**Objectives**

Develop Camtracking Sunphotometer using HD camera for sun tracking at similar or improved accuracy to photodiode quadrant detector tracking sensor while simultaneously obtaining real-time sky imagery for error processing during Direct Sun Tracking, Sky Scanning and Zenith Viewing.

**System Dynamics**

The CamTracker dynamics:

\[
\begin{align*}
\sigma_t &= \sigma_t + \Delta t, \\
\omega_t &= \frac{\tau \Delta t}{I_t} + \omega_t - 1, \\
I_t &= 1/2M_{ax}(r_{ax}^2), \\
\gamma &= \frac{K_d}{\Delta t^2}
\end{align*}
\]

1. Determine the centroid of optical source despite some cloud obstructions using Python OpenCV.
2. Inner control loop to perform micro adjustments for sun following within +/-0.1 degrees.
3. Outer control loop using calculated Ephemeris sun tracking values for macro adjustments of within +/-1 degrees.
4. Use sun and sky imagery for flagging cloud effects impacting atmospheric data quality.

**Device Architecture**

**Conclusions**

- Created sunphotometry platform for testing computer vision and controls algorithms.
- Created Labview Modbus driver and encoder modules.
- Created more compact computer rack.
- Created Labview real-time camera imagery feedback for operators and scientists.
- Currently stable up to 6 deg/sec of yaw with roll and pitch perturbations of 1-2 Hz.

**References**


**Future Research**

- Add logarithmic response tracking camera.
- Add advanced image detection algorithm for additional data quality flagging.
- Add autonomous radiometric calibration.
- Utilize FPGA or GPU for speedup.
- Be robust for spinal climb maneuvers.
- Create turn-key Matlab module to simulate nonlinear control for similar 2-axis sunphotometers.

**Contact Information**

Web: [www.nasa.gov](http://www.nasa.gov) and [www.asl.soe.ucsc.edu](http://www.asl.soe.ucsc.edu)

Email: jliss@ucsc.edu