Overview

Advanced Scientific Concepts, Inc. (ASC) is a 3D camera & semiconductor company
- Founded in 1987
- Designs: Semiconductors + Lasers + Optics = 3D Flash LIDAR Camera™

- Multiple, broad patents granted, several more in process
- Stackpoole Consulting LLC working as ASC Business Development Representative

Technology Advantages
- Eye-safe lasers illuminate a unique 3D Focal Plane Array (16384 pixels)
- Real-time 3D images/streams without motion distortion
- Lightweight, non-mechanical camera (i.e. non-scanning)
- 3D zoom like ordinary 2D digital cameras
**3D Imaging with Benefits**

Streaming 3D images of vehicles, pedestrians, roads, markings, signs, works in bright sun, in absolute darkness or through obscuration (e.g. rain, smoke, snow and fog)

---

**What is 3D Flash LIDAR and Why Does It Provide the Best 3D Depth Data, Accuracy & Compact Size?**

Invisible, eye-safe laser pulse illumination (Class 1)

A very short pulse of laser light is reflected back to 3D camera. Range/Distance measured by “time-of-flight” creating accurate distance/depth map for all pixels individually.

**3D Flash LIDAR is the best 3D Sensor choice for all vehicles**
- 3D Point Cloud provides thousands of data points vs. MMW radar (16)
- Compact, rugged solid-state camera (no moving parts) vs. scanning ladar
- Use day or night, in fog or smoke; immune to bright sunlight & glare
- Fast capture time (<700ns) rendering the 3D image data immune to vibration or motion blurring
- Images more materials than radar (non-metal, concrete, etc.)
- Stereoscopic needs light and has severe limits
MM Wave Radar vs. ASC 3D Focal Plane Array

<table>
<thead>
<tr>
<th>Features</th>
<th>Millimeter Wave Radar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size/Weight</td>
<td>6 cm x 6 cm x 3 cm/170gm (10 oz)</td>
</tr>
<tr>
<td>Resolution (pixels)</td>
<td>1,024 – 16,384 (or larger)</td>
</tr>
<tr>
<td>Maximum Range</td>
<td>&gt;150m</td>
</tr>
<tr>
<td>Accuracy</td>
<td>High (3 cm)</td>
</tr>
<tr>
<td>False Alarms</td>
<td>Low (Due to high resolution)</td>
</tr>
<tr>
<td>Operation in daylight/fog and smoke</td>
<td>Very Good (SULAR) Very Good</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>2 - 6 W</td>
</tr>
<tr>
<td>Information Provided</td>
<td>High (Depth Map &amp; Intensity)</td>
</tr>
</tbody>
</table>

Imaging Through Obscuration
Intensity Map and 3D Point Clouds in Real-time
Original 3D Flash LIDAR IP

Chips (InGaAs and CMOS)
- Non-CCD/CMOS hybrid sensors

Lasers & Optics
- Diode or “pumped” depending on application

Software

3D Flash LIDAR Cameras
- Portable 3D FLC
- TigerEye 3D Camera
- TigerCub 3D Camera
- DragonEye 3D Space Camera for SpaceX’s Dragon Vehicle
- RexEye Deep Space 3D Camera (for OSIRIS-REx project)

SpaceX: DragonEye 3D Flash LIDAR
Successful Autonomous Rendezvous & Berthing with the ISS

Pictures used with permission from SpaceX & NASA
Brought to you by Stackpoole Consulting, LLC
DragonEye 3D Flash LIDAR On-Orbit Tests
STS-127 & STS-133 Successful DTOs

3D Flash LIDAR image (single frame) STS-133 approach to International Space Station using 45x45 degree FOV lens, from 1.5km to docking.

Material used by permission NASA and Space Exploration Corp.

Sample Raw Data: City Driving
One data set shown from 2 different angles; no visual 2D data

45° field of view, point cloud data; the right scene is exactly the same data as the left with different viewpoints; NOTE the lane markings in real-time

Left 'click' on left scene to start animation
Range & Intensity Data in Real Time

OSIRIS-REx *Bennu* Asteroid Sample-Return Mission

GoldenEye 3D Flash LIDAR to Drive GN&C
Sample Raw Data: City Driving
Range and intensity map only, no color coding for range

Animations created using SAIC's Urban Reality 3D Viewer
"Left click" on the scene to start animation.

9° field of view, raw point cloud data captured at 10 Hz rotated for visibility.

Data Fusion
3D Cloud Point Data Textured with 2D Data

NOTE: Scene "rotating" in order to show 3D on a 2D display.

1.1 km distance fused 2D images as 3D overlay.
Pixel Pitch 128x128: 8.6° vs. 45°

8.6° TigerEye
(At 17m, pixel pitch is ~2cm)

45° TigerEye
(At 17m, pixel pitch is ~10.4cm)

45° Combined Range & Intensity

Range & Intensity Map Combined
Single Laser Pulse, <10nS
Data Fusion

These samples are "rotated" to show 3D perspective on a 2D display

Multiple 2D+3D cameras would allow a full 360° experience
- Analytics & metrics, measuring ball and player speed; distances, statistics, etc.
- Viewing from various perspectives

Airborne Applications

- Mapping
- Wire Detection
- Landing Zone Evaluation
- Autonomous Refueling
- Collision Avoidance
- Situational Awareness
- Brownout Landing
- Surveillance
- Countermeasures
Aerial Mapping

http://www.youtube.com/watch?v=vJ-rQJqOM

ASC’s Value Added Reseller (VAR), Ball Aerospace, uses 3D Flash LIDAR in their Total Sight™ streaming aerial mapping system, fusing 3D and 2D data and geo-referencing in real-time.

Landing Zone Evaluation

- Demonstrated 3D Flash LIDAR's ability to create 3D hazard maps in real time
- 3D map of Yuma LZ is stitched together for a large area map
- Individual frame will provide 200ft x 500ft landing lane image with 1mRad resolution
Airborne Refueling

- High performance air vehicle Probe & Drogue Refueling (PDR)
  - Simple, flexible implementation,
  - Relies on receiver to make connection
  - Multiple air vehicles can be refueled simultaneously
  - NATO and US Navy standard

- ASC’s 3D Flash LIDAR
  - Accurate real-time 3D measurement
  - Able to visualize through clouds, day, night
  - Eye-safe
  - Not possible to “jam”
  - 5cm – 1km
  - Autonomous AAR
  - Real-time
    - Trajectory
    - Bearing
    - 6 DOF

Dust Penetration Testing

- Dust Penetration Testing at Yuma Proving Grounds
3D Flash LIDAR Brownout Results

Wire Detection Close Range
3D Flash LIDAR through Water
“Seeing” though water

Panel
Out of Water

Note: Rippled bottom (and distortion) resulting from lack of calibration