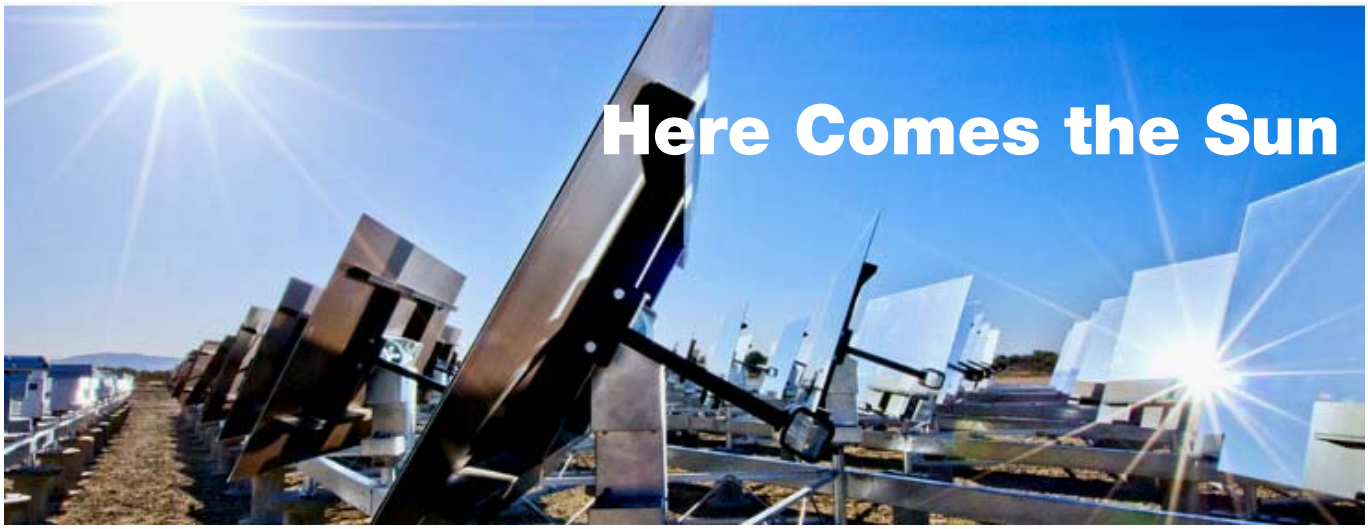


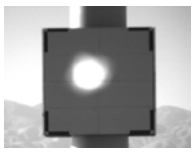
eSolar – Utility Scale Solar Power

Based in Pasadena, California, **eSolar** is one of the half dozen startups currently building Concentrated Solar Power (CSP) plants in the Southern California desert. The company has developed a proprietary solution that has attracted the attention of investors such as Oak Partners, Google.org and Idealab.

Concentrating Solar Power: eSolar CSP Power Plants

eSolar develops CSP power plants (Concentrating Solar Power) based on mass-manufactured and low-cost components designed for rapid construction, modularity and unlimited scalability in order to provide affordable solar energy. An important component of the eSolar solution is its small-sized heliostats. Heliostats are mirrors which are continuously oriented to reflect sunlight into the aperture of a thermal receiver mounted atop a tower. Such concentrated light is used to boil the water within the receiver into steam. The steam is aggregated to a turbine and powers a generator. Steam is then cooled back to liquid (water) form and the process repeats.

The Need for Machine Vision: Tracking and Focusing the Sunlight



Where other solar thermal power plants use a relatively small number of expensive and large curved mirrors to reflect the sunlight, eSolar uses thousands of small flat mirrors. Measuring only a few square feet in area - as opposed to mirrors that are hundreds of square feet commonly used in the industry - eSolar heliostats arrive pre-assembled with the wiring and sun-tracking motors built-in. Mirror fields are installed low to the ground for a fast and cost-effective installation. By utilizing a sophisticated tracking system, mirrors continuously focus sunlight to the receiver. The tracking system is able to compensate for the manufacturing and installation tolerances for each heliostat in the field. A key ingredient of the system is image processing based on a set of cameras installed around the field. By allowing heliostat tolerances to be corrected via the tracking system, eSolar achieves lower overall costs by cutting down on manufacturing and reducing the individual alignment of mirrors.

The Solution: Eight Prosilica GC750 GigE Vision Cameras

The cameras used in the eSolar application are the ultra-compact 752x480 monochrome Prosilica GC750. The GigE Vision™ compliant GC750 features a 1/3 progressive scan CMOS sensor that offers high-performance and resistance to blooming. eSolar's 5 MW commercial demonstration facility in Southern California uses eight cameras distributed around the field's perimeter and mounted atop individual towers. The plant consists of two adjacent modules featuring a total of 24,360 heliostats. Each module is divided into two 175x95m (576' x 312') sub-fields of 6,090 mirrors each that reflect the light onto a central thermal receiver located between the sub-fields.

Each camera is fitted with an Edmund Optics 58-440 varifocal 20-100mm lens, with a fixed focus and zoom set during the installation. The cameras are set inside ventilated/heated Pelco enclosures with a sunshield for heat management, and are mounted atop 27m (90') towers located at the fields' corners. Each camera points to one of the four 5x5m (17x17') white painted steel targets where light from the mirrors is projected. The targets are located approximately 150m (500') away from the cameras and are mounted 36m (120') above ground on the central thermal receiver tower in each field.

The four cameras in the first field connect to a GigE switch linked to fiber optic cabling that goes 200m (650') around the plant to another GigE switch connected to the four cameras in the adjacent field. An additional 300m (1,000') of fiber optic cable links the installation to the control room. The image data received is then stored before being transferred to a laboratory located 90km (56 miles) away via high speed internet connection for analysis.

Use in Practice: How it Works

Mirrors are programmed to track and focus the sun to the center of a target. Random mirrors within all four subfields are sampled throughout the day. Individual frames are taken at 30 second intervals as various mirrors slew on the target. All imaging is software-controlled. Once the system receives confirmation that a mirror is pointing at the target, an image is taken. Hardware and sensor triggers are not necessary in the process.
When an image is received, its background is automatically removed to show the image of the mirror reflection. The basic analysis is a centroid of the reflected sunlight compared to the center of the target. A perfectly aligned mirror will consistently reflect sunlight to the center of the target throughout the day. When a divergence is spotted, eSolar engineers update the proprietary sun-tracking algorithms to correct the mirror alignment. Camera functions controlled by software include triggering, exposure, and gain. All of these are set to provide the best image of the reflected sun. The application software was developed by eSolar's engineering team using the Prosilica SDK for Windows. The programming was done using C#, C++ and Microsoft Visual Studio tools.

Looking Forward

Currently operating a 5 MW commercial demonstration facility, eSolar is developing and building a project pipeline of over 1 GW of solar thermal power plants across the Southwestern United States and globally.

Prosilica, Pioneer in GigE Vision Cameras

PROSILICA

GiGE VISION™

Founded in 2003, Prosilica of Burnaby, BC (Canada) is a pioneer of the introduction of digital cameras with Gigabit Ethernet interface in the machine vision market. Prosilica designs and manufactures high-performance GigE Vision digital cameras for a wide variety of applications and is a 100% subsidiary of Allied Vision Technologies since 2008.

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