

Canesta Intellectual Property Overview

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Overview

Canesta has been granted 37 US patents and has many more pending patent applications in several different areas related to 3D electronic perception technology.

The patents fall into three broad important categories:

1. **Fundamental 3D time-of-flight (TOF) patents** that make robust 3D sensing possible in an ordinary CMOS process,
2. **Software patents** that will apply to many 3D human-machine interaction (e.g. gesture control, video gaming) and automotive applications regardless of 3D sensing technology used, and
3. Patents encompassing many different **uses of 3D technology** for a variety of 3D applications that are likely to become common practice.

Granted patents and some important pending patent applications are listed below.

1. Fundamental CMOS 3D TOF Patents

Enabling 3D TOF in a standard CMOS Process

- 3D Time of flight detection: Canesta has invented a fundamentally different technology for 3D Time of flight detection that can be implemented in an ordinary CMOS process. The Canesta technology is specifically designed for CMOS in that it is immune to surface defects that always exist in CMOS, and the performance improves as feature sizes in CMOS get smaller. Several successive generations of time of flight detectors have been patented, culminating in a robust, proven high performance detector.
 - USP6,515,740 / USP6,580,496 / USP6,906,793 / USP7,352,454 / USP7,464,351/ Pending

Making 3D TOF Robust

- Ambient Light: Canesta has patented a number of methods to deal with ambient light in TOF systems including Canesta *Sunshield™* technology that enables operation without saturating at any shutter time in full sunshine (100Klux).
 - USP6,919,549 / USP7,176,438
- Dealiasing Technology: Canesta *FarSight™* technology allows efficient unambiguous operation at long range (e.g. > 5m).

- Pending
- Motion blur reduction: Canesta *ClearShot™* technology allows accurate capture of fast moving objects.
 - USP7,283,213/ 7,450,220/ Pending
- Multiple systems operating on the same FOV: Allows multiple 3D units to operate on the same field of view without interfering with each other. Allows a 3D system on every desktop and multiple 3D systems in a game.
 - USP7,405,812
- High dynamic range: A collection of hardware and software techniques enabling high dynamic range in which close and far objects over a wide range of reflectivity are imaged properly. Scope of patent coverage is not limited to time of flight and has applicability to any 3D capture technique.
 - USP7,157,685 / USP7,321,111 / USP7,379,100 / USP7,379,163
- Quantifying 3D Accuracy: Quantifies the depth accuracy at each pixel.
 - USP7,405,812
- Robust system timing: Removes the effects of temperature and certain component delays.
 - Pending
- Next Generation Architecture: A collection of techniques that form the basis of a low-cost, high performance TOF architecture.
 - Pending

Mass market manufacturability of 3D TOF Systems

- Fast Calibration: Method and system to enable accurate rapid production line calibration of TOF units.
 - USP7,433,029 / USP7,471,376 and others Pending
- Single Chip RGBZ: Blueprint for a future chip and optics that acquires RGB and depth on a single die.
 - Pending

2. 3D Software

Gesture Control

- Virtual input device: Claims encompass use of any three dimensional sensor to acquire position of a body part (e.g. finger) to determine if a virtual button in 3D space has been touched, as might be required to select an option in a game or human-machine interface. The claims also encompass using a three dimensional sensor to

acquire the position of a body part to control a cursor, as might be used to move or select an object on a computer or TV screen.

- USP6,614,422
- Gestures: The claims of this patent encompass using any three dimensional sensor to recognize a dynamic gesture (e.g. waving of a hand) as might be required during a game or control of an electronic device such as a TV or mobile phone.
 - USP7,340,077/ Pending

Obstacle detection

- Obstacle detection: Detection of an obstacle behind a car in an automotive backup assistant application. Another patent application covers detection of obstacles for automatic doors and lift gates in cars and SUVs.
 - Pending

RGB Manipulation

- Up sampling: In an RGB + depth system, uses the high resolution RGB image to improve the spatial resolution of the Z image. A low resolution Z system can, with the interaction with an RGB sensor, appear to have many more pixels than it physically has thus reducing overall cost.
 - Pending
- Background substitution using 3D information: Allows video bloggers to create professional looking videos (e.g., like a newscast) without the use of a green screen as in news studios. In a high resolution (e.g. 1024*768) RGB image using a low resolution Z camera (e.g. 160*120) removes the background and substitutes it with a video stream or image of the user's choice.
 - Pending

Airbag Deployment

- Intelligent airbag deployment using 3D data: Deploys an airbag at different strength levels depending on the position and size of the occupants in a vehicle.
 - Patent has been allowed awaiting issuance.

3. Using 3D Technology

- Embedding 3D info in an RGB Image: Encodes depth information in an ordinary RGB image in a fashion invisible to the human eye. Existing RGB applications can still view the RGB portion on the image, and special applications can also recover the depth data.
 - USP6,674,895
- Refocusing an image using 3D information: 3D information is used to refocus a high resolution RGB image using image editing software. The software allows the image to

- be refocused on any particular object in the image or simultaneously everywhere in the image.
- USP6,876,775
 - Using a desktop 3D camera to make a 2D computer screen appear to show 3D data: Allows computer screens and TVs to come alive and render images such that they appear to be 3D. Can make a large TV screen look like a window with close objects moving faster than far objects.
 - USP7,375,803
 - Low Bandwidth Video compression based on 3D information: Intelligently compresses the foreground and background at different bit rates to reduce bandwidth. Is not fooled by backgrounds that move because the camera moves.
 - USP7,203,356
 - Intelligently mining data during video communications: Uses background subtraction to create a virtual conference/chat room on a desktop that displays the foreground from each of the participants. May interject ads based on the exchange between participants.
 - Pending

Other Areas

Other 3D TOF Methods

- Various other time of flight methods and improvements: A list of patents encompassing hardware and software methods that cover various other time of flight sensing techniques.
 - USP 6,323,942 / USP 6,512,838 / USP 6,522,395 / USP6,587,186/USP6,678,039

Structured Light

- Coded grid structured light: Coded grid methods in one form or another are at the heart of many/most 3D structured light methods when the scene may include images of any shape and distance.
 - USP7,212,663
- Object size measurement using a handheld structured light unit: An inexpensive 3D handheld tool that would enable a delivery carrier (e.g. FEDEX) to quickly determine the size of a package.
 - USP7,310,431

Multispectral Capture

- Same 3D detector can be used for color capture: Can be used in biometrics to more accurately determine the spectral composition of a user's skin. Built from the same

CMOS structure that enables time of flight. Acquires color without the use of RGB color filters.

- Pending

Projection Keyboard and Mouse

- Patents are directed to the projection keyboard and mouse application: These patents have been sold.
 - USP6,690,618 / USP6,710,770 / USP 7,006,236 / USP 7,050,177/ USP 7,151,530

Other

- Reducing KT/C and $1/f$ noise via amp in pixel: Any CMOS image sensor company may incorporate this method into their pixels to reduce noise.
 - USP7,713,230
- Accelerating object detection in a 3D system: Shortcuts for quick 3D detection of an object without performing a full 3D correction transform. Applications taking this tempting shortcut risk infringing this patent.
 - USP6,690,354