NAMUGA
VISION CONNECTIVITY




Vision Connectivity




Company at a glance

Est. 2004

Listed 2015
(KOSDAQ)

Revenue : $354M
Operating Profit : $20M
(3 Year Average)

CEO
Don Lee

NAMUGA's Customer Focused Capacity

Custom Design Loyalty

Speed
(within 4 months for IT camera module development)

Flexibility
to meet the customer requirements

Pursuing win-win spirit with customer

Milestones - Stay humble and Keep moving forward

2004
- NAMUGA Founded

2008
- Supplied camera modules to WINTEL base system PCs
- Supplied laptop camera modules to Samsung Electronics

2010
- Started camera module supply to Samsung Mobile
- NAMUGA's first ToF module developed

2011
- Extensive R&D for ToF 3D camera module

2012
- Registered as 1st tier vendor for Samsung Mobile
- Supplied 5M AF camera module to Samsung Mobile

2014
- Relocated main manufacturing facility from China to Phu Tho, Vietnam

2015
- Supplied 3D sensing module to Intel/Sony/Infineon

- Listed on KOSDAQ

2016
- Developed camera module for ToF Projector

2017
- Supplied ToF module to Sony AIBO*

*Pet Robot

2019
- Supplied ToF module to Samsung Galaxy Note 10 Plus

2020
- Ownership realigned as a DREAMTECH affiliate
- Expansion of 10 Class manufacturing in Vietnam
- Developed in-cabin camera module for automotive applications

2021
- Started supplying 3D module for Samsung BESPOKE Robot cleaner
- Setup production line of OIS Micro-Actuator

- Started supplying 12M AF, 12M UW camera modules for Samsung Galaxy series

2022
- 'Best Partner Innovation Award' by Samsung
- 'Galaxy Best Quality Award' by Samsung

2023
- Developed Head/Eye Tracking ToF camera module for XR application
- Started R&D for Hybrid OIS module (Flat Pattern Coil Applied)

2024
- Headquarters relocated to Pangyo, KOREA
- Extensive R&D continue on world's smallest OIS module
- New projects expand in Vision Wearable/Mobility/Security/ Bio-medical sectors

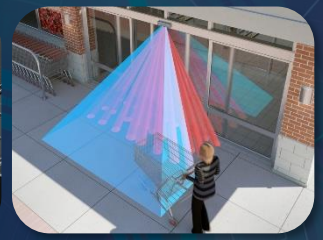
Strategic Target Market

Wearable





Security



Vision Connectivity

Mobility





Biomedical




Key Products – Camera & ToF Modules

IR & RGB Camera Module

Since 2004

Application for Samsung Mobile Phone

Sensitive High Resolution RGB Module

- 40M AF FOV80D
- 12M UW AF FOV120D
- 50M AF FOV77D
- 108M Bi-Direction AF FOV85D

Active Align RGB Module

- 13M FOV79D
- 32M FOV80D

Multi Camera Module

- Dual : 13M AF + 5M UW & others
- Triple : 48M AF + 8M UW + 5M Bokeh & others

IR Camera Module

- Infrared Recognition Camera

ToF Camera Module

Since 2011

Various Application for Many Customers

Intel Eco-System

- R&D Module for the market at early stage of TOF Market with Intel Eco-System

Samsung Mobile Phone

- Production of 20M modules

Intel Stereo Camera of “RealSense”

R&D for Illuminator

- IR TX Projector
- All in One TX
  (VCSEL + Photo IC + Drive IC)

Sony AIBO2

NAMUGA Factory in Vietnam

Advanced CM Production Facility in Phu Tho, Vietnam

- Over 99% Yield for MP (RGB Camera)
- 100% On-time Delivery to Customer

Location	Phu Tho, Vietnam (1hr distance from Hanoi Airport)
# of Employee	1,335 (Current)
Established (Yr)	2014
Manufacturing Area	▪ Lot Area: 57,800㎡ ▪ Facility Area: 38,000㎡
Manufacturing Capacity	15 Million modules per month → Factory expansion in 4 months
Size of Plant	▪ Plant 1 : 6,100㎡ ▪ Plant 2 : 6,908㎡ ▪ Plant 3 : 10,046㎡

NAMUGA Factory in Vietnam

NAMUGA is the only Korean company operating overseas 10 Class cleanroom semiconductor facility

- World-class cleanroom facility operation

Cleanroom -10 Class

Scale : 4,916㎡

Process : Front - Packaging / Active align

Cleanroom -1,000 & 10,000 Class

Scale : 10,550㎡

Process : Front - Packaging / End - Test

Cleanroom -100,000 Class

Scale : 5,337㎡

Process : SMT/ End - Test

R&D – More than 60+ experts in Camera modules and ToF sensors

3D Camera

Team Leader

- 26 years of experience in camera industry (including 13 years of experience in 3D camera)

Experts Detail

- Software Engineers
- Hardware & Mechanical Engineers
- Optical Engineer

Design Ability

- 3in1 Tx for signal efficiency
- ToF Fusion module
  - iToF → sToF → isToF
  - 2D Line Beam Tx
- Retention of Core Design Ability
  - Management of Signal Interference
  - Management of Transmission and View Angle
  - Compact design

IR & RGB Camera

Team Leader

- 26 years of experience in camera industry

Experts Detail

- Software Engineers
- Hardware & Mechanical Engineers
- Optical Engineers
- Process Engineers

Design Ability

- Various simulation analysis of lens performance for the best choice for the customer
- Development of LSC and LDC
- Compact design

OIS Actuator

Team Leader

- 18 years of experience in camera industry (specialty in OIS/Actuator)

Experts Detail

- Mechanical Engineers
- Hardware & Software Engineers
- Process Engineer

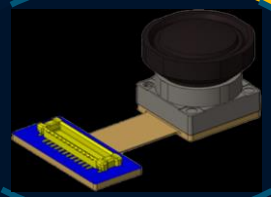
Design Ability

- Hybrid Type OIS of compact size and simplified assembly process
- Micro-scale actuator design & manufacturing
- CAE-based static/dynamic analysis
- Mechanical structure optimization technique

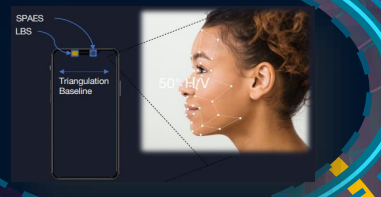
NAMUGA Vision Connectivity for Automotive

Time of Flight
✓ Tx, Rx Core Technology

IR Recognition
✓ Vision, Security



Hybrid 3D
✓ Low Power, Low Latency



NAMUGA
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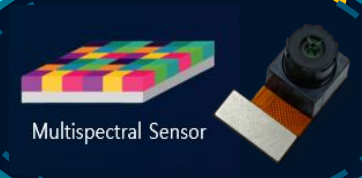
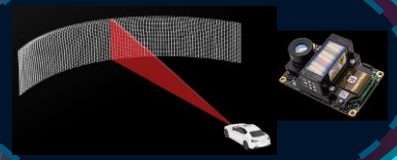
Multi Spectral
✓ Face recognition, Bio



LiDAR
✓ Beam Steering for Tx



Bio Medical
✓ VOR, UDI, PLASMA

Automotive
✓ Viewing, Sensing

Beam Steering for LiDAR

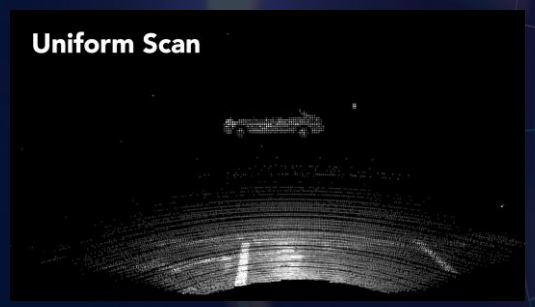
Control Light ✗

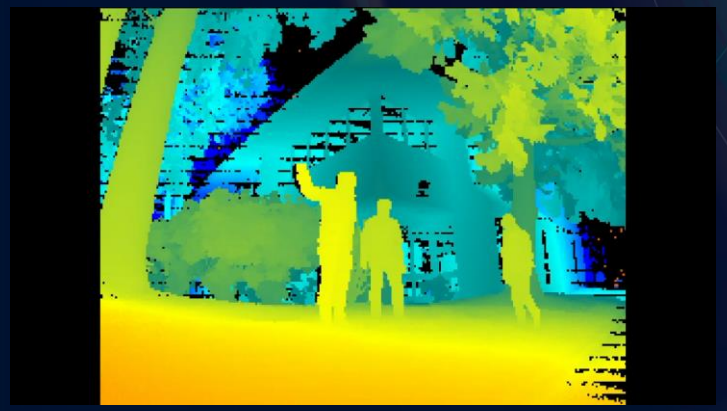
Mechanical beam steering
Poor cost, size, reliability
or
No beam steering (flash)
Poor performance

LCM Beam steering ✓

Semiconductor based
Digital, solid-state beam steering
Software-defined performance
Low cost and size
High reliability

Programmable optical semiconductors made up of microscopic structures that capture and steer light at the subwavelength scale without any moving part





Advantages

High Performance

Scalable Performance
5-300m max range with same architecture

Ultra wide FoV
Up to 180°

Software defined performance
Multiple virtual lidar sensors via API

Robust operation in sunlight
Up to 100 klux

High point cloud quality
No point jitter
Low multi-path and low blooming

No angle calibration required
No variation over temp or time

Mass Deployable

Radically low-cost system
>5x lower vs. mechanical or addressable VCSEL

Ultra-small size
>5x lighter vs. mechanical

High reliability
Immune to mechanical wear, shock and vibration

Core Technology For 3D Sensing

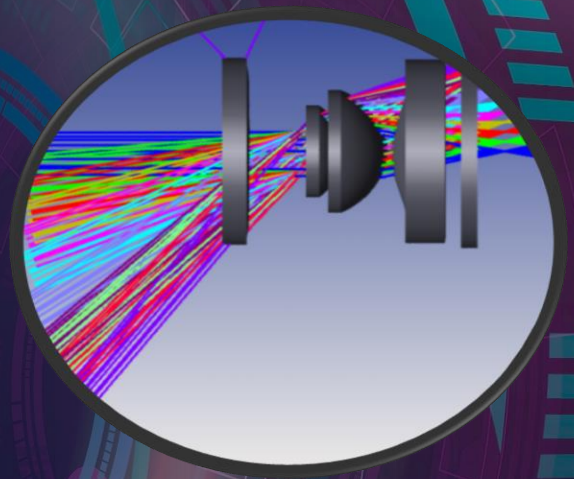
Key Part(Sensor)

- Strategic partnership with major 3D sensor vendor
  (∵ experience of high volume mass production)

Infineon, SAMSUNG SYSTEM LSI, SONY, onsemi, ST

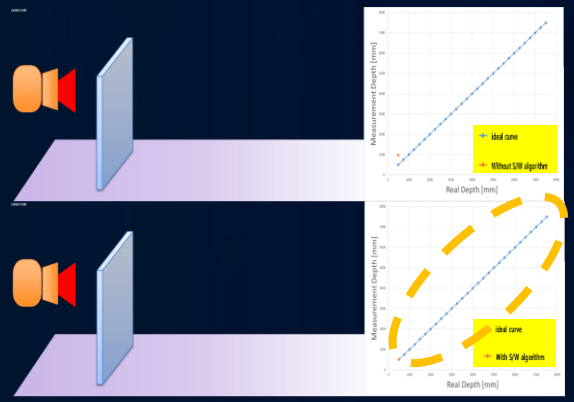
Dedicated 3D Optical Lens

- Customized ToF lens : FOV, F No, RI and E.T.C
- Slim lens design for compact module



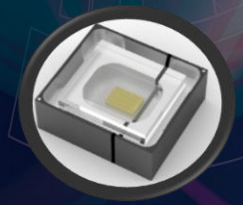
Data Processing

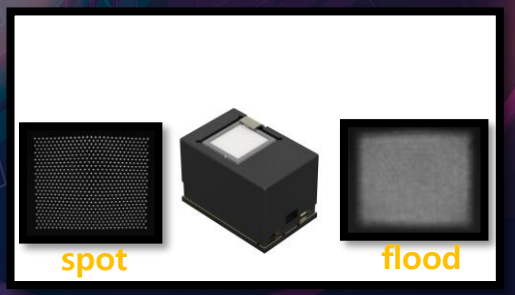
- S/W management technology
  - -Raw data processing
  - -Temperature compensation
  - -Intrinsic compensation(Lens parameter)
  - -Noise removal filters by software
  - -Custom-developed IPs to optimize 3D data



Tx illumination(Projector)

- Specific package for VCSEL projector
- Customized optic design of diffuser & spot DOE
- Dual mode(switching) for spot and flood light

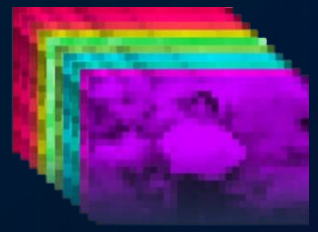


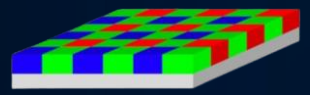


Multispectral Module Solution

3 Color images

Multispectral images





Standard RGB Sensor

Multispectral Sensor

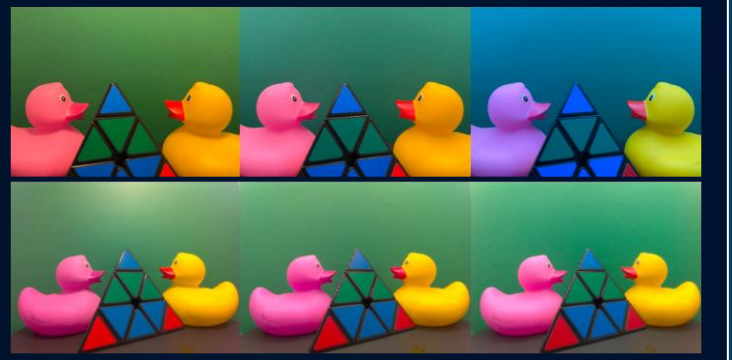
Warm white Flourescent

Warm white LED

Cold white LED

"i" maker phone

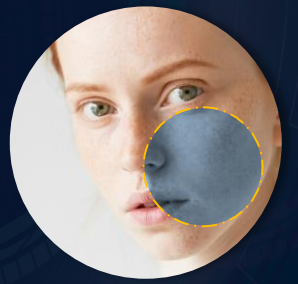
Multispectral Solution



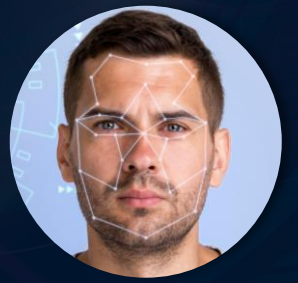
Model	S1
Sensor	Spectricity SP4072M
Resolution	864*648
Wavelength(nm)	400~850
Dimension(mm)	7.0*7.0*7.0(H)
FOV	81°(D)
TTL(mm)	6.45
RI	>50%
F#	2.0
Distortion	TV distortion ≤|5%|

Applications

Auto White Balance
True color photography
Color matching (e-commerce)
Accurate object rendering (AR)



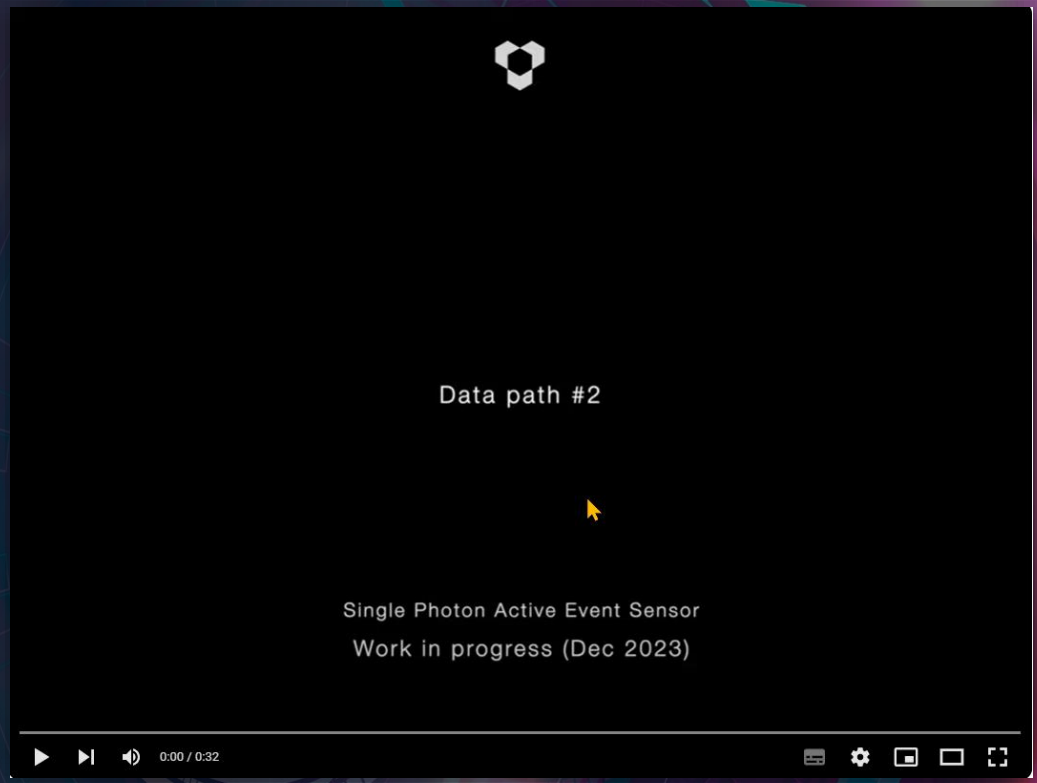
Skin Analysis
Skin biomarkers
for health monitoring
Remote cosmetics



Face Authentication
Anti-spoofing

Hybrid 3D sensor(ToF & Structured Light)

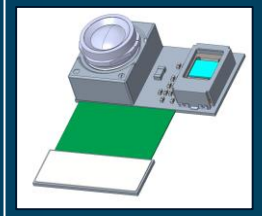
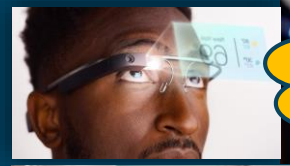
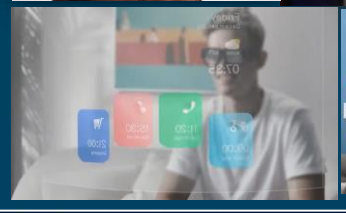
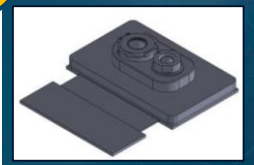
Mobile	SPAES			dToF (Apple)	dToF (ST)	iToF (Sony)	MLdepth
Depth Range	2.5cm – 10m			20cm – 4m	5cm – 10m	Short Throw	0.25 - 4 m (clipped)
Tolerable ambient conditions	100klux			100klux (3m)	“strong ambient”	10klux	20 klux
Behavior to edges	Super sharp					Reasonably sharp (yet flying pixels)	Smoothing out / blending edges
Baseline	*4cm*			*N/A*	*N/A*	*N/A*	*N/A*
DFoV	80deg			70deg	~70deg	80deg	90deg
Spatial Resolution	**2k**	**80k QVGA**	**300k VGA**	1k	2.4k	VGA	30 k
FrameRate (fps)	**30**	**90**	**15**	15	30	45	10
Depth Noise (1 sigma)	1cm @ 1m			1%			7%
Power	**5mW**	**125mW**	**50mW**	300mW	300mW	400mW	280-400mW
Imaging Resolution	500k passive				2.4k active	VGA active	30k



- ✓ **Low power consumption (Tx & Rx)**
- ✓ **Low latency**
- ✓ **Low computation**
- ✓ **Face recognition**

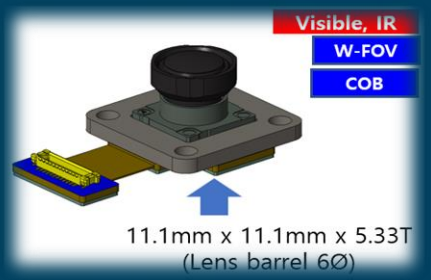
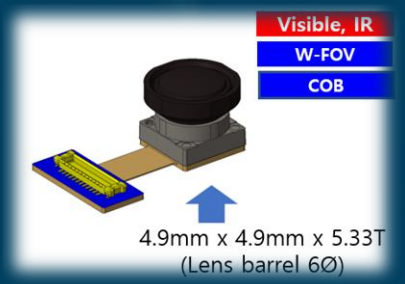
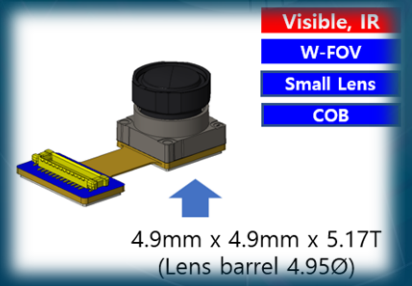
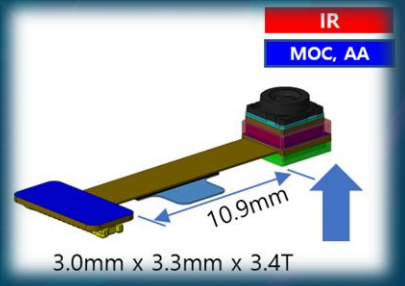
*SPAES : Single Photon Active Event Sensor

3D TOF Module

Model	Titan100	Pinocchio
Sensor	**Samsung LSI/S5K63DSX**,1/6.3" QVGA	Infineon /IRS2975C, 1/6" HQVGA
Tx VCSEL	Lumentum / Qianmu, dual junction	AMS, single junction
Tx Power	8.4W@3.5A	1.0W/1.25A
Rx FOV	85°(H), 69°(V), 100°(D)	57.4°(H), 44.6°(V), 70.1°(D)
Dimension(mm)	16.475(L)*8.95(W)*6.175(H)	16.0(L)*10.0(W)*4.1(H)
Modulation freq.	100+20MHz (dual)	Landscape mode: 60 + 52MHz (dual) Roomscape mode: 80 + 60MHz (dual)
Distance range*	0.3~7.5m	Landscape mode: 0.5~17.5m Roomscape mode: 0.5~7.5m
Depth accuracy	±3%@500mm	±1%@500mm
FPS	30/60	15/30
Lens F#/distortion	1.3 / <3%	1.1 / <3%
interface	MIPI CSI-2 1Lane	MIPI CSI-2 2lane
Power consumption	0.26W (Avg.), 1.04W (Peak) VDDA2.8V-100mA (Peak)/ VDDIO1.8V – 15mA (Peak) VDDD1.05V – 200mA (Peak)/ VDDPG1.05V -< 500mA (Peak)	MODULE 0.66W (RMS), 5.44W (PEAK) VDD1.8V – 0.03A (RMS)/ 0.17A (PEAK) VDDA2.8V – 0.04A (RMS)/ 0.25A (PEAK) VCSEL2.95V – 0.17A (RMS)/ 1.5A (PEAK)
Application	    AR/VR & Gaming Space tracking, Object detection, Gesture recognition    Robot Slam & object recognition for vacuum cleaner	  Portable projector Auto key scan, focus  Homecare Robot Object avoidance

*Maximum distance may vary depending on input current

IR Module

Model	VF200X(Head Tracking)	VF203X	VF301W	VF400X
Application	**Head Tracking**	**Head Tracking**	Head Tracking	Eye Tracking
Sensor	S5K931SX14/GS, 1/10″	S5K931SX14/GS, 1/10″	S5K931SX14/GS, 1/10″	S5K931SX03(S.LSI)/GS, 1/10″
Resolution	640*640	640*640	640*640	400*400
Wavelength(nm)	Visible / 850	Visible / 850	Visible / 850	850~940
Connector P/N	AXE824124 (Panasonic)	AXE824124 (Panasonic)	AXE824124 (Panasonic)	AXE824124 (Panasonic)
Dimension(mm)	11.1*11.1*5.3(H)	4.9*4.9*5.3(H)	4.9*4.9*5.3(H)	3.0*3.0*3.4(H)
FOV	160°(D)	160°(D)	150°(D)	90°(D)
TTL(mm)	4.45	4.45	4.29	2.09
RI	>32%	>32%	>32%	>30%
F#	1.8	1.8	1.8	2.2
distortion	≤|14.5%|	≤|14.5%|	TV distortion ≤|15.0%|	TV distortion ≤|1.0%|
Video FPS	180fps@full 0.41M, 240fps@VGA, 400fps@QVGA			180fps@full 0.41M, 240fps@VGA, 400fps@QVGA
Color Filter	Mono-chrome / RGB			Mono-chrome / RGB
Figure				

Latest References [Micro-Scale Actuator]

Robustness Relatively High Stiffness Anti-External Shock
Performance & Reliability Excellent Motion Stability & Control Excellent Dynamic Characteristics
Compact Size Low Shoulder Height
Anti-EMI/RFI Low Electro-Magnetic Interruption Effective for multi camera module
Anti-Particle & Contamination

- **Leveraging its insight into core camera component technology and hands-on manufacturing experience, Namuga has developed an innovative OIS & AF Actuator solution that will disrupt existing micro-scale actuator design concepts to overcome technical changes required by the market.**

OIS & AF Actuator

Since 2020

Internalization & Other Major Customer

Hybrid-OIS Actuator

- 64MP 1/1.7X" Sensor Applicable
- 48MP & 50MP 1/2.X" Sensor Applicable
- 200MP 1/1.3"~1/1.4" Sensor Applicable

Compact Ball Guided AF Actuator

- 12MP UW AFA
- 50MP UW AFA

NAMUGA
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Thank You