and motion controller to create a complete CT TD-THz imaging system prototype. A data collection software script was developed that takes multiple z-axis slices in sequence and saves the data for batch processing. The data collection software was integrated with the ability to batch process the slice data with the CT TD-THz image reconstruction software. The time required to take a single CT slice was decreased from six minutes to approximately one minute by replacing the 320 ps, 100-Hz waveform acquisition system with an 80 ps, 1,000-Hz waveform acquisition system.

The TD-THZ computed tomography system was built from pre-existing commercial off-the-shelf subsystems. A CT motion control gantry was constructed from COTS components that can handle larger samples. The motion control gantry allows inspection of sample sizes of up to approximately one cubic foot (≈0.03 m^3). The system reduced to practice a CT-TD-THz system incorporating a COTS 80-ps/l-kHz waveform scanner. The incorporation of this scanner in the system allows acquisition of 3D slice data with better signal-to-noise using a COTS scanner rather than the "chirped" scanner. The system also reduced to practice a prototype for commercial CT systems for insulating materials where safety concerns cannot accommodate x-ray. A software script was written to automate the COTS software to collect and process TD-THz CT data.

This work was done by David Zimdars of Picometrix LLC, subsidiary of Advanced Photonix, Inc. (Amex: API) for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18776-1.

Adaptive Sampling of Time Series During Remote Exploration

The challenge is addressed as an "active learning" problem.

NASA's Jet Propulsion Laboratory, Pasadena, California

This work deals with the challenge of online adaptive data collection in a time series. A remote sensor or explorer agent adapts its rate of data collection in order to track anomalous events while obeying constraints on time and power. This problem is challenging because the agent has limited visibility (all its datapoints lie in the past) and limited control (it can only decide when to collect its next datapoint). This problem is treated from an information-theoretic perspective, fitting a probabilistic model to collected data and optimizing the future sampling strategy to maximize information gain. The performance characteristics of stationary and nonstationary Gaussian process models are compared.

Self-throttling sensors could benefit environmental sensor networks and monitoring as well as robotic exploration. Explorer agents can improve performance by adjusting their data collection rate, preserving scarce power or bandwidth resources during uninteresting times while fully covering anomalous events of interest. For example, a remote earthquake sensor could conserve power by limiting its measurements during normal conditions and increasing its cadence during rare earthquake events. A similar capability could improve sensor platforms traversing a fixed trajectory, such as an exploration rover transect or a deep space flyby. These agents can adapt observation times to improve sample coverage during moments of rapid change.

An adaptive sampling approach couples sensor autonomy, instrument interpretation, and sampling. The challenge is addressed as an "active learning" problem, which already has extensive theoretical treatment in the statistics and machine learning literature. A statistical Gaussian process (GP) model is employed to guide sample decisions that maximize information gain. Nonstationary (e.g., time-varying) covariance relationships permit the system to represent and track local anomalies, in contrast with current GP approaches.

Most common GP models are "stationary," e.g., the covariance relationships are time-invariant. In such cases, information gain is independent of previously collected data, and the optimal solution can always be computed in advance. Information-optimal sampling of a stationary GP time series thus reduces to even spacing, and such models are not appropriate for tracking localized anomalies. Additionally, GP model inference can be computationally expensive.

This work was done by David R. Thompson of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-48430

A Tracking Sun Photometer Without Moving Parts

This reliable instrument is used to collect valuable information about the atmosphere.

Ames Research Center, Moffett Field, California

This innovation is small, lightweight, and consumes very little electricity as it measures the solar energy attenuated by gases and aerosol particles in the atmosphere. A Sun photometer is commonly used on the Earth's surface, as well as on aircraft, to determine the solar energy attenuated by aerosol particles in the atmosphere and their distribution of sizes. This information is used to determine the spatial and temporal distribution of gases and aerosols in the atmosphere, as well as their distribution sizes.

The design for this Sun photometer uses a combination of unique optics and a charge coupled device (CCD) array to eliminate moving parts and make the instrument more reliable. It could be self-calibrating throughout the year. Data products would be down-welling flux,