2018 Consumer Electronics Show (CES)

Notes
on
Selected Sectors and Exhibitors
By Richard Helfrich

CES 2018 contained about 4,000 exhibits and had over 170,000 attendees.

This document is a limited overview of a small portion (~10%) of exhibits at CES. This is not an attempt to provide complete coverage and not all technology sectors are covered.
These notes are personal opinions based on brief hand notes, recollections, literature and comments received during limited times at selected display booths.

 17 January 2018

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1. Table of Contents

It is time to start planning for CES 2019 (from Jan 8 to Jan 11, 2019).

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2. CES 2017 – INTRO AND SUMMARY

CES 2018 in Las Vegas had more companies with exhibits (~ 4,000) and more attendees than CES 2017. CES 2018 did not have as many completely new products as 2017 and did not generate nearly as much excitement and enthusiasm as last year.

Highlights: ▲ Rapid advance in self-driving sensors (LiDAR, MM Wave), hardware processors (sensor fusion, image understanding, 30 teraflops processor board)
▲ Very-large video screens with built-in local area image enhancement at good prices
▲ 4K 65-inch TV screen using OLED technology that can be rolled up
▲ Components inside devices including nanosensors and custom semiconductors

Lowlights: ▼ Slow advances in home robots that serves multiple functions housekeeper (chef, butler, maid) and healthcare (assistant for handicapped, nurse, physical therapist).
▼ High turnover of companies at CES booths developing health-care hardware between 2017 and 2018 for many reasons: management, capital, production difficulty, unable to win FDA approval, other.

There were many poorly-presented exhibits, making it difficult to determine by their banners or displayed gadgets what the exhibitor made or sold. This was especially true in the Eureka Park section for early-stage companies. Most companies in Eureka Park were focused on finding investors and less on finding customers or distributors. Considering the high prices charged by CES for booth spaces, those early-stage companies should have invested more time and energy on crafting a better message.

More notable than the companies that had booths in exhibit areas were companies that chose to not interact with consumers at CES 2018, or to skip participating in CES 2018 entirely. For example, Fitbit was absent from the exhibit floor after having a very large booth at 2017 CES. Fitbit had a private meeting room, not open to the public. Other large companies were absent, including many companies I visited at last year's CES.

There were numerous products and services presented by exhibitors. A common approach by exhibitors is the "dumbing down" of products and services for end consumers. Many products, services and Apps tended to produce an ultra-simple result such as "Good" or "Bad" without providing any reasoning or presenting the data.

For example, there were several devices that claimed to analyze drinking water coming out of your faucet. Each product measured a handful or so of possible contaminants. In general, the outcome of the testing was "OK to drink" or "Not OK to drink" based on whether the sample tested was above or below a preset threshold. If that threshold was preset at 300 parts per billion (ppb) then a sample at 299 ppb was "OK to drink" while a sample at 300 ppb was "Not OK to drink" despite the nearly imperceptible difference of 1 ppb which is 0.033%. Testing accuracy levels were several times larger than that 1 - ppb difference. Are consumers as dumb as these companies believe?

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3. Overview of Select Categories

AUTONOMOUS VEHICLES - Splashy at CES

Automated-driving vehicles[1] were big news topic at CES 2018 but not as hot an area as CES 2017, with fewer brands present. Auto companies were focused on: **Level 3** _ (conditional automation able to handle most driving but will prompt driver to take over when road conditions are bad, or traffic creates a situation beyond automatic capabilities; **Level** 4 (high automation) and a few **Level 5** (fully-autonomous no steering wheel) vehicles.

Self-driving vehicles displayed included an actual Peterbilt rig modified by a 3rd party company for long-haul tractor-trailer use with self-driving capability. The team manning that booth claimed Level 4 capability on interstate highways and Level-2 to-3 capability on city streets.

[Note: additional information in sections below on Details of Sectors and Companies]

TV MONITORS – Lower Prices and Larger Screens

LARGE-TO- JUMBO SCREENS

TV manufacturers believe that many consumers will purchase large (90-inch to 110-inch diagonal screens) when prices are below about $2,000, and a subset will purchase very-large TVs (110-inch to 140-inch diagonal screens) when prices are below about $5,000. To produce pleasing video on these larger TV screens requires enhancing the picture to better match the performance of the human eye in terms of dynamic range and localized colors in various portions of each frame. Each type of screen needs a specialized type of processing and each frame of video may require somewhat different enhancement depending on the range of brightness within a single video frame and the colors within a single video frame. TVs in production at the end of 2017 have no capabilities to provide that enhancement.

VIDEO SCREEN AT FULL 4K RESOLUTION THAT IS ROLLABLE

LG had a prototype 65-inch TV that could be rolled up. The screen uses OLEDs which means all components can be produced using plastic, so no glass is needed. This can open a new world of portable video. Imagine being able to unroll a 27-inch screen from your mobile device while on an aircraft. What if people in every seat have one?

MOBILE APPS for Phones and Tablets

There were way too many startups and emerging companies offering Apps. Too many apps were similar to other apps and very few were innovative. One interesting app measured blood pressure using the camera on a mobile phone and displayed blood pressure without any added hardware.

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[1] Automated-Driving Vehicle Standards – SAE J3016 https://www.caranddriver.com/features/path-to-autonomy-self-driving-car-levels-0-to-5-explained-feature

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DRONES – Evolving Towards Commercial Applications

This is one area where I devoted little time. Drones, such as quadracopters, for consumers have become so inexpensive that a shakeout of companies is in process. Commercial and industrial drones that provide value to business are emerging, such as drones to monitor large construction projects or patrol large events. This category of drone requires extended flying times (several hours) and larger payloads (5 to 10 pounds). Commercial and industrial drones can become successful at prices that are 10 to 100 or more times greater than consumer drones.

ROBOTS – Large Markets but Practical Technology Not Ready Yet

There were more companies promoting robots but very little improvement in robot capabilities over 2017 CES. An example is the U05 Humanoid Robot. There were many robots suitable to be a friend or pet that can be considered advanced toys.

There may be some business applications for robots with the capabilities presented at CES 2018 in terms of delivery of small items inside buildings. The robots demonstrated at CES 2018 do seem able to deliver mail to each unit inside an apartment building from a central postal drop point. Likewise, that same type of robot could deliver room-service food and beverages to hotel rooms. Navigating a building crowded with people is not trivial, especially elevators. However, the overall delivery task is much less complex than that of a “home healthcare robot”, which may be the largest and most profitable application for robots.

SPORTS DEVICES & WEARABLES – More companies - less excitement

The real advance in wearables for CES 2018 was sports watches that could pass for dress watches with actual analog dials that could pop up steps walked, pulse and other functions similar to features on Fitbit or Apple watches.

Price competition is fierce, and many companies will either drop sports devices/wearables or discontinue operations as cash runs low. Even companies with high market share such as Fitbit are rumored to be running low on cash.

Someday wearables display more than just simple functions such as pulse, respiration rates, steps, and calories. A few wearables have added blood oxygen measurements.

Many wearables from watches to patches are attempting to provide continuous blood glucose monitoring. Approaches likely to be offered within the next 18 months will use the proven method of subcutaneous testing via micro-needle arrays. These devices require reagents and even the smallest microneedles tend to cause localized skin reactions that block testing in a few days to about a week.

Totally non-invasive blood glucose testing will someday be possible with some type of optical measurement. Experimental devices appear to provide acceptable accuracy using several lasers with combinations of various wavelengths from visible to several infrared bands. Semiconductor diodes can miniaturize the size of those lasers. A greater challenge is how to power several lasers with sufficient optical power to penetrate skin and operate every few minutes for 24 hours. So far, a watch-sized battery lacks capacity and the volume-density of power in watch batteries has not improved much, if at all, over the last several years; despite major research efforts.

HEALTH MANAGEMENT DEVICES/EQUIPMENT - Advances but limited Buzz

In general, I classify a device as a health device if it requires FDA clearance/approval.

There were better health-related devices at CES this year and several already had CE (European version of FDA) and/or FDA approval, but most were in some stage of pre-clinical or clinical trial. Discussions with a sampling of companies indicate many are focusing on first getting European approval to enable sales in Europe and then pursuing FDA approval. The "EU first" approach enables shorter time-to-revenue with cash flow that can be used to finance US FDA trials. Tracking end-user results of products selling in Europe can accelerate and reduce costs for US FDA trials. Unfortunately, the EU first approach delays the availability of products to Americans.

[Note: additional information in sections below on Details of Sectors and Companies]

VIRTUAL REALITY, AUGMENTED REALITY – Games and Other

Both VR and AR had greater numbers of participants this year. There are many new entertainment and other offerings for VR and AR this year, but which ones will survive during the next 12 months is not obvious. There were some new applications for training workers and students in selected vertical application sectors. Time will tell if AR or VR is a cost-effective and efficient method in each application vertical. There were too many companies, mostly small companies, selling hardware and or software for virtual reality (VR) or augmented reality (AR) in specialized applications or sectors, so I was not able to accurately evaluate this area in 2018.

Video games cover a wide range of products covering: Apps for Android and iPhone devices; software for standard PCs; software for gaming PCs; and web-based multiplayer games. I am not able to predict with ones will win customers since I do not play video games and am too far removed from the under 35-year old crowd to understand their proclivities.

HOME AUTOMATION - SMART HOME – Total Automation

Some functions in a home are automated and interconnected to a central hub by companies seeking to take advantage of being associated with "smart homes", without being able to explain significant benefits for consumers, or why customers should

replace 2-to-4-year-old products that achieve nearly the same results. Most of these companies could not explain how their connected appliance or App has adequate security to prevent unwanted access, especially when many smart home products can spend my money without any participation on my part – i.e. a smart refrigerator that can order groceries or a furnace that can order filters.

Appliance makers have jumped onto the "smart appliance" bandwagon and many companies claim some entry to the smart home market. Nearly every appliance at CES 2018 has the potential to be controlled by a mobile device and therefore new potential access points for a hacker. Some smart appliances offer very useful benefits to consumers. Many other appliance makers are adding smart capabilities with little or no benefit other than having the appearance of being new and modern to appeal to consumers.

Amazon appears to lead in the smart home voice connection space, so most smart appliances will connect with Alexa although Google Home may be tied with Amazon in terms of connectivity of 3rd party devices.

[Note: additional information in sections below on Details of Sectors and Companies]

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4. DETAILS ON SELECTED SECTORS AND COMPANIES

TV MONITORS

TV manufacturers want to continue to sell flat screens at high profits. Now that many homes have 60-inch to 80-inch screens and prices are very competitive, TV makers are planning to promote the next steps in sizes. The next step is screens with a diagonal of 90 to 110 inches for the mass market and an upscale screen of 120 to 150 inches.

Companies making TV monitors have learned that most home TV viewers sit relatively close to their display for a given screen diagonal due to the limited space in many homes. Screens as large as 90-inch diagonal size look good at 10 feet from the viewer. Screens larger than 90 inches may start to appear grainy when viewed at 10 feet.

Most larger screen makers will opt for higher resolution – 8K horizonal by 4K vertical. That really brings the movie screen into the home. At that size and resolution there tend to be visual anomalies caused by the limited dynamic range of displays relative to the human eye when a given frame contains high-resolution bright portions and low-resolution dark portions.

VIDEO ENHANCEMENT FOR LARGE SCREENS

One result shown at CES 2018 was the promotion of enhancement of images via extensive digital-signal-processing on localized portions of each frame. This processing becomes very important on large TVs (over 80 inches) to have reasonable contrast on both dark and bright parts of every image. This processing compensates for the limited dynamic range of LED and OLED screens compared to the dynamic range of the human eye (almost 1,000 times better).

This type of image processing requires many billions of floating point operations per second; hundreds of times more than the fastest microprocessors. Each TV maker develops a proprietary and very complex semiconductor chip to better match the performance of their version of LED or OLED display. This type of chip development requires hundreds of specialized engineers working as a team for a couple years or more. Development costs in the range of $400 million for each of these large and complex chips is typical.

HIGHER RESOLUTION AND FASTER FRAME RATES

2018 CES had exhibits with a few 8K TVs, but the greatest change was lower prices for large-size screens. I did not see any demonstrations of 3D this year. There were some very large screens: there was a 145-inch screen at the LG booth. Some manufacturers hinted that development was still in process for 3D TVs that do not require 3D glasses. Most experts manning CES booths indicated that 3D TV without 3D glasses will require 8K by 4K display screens with a physical refresh rate of 480 frames per second.

MISSING LINK – LACK OF BANDWITH TO STREAM 8K VIDEO AT 480 FPS
Delivering that amount of data to a home and then to the TV is a challenge no one is addressing, especially for a home that has multiple TVs or a condo building where several units have one or more TVs each. It is not likely that video for 8K TV at 480 frames can be sent to a screen via WiFi without motion blurring of rapidly changing images such as when the TV camera operator follows the path of a baseball, football or soccer ball. While 8K TV that provides 3D without glasses may be practical in 5 to 7 years, it is likely to take years longer until there is suitable infrastructure to deliver sufficient bit rates to most homes with good image motion capability. Perhaps Over-the-Top video using the Internet will produce the needed 200 Mbps bandwidth to some homes. While some cities offer Internet at 200 Mbps (i.e. Las Vegas has multiple providers at 1,000 Mbps), most homes in the USA are not likely to have access to those data rates for 10 or more years.

It may be possible to provide 3D video on DVDs – but that will require much greater capacity DVDs that have about 500 GB per disk to store a 2-hour movie.

HEALTH MANAGEMENT DEVICES/EQUIPMENT

Health Management Devices are advancing, and some exciting devices are being developed. The most important devices require FDA clearance or approval and startup companies are struggling to raise sufficient capital to complete FDA trials along with production startup and building distribution channels.

Beewell part of Visiomed Group – Visiomed Group
http://en.visiomed-lab.com/ https://bewell-connect.com/
Beewell had a larger booth at CES 2018 than at CES 2017.
Visionmed Group SA is an emerging healthcare device and equipment company based in Paris, France that sells products using the Beewell brand name. Beewell is offering a moderately complete “Remote Medicine”. Their major product, introduced at CES 2017, is VisioCheck® which is a collection of medical diagnostic devices for sophisticated consumers or home-healthcare workers. VisioCheck performs a single-lead ECG, blood pressure, pulse oximeter, blood glucose and body temperature measurement using a handheld device with connected probes. VisioCheck has achieved its “CE mark” meaning it is approved for use in the EU. Visiomed employees indicated that US FDA testing was in process, with their goal to win approval in 2018.

Yaklee Network Bone conduction hearing aids and sports headphones
www.yaklee.cn
Yaklee offers small lightweight headsets that do NOT contact the ear. Their transducer headphone units press the transducer behind the ear where there is lesser tissue between the skin and the bone. Those transducers cause the bone to vibrate which is picked up by the middle ear and therefore bypass the outer ear.

I found wearing that headset was less noticeable than wearing in-ear or over-ear headphones. Music played through the headset produced very good frequency response from bass to treble as well as wide dynamic range from low-volume to high-volume, while at the CES booth.
There is no attenuation of background sound, so it is possible to have a normal conversation while listening to music. These headphones would be safer to wear while bicycling or jogging and crossing streets since traffic sounds would not be blocked.
The volume price was very reasonable.

Neurometrix - Quell - pain relief via neuromuscular electronic stimulation
https://www.quellrelief.com/
Neurometrix - Quell was NOT present at CES 2018. Quell was my favorite health device of CES 2017. The Quell device is consumer electronic pain reliever for any pain from the neck down using nerve stimulation in the lower leg (calf). Quell is listed on the NASDAQ pink sheets, advertises on US television and sells Quell electrodes on Amazon. Quell's stock has about doubled since CES 2017. Disclosure: I have purchased a Quell unit as a gift.

HOME APPLIANCES

LG Home Appliances
LG has completed development on several products that were early prototypes at CES 2017.
One product that attracted substantial crowds was a slim cabinet that sanitizes, deodorizes and de-wrinkles clothes using a combination of steam and shaking. The claim was that by using this cabinet you would require far fewer trips to the dry cleaner. This unit could provide an attractive solution for office workers that are required to wear business dress clothes to work daily.

LG Signature Air Purifier-Humidifier This device is the size of a robot - like R2D2 - and available for purchase. The unit provides both air cleaning and humidifier functions, using a fan to blow air through a recirculating waterfall. It contains multiple sensors and controls, so each user could set their desired level of humidity and air filtering particle density. The price is about $1800 retail. That seems excessive when there are whole-house humidifiers that attach to a central furnace and water supply that have a similar price tag – INCLUDING installation.

LG appears to be in direct competition with Samsung, Sony and several other large companies in Japan for home-assistant robots that appear to be aimed to perform various physical chores, especially for the elderly.

Toto USA - ceramic products with technological features
www.totousa.com

Toto continues to be a world leader in development and sales of advanced toilets. Toto is a Japanese company that started as a ceramics company and became an early developer of nanotechnology. Toto was the first, and remains one of the few, makers of a nano-coated ceramic toilet that requires much less cleaning. Based on personal experience with these nano-coated toilets, I fully agree.
Toto has advanced to augmented toilets. One is a self-cleaning model that uses powerful water jets for a cleaning cycle.

Self-cleaning addresses the demographics of Japan, which has the largest percentage of retired workers but few young people willing or able to perform housework in the homes of retired workers. The US and Europe have a lesser but significant aging demographic that would also provide a good market for self-cleaning.

Toto has also jumped into advanced bathroom tubs that are like Jacuzzi units with a few added functions and offer an attractive sculpted design unlike any others. These units are priced well above competing units, banking on their design appeal to win market share.

AUTONOMOUS VEHICLES (INCLUDING SENSOR IMAGE PROCESSING)

There were not as many automotive companies at CES this year. Auto companies that did have exhibits were focused on self-driving vehicles and/or subsystems of those vehicles. This year lacked any emphasis on electric or hydrogen vehicles. CES 2017 highlighted both electric and hydrogen powered vehicles, and promised leaps in efficiency and power density for 2018. So far there have been very minor improvements in batteries and fuel cells over the last two years.

As usual, I spent limited time visiting exhibits with vehicles and more time examining (A) sensors and (B) image processing and (C) image analysis - decision processing.

The most important automotive improvements over CES 2017 were actual vehicles ready to be tested for National Highway Traffic Safety Administration standards in Level 4 mode (no human driver under select conditions) and some in Level 5 mode (no steering wheel or brake pedals) driving mode.

Autonomous vehicles continue to fuel the imagination of most CES attendees and probably most of the world. Autonomous driving was the theme at every auto company exhibit. Many companies displayed exotic “concept cars of the future”. Most were flashy, with scissor doors, and some lacked steering wheels and pedals for braking-acceleration.

There were numerous vehicles offering test drives in a dedicated off-road area in front of the Las Vegas Convention Center (LVCC). As usual there were extensive lines, so I avoided that area.

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Suppliers of autonomous vehicles and critical vehicle components attracted extensive attention. Inside the LVCC some auto companies had large display booths with vehicles on display.

This year there were fewer automotive brands on display. Another change was that most brands promoting self-driving autos updated their concepts to include many more sensors per vehicle. Engineers at those booths indicated that it is much more difficult to have fully autonomous driving in all weather conditions that can include dense fog, snow, ice, rain accumulation and detours/lane changes due to construction.

Another notable change from last year's CES was widespread adoption of many more sensors on self-driving vehicles. Early autonomous vehicles envisioned an array of video cameras on all sides of a vehicle; some added a front and rear millimeter wave radar.

Newer self-driving vehicles now have many more radars on front, back and sides. Many have some form of separate infrared video cameras that cover longer wavelengths to 14 microns to detect small children and small animals. Most have several LiDARs (laser radars that may be visible and/or infrared) that are better at detecting recent road changes not yet in GPS databases, as well as determining the nature of objects on the sides of roads in total darkness – i.e. for people about to enter the roadway, animals that may jump into the road or traffic cones and other inanimate objects.

Mercedes Benz AMG - Supercar

A new model of a Mercedes AMG that is being sold in 2018 was my pick for the most appealing design, albeit at a price of around $2.8 million. It looks a lot like an updated Batmobile but was built based on a Mercedes Formula 1 racing design. It was a hybrid with a gasoline engine over 800 horsepower plus electric motors that add over 300 horsepower to achieve close to 1200 total horsepower for rapid acceleration and a top speed far above 200 mph.

Ford – Self-Driving Vehicles for Delivery

Ford displayed a prototype vehicle with many sensors including roof mounted laser radars (LiDARs), millimeter wave radars on all 4 sides, along with multiple visible cameras. One prototype had a roof with a thickness of about 7 inches. The LiDAR units were mounted in this very thick roof, so they did not protrude and create much air resistance at higher speeds. While those LiDAR units in the thick roof were obvious with their clear lenses, they are a much more aesthetically pleasing design than the cans that look like the rotating beacons on police vehicles that protrude from other self-driving prototypes.

Ford has partnered with a company called Postmates (based in Silicon Valley) for delivery businesses. Field trials of their initial vehicle will begin in March 2018, but are likely to have a human on board.

Toyota – Self-Driving Vehicles for Delivery

Toyota has partnered with Pizza Hut and Amazon for deliveries with a self-driving van. Field trials of this van are planned for the 2020 Tokyo Olympic Games, with a budget of $1 billion for research and development to create and deliver vehicles for the Olympic field trials. These vehicles look more like a trailer pulled by a car, but are fully autonomous vehicles (Level 5), with no human participation.

TuSimple Tractor for Tractor-Trailer Long-haul Trucking

TuSimple is based on China with offices in San Diego. **TuSimple.ai**

There was an actual operational Peterbilt truck at the TuSimple CES booth. TuSimple acquires trucks, then modifies them to achieve a self-driving long-haul truck able to pull 1 to 3 trailers. TuSimple installs sensors (8 each video cameras and 3-millimeter wave radars), electro-mechanical driving controls and their own artificial intelligence (AI) to achieve Level 4 driving capabilities.

RoboSense MEMS LiDAR **www.robosense.ai**

MEMS LiDAR RoboSense created an all-electronic laser radar (LiDAR) unit designed for self-driving vehicles using technology from the Harbin Institute of Technology (HIT) in Shenzhen, China.

Their LiDAR unit is the size of an internet cable modem; smaller than other LiDAR units that generally use scanning mirrors. The small size of RoboSense units enables installing units without multiple devices in the shape of rotating lights on police vehicles that stick up above the roof of a vehicle.

The RoboSense unit uses tiny moving MEMS mirrors on a semiconductor chip for scanning, very similar to the MEMS mirrors used for projection television units made by Texas Instruments. The MEMS chips for television units have become very reliable and operate accurately for years. This MEMS approach to LiDAR is a logical approach. There may be a loss of a several angular degrees in the field-of-view in a MEMS device compared to physically moving mirrors. However, the small size, greater reliability and much lower production cost are overwhelming advantages. The addition of an extra MEMS units can more than compensate for a lesser field-of-view.

Nvidia – AI Sensor Fusion, Image Processing and Navigation

www.nvidia.com Nvidia has achieved global recognition due to its skyrocketing share price on the NASDAQ.

Nvidia has captured the vast majority of the automakers for sensor integration, image processing and navigation for self-driving at Level 3, Level 4 and Level 5.

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The most impressive product at CES from my perspective was Nvidia's large-sized image processing board rated at 30 trillion floating point operations per second (30 Teraflops).

This module included a full-custom semiconductor image-fusion and image analysis processor chip [editorial comment – likely to have required $400M+ to develop] plus different a full-custom semiconductor video processor chip [editorial comment – likely to have required a separate investment of $400M+ to develop]. This module can perform sensor fusion from a combination of sensors including numerous visible cameras (up to 16), multiple Lidar (active visible or infrared light radars), and multiple millimeter wave (MMW) radars. The board has inputs for 40 or more independent sensor units. The module also has artificial intelligence analysis capabilities that provide navigation routing and decision analysis to control automotive steering, braking and acceleration.

Auto companies that need more than 30 Teraflops can connect a parallel board to achieve 60 Teraflops and added redundancy.

Nvidia is a world leader in gaming computer video processors boards. Nvidia uses the same full-custom semiconductor chips both in gaming boards and in automotive self-driving. Gaming boards can be sold as soon as they are operational, allowing Nvidia to "test" their performance and reliability with over a hundred thousand customers. Meanwhile, Nvidia can go through the extensive over-two-year long automotive qualification process required for their mission-critical boards used for self-driving.

HOME AUTOMATION

CES 2018 offered a very large number of new Apps for both Android and Apple. There were very few Apps for Windows.

While there were many new Apps, there were few if any new capabilities provided by Apps. There were improvements on the hardware aspects enabled by better sensors and innovative sensor subsystems/modules that are smaller and less expensive to manufacture.

AerNos MEMS Gas sensors and monitoring devices www.aernos.com

AerNos is an emerging company designing, developing and producing chips to sense and quantify several toxic and dangerous gases simultaneously using nanoscale sensors. AerNos makes their chips for customers at a minimum volume of a million units and discounts for volumes much greater than a million are offered. A prototype chip displayed at CES could measure nitrogen oxides, SO2, CO, O3, VOCs, formaldehyde, CO2, methane and other hydrocarbons.

Fraunhofer Institute - Facet Vision Project for Ultra-Thin Cameras
www.facetvision.de

Fraunhofer Institute is a large, and highly-respected research institute with a history of hardware innovation. This year, their offering was an ultrathin CMOS camera chip with 20-megapixel imaging using 1.12-micron pixel pitch and an innovative "planar receptor array optics". The entire camera module was only 3.5mm thick so it offers almost ½ the thickness of existing cameras using traditional lens designs. This is an advantage in smartphones: this camera was targeting smartphone applications, but may be more valuable for use for robot vision or self-driving vehicles.

Brinno Home Security WiFi and hidden cameras http://www.brinno.com/
Brinno offers home-security cameras for residential and commercial applications. Their home devices include miniature cameras that can be hidden or disguised. One looks like a normal peephole on a front door that is motion-activated from sleep mode, so it will operate for weeks on a single charge. Brinno has many small company competitors, but few are addressing the application for outdoor-capable hidden cameras.
Several competitors offer features such as higher camera resolution, lower light sensitivity and wider fields of view. No company in this space offers all those useful capabilities so far. There is no technological reason why all these features cannot be provided in a small, low-power, inexpensive unit.

BreezoMeter Air Monitoring with Location Based Data
www.BreezoMeter.com
BreezoMeter is based in Israel and partners with companies that make devices, systems and/or provide services that generate data on air and water quality. BreezoMeter continuously collects data from its partners and analyzes the combined set of data from all its partners and public sources around the world. BreezoMeter then produces localized data that is provided to subscribers.

ROBOTS

There were many more companies demonstrating robots this year. Some had improved performance or added capabilities compared to CES 2017. Some could serve businesses in a limited capacity. None appeared to be ready for use in a home due to the combinations of higher prices and limited capabilities.

Some of the robots at CES 2018 were targeted to delivery small items inside a building. The greatest quantity of robots displayed claimed to be "friends", such as robot pets or interacting voice robots that could move – like an Amazon Alexa in an R2D2 body.

The home-run application for robots is the Home Healthcare Physical and Medical Assistant.

Given aging demographics in advanced economies (USA, Europe and Japan) and a severe shortage of highly-skilled home health-care workers, companies are still aiming

to create one or more robot products that fulfill those needs. The intelligence aspect of these robot prototypes has improved since CES 2017. Some have on-board artificial intelligence while others connect to a remote supercomputer, such as IBM's Watson. That remote connection may be needed for advanced medical function robots.

HOME HEALTHCARE ROBOT NOT READY TO PHYSICALLY HANDLE HUMANS
That type of home healthcare robot will require a leap in physical capability beyond prototypes shown at CES 2018 including: (A) far more sensors to adapt to physical conditions in each home and where/how to make contact with a human patient; (B) much better manual dexterity to assist impaired people with everyday activities; (C) along with the capability to lift and manipulate people up to hundreds of pounds without causing injury or pain; and (D) include vastly greater artificial intelligence able to adapt to unforeseen circumstances.

Home healthcare workers are frequently called upon to move subjects who have little or no physical strength or non-functioning limbs. Some normal tasks needed daily are to transfer subjects out of bed and into a wheelchair, or from a wheelchair into a bathtub or from a wheelchair into a vehicle to go to a doctor. Those subjects may weigh 300 pounds and have random and changing areas on their body that are painful if touched. Such needs demand a robot that has a wide range of dexterity and physical strength in many linear and rotational dimensions. No robot comes close so far.

Beijing Canny Unisrobo Technology Company

Beijing Canny Unisrobo Technology Company demonstrated the "U05 Humanoid Robot" model of their Canbot robots for commercial applications.
http://www.uurobot.com/en/
This unit had some interesting features, such as free speech interaction, rapid face recognition, autonomous walking capability, a modest level of dexterity and the ability to serve as a hub to numerous internet-of-things devices. It might be useful to slowly guide customers around a supermarket to find items (speed is limited to 3 feet per second); or to deliver mail in a large office building. It may be capable of picking letters/envelopes out of an array of boxes in an X-Y array like those used to hold messages in a hotel. It did not appear capable of picking items off a supermarket shelf and placing them in a shopping cart.

APPS

There were too many App companies at CES 2018 and most are not likely to survive until CES 2019. One health related App that demonstrated a useful application is LMD.

Leman Micro Devices (LMD) – blood pressure, blood oxygen, pulse and other information
www.leman-micro.com

LMD is a pre-revenue company that has developed an App that measures blood pressure, blood oxygen, pulse rate, respiration rate and body temperature health signals without any devices other than a smartphone with a camera.

The App collects a signal from blood flow in a finger and then analyzes that signal to calculate blood pressure, pulse rate, and similar information.

I tested this App and it produced results that were reasonably accurate. This type of App has been tried in the past, but prior attempts result in reporting substantially lower blood pressure than a cuff in a high percentage of users.