BLINDED BY THE LIGHT: RESOLVING THE AMBIENT LIGHT PERFORMANCE ISSUE OF A TOF CAMERA

Ian Blasch
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MARKETS WE SERVE

OUR ABILITY TO EXECUTE

~250K Employees
130+ Locations in 29 Countries
27,000+ Supply Chain Partners
1,600+ Capabilities
400+ Brands
$29.3B FY21 Revenue
AMBIENT LIGHT POSES A SIGNIFICANT CHALLENGE FOR DEPTH CAMERAS

Notice the dark spots in the depth images. If this were on a moving robot or vehicle, the blind spot could pose a safety risk.
IT ISN’T JUST TOF DEPTH CAMERAS THAT SUFFER

850nm Active Stereo Camera

Visible Spectrum Depth Camera
TRICKS TO REDUCE IMPACT OF AMBIENT LIGHT

Narrow Bandpass Filter

Background Subtraction

\[ \Phi (\text{phase}) = \tan^{-1} \left( \frac{Q_{270} - Q_{90}}{Q_{180} - Q_0} \right) \]

Amplitude = \sqrt{(Q_{180} - Q_0)^2 + (Q_{270} - Q_{90})^2}

\[ Z (\text{depth}) = \frac{c}{2f_m} \times \frac{\Phi}{2\pi} \]

Large Full Well Capacity

Global Shutter vs Rolling Shutter
IF YOU CAN'T BEAT THEM.....
1380NM: INCREASED SIGNAL AND INCREASED SAFETY

**ISSUE**
Active illumination is reduced by $1/r^2$

**CONSTRAINT**
Laser eye safety limits the amount of laser power at 940nm

**SOLUTION**
Use a wavelength that can increase the magnitude of the signal while remaining below laser eye safety / skin safety limits (MPE)

**1380nm**
Potential for order(s) of magnitude more laser power than 940nm

The exposure limit values for the eye and skin are significantly higher at 1380nm than at 980nm. This is because the focusing effect of the lens has hardly any influence at 1380 nm because the light no longer reaches the retina.

(1) Depends on many factors
JABIL RESEARCH AND DEVELOPMENT PROGRAM

Goal: Develop a ToF depth camera based on 1380nm illumination
Outcome: Performance comparison of the 1380nm depth camera to current NIR depth cameras and active stereo cameras on the market
Timeline: 1Q22-2Q22
Risks: Limited selection of sensors, filters, lasers in the 1350nm-1400nm range

Outdoor scene with sun facing camera
Outdoor scene captured with 940nm 3D Depth camera
Outdoor scene captured with 1380nm proof-of-concept 3D Depth camera - the sun is gone!
WHAT JABIL OPTICS CAN DO FOR YOU....

PROCESS DEVELOPMENT
- Advanced process solutions
- Optimal material and component selection
- Customized adhesive solutions
- Equipment guidance and selection

MANUFACTURING ENGINEERING
- Design and procurement of optical lens assemblies and sub-assemblies
- New product introduction
- High-volume production of optical solutions
- Final goods assembly
- Test
- Pack-out

ACTIVE ALIGNMENT
- Active alignment
- Precision components placement
- Lens assemblies
- Gluing technologies
- Chip-on-board, Chip-on-flex
- Chip-on-stiffener, FlipChip
- Wire-bonding and ACF bonding
- Assembly automation

PRODUCT DESIGN
- World class optics design
- Electrical engineering
- Design for high-volume manufacturing
- Design to cost

Huangpu
Burlington
Taipei
Jena
WHAT YOU CAN DO FOR JABIL OPTICS....

Dream innovative products

Supply (SWIR) image sensors lasers (VCSELs, EELs) filters

Collaborate design cutting edge technologies

Demand world-class manufacturing partner