Naval Surface Warfare Center (NAVSEA) Crane Division

Tilt Lock Mechanism and Method for a Movable Optical or Display Device

(Patent # 7,885,001)

Mini Market Study Report

August 2011

Sponsored by:

Integrated Technology Transfer Network, California State University San Bernardino

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MARKET STUDY REPORT

Technology Synopsis

Many pilots use head- or helmet-mounted display (HMD) devices that provide heads up display information through helmet mounted goggles. Pilots of any aircraft experience strong flight vibrations and occasional jolts from hitting large air pockets or from fierce maneuvering while in battle which can easily cause the helmet goggles to be misaligned.

This invention is a mechanism that allows the adjustment of an optical device, such as head- or helmet-mounted display (HMD) devices (i.e., binoculars or night vision goggles), to be easily customized or adjusted to fit the user's visual preference. The technology enables users to incrementally rotate the binoculars to tilt, or face more downward or upward so that the user's line of sight points more downward or more upward. Hence, the helmet-mounted binoculars can tilt over a range of angular degrees to optimize the line of sight. Therefore, once a desired position is chosen, a locking mechanism can keep the optical device in that specific orientation until the user needs to adjust it to a new desired angle or alignment. A second function of the invention addresses the difference in users' interpupillary distance (IPD)—the horizontal distance between the user's eyes. Users can also adjust the distance between the monoculars on the device independently to be either wider or narrower depending on the user's eye separation.

This technology is critical because failure to have, for instance, night vision goggles (NVG) locked in a selected position may cause the system to fail to operate or interact with other systems that require a specific alignment, steadiness of the head mounted device, or a certain spatial relationship with exterior objects.

Potential Applications

Industry Segments	Application Segments
A. Military	1. Helicopter pilot HMDs 2. Fixed wing aircraft HMDs 3. Naval ship board optical monitor devices 4. Land based vehicles (MRAP, M-ATV)
B. Government	1. Police, firefighting, and FBI for mapping, thermal, or night vision HMDs
C. Civilian/Commercial Aviation	1. Pilots using HMD devices
D. Gaming	1. 3D video gaming HMDs 2. Virtual reality optical devices
E. Racing	1. Formula One driver HMDs

Abbreviations: HMD – helmet/head mounted display, MRAP – mine resistant ambush protected, M-ATV – MRAP all-terrain vehicle

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Competing Technologies

Company Product and Product Description/Features	
Northrop Grumman Litton EOS M949 Aviator 's Goggle AN/AVS-9 • Tilt adjustment: 10 degree minimum • IPD adjustment: 52 – 76 mm • Goggle/mount combined weight: 870 g	
Newcon Optik Night Vision Goggles • Tilt adjustment: N/A • IPD adjustment: 56 – 72 mm • Goggle weight: 610 g	
Vision Systems International (VSI), an Elbit Systems/Rockwell Collins joint venture's ANVIS/HUD • Tilt adjustment: N/A • IPD adjustment: N/A • Goggle weight: 230 g	
Fenn Night Vision LTD NG 2000/2000A • Tilt adjustment: 8 degree minimum • IPD adjustment: 52 – 72 mm • Goggle weight: 590 g	

Competitive Advantage

- Quick, easy, and stable tilt adjustment capabilities
- Inter-pupillary distance (IPD) adjustment capabilities
- Highly durable tilt locking pin mechanism
- Stronger metal material for superior endurance
- Light weight
- Less cumbersome

The competitive advantage for the tilt lock technology developed by the Navy comes from its tilt and locking capabilities under heavy jolting and vibration experienced in environments such as aircraft flight piloting. Currently, pilots are in need of a tilt adjustment mechanism that effectively locks into the desired position under these flight conditions. Other technologies such as Elbit's tilt lock mechanism fail to withstand the vibrations partly because of its plastic pin-plunger component and throw the line of sight of the operator off at a critically compromising angle.

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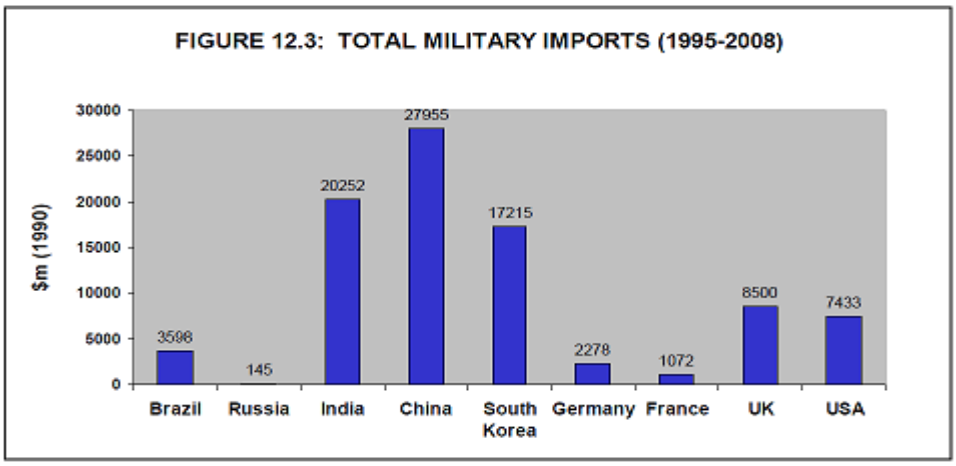
Head- or helmet-mounted display systems (HMDs) are continually being enhanced and improved across the electro-optics and night vision goggle industries. However, current HMD systems are bulky and cumbersome and create extreme g-force conditions on pilots' necks which are driving manufacturers to produce lighter weight HMD systems for the market.

Market Opportunity



[1]

	Defense Purchases	% World Market
USA & Canada	$103B	46%
NATO Europe	$48B	21%
ASIA -China -Japan -India -S. Korea -Australia -Taiwan -Indonesia	$38B -$14B -$10B -$4.3B -$3.6B -$3B -$1.6B -$1.6B	17%
Non-NATO Europe -Russia	$17B -$13B	7.5%
Middle East -Saudi Arabia -Israel	$12B -$6.6B -$3.5B	5.5%
Latin America -Brazil	$4.8B -$2B	2%
Africa	$2.7B	1%
Total	$227B	100%

[2]

[1] http://ec.europa.eu/enterprise/sectors/defence/files/study_defence_final_report_en.pdf

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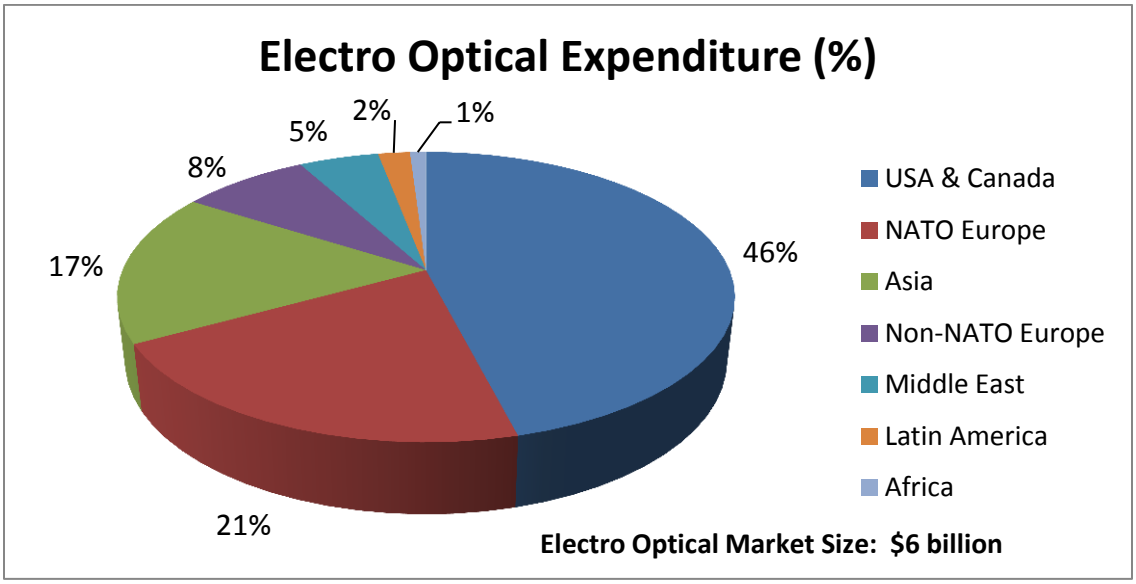
Some of the most promising market potential for the tilt lock technology comes from the military markets. Opportunity also exists in the Foreign Military Sales (FMS) approach. Selling the tilt lock technology to our military allies reveals more market potential, especially for those countries that are only recently developing and implementing HMD systems. Countries such as China, India, and South Korea have shown the highest military import activity, but there is still potential in other military markets, such as the United Kingdom. The table showing defense spending for different regions in the world further validates the potential within the FMS markets. Half of the global demand in the defense industry comes from the US and Canadian markets.[2] In conjunction with the wars in Iraq and Afghanistan, budget forecasts are favorable for commercializing technologies such as the tilt lock mechanism. Demand for innovative solutions like the tilt lock mechanisms is large and growing. Helicopter pilots in Afghanistan, for example, liked the technology so much that they said they cannot get the tilt lock systems fast enough. The defense budget includes $1.2 billion for procurement through fiscal year 2015 under the U.S. Army's Night Vision, Thermal Weapon Sight program. Annual funding rates ran from as high as $435.2 million in fiscal year 2010 and could run as low as $96.7 million for fiscal year 2015.[3] Military sales of helmet-mounted personal viewers for situational awareness are forecast to reach $330 million in 2012, with growth resulting from higher definition and color displays.[4]



The chart above shows the global electro optical expenditure by region. The electro optical (EO) market is estimated at $6 billion and forecast to grow by 55% in the next decade. It can be expected to reach as much as $9 billion. The U.S market accounts for 46% of the EO market while NATO Europe accounts for 20% of the EO market.[2]

Some of the key role players in the market fall under the head- or helmet mounted display systems (HMDs) and the night vision industries. Most markets involve near-eye imaging

[2] http://www.magna.isa.gov.il/internet/Forms/2008-01-093603/FinancialValuation_isa.pdf
[3] http://www.forecastinternational.com/samples/F638_CompleteSample.pdf

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applications for products such as viewfinders for digital cameras, or for head-wearable displays. These near-to-eye viewing products have been characterized as the Personal Viewer Market. The McLaughlin Group forecasts the total Personal Viewer Market to reach as much as 16.0 million units and $5.7 billion in revenue by 2012.[4]

Potential Targets for Licensing

Licensing this technology can be achieved by enforcing a method of *co-optition*, that is instead of competing head-to-head with the well-established corporations pursue strategic partnerships with these companies to maximize consumer awareness and market potential. Therefore some of the best targets include those mentioned in the competing technologies chart above. Should some of the larger, more established companies such as Elbit Systems, ITT Industries, and L3 Communications not reach favorable agreements, we can target smaller businesses like Intevac or Newcon that might not have integrated a tilt lock mechanism into their product line already. Still, potential applications for the tilt lock technology are broad so industries like virtual gaming and formula one racing may be tapped into for alternative commercialization.

Keys to Commercialization

Based on the research gathered in this market study, the HMD market is a very competitive industry with several companies developing comparable technologies. However, it is apparent that there is plenty of demand for a technology that has this invention's capabilities. Soldiers are anxious to use the invention to maximize their performance and make it easier to complete their objectives. Some of the key actions that need to be executed for successful commercialization of the tilt lock technology include pursuing agreements with interested companies for tests, trials, or licensing while leveraging the technology's functional capabilities, its ease of use, reliability, enhanced durability, and effectiveness. Therefore, one of the main keys to commercialization is to integrate this technology into the HMD product line for potential applications within the military with L3 Communications or ITT Night Vision & Imaging.

[4] "eMagin Corporation" Annual Report. 2009, December 31. http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MzgzODI1fENoaWxkSUQ9Mzg1MTQ3fFR5cGU9MQ==&t=1

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APPENDICES

A. Inventor Interview Summary

B. Primary Research Contact Interview Summaries

C. Market Study & Technology Notes

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Introduction

The Office of Research and Technology Applications at the NAVSEA-Crane Naval Surface Warfare Center's Technology Transfer Office is conducting a market study for the igniter for exothermic torch rod technology. The study is sponsored by the Integrated Technology Transfer Network's (ITTN's) entrepreneurial program at California State University San Bernardino.

This report involves a market study for a commercialization project regarding the igniter technology. The feasibility study is being conducted in order to better understand how to optimize the technology's path to commercialization.

Contact Information

Naval Surface Warfare Center (NSWC) – Crane Division

Charles Greer, Tilt Lock Mechanism and Method Inventor Building 3291

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Introductory Question:

Q: Basically, what is the invention? What is your baby? And, why is it cute? Why is it so valuable?

A: This invention applies to helmet mounted cueing systems which enables missiles to turn in corresponding directions when the pilot turns their head. Essentially the missiles can turn with the pilot's head for better aiming. Gun mounts are also being developed to be used in the same fashion. Poor aiming forces soldiers to come closer to the target enemy which is not a good thing, so this tech allows users to aim from a further location. This mechanism keeps the pilot's line of sight locked and stable during flight vibrations, shaking, and jolts.

Background Questions:

Q: Why exactly was this technology invented?

A: To keep the pilot's line of sight stable and accurate.

Q: What drove the internal need for the invention?

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A: Users needed to be able to keep the device locked into a specific position. This matters because when bore sighting at 4,000 meters any small jolt—even from hitting a small air pocket—could change the aiming point. So you could be off by 20 ft, thereby missing a moving target such as a truck. The longer the distance, the more your missile will be off target. These missiles shoot at over 10,000 meters.

Technology Questions:

Q: Are there limitations to the sizes (optical device circumferences) that the mechanism can be used on?

A: Not really. You can upgrade the spring system to match any size.

Q: Can the mechanism be used or fitted onto different sized optical devices? Can it be retro-fitted onto existing optical devices?

A: Yes, that wouldn't require much hassle.

Q: Can you explain what the top of the housing component is used as? Is it for mounting the entire system device to existing components?

A: Mounting system for pilots' helmets

Q: What do you think is most interesting about the technology?

A: What it's used for. It ties 3 technologies together missiles, night vision goggles (NVGs), and the tracking system in the aircraft.

Q: What have others found interesting about the technology?

A: Mostly marine core uses it, and the coast guard wants to use it. They just got the head tracker and helmet mounting systems installed.

Q: How has the technology been tested? Under what conditions has the device been tested?

A: Military standards for vibration and shock tests were gauged. Shock and vibration profiles were performed. Environmental test chambers simulated tests for over 12 hours and it held up the whole time.

Application Questions:

Q: Is the tilt lock mechanism only designed for mounted optical devices?

A: Yes, for specific NVGs.

Q: What potential applications do you think the technology has?

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A: One application is in ship board optical devices that monitor what goes on around the ship. They look down the sides of the ship. The mechanism would need to be upgraded in size and they would be much heavier. Coast guard, naval, aviation, anyone using NVG, any fixed wing aircraft, could use the technology. It used to be only for helicopters but has expanded to other aircraft.

Q: Who are the end users for this technology? Who would have a need for the tilt lock mechanism?

A: Pilots. Special operations boats are using similar missile seeking systems which queue to wherever the users are looking.

Q: What does the technology not work well for? What doesn't work?

A: Nothing, it does what it is supposed to do.

Q: What works well? What do you see as the key application for this technology?

A: Pilots for helmet/head tracking. It stabilizes the aim point and locks it into place.

Alternative Solutions / Competing Technologies:

Q: What are some of the existing alternative solutions to the problem?

A: Ground test firing range bore sighting is used. After firing a shot at a target they mark the missile strike point on the canopy of the aircraft. This means you will be down one missile (wasted ammunition and money). Basically, they land the aircraft, fire a missile at the target, mark the strike on the canopy, and base the needed tilt off of that test.

Q: What key advantages do you think this technology has over the others?

A: It may help mitigate the problem of EM fields radiating to throw off the aim. Radar antenna on the aircraft translates distance to the seeker on the air craft, but if there's ten other things radiating signals in the battlefield your radar may be off because electromagnetic (EM) fields are radiating all over the field.

Development, Market & Market Entry Questions:

Q: How is the technology fielded?

A: Marine Corps is using it. The coast guard is doing test and evaluation now, and other classified users are using it.

Q: What has the experience been like so far during the process (any challenges)?

A: Not really any challenges. The biggest issue was changing the spring. Largest problem: limiting this mechanism to only those pilots that need it, and actually have the

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fixed wing joint helmet mounted cueing system. Other helmet cueing systems include: Rotor wing aircraft systems which have an optimized top owl system, or ANVIS aviators night vision imaging system, and the Scorpion.

Q: What do you know about the market for optical device mechanisms and optical device systems?

A: All military aircraft are going toward this system instead of having to check radar systems, achieve missile lock, and align the aircraft to the necessary roll and pitch. Instead, pilots can just hear a tone and pull the trigger.

Q: Where do you see the largest market potential?

A: It could be used in tanks, M-RAP vehicles, MATVs, S-RAP anti IED vehicles.

Q: Have you spoken to any potential end users for the technology?

A: Yes

Q: What kind of feedback have you gotten for the technology?

A: "When are you going to get us more of these?" Apache helicopter pilots couldn't wait to get their hands on it.

Q: What have others found to be lacking in the technology? What caused them to back out and not take interest in the technology? Were there any turn-offs to the technology?

A: No turn-offs, everyone wants it. One company wants to make the money but not share with anyone else.

Q: Who are the key players in the market? Who are the industry leaders?

A: ITT Night Vision, L3 Communications and Elbit Systems of America. Raytheon makes the seeker heads. Bring it to ITT Night Vision or L3 Communications.

Q: Who have shown interest in the technology?

A: Elbit Systems built their own NVG. The way they lock their goggles is ineffective; it doesn't work. They use a metal pin, but plastic components which break easily from aircraft vibration.

Q: What have the discussions and concerns been with interested parties, users, and companies?

A: Issues include making all the large contractors work together (i.e., missile, NVG, tracking system companies)

Q: Which companies do you think would the technology be ideal for as a new product offering?

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A: ITT and L3

Q: What is the estimated cost to produce the tilt lock mechanism?

A: $10-$20 for the mechanism, produce a couple 100 at a time

Q: What is the estimated price point?

A: $10-$20

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ITT Night Vision & Imaging
7635 Plantation Road
Roanoke, VA 24019
Telephone: 540-563-0371

Trent Hutchison
Business Development & Program Manager
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Target identified and interview lead by analyst: Justin Frederick.

ITT Night Vision & Imaging provides innovative night vision solutions for all military and law enforcement operations. The company offers image intensifier tubes and systems to many allied and friendly nations. ITT has a well-established international presence. They have won the two largest-ever international night vision contracts: $26 Million (U.S.) from Switzerland and $80 Million (U.S.) from Australia. Since 2002 ITT has supplied the U.K. Ministry of Defense with over $30 Million (U.S.) worth of night vision equipment, and they are contracted to deliver the Norwegian armed forces more than $30 Million (U.S.) worth of ITT Night Vision equipment. ITT has a network of dealers and representatives that are positioned around the world.

ITT Night Vision & Imaging offers leading night vision solutions by maintaining strong relationships with customers and industry partners. ITT is currently engineering and creating initial prototypes of helmet-mounted systems that will provide enhanced capabilities such as combining image intensified (I2), short-wave infrared (SWIR) and long-wave infrared (LWIR) imagery for display to the user[5].

This primary research target has been identified because ITT Night Vision manufactures a variety of multifunction night vision binoculars, as well as other equipment for both aviation and ground systems. Some of the product offerings include helmet mounted night vision aviation systems called AN/AVS-9 and AN/AVS-6. Also, ITT would make a key ally because they have systems that could be enhanced with and benefit from our technology. Trent Hutchison works with Night Vision Visual Augmentation Systems covering OEM for image intensified and image fused (I2 + Thermal) night vision products. In general, Hutchison works with the Advanced Visualization and Training Systems at ITT Night Vision & Imaging.

Key questions:

Q: Would ITT be interested in experimenting with tilt lock mechanism that the Navy has developed and is looking to commercialize?

A: Yeah, right now we are engineering resource strapped, we would have to pull off a real program to do an experiment. We only have a certain number of engineers

[5] http://www.nightvision.com/about/index.html

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available, therefore we must reallocate their resources, but it's not a problem to integrate it. Yes, we'd be interested.

Q: Do you believe that a technology such as this can be incorporated into any existing projects that are currently taking place at ITT Night Vision & Imaging?

A: No, it would be a stand-alone development. We've already quoted a company called Loughmiller Machine & Assoc. who is an integrator. They've been building the tilt lock for us. They've built over 2000 systems. We sent 1000 tilt lock mechanisms so they were supposed build the mounting systems for them.

Q: Do your current helmet mountable image systems require specific certification or UL (underwriter's laboratories) approval? If so which certifications?

A: Standard military specifications apply: Military performance specification S49-49

Q: Would you be willing to list some of the purchase and performance criteria for your current helmet mounted vision systems (field of view, angular range, etc.)?

A:

Q: What are some of the major strengths and weaknesses that your current helmet mounted binocular systems have?

A:

Q: How durable are your current helmet mountable and helmet mounted night vision systems? How much wear and tear can it withstand?

A:

Q: What would be the typical process in your organization for integrating a new technology, such as the tilt lock mechanism technology, into your business product line?

A:

Q: Based on your company's outstanding history and remarkable customer base with various niche market consumers—such as aviation and law enforcement purchasers—what kind of trends are you observing with respect to military and government use or activity? Is military use fluctuating, standing still, steadily growing, or gradually slowing?

A:

Next Steps:

- Reach Josh Airline at 812-854-4060 to team up with him, check the status of his relationship with potential licensees, and to help develop dialogues for potential companies for licensing.

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- Contact Pam Loughmiller at 812-295-3903 to gauge potential licensing interest for technology commercialization and further information regarding the technology's potential applications with Loughmiller Machine Tool and Design.

L3 Communications 7-12-2011
Primary Research Contact Information and Interview Summaries

L-3 EOS
3414 Herrmann Drive
Garland, TX 75041
Phone: (972) 840-5600

James Martin
Operations Program Manager, L-3 Communications
Phone: (972) 840-5788 Email: james.martin@l-3com.com

Target identified and interview lead by analyst: Justin Frederick.

L-3 Electro-Optical Systems (L-3 EOS) has over forty years of experience offering superior night vision products, including monoculars, binoculars, weapon sights, driver viewers, infrared modules and image intensifiers. The company is a leading supplier of Electro-Optical and Applied Optics technologies, and produces high quality, reliable night vision systems for U.S and international allies.

L-3 EOS has successfully fielded over one million different systems to the military, law enforcement and related agencies around the world. L-3 EOS's applied optics facility is a leading supplier of advanced optical coatings and precision optical fabrications, and continually works to maintain their position as a leading supplier for Department of Defense and commercial applications[6].

This primary research target has been identified because L-3 EOS produces a variety of head/helmet mounted night vision products such as the M963 Military Goggles, M953 Binoculars, and M949 Aviation Goggles among others. L-3 EOS would make a key ally because they have products that could be enhanced with the tilt lock technology. James Martin works as an operations program manager for L-3 Communications.

Key questions:

Q: What are some of the major strengths and weaknesses that your current helmet mounted binocular systems have?

A:

[6] http://www.l-3nightvision.com/L3_Communications.html

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Q: How durable are your current helmet mountable and helmet mounted night vision systems? How much wear and tear can it withstand?

A:

Q: Would L-3 EOS be interested in experimenting with tilt lock mechanism that the Navy has developed and is looking to commercialize?

A:

Q: Do you believe that a technology such as this can be incorporated into any existing projects that are currently taking place at L-3 EOS?

A:

Q: Would you be willing to list some of the purchase and performance criteria for your current helmet mounted vision systems (field of view, angular range, etc.)?

A:

Q: Do your current helmet mountable image systems require specific certification or UL (underwriter's laboratories) approval? If so which certifications?

A:

Q: What would be the typical process in your organization for integrating a new technology, such as the tilt lock mechanism technology, into your business product line?

A:

Q: What kind of trends are you observing with respect to military and government use or activity for the helmet mounted systems? Is military/law enforcement use fluctuating, standing still, steadily growing, or gradually slowing?

A:

Next Steps:

- Reach James Martin or other contacts at L-3 Communications to evaluate licensing potential. Other contacts include Susan Gardner and Patricia Tanner at L-3 Communications.

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Essence of the technology:

What is it for?

The tilt lock mechanism keeps pilot's line of sight stable and locked in an adjustable position.

What problem does it solve?

Pilots' helmets using a helmet mounted display or missile tracking device must be able to keep their line of sight in a locked or stable position especially while experiencing random jolts and vibrations from various aircraft phenomena. The tilt lock mechanism inhibits unwanted movement of the goggle's display and allows for user adjustment for optimizing their line of sight.

Who needs it?

Anyone using a helmet mounted cueing system (such as military pilots).
Airline pilots, helicopter pilots, any fixed wing aircraft, tank drivers, ship board optical devices that monitor what goes on around the ship, special operations boats, virtual reality or eye correlated users (i.e. video gaming).

Why is it important?

Pilots using the helmet mounted cueing device can accurately target their enemies and not be off target from aircraft jolts and vibrations throwing off the user's line of sight through the display system. Being able to quickly adjust and lock the tilt of the helmet device is crucial because when aiming at 4,000 meters away, a small jolt or vibrations could force the pilot to be off target by 20 feet, causing them to possibly miss the target completely.

What are the current alternatives to solving this problem?

Ground test firing range bore sighting is used. After firing a shot at a target they mark the missile strike point on the canopy of the aircraft. This means you will be down one missile (wasted ammunition and money). Basically, they land the aircraft, fire a missile at the target, mark the strike on the canopy, and base the needed tilt off of that test. Elbit Systems built their own NVG. The way they lock their goggles is ineffective; it doesn't work. They use a metal pin, but plastic components which break easily from aircraft vibration.

What is the magnitude of the market or value added by this solution (in a popular expression or a simplified statement)?

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Easily adjustable, click-into-place locking for optimizing line-of-sight visualization through optical displays or devices.

Keys to commercialization:

Finding out:

- Who will license it?
- Who needs this specific technology?
- Who makes alternatives to the technology?

Therefore, target licensees will include companies making optical display devices using goggles or any components requiring user line of sight adjustment.

Gaps, inconsistencies, and questions:

- Are there limitations to the sizes (optical device circumferences) that the mechanism can be used on?
- Can the mechanism be used or fitted onto different sized optical devices? Can it be retro-fitted onto existing optical devices?

Notes, Highlights, and Observations:

- See inventor interview

Initial research:

- Who would license this technology?
- Who needs the technology? What applications does the technology have?
- Who makes alternatives to the technology? What are these alternative technologies capable of?

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