Market Intelligence

3DTV Market — By the Numbers

Below is a summary of recent market data on the 3DTV market.

LCD Panel Makers Have Aggressive 3DTV Targets

According to DisplaySearch, worldwide Q1'11 shipments of LCD 3DTVs increased 104% from Q4'10 to reach 1.9M units. That represents a 3.9% penetration of all LCD TV shipments, which panel makers hope to expand rapidly to 16.8% by Q4'11 so that overall 2011 penetration levels reach 12.3%.

While the sale of a 3DTV counts toward meeting this penetration level, whether it is used to actually watch much 3D content is another issue. In fact, there are two adoption cycles happening with 3DTV simultaneously.

The first is a technology upgrade cycle. This can happen quite rapidly, as represented by the move to LEDs, 240Hz panels, Smart TV functions and 3D capability. This cycle establishes the functionality in the TV.

The use of this feature is on a different penetration curve. Use of the LED backlight is universal among purchasers of LED TVs, but the use of dynamic dimming may not be universal because of the impact on picture quality (it can make film content look like video, which many object to). Use of the Smart TV feature is coming quickly too, as Internet gateways from the TV and many accessory devices are enabling delivery of over-the-top content.

But adoption of 3D has many different adoption factors. It requires all new content, the use of glasses to see the effect, and the possibility of getting sick is a concern. All these factors will make the USE of the 3D feature on a much slower penetration curve. The point it, which increasing hardware penetration numbers are a necessary step, they do not reflect the use of the feature in real life.

According to DisplaySearch, worldwide Q1'11 shipment of shutter glass type 3DTV panels reached more than 1M units, while pattern retarder type 3DTV panels followed closely behind with approximately 880K units shipped.

The panel premium for the 240Hz panels need for the shutter glass type 3DTV has been reduced from $50 last year to $25. While this premium is thought to be lower than the addition of the Film Patterned Retarder (FPR), FPR makers are not stuck using 240Hz panel to create a 3DTV solution. In fact, they can use 120Hz and even 60 Hz panels, as a well as CCFL backlight units, to create value-oriented 3DTV solutions — something shutter glass type 3DTV makers can't do very well.

3DTV panel production is lead by four companies: Samsung Electronics, LG Display, AU Optronics (AUO) and Chimei Innolux (CMI).

U.S. Market Off to Good Start in Q1'11

According to NPD data, 3DTVs from Samsung Electronics accounted for more than half (51.1% to be precise) of 3DTV unit sales in the U.S. from January to April 2011. The company also led in LED-backlit LCD television, Internet-enabled TV (IETV) model (48.1% unit share), and, for the first time, plasma panel display (41.8% unit share).

As a result, Samsung remains the number one TV brand in the U.S. in terms of both unit sales and revenue.

According to Quixel Market Research (Portland, OR), 586,276 3D televisions were shipped to U.S. dealers during the first quarter of 2011, up 352% from the same period a year before. However, this rate is exaggerated because 3DTVs only first came on the market in March of last year. Plasma 3DTV sales represented about 153K, LCD about 340K, with the rest spread between front- and rear-projection 3D products

In 2010, Quixel says 1.23M 3DTVs were shipped in the U.S., which compares to Insight Media's forecast (issued in Feb. 2010) of 1.2M units. For 2011, Quixel is quite bullish on 3DTV, predicting 6.2M units for U.S. dealer sell-in. Quixel says that 60% of the 40-inch and larger flat panel TV offering now have the 3D feature.

3DTV shipments continue to build momentum in the years ahead, with forecasts of 10.3M 3DTVs in 2012, rising to 18.6M for full year 2014, which remains ahead of Insight Media's forecast.

Passive flat-panel 3DTVs are expected to have a big impact rising for 5% of sales in Q1 to nearly 18% by year's end. Vizio, LG and Toshiba are the most aggressive brands in the U.S. For more on Insight Media's Passive Polarized 3DTV report, see the link below:

http://www.insightmedia.info/reports/20113dpassivedetails.php

China 3DTV Sales

The China Electronic Chamber of Commerce (CECC) estimates that 5M 3DTVs will be sold by the end of 2011. Meanwhile, consulting firm China Market Monitor Co. (CMMC) said that 3DTVs would take about 12% to 15% of the share in the panel television sector by the end of 2011, and Displaybank estimated that more than 86% of plasma TVs will support 3D technology by the end of 2013.

Consumers in China are starting to buy 3DTVs, as reports on the Labor Day holidays in early May suggest that 3DTVs accounted for 10% of all LCD TV sales. According to CMMC, FPR technology grabbed a 45% of market share in April, an increase from zero in less than five months.

DisplayBank said that 3D panel supply share recorded 14.2% of the total in April 2011, an increase that was supply limited and dominated (82%) by Korean suppliers. Total panel shipment toward Chinese TV brands in April 2011 recorded 2.91M units, which increased 11% Y/Y.

DisplayBank reads the Chinese tea leaves a bit differently. It says the current Chinese TV market is moving toward premium-class TVs from low-cost models. Sales of premium-class panels, namely large-size, LED backlit and 3D-enabled panels from the top six Chinese TV

brands — including Changhong, Haier, Hisense, Konka, Skyworth and TCL — show a gradual increase.

Other reports suggest that Chinese consumers are reacting very favorably to the low-cost FPR 3DTV models. Clearly, this an important market to watch.

LG Targets Middle East and Africa

According to news reports, LG Electronics is hoping to capture a 40% share of the 3DTV market in the Middle East and Africa. It thinks its FPR technology can be used to create the value products this market wants.

DisplaySearch thinks the sales potential for 3DTVs in the Middle East and Africa will be 730K units in 2011, 1.69M in 2012, 2.74M units in 2013 and 3.89M units in 2014.

Taiwan 3DTV Market Still Developing

Domestic sales of 3DTVs in Taiwan are reported as slow. Local TV makers hope to change that. For example, according to a *DigiTimes* article, Chimei Innolux (CMI) and BenQ will be introducing new lines of 3DTVs in the second half of 2011.

CMI plans to adopt active 3DTV panels for its large-size LED TVs, while BenQ will adopt passive 3D panel technology for its 3DTV product line. *–Chris Chinnock*

Quixel Market Research, Tamaryn Pratt, [1] 503-460-0078, tamaryn@quixelresearch.com

3D Industry

The 3D Sky Is Not Falling

There has been a ton of press in recent weeks about the consumer backlash to 3D — especially in the theaters. In fact, some of the criticism is justified. But, the reactions and consequences that some have predicted have gotten way out of hand. What we are seeing is a natural cycle in the introduction of new technology. 3D will continue, and calls that the boom is over are misguided.

The main complaints in the theater arena are the low brightness of the 3D film, the extra cost you have to pay to sometimes see inferior image quality, and the overuse of 3D for movies where it adds no real value. These are indeed fair complaints.

The reality is that many 3D movies are being screened at 3-4 Ft-L — a far cry from the 14-16 Ft-L recommended for 2D films. Hollywood has had to live with the low brightness of 3D due to the technology limitations, but theater owners are making it worse. They have to pay for the lamps in these projectors, and they are therefore motivated to run them as long as they can. Unfortunately, some are running them too long and creating 3D images that are so dim that even ordinary consumers are noticing. In addition, they are so dim that the color grading is no longer

accurate; and the movie has muted colors too. The overall impact is poor image quality — which consumers are paying a premium to see.

Theater operators don't usually have the option to add a larger Xenon bulb, so ideally they need to replace the bulbs more often. But, when the 3D screen is not drawing extra revenue, it is hard to justify the added expense. Theater owners operate on thin margins, so we understand the attention to the bottom line. However, if you create bad word of mouth for 3D in the process, is that a good trade-off? Probably not.

From the Hollywood side, the use of 3D in some movies is clearly being questioned by consumers. Some consumers don't see how 3D is adding to the movie and, thus, view it as a gimmick to get more money out of them. Again, the criticism has some validity.

Some movies may just not play that well in 3D. *Transformer: Dark of the Moon*, due July 1, may be such a film. This series has been full of fast action and visually rich scenes that may be very confusing and overwhelming in 3D. We will have to see if the same stye was applied to the 3D version and how that plays with audiences.

Box-office results for some of the latest 3D movies have not been as strong as Hollywood would have liked, but most films in general have performed under expectations. It has not been a very good spring, nor start to the summer blockbuster summer … so far. The box-office performance in the first six months of 2011 was soft — revenue fell about 9% compared with last year, while attendance was down 10%. 3D can't save films.

Complicating the picture is that the backlash is not yet happening in other parts of the world. While Disney's *Pirates of the Caribbean: On Stranger Tides* did not do too well in North America, it had a powerful opening weekend abroad, which Disney trumpeted as the biggest international debut of all time.

Some have asked: With 70% of the box office for Hollywood being international, does the domestic market really matter that much? One would think so as trends that show up here, as detailed above, are likely to show up later in international markets.

Again, the planning of 3D films is probably going through a natural correction phase. Sub-par 3D films won't kill 3D, but they will actually improve it as Hollywood learns to use 3D in the right films.

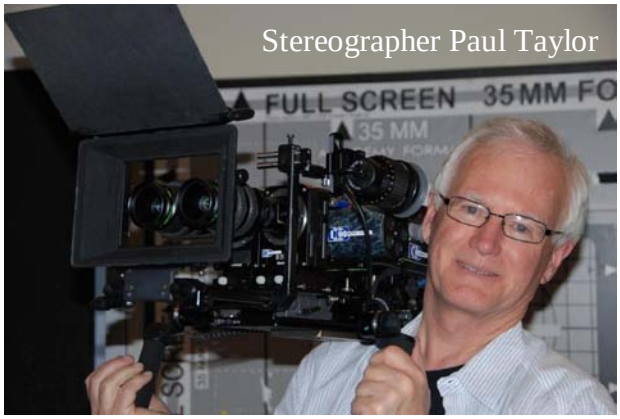
Using 3D in a film is an artistic choice — and should not be used as a way to drive ticket sales. 3D revenue peaked in the 60% range last year and is falling in the 40% range this year, but this was to be expected.

So, while storm clouds are in the area, the sky is not falling — sunnier days will return. – *Chris Chinnock*

3D Content Creation

The Evolving Role of the Stereographer

As Hollywood struggles to conquer the challenges of stereoscopic 3D production, one of the least understood positions on the production crew is the stereographer. Yet that person is the one most responsible for making sure that the visually challenging 3D medium doesn't become not just incomprehensible, but downright upsetting to the viewer.



Stereographer Paul Taylor

Although it reaches back to the first heyday of 3D in the '50s, today the role of the stereographer is rapidly evolving and may someday, like the vaunted "Technicolor Color Consultant" of the '40s and '50s, be absorbed into the responsibilities of other key positions on a 3D shoot.

This article was sparked by a fascinating discussion between famed stereographer Paul Taylor ("Harold and Kumar 3D" and "Kylie Minogue 3D" music video), and the founder and CEO of 3Ality Digital, Steve Schklair, during a panel discussion on 3D post during June's CineGear Expo 2011 held on the Paramount lot in Hollywood.

The functional job of the stereographer is to determine the "depth budget" of individual shots and control the way they fit into a production as a whole by setting the interaxial distance (IA) on a 3D film or video camera. That's the distance between the 3D camera's left and right lenses that determines how much depth the audience will see in a given scene with a greater distance producing a greater depth budget.

Then the stereographer also sets the angle of convergence between the two camera's lens arrays, which positions objects in the scene either in front of the screen (negative parallax), at the screen plane (zero parallax) or behind the screen (positive parallax).

Or, as Taylor puts it, "The first responsibility of the stereographer is to make sure the 3D doesn't hurt your eyes."

The way it works on most modern 3D sets, the stereographer mans his own console that has controls to adjust both the IA and convergence. Taylor explains that the director of photography is usually either too busy to handle this technical concern or often does not have the experience to deal with it properly. Yet since studios and producers have learned that bad 3D can kill a film's box office, it's a position that can affect a production's market success.

The controversy arises between different philosophies governing how to best use that depth budget to enhance a film's visual aesthetics.

"In a feature film, I want the 3D effect to be unobtrusive so each scene looks natural," Taylor said. "The viewer should not be aware of the depth budget when immersed in the story. It's both an art and a science of trying not to make the 3D effect call attention to itself."

Taylor makes an analogy to the role of a film's music composer. "The top composers tell me if you heard my music, I failed. That's the way I feel about 3D. Of course, there will be exceptions, but as a default I feel if the viewer was aware of the 3D, I have failed as a stereographer."


3ality Digital
CEO Steve Schklair

Steve Schklair, CEO of 3Ality Digital, a major producer of 3D camera rigs and processing equipment, politely disagrees with his friend Paul by contending that the depth budget of the 3D effect in a film should be used as a creative element just like depth of field, shot composition or multi-plane focus.

"I believe the stereographer's role is to help the director of photography creatively interpret the imagery of a screenplay the way the film's director envisions," Schklair said. "As an example, if you have a character who is feeling alone and isolated, you can push them farther away from the audience within the depth budget to enhance their sense of isolation with other characters. Or, if the scene is intended to be intimate, the character can be brought closer to the screen so the audience feels more personally connected with their situation."

Schklair makes the comparison to a DP erroneously insisting on exclusively using 50mm lenses that emulate normal human vision. "Telling me you cannot use 3D as an interpretive tool defeats the purpose," he insisted. "Where the characters appear in negative or positive parallax has a lot to do with how the story is told. Otherwise, 3D is just being used as a novelty, and audiences will get tired of that within weeks."

Regarding the control of convergence, 3Ality Digital has developed a system called IntelleCam for live multicam shoots like sports events, which we covered during our reporting on the NAB convention in the May *Large Display Report*. With IntelleCam, the stereographer sets the overall depth budget for individual cameras on a multicam live shoot, and then a complex series of algorithms adjusts the convergence for each camera's position.

So will there be a time when the role of the stereographer will be folded into the responsibilities of the DP? Both Taylor and Schklair feel this will be part of the evolution of 3D.

"DP's are more and more taking a stronger hand in this," Schklair said. "On some movies, they are already fulfilling the role of the stereographer, and this will increase as the necessary skills are more universally understood."

Taylor agrees. "We can't go on having stereographers forever. Some day, with a whole new generation of filmmakers who learn 3D in school, it may be possible that DPs will absorb those abilities. But that may be 10 years away. Until then, why would a DP want to risk his job by undertaking a function for which he or she does not have the necessary experience or skills?"

But when that day comes, the sovereign role of the independent stereographer may become as arcane as the Technicolor Color Consultant is today. *–Jay Ankeney*

3D Broadcast & Distribution

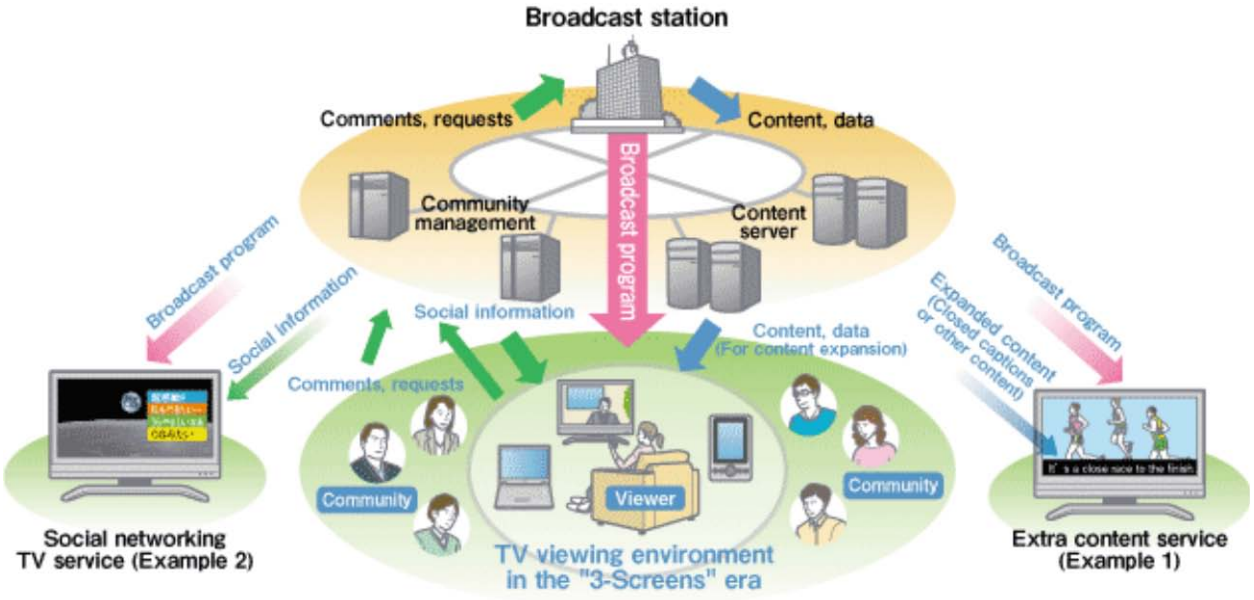
NHK Sends Full-HD 3D to Each Eye Using "Dual Stream" Technology

NHK Science & Technology Research Laboratories (Tokyo, Japan) has demonstrated transmission of full HD 3D video to each eye using a "dual-stream" technology. The feat was accomplished by the simultaneous use of broadcast and communication channels. The video was presented on a 3D-compatible TV.

The demonstration took place at Open House 2011, which was available to the public from May 26 to 29. The new technology was developed in collaboration with Nippon Telegraph and Telephone Corp.

There are an increasing number of broadcast TV channels offering 3D HD content, most of which utilize side-by-side transmission. This approach compresses the image for each eye by about 50% and stores both of them in one full HD video frame. The video is decompressed at the TV side. At this time, broadcast-grade content cannot deliver 1080p per eye.

The most important benefit of dual stream technology is that it does not reduce resolution. With this approach, video for one eye is transmitted to a home TV using the airwaves. Video for the other eye is transmitted by a communication line (IPTV or Internet-based video). As a result, it becomes possible to transmit full HD video to both the right and left eye.



An important issue with the dual-stream technique is that signals transmitted via a communication line normally lag behind those transmitted by airwaves. NHK reports that this issue was addressed by embedding a Presentation Time Stamp (PTS) signal in both the airwave and the communication line video. These signals are used to synchronize the video for the right and left eyes when received at the TV side of the transmission.

The demonstration used a Panasonic 54-inch 3DTV model TH-P54VT2. NHK did not indicate if the specifications of the TV were changed in any way to enable the demonstration.

NHK exhibited the new 3D technology as one application of the company's new Hybridcast service. The service combines broadcast and communication. As to when NHK may offer the services to consumers, the company stated only that "We are laying the groundwork for a variety of new broadcast services that will be in tune with future needs of our viewers in the 3-Screens era." *–Arthur Berman*

AS-3D Displays

DTI Reveals Impressive New Approach

DTI has demonstrated a 22-inch AS-3D monitor using a newly developed scheme that solves many of the problems with conventional barrier or lenticular designs. In particular, it allows a full resolution view to be delivered to each eye, and it can operate as a conventional 2D display without any image compromises.

As most readers know, conventional barrier and lenticular designs loose resolution per view, and this increases with the number of views. In addition, viewing 2D content is really not possible unless special processing or switchable lenticular or barrier technology is used.

The innovation that DTI has come up with seems elegant in concept, but the details of implementation have not been revealed, so it is hard to fully judge the impact this will have on the market. (DTI's goal is to license the technology, so it will need some help in commercializing it.)

In June's *MDR*, we described an approach from Sony that created a new AS-3D backlight featuring two modes. In 2D mode, the backlight operated as usual for good 2D images, while in 3D mode, a second backlight is used to create lines of illumination that simulate the light that would have come through a parallax barrier. This eliminates the barrier itself.

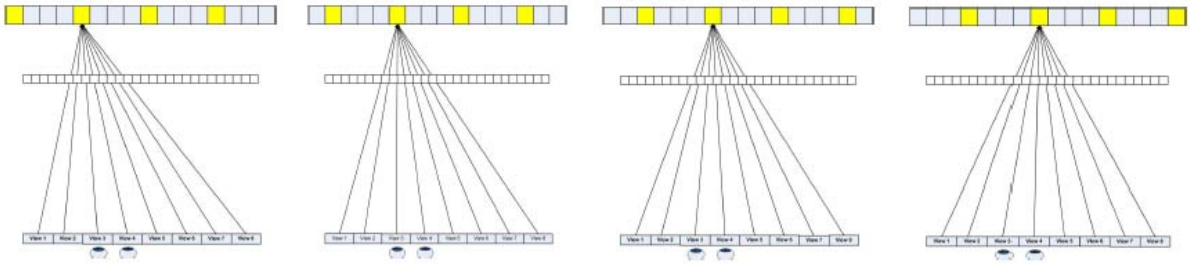
DTI's approach uses this same concept of lines of illumination in the backlight, but takes it one step further. According to Jessie Eichenlaub, the chief science officer at DTI, "The illuminating lines are formed by focusing light from conventional sources into hundreds of thin, bright lines. Thus, the display can be as bright, and nearly as power efficient, as a normal 2D display. The use of DTI's patented lighting technology behind an LCD is extremely versatile in the sense that the function of the display can be changed merely by turning the light sources on and off in different patterns."

This allows the two unique features of this technology:

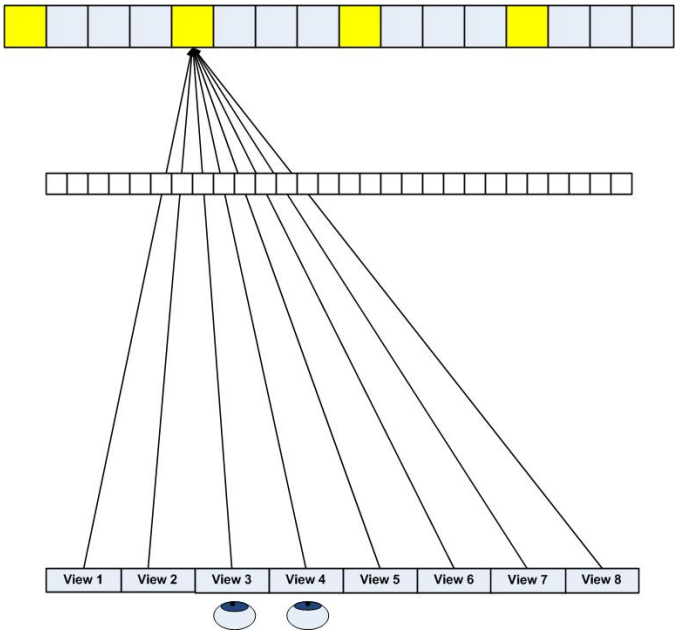
Its ability to change the illumination between the light line pattern for 3D viewing and conventional illumination for perfect 2D viewing simply by turning on different sets of light sources. Normal 2D content looks no different than it does on any other display.

Its ability to use flashing light line patterns in combination with time multiplexed 3D images on the LCD can create 3D images with the same resolution as the 2D images.

The key is to use higher refresh rate LCD panels. For example, Eichenlaub says that if a 120Hz refresh panel is used, an eight-view autostereoscopic mode with HALF-resolution per view is possible. If a 240Hz refresh panel is used, then an eight-view autostereoscopic mode with FULL resolution per view is possible.



So far, Eichenlaub has demonstrated the technology in a 22-inch monitor with 1680 x 1050 resolution. But, the concept can be scaled to nearly any size display with any resolution (assuming the processing is there for the pixels). He also says the approach eliminates potential moiré effects.



The way that the flashing light line pattern works is illustrated in the four images below, showing four sets of light lines flashing in sequence, once every 120th second. Note that during the four-flash sequence, each eye located in one of the viewing zones sees light coming through half of the pixels, instead of just 1/8th as would be the case with a fixed parallax barrier.

It seems that the DTI demo uses a 120Hz panel with modest resolution. If a four-flash approach is used, that will create AS-3D images that update at 30Hz, which may cause some artifacts. So, DTI's next demo should use a two-flash approach or move to a full 240Hz panel for a four-flash approach. *–Chris Chinnock*

3DI Offers a New Autostereoscopic Touchscreen Display

3D International (Kuala Lumpur, Malaysia and Jena, Germany) has introduced a 21.5-inch autostereoscopic display product with touchscreen capability.

The press release describing the new product explains that the majority of previous autostereoscopic 3D displays have had a design viewing distance that is longer than the length of a human arm. As a result, they were not useable for touchscreen applications. In the company's new 21.5-inch so-called CLD display, the 3D viewing distance has been shortened to arm's length, while still claiming to achieve an excellent 3D impression.

A datasheet for the new display can be found here.

Specifications for the new display include a viewing distance of from 80-180cm and a resolution of 1980 x 1080.

The 3D display is reported as embodying five new patents/patents pending. Apparently, the 3D technology is based on its own technology called Chromatic Light Deflector (CLD). We are unsure how this works exactly. The monitor also supports multi-touch functionality based on an infrared technology.

No comment is offered on any potential user/use-related issues that might arise from combining touch technology with 3D imagery.

The company Website indicates that the 3D International organization includes two companies with names familiar to the 3D industry: True Vision Technologies and VisuMotion GmbH. No word on pricing or availability either. *–Arthur Berman*

3D International, Ambrose Nari, +60(0)3 8060 0748 / 0762, ambrose@3di.com.my

3D Mobile Products

Lytro Announces Light Field Camera

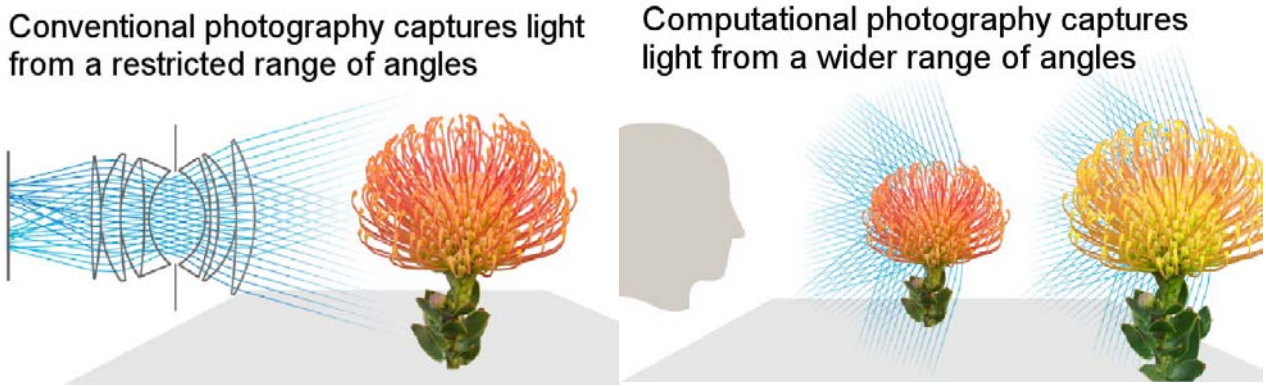
Lytro Inc. (Mountain View CA) has announced a point-and-shoot light field camera targeting the consumer market. No details, such as price, availability, resolution, etc., were available for the camera, however. The press release from Lytro said the camera would be available "later this year."

"This is the next big evolution of the camera," said CEO and Founder Dr. Ren Ng. "The move from film to digital was extraordinary and opened up picture taking to a much larger audience. Lytro is introducing Camera 3.0, a breakthrough that lets you nail your shot every

time and never miss a moment. Now you can snap once and focus later to get the perfect picture."

Light field science was the subject of Ng's 2006 Ph.D. dissertation in computer science at Stanford, which was awarded the internationally recognized ACM Dissertation Award in 2007. Ng's research focused on miniaturizing a roomful of a hundred cameras plugged into a supercomputer in a lab. In 2011, the Lytro team will complete the job of taking light fields out of the lab and making them available in the form of a consumer light field camera.

Computational photography using light field reconstruction has been a research topic for a number of years. One of the problems with computational photography is the very large amount of data associated with a high-resolution image. To get the image quality a consumer associates with a normal 1MByte snapshot from an 8Mpixel camera, it may be necessary to store as much as 100MB of data and use an imager with 800 megapixel. Obviously, this would not be practical in a point-and-shoot camera, so Insight Media is looking forward to seeing how Lytro solves this problem. Even at a professional level, 800 megapixel sensors aren't really practical, which is why researchers into computational photography have used a room full of a hundred individual cameras in the past.



Typically, both the sensor and the "lens" in computational photography are large in area but can, at least theoretically, be very thin. Since no specifications on the camera are available, it is not clear if the proposed point-and-shoot camera is also a pocket camera. Size isn't necessarily a catastrophic barrier — people have accepted the 10-inch size of the iPad, for example, to get features and a display not available in a four-inch smartphone.

Another problem with computational photography is it doesn't produce a viewable image until after the "computational" part. Presumably, any handheld camera from Lytro would include the basic software needed to produce an image visible on the camera display. Typically, computational photography involves post processing and image editing. Again, from a consumer point of view, is this what they want? Taking a photo but being unable to view it in its full glory, except after a half hour or so of optimizing it on your computer, is not really what point-and-shoot photography is all about.

Claimed advantages of the technology include:

- No focusing required. Focus of the image can be done in software after the image is complete, so the viewer can focus on the part of the image desired. Since no

focusing is required, there is no lag from the auto-focus mechanism between pressing the shutter button and when the photo is taken.

- Living pictures: The photographer and other viewers can interact with the photo.
- Low-light sensitivity: Computational photography can utilize a higher proportion of available light than can conventional photography.
- Immersive 3D: Using the full set of light field data will allow people to easily switch between 2D and 3D views or shift the perspective of the scene. This claim from Lytro is perhaps another indication that the system may be point-and-shoot but not pocketable, since you can't get 3D, let alone perspective changes, from a pocket-sized system. Not even with computational photography.

Lytro has an online picture gallery of Adobe Flash photos that can be manipulated over the Web. While it is not stated, presumably these photos were generated with the Lytro camera, either laboratory model or prototype of the consumer version. (Note: Anyone who can use a Nixie tube display as the subject of a photo demonstration is a geek after my own heart!)

While Insight Media may be skeptical, Ng has obviously convinced others of the value of his technology. Lytro has raised approximately $50M to date from Andreessen Horowitz, Greylock Partners, NEA and K9 Ventures along with individual investors. Greylock Partners seeded Lytro, and Andreessen Horowitz led the most recent Series C round, which raised $37.6M for Lytro's push into consumer markets this year. NEA led the Series B round in 2010. Advisors to the company include two Nobel laureates, Stanford physics professor Douglas Osheroff and physicist Arno Penzias, as well as Intuit cofounder Scott Cook, Dolby Labs Chairman Peter Gotcher, VMware cofounder Diane Greene and Sling Media cofounder Blake Krikorian.

Lytro currently employs about 40 people at its headquarters in Mountain View and its facility in Hong Kong. Plus, they are expanding: The Lytro Website lists 10 jobs, most in Mountain View but one in Taiwan, including a job whose title is "Director of Delight." – *Matthew Brennesholtz*

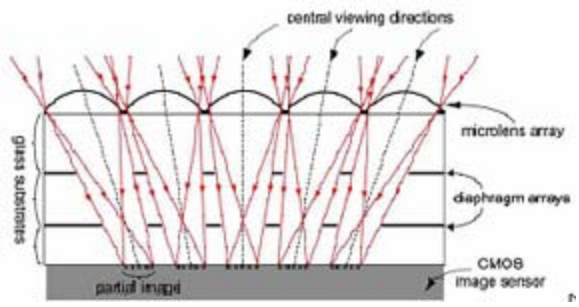
The Outcast Agency for Lytro, +1-415-392-8282, lytromedia@theoutcastagency.com

Coming Soon: A Technology That May Put a Bit of a Bug in Mobile Cameras

The trend in personal mobile electronic devices is toward the inclusion of cameras having progressively higher resolutions. The lenses needed to support such products are pushing the limits of conventional optical design while simultaneously making manufacture more difficult.

One potential means to address this problem is under development at the Fraunhofer Institute for Applied Optics and Precision Engineering (Jena, Germany). The idea is to adopt a microlens array-based design that mimics the composite eye structure found in some insects. The name adopted for this technology derives from its functionality — Electronic Cluster Eye (abbreviated to eCley).

The microlens array is a multi-aperture imaging system. Each optical channel is separate and composed of a single microlens and an aperture stop.



Placing an aperture at a certain distance from the lens serves to reduce optical aberrations, such as coma, astigmatism and field curvature.

Another issue of importance in multi-aperture imaging systems is optical crosstalk. If present, a ghost image can occur due to light from one microlens imaged onto the photodiodes of a neighboring channel. In order to suppress optical crosstalk, adjacent optical channels need to be optically isolated. In eCley, an aperture array is included in the optical system to absorb stray light.

Each aperture or channel captures a low-resolution image of the full field of view. An image registration and fusion algorithm is used to stitch together the partial images to form a final image. In addition, a software correction is applied to each partial image so that the final image is made free of distortion.

A major benefit of adopting this approach is that it may significantly reduce the thickness of camera systems. To put this in context, the objective lens in an iPhone is 3–4mm long. With a microlens array approach, this could be reduced to 1mm while also achieving an extremely wide field of view.

Regarding this last point, the reason is that the segmentation approach used in eCley changes the nature of the trade-off between focal length and field of view. In traditional lens designs, a wide field of view corresponds to a short focal length lens, and lens length is proportional to focal length. With eCley, a short overall lens length may be achieved while using a small field of view for each individual channel.

Another goal of the approach is to have the microlens arrays fabricated at the wafer level. Such a manufacturing process would offer the best potential for producing high-volume, low-cost components for consumer products.

Historically, wafer-scale optic fabrication has not produced good results in related optical systems. The reference here is to wafers containing sensors with a single aperture. The principal difficulty has been the relatively limited resolution that can be achieved for such a “large”-sized optic.

The eCley approach can, however, successfully address this issue. The reason is that the wafer-level photolithography and reflow of photoresist fabrication processes are now being applied to tiny components. In this case, each of the individual optical channels has a smaller lens sag and suffers less shrinkage during molding than would a single aperture wafer-level optic. This, in turn, enables a higher resolution optic.

An article describing the optical design and manufacturing technologies can be found here.

The eCley demonstration module achieved approximately VGA resolution with an overall lens length of 1.4mm. This is about half the length of a comparable single aperture optic on an image sensor of the same pixel pitch. The field of view was 58° (H) x 46° (V). The alignment and assembly of the prototype optical component was implemented at the wafer level.

In future work, the researchers plan to improve image quality and resolution of the eCley. This will be done by addressing limitations of the current algorithm for partial image stitching. Furthermore, the researchers hope to extend the basic eCley working principle to achieve camera optics having one or two megapixel resolution with extremely short overall lens length. *–Arthur Berman*

DXG Intros $70 3D Camera

DXG has begun shipping the DXG-018 point-and-shoot digital 3D camera. The camera uses dual lenses to take side-by-side photos of a subject using a single 1.3mpixel imager. What's different about this 3D camera — there is no AS-3D display. Instead, users are supposed to print the captured stereo pair in a 4" x 6" format. This print is then inserted into a viewer to allow users to see the 3D image.

Sound familiar? It is very much like the ViewMaster product that was introduced in 1939. With the ViewMaster, consumers purchased pre-printed stereo pictures. With the DXG-018, consumers can capture their own stereo pairs as jpeg images on SD cards.

The camera is available in pink, lavender, green, orange or yellow. It comes packaged with one or three viewers (DXG is unclear about this), a USB cable and batteries.

Sounds like a great kid's toy. *–Chris Chinnock*

HTC Evo 3D Handset Available Through Sprint

Sprint has started to sell the new HTC Evo 3D mobile handset. The 3D Droid phone has a regular price of $549 but is available for $199 with a two-year contract.

The Evo 3G was unveiled at CTIA in March. It features an autostereoscopic 540 x 960, 4.3-inch display, using a switchable parallax barrier design, we believe. There is a 1.3mpixel front-facing camera and dual 5mpixel back-facing cameras to capture 2D or 3D stills and video. It is a little unclear if the 3D video is captured in 720p or 1080p, but if it operates like the LG Optimus, 3D capture is at 720p/30.

In addition to user-generated 3D content, the phone comes pre-loaded with a trial version of

Spider-Man 3D, along with Blockbuster on Demand for access to 2D and 3D titles. The Gameloft storefront offers 3D games. Gameloft is also making games for both the LG Thrill and Nintendo 3DS. Based on feedback so far, this is not enough 3D content, so Sprint needs to find ways to satisfy consumer demand here.

The unit is power by a SnapDragon MSM8660 (1.2 GHz Dual Core processor) + SQN1210 (WiMAX) and Android 2.3 with HTC Sense. The Sprint network is CDMA2000 1x/ EVDO rev. 0/ EVDO rev. A and 4G WIMAX.

Sprint's Everything Data plan gives unlimited text, Web and calling to any mobile phone in America for $79.99/month. *–Chris Chinnock*

LG Releases Optimus 3D Phone

The second big 3D phone announcement comes from LG, as it has released the Optimus 3D, sometimes called the LG Thrill. It will be offered in the U.S. by AT&T this summer (after several delays in other parts of the world), but no pricing is available yet.

The AS-3D display is a 4.3-inch panel, which we suspect is a switchable parallax barrier type with a native resolution of 800 x 480.

Three different games will come pre-installed on the smartphone: N.O.V.A, Let's Golf 2 and Asphalt 6. Also available to download from the Gameloft store will be another 14 titles arriving throughout the launch period, including Spider-Man and Assassins Creed. A special 50% discount will be available on the apps for the first three months using an icon on the Optimus 3D's desktop.

Looking at the YouTube video of the promotion of these games on the phone creates a very misleading representation of the 3D experience. Such consumer expectations could lead to disappointment later.

The phone comes equipped with dual 5mpixel cameras that in 2D mode can capture 1080p/24 or 720p/30. The 720p/30 mode is only available for 3D video capture. For still image capture, 2D or 3D images can be acquired at 3mpixels. There is also software to convert 2D photos and video content to 3D now, with conversion of game content coming this fall.

Other features include Bluetooth, Wi-Fi, a personal organizer, USB syncing and mass storage, GPS, a music player, 8GB of internal memory, a 1,500 mAh battery, and support DLNA/HDMI connection.

The product was first announced in February at Mobile World Congress and will be released to more than 60 markets over the summer. *–Chris Chinnock*

Toshiba Offers Qosmio X775-3DV78 Laptop

Toshiba launched its newest 3D laptop in mid-June, the Qosmio X775-3DV78, which features a 17.3-inch LCD screen that is compatible with active shutter glasses. MSRP is $1,899 with retail pricing about $100 less.

The display is FHD resolution, and synchronization with the shutter glasses comes from an IR emitter embedded in the bezel. Looks like this is a 120 Hz panel.

It is powered by an Intel Core i7-2630QM (quad core) processor, Windows 7 Home Premium (64-bit), and an NVIDIA GeForce GTX 560M (3D Vision) with 1.5GB GDDR5 video memory. Additional features include a Blu-ray player, HDMI outputs and USB 3.0 high-speed connectors. It is also Energy Star and EPEAT Gold Compliant.

A stereo Webcam is included for user-generated content, but no details are provided on the hardware or related software support. 2D-to-3D conversion support for games is included, but probably not for other content. Content can be output to a 3DTV too. *–Chris Chinnock*

Toshiba Readies Two AS-3D Laptops

Toshiba has been showing and discussing the introduction of a glasses-free laptop since it first showed a prototype at CES'11. Now, it says it is ready to ship the Qosmio F750 in the UK in August (for about £1,300) and the Dynabook T851/D8CR in Japan in July.

The Qosmio F750 model comes with a 15.6-inch screen with 1920 x 1080 resolution, updated at 120 Hz. It uses an HD Webcam and eye-tracking software to follow the user's eyes and adjust the image on the screen to shift the two-view image to follow the user. Toshiba says the screen can have both 2D and 3D windows.

While Toshiba does not provide any more details on the screen, it has been working on its own switchable lenticular technology, but it could also be sourcing a switchable lenticular panel from AUO.

We also note that Toshiba is said to be launching the Dynabook T851/D8CR notebook in Japan in July for about 230K yen, which also features an eye-tracked glasses-free display. Specs for this panel show a lower resolution of 1280 x 800 in the same 15.6-inch screen size.

The Toshiba Qosmio F750 3D laptop is the more powerful machine offering a 2.0GHz Core i7 processor with6GB of DDR3 memory and an NVIDIA GeForce GT 540M graphics. The laptop also features a Blu-ray XL recordable drive, 2D-to-3D DVD conversion software and

Harman Kardon speakers. For connectivity, the laptop sports Wi-Fi, Bluetooth 3.0+HS, and has three USB 2.0 and a USB 3.0 and a memory card reader.

The Dynabook T851/D8CR features an Intel SandyBridge i5 processor with the same Nvidia GT540M GPU.

According to some early user reports, the eye-tracking system was remarkably quick and refused to be fooled by the sharp movements and head-bops, but the adjustment of the 3D effect was slower to catch up. Even a relatively small head movement caused the 3D effect to falter momentarily before settling again.

We hope to learn more once these products are released. *–Chris Chinnock*

Samsung Introduces World's Brightest 3D Notebook

Samsung Electronics has introduced a 3D laptop with a 17.3-inch FHD screen, Bluetooth connectivity to its shutter glasses, and a bright 400nit LCD (in 2D mode). It is available now on the Korean market for the equivalent of about about $2,400. No word on availability in other regions yet.

Samsung says the 400 nits is about 80% brighter than most laptops, but there are no details on the 3D image brightness.

Powering the laptop is an AMD Radeon HD6650M equipped with 2GB dedicated memory and integrated SRS 3D audio Theater Sound system. An Intel Core i7 CPU with Turbo Boost improves the performance of the notebook, distributing power where it is needed most. Fast Start technology allows you to start using the notebook within a few seconds.

The laptop ships with two pair of shutter glasses and includes two USB 3.0 ports, two USB 2.0 interfaces, 2D-to-3D conversion software, plus a 1.3Mpixel Webcam for HD video calls. *–Chris Chinnock*
