte, Connor Krause, Zack Lindsey, Desmond McReynolds, Kellen Monestime, Tobin Price, John Schlaerth, Phillip Wu

Mechanical Engineering
University of Colorado Boulder

DESIGN CENTER COLORADO

Project Background

- Doppler Lidar scanning measures profiles of wind speed, turbulence, aerosol backscatter
- Lidar can help develop atmospheric models for weather prediction and pollution mitigation
- We worked with NOAA/CSL's Atmospheric Remote Sensing group to create a Doppler Lidar scanner
- Tasked with upgrading chassis and control system for increased accuracy and continuous rotation

Project Requirements

Resolution	0.02° *(all maneuvers)*
Rotation (Azimuth)	0° to 360°
Rotation (Elevation)	-20° to 200°
Angular speed	0.1°/s to 60 °/s
Power transmission	Continuous rotation *(no wire interference)*
Size and Spacing	Must allow passage of 3" laser with at least 0.5" of clearance
Integrates with NOAA Systems	Uses LabVIEW and Kollmorgen Motors

Electronic Systems

- Kollmorgen AKD motors and controllers
- NI real-time computer
- Panasonic Limit switches
- Encoder Products high resolution encoders
- Senring slip ring

Software

- LabVIEW based software integrates with existing NOAA systems
- PID based position and velocity control built into Kollmorgen motor drivers
- Initialization, relative movement, absolute movement, and scanning programs

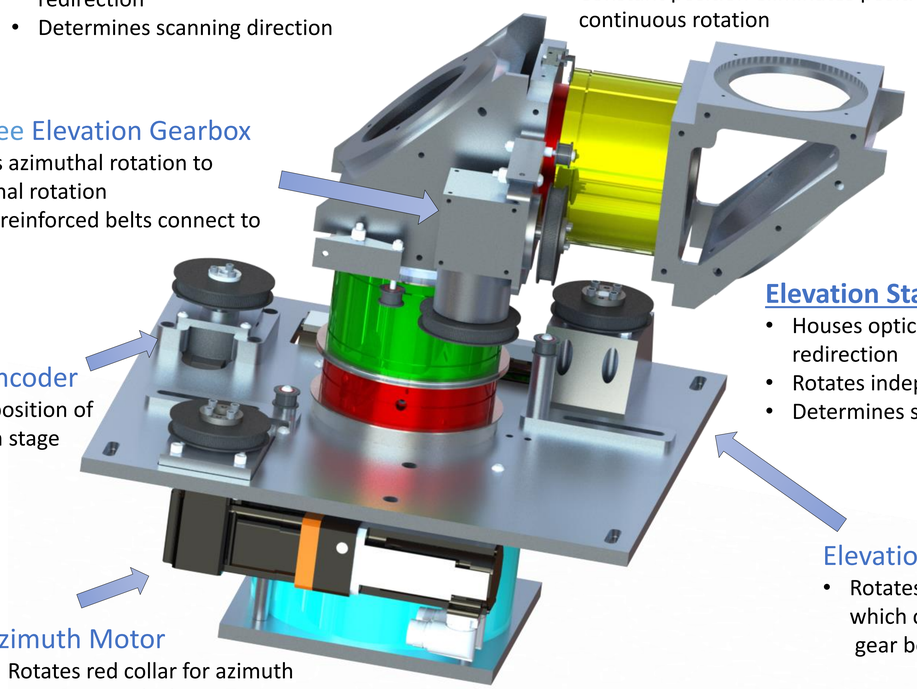
ADLS Version 9

Azimuth Stage
- Houses optical mirror for beam redirection
- Determines scanning direction

Elevation Limit Switch
- Triggered by small tab attached to Upper Drive Pulley
- Constant position eliminates position uncertainty for continuous rotation

90° Degree Elevation Gearbox
- Converts azimuthal rotation to elevational rotation
- 2 Kevlar reinforced belts connect to pulleys

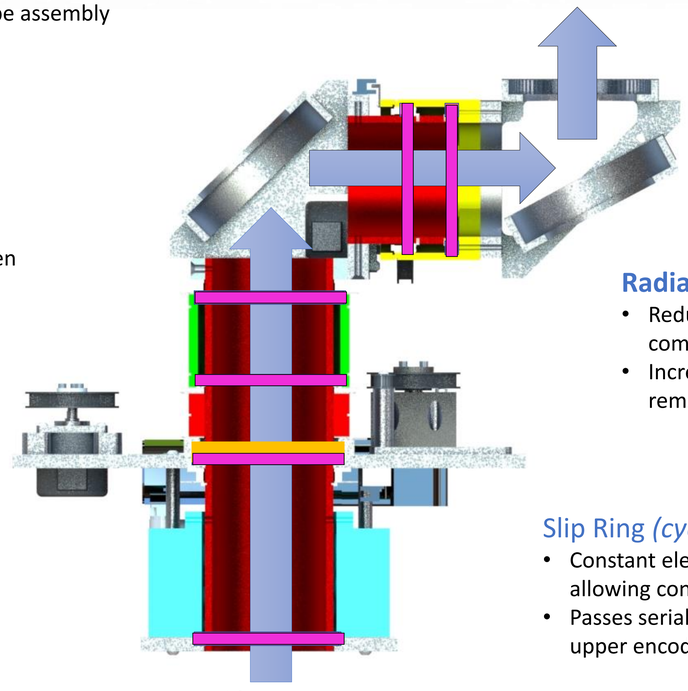
Lower Encoder
- Tracks position of azimuth stage



Elevation Stage
- Houses optical mirror for beam redirection
- Rotates independently
- Determines scanning elevation

Elevation Motor
- Rotates green collar, which connects to 90° gear box

Azimuth Motor
- Rotates red collar for azimuth movement, which turns upright tube assembly



Thrust Bearing *(gold)*
- Reduce friction between rotating assembly and baseplate
- Support weight of assembly

Radial Bearings *(magenta)*
- Reduce friction between all components
- Increase precision by removing slop

Slip Ring *(cyan)*
- Constant electrical contact during allowing continuous rotation
- Passes serial communications from the upper encoder and upper limit switch

Lidar Beam

Power Transmission

- Pulley Drive System utilizes Kevlar reinforced timing belts
- Previous methods employ various wires passed through the central assembly that impede motion
- ADLS-9 allows for continuous rotation via slipring
- Three 90-degree rotational power transmissions

Manufacturing

- Over 500 collective hours of fabrication
- Team utilized lathes, mills, water jet cutters, 3D printers, and drill presses to machine over 40 individual components of the ADLS-9
- Stock materials consisted of Aluminum 6061, Delrin, Fiberglass Reinforced polycarbonate

Project Challenges

- Need for continuous scanning without cable interference
- Inner bore accommodates LIDAR beam
- Small size allows for remote deployment
- Supply chain issues resulted in 2+ month delay in delivery of Kollmorgen motors

Future Testing

- Azimuth and elevation stage rotation
- Mechanical system backlash
- Elevation stage sag
- Angular speed and resolution

Results and Next Steps

- Mechanical assembly has been completed
- Final motors must be integrated
- All except 2 requirements met, last 2 will be tested by NOAA after motor delivery *(resolution & speed)*
- Detailed documentation and testing plan delivered to NOAA within next 2 weeks
- NOAA considering manufacturing 2+ additional ADLS systems to the same specifications

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