

Electronic Perception Technology

Real-time single chip 3D imaging

Canesta has invented electronic perception technology, a low-cost sensor technology that enables everyday devices to perceive and interpret their surroundings in three dimensions and in real-time. This innovation is a CMOS-based, single chip imaging technology that generates frames of 3D information using a modulated infrared light source. Distance values are determined in each pixel of the sensor by measuring the difference in phase from the outgoing modulated light and the returning light. No additional processing is required.

The Electronic Perception Development Kit (EP DevKit™) is a system which includes this technology, which can be used for developing and deploying electronic perception applications. The system comes with a software development kit that provides access to frames of 3D data, enabling the rapid development of applications which utilize 3D information.

The system is suitable for the development of all kinds of applications, including for example:

- Size and depth detection – determining the size of an object or its distance from the device (e.g. enabling a robot to determine the size of a package and how far away it is; determining the size of a box, evaluating a cargo load)
- Image segmentation – separating the discrete objects in a scene (e.g., separating foreground from background or separating a human form from a picture on the wall)
- Object classification – identifying objects by class or type (e.g. determining whether a moving form is a human or animal)
- Object tracking & location analysis – determining the location, position, size and movement of an object (e.g., tracking the position of a car passenger's head to deploy an airbag properly, child monitoring systems, driver attention monitoring)
- Human interaction – watching human motion or body gestures to control electronic systems (e.g. automatic doors, gesture control for electronic systems)
- Many more possibilities...



Electronic Perception Development Kit (EP DevKit)

When the unit is connected to a PC, and the software is installed, the system operates “right out of the box” with no additional hardware development required. The system may also be implemented in a USB-based embedded system for deployment in applications where a PC is not available.

The EP DevKit includes a light source and corresponding optics which may be selected from a set of options. They vary only by field of view and include 30 degree, 55 degree, and 80 degree options (Model # DP203, DP205, & DP208 respectively). Additional customized options may be developed for a separate fee.

Electronic Perception Software Development Kit (EP SDK)

The Electronic Perception Software Development Kit (EP SDK) provides an application programming interface (API) for writing applications for the EP DevKit using Microsoft Visual Studio 6.0 on a Windows 2000 or Windows XP PC. It supports the authoring, debugging, and execution of applications on a host PC in C or C++. The software development kit provides access to raw brightness and depth image frames. The user can set sensor parameters, such as the frame rate, shutter speed, operation mode, window size, and the region of interest. The software development kit comes with documentation and sample code to illustrate the operation of the kit.

The API is common across Windows and embedded platform implementations. Therefore, application software can be ported from the PC to a future embedded environment with a minimal amount of changes. The SDK provides programming guidelines for writing efficient embeddable applications.

Path to Embedded Deployments

Canesta's single chip solution offers two paths to embedded system deployment. The current EP DevKit module may be built into embedded system designs which include USB host or USB On-The-Go functionality. The entire EP DevKit module simply functions as a USB device.

Canesta will also offer the core perception chip technology for integration into embedded systems. This chip will provide depth and brightness values for each pixel in each frame. The software SDK will also be available for porting. Contact Canesta Sales for the target chip performance characteristics, electrical interface specifications and current availability.

System Features:

- Real time 3D and brightness video stream output at API level (up to 30 full frames/second).
- Built in IR laser array for active illumination
- Built-in IR filter and CMR technology for rejection of daylight interference
- Pre-calibrated units (usable out of the box) for one of the three optical field of view options.
- Dimensions 12.5cm x 6cm x 6.3cm with a standard tripod mount.
- A C-level SDK with API for
 - Start/stop of video stream
 - Access to depth, brightness separately
 - Adjusting frame rate
 - Setting shutter time
 - Setting digital gain
 - Setting light source power
 - Setting modulation frequency
 - Setting Window of Interest (WOI) and Region of Interest (ROI)
 - Setting ambient light rejection level
 - Support for single- and multi-shutter modes
- EP Toolkit program and source code to visualize the depth and brightness images and change system operating properties
- Demo programs for
 - Object tracking
 - Object detection
 - Paint application which allows the user to use their hand to "paint" on a canvas in 3D space

General Specifications

System Specification	
Imager	1/3 inch CMOS
Lens Mount	CS
Lens¹	DP203: 30 degree FOV CS Lens with F1.2
	DP205: 55 degree FOV CS Lens with F1.2
	DP208: 80 degree FOV CS Lens with F1.2
Focus	Fixed
IR Light Source	Integrated Light Source from laser array providing up to 1W of eye-safe (Class 1) IR light @785nm
	DP203: 30 degree divergence
	DP205: 55 degree divergence
	DP208: 80 degree divergence
Effective Picture Elements	64 (H) x 64 (V)
Scanning Area	Selectable
Synchronization	Internal, master sync output
Scanning	Progressive
Electronic Light Control	Power (programmable 0.2W to 1W, 8 bits resolution)
	Frequency control (13MHz, 26MHz, 52MHz and 104MHz)
Video Output	USB 1.1
Gain Control	Programmable gain 1x, 1.3x, 2x and 4x
AGC	None
Electronic Shutter	64µs to 1 s with 64µs increments (14 bits)
Frame Rate	Variable Frame Rate: 1 to 30 fps in full frames. Higher frames rates for smaller windows.
Dimensions	125mm(w) x 60mm(d) x 63mm(h)
Power Requirement	<10W (2A@5V)
Operating Temperature	-10°C to +40°C
Supply Voltage	+5VDC ±10% 100-240VAC, 50/60Hz AC Power Adapter supplied
Extra Hole Locations	The EP DevKit module has features on the top and bottom so that it can be mounted robustly on a tripod.
Cover	The system has protective covers which may be removed without affecting operation or safety level.

¹ Values are diagonal FOV. For vertical x horizontal FOV, values are 21.5x21.5, 40.5x40.5, and 70x70 degrees respectively for DP203, DP205, DP208

Performance Specifications

The EP DevKit system performance specifications are verified during Canesta production. Unless noted, the system performance values listed are based on the following test conditions:

Parameter	Value
Modulation frequency	52MHz
Reflectivity	1.0
Light source optical power	1.0W
Frame rate	15fps
CMR value	3

System Performance			
Measurement Depth & Depth Resolution at optical axis (Per pixel, per frame)		Measurement range (75% of full frame)	Minimum depth resolution (on-axis pixels)
	DP203:	50cm to 500cm	5cm
	DP205:	30cm to 150cm	2cm
	DP208:	30cm to 150cm	3cm
Dynamic Range for Range Resolution	17dB dynamic range, active illumination, under nominal conditions		

Typical Performance Guidelines

The EP DevKit typical system performance guidelines are based on characterization data and are not verified in production.

Typical System Performance			
Minimum and Maximum Depth & Depth Resolution at optical axis (Per pixel, per frame)	Minimum and maximum values assume optimized values for frame rate, object reflectivity, optical power, and modulation frequency at each boundary condition. These values may not be feasible for the unique characteristics of an individual application. Consult separate Performance Guidelines document for greater detail.		
		Minimum range (75% of full frame) & accuracy @ range ²	Maximum range & accuracy at range (assumes anti-aliasing applied) ³
	DP203	~50cm (1.2cm std. dev.)	~20m (20cm std. dev.) ⁴
	DP205	~30cm (0.95cm std. dev.)	~10m (20cm std. dev.)
DP208	~30cm (0.6cm std. dev.)	~6m (20cm std. dev.)	
Depth Resolution Roll Off at the off axis regions	The average degradation of depth resolution shall not be more than 2x of the depth resolution given above.		
Dynamic Range for Range Resolution	Approximately 17 to 21 dB dynamic range, active illumination, under nominal conditions.		

² White paper (reflectivity 1.0) at 30 frames per second (fps)

³ Maximum range defined as maximum distance at which it is possible to detect movement of a human being. Accuracy figure assumes anti-aliasing, object reflectivity of 1.0, frame rate of 5fps, 1 watt light source, single-mode, and modulation frequency of 13MHz.

⁴ Note that 20m is beyond the unambiguous range of DP203 with a 13MHz modulation frequency.

Typical System Performance	
SNR for Range Resolution	37 dB under nominal conditions
Dynamic Range for Brightness	Up to 34 dB dynamic range
Ambient Light Rejection	30 to 50W/m ² sunlight rejection under nominal conditions with 1W laser power. The average degradation of depth resolution shall not be more than 2x at 30 to 50W/ m ² rejection.
System Latency	<50 ms from end of shutter until data appears at the PC application

Pricing and Availability

The EP DevKit system is available in 3 different models and each is a part of the DP200 product family:

Model #	Specs
DP203	30 degree FOV
DP205	55 degree FOV
DP208	80 degree FOV

Each model includes:

- Development system hardware with selected FOV
- Canesta EP Toolkit software
- Canesta EP Software Development Kit (EP SDK)
- Documentation and guides for developing applications
- Sample applications, including source code
- 90 days of email technical support in installing, configuring, and using the DevKit. Additional technical support and consulting is available for a separate fee.

Please contact Canesta Sales (see below) for a quotation. Pricing is volume dependent. To expedite your inquiry, please include your name, your job title, your company name, a description of your application, and any other information you feel would help us to better understand your needs.

Canesta Sales

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Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated 26 July 2001.

Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures