September 28, 2015

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Capstone Project proposal for True Sight

Dear Dr. Rawicz,

Enclosed is the proposal for True Sight, a portable real time laser mapping device. Our goal is to design and implement such a device, with a primary intention of aiding emergency responders who struggle navigating low visibility environments.

In our proposal, we present a general overview of the device, and its intended functionality. We highlight and describe the market in which this product could be sold, what competitors the product faces and the overall expected costs of the device. We also delve into the details about our company and its members, as well as our plans for scheduling such a project over the next few months.

Our company, Absolute Vision Systems, consists of five motivated and experienced electrical, biomedical and systems engineering students. Our team includes Don Labayo, Curtis Rietchel, Tomasz Szajner, Samson Tam and Jim Tu. Please contact us at dlabayo@sfu.ca if there are any questions or concerns.

Sincerely,

Don Labayo

CEO

Absolute Vision Systems

September 28, 2015

TRUE SIGHT

ABSOLUTE VISION SYSTEMS

PROPOSAL FOR REAL-TIME 3D LASER SCANNING DEVICE

PROJECT TEAM

Don Labayo
Curtis Rietchel
Tomasz Szajner
Samson Tam
Jim Tu

SUBMITTED TO

Andrew Rawicz - ENSC 440
Steve Whitmore - ENSC 305W

School of Engineering Science
Simon Fraser University

PRIMARY CONTACT

Jim Tu
jimt@sfu.ca

ISSUED DATE

September 28 2015

REVISION

Rev 01

Executive Summary

Emergency response teams work in inherently dangerous environments. With over 152 injuries across 5 years for firefighters in Canada alone, emergency response workers constantly risk their lives on the job [1]. Where quick response times are essential to save the lives of both victims and rescuers, being able to visualize the environment will give response teams a better handle of their surroundings and save more lives.

There are very few devices on the market which are capable of real-time environment scanning. They are prohibitively expensive and largely immobile as they are designed to scan high detail environments from stationary positions.

This document proposes to pursue the development of a vision enhancement system to aid emergency response teams in low visibility environments. The True Sight platform will use lasers to evaluate structures and potential victims obstructed from a rescuer's field of view and display them back to the user in real-time.

Absolute Vision Systems consists of a group of determined electronics, biomedical, and systems engineers with a passion to innovate. Our diverse skill sets will guide the True Sight platform from research and design, all the way through prototyping and testing, within a 13 week period. With help from the ESSEF, our budget for this product is estimated to be $665.

Table of Contents

©2015, Absolute Vision Systems

List of Figures

List of Tables

©2015, Absolute Vision Systems

1. Introduction

A chaotic and hazardous environment such as a burning building can be extremely difficult to navigate. For emergency responders, smoke and flames significantly hinder their ability to see. This results in slower rescues, increased use of oxygen, and longer exposure for the victims. Even now, a firefighter must keep in contact with the walls of the building or crawl along the ground for navigation [2]. Our goal is to create a second pair of "eyes" for these emergency responders, which could help tackle low visibility environments and ensure a quick rescue.

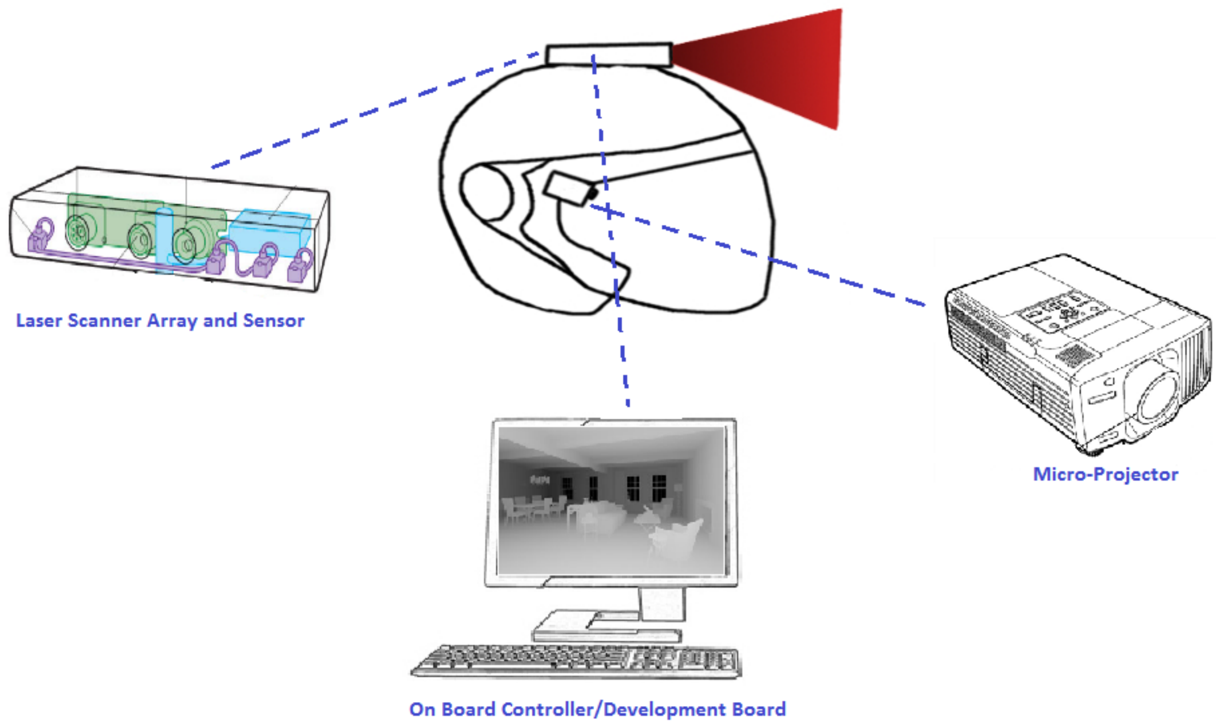


Figure 1 High Level Design Concept

Our project will involve the research and development of True Sight, a real time 3D mapping system using infrared lasers. Figure 1 shows the design concept of the True Sight product. As seen in the figure, our goal is to make the mapping system as portable as possible, with the IR sensors and array being helmet mounted. The infrared sensor would retrieve the depth information and project this image into the helmet of the user. The display replicates the field of view of the user to make it feel comfortable and not disorienting. Although the main feature for this project will be the infrared mapping system used for emergency responders, the system could also be incorporated into other applications such as robotic navigation and underwater welding.

©2015, Absolute Vision Systems

2. Scope

Figure 2 provides a top-level system diagram of our Real-Time Laser Mapping Device. Our device consists of 3 main components: a Kinect Sensor, an embedded computer, and a pico projector. These components will be mounted on a firefighter-type helmet, and will be battery-powered.

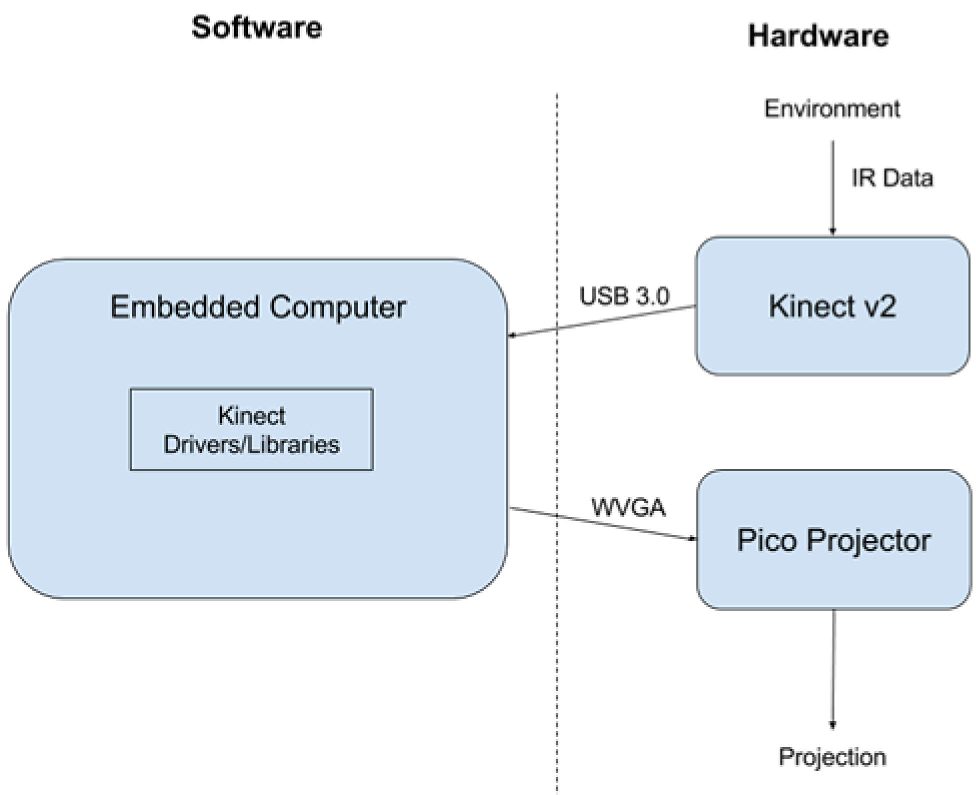


Figure 2 System Logical Layout

The Kinect v2 sensor uses an IR emitter and depth sensor to provide a depth map of the environment. This depth map is accessed and processed on the embedded computer, and will be used to produce an appropriate image that will be used to overlay, or highlight, objects in the user's field of view. The image will be displayed via the Pico Projector and projected onto the user's helmet visor to provide the real-time laser map.

Figure 3 shows an example of the depth maps the Kinect sensor is capable of making. The depth map data will be used to assemble an unobtrusive image that will be overlaid on the helmet visor and will allow the user to still make use of their vision.

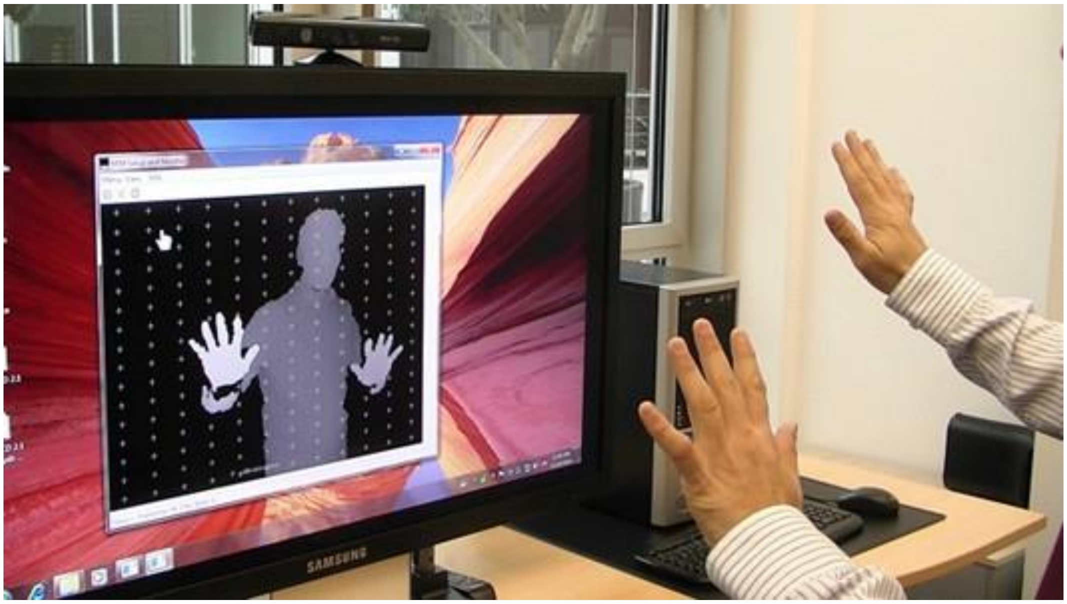


Figure 3 Depth Mapping Performed by a Microsoft Kinect [3]

2.1 Benefits

Our real-time laser mapping device would be used as a visual aid in low-visibility environments, particularly in dark, smoky buildings for firefighters. The prototype will be designed with a firefighter-type helmet. Additionally, by storing and processing the real-time data, we can save a 3D map of the environment that can be used for data analysis afterwards, or producing a "birds-eye" view of the surrounding environment by converting a 3D map into a 2D top view.

2.2 Risks

There are a few risks in developing this device that may come up in application. First, we must make sure that the device provides an accurate image of the environment. An inaccurate image would do more harm than good if it misleads the user. This will be thoroughly tested during the prototype testing phase. Additionally, the device should not be a nuisance to the user. This includes designing the system so that it is not cumbersome/heavy, as well as being a supplementary tool in aiding vision. This also means that the projection will only be used to *outline* the environment objects, and the user will still be able to still make use of their vision wherever possible. We will also have to consider a method of cooling so that our components operate within their thermal range.

©2015, Absolute Vision Systems

3. Market, Competition and Project Benefits

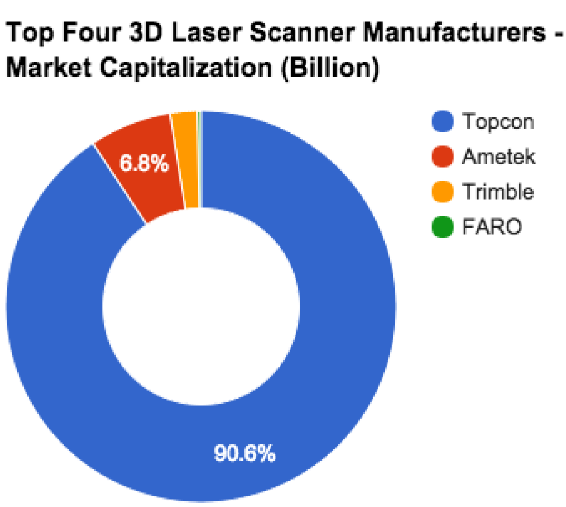
3.1 Market Research:

Due to the extensive applications of True Sight, the demand for 3D laser scanner market is expected to reach $3.7 Billion by 2020 [4] according to MarketsandMarkets.com. With CAGR (Compounded Annual Growth Rate) at 13.8% from 2013 to 2018 [5], our product is expected to have long term growth, deep market penetration rate, and vital for various vertical markets such as [6]:

- Entertainment and Media
- Aerospace and Defense
- Medical and Healthcare
- Architecture and Engineering
- Oil and gas, Energy and Power
- Automotive and Transportation
- Manufacturing and Others

3.2 Competition:

Our major competitors are a collection of top 12 well established laser scanner manufactures who occupies the majority of the market share for 3D laser scanner Figure 5 (right). To compare the relative size of the competitors' market cap, four largest public traded companies are selected:



#	Company Name	Public/ Private Traded	Market Cap (Billion)
1	Topcon	Public	168.25
2	Ametek	Public	12.6
3	Trimble	Public	4.16
4	FARO	Public	0.5961
5	3D Digital Corp	Private	Unknown
6	Barcoding	Private	Unknown
7	Leica Geosystems	Private	Unknown
8	Maptek	Private	Unknown
9	NextEngine	Private	Unknown
10	ShapeGrabber	Private	Unknown
11	Steinbichler	Private	Unknown
12	Surphaser	Private	Unknown

Figure 4 Market Capitalization for Top 4 Companies [7]

©2015, Absolute Vision Systems

3.3 Research Rationale:

In Absolute Vision Systems, we want to create a 3D laser mapping system to enhance human vision in the low visibility environment. Current 3D laser scanning products are used as survey tools, which require precise instrumentation and heavy data analyzation in both hardware and software. The differentiator between our product and the existing, is that True Sight both updates and displays information in real time, minimizing the latency in data processing. Our goal is to minimize the unnecessary redundancy in data collection, by increasing the scanning speed while decreasing the sampling counts.

In a tough operating environment, like a burning building, traditional imaging techniques like infrared cameras do not work as intended as the heat generated by the fire over-saturates the imaging sensor. In our design we plan on implementing a laser as a source of illumination. The coherent and single wavelength light enables better penetration through tough conditions like smoke and fog. Using a mono wavelength light source we will be able to implement a large amount of filtering which we hope will reduce the effects of background noise and artifacts. By taking advantage of the speed of light we will be able to map the environment in sufficient resolution and in a frame rate that is quick enough for first responders to analyze a room quickly.

©2015, Absolute Vision Systems

4. Project Budget

The table below shows the preliminary budget for the project. Unit costs are estimated off of average online values.

Table 1 Estimated Cost of Components for True Sight platform

Component	Estimated Cost ($)
Kinect V2	$150
Nvidia Jetson TK1 Dev. Board	$200
Kinect USB Adapter	$60
HW8G3 Pico-engine	$30
Projector PCB	$50
Battery Pack (12Ah USB power pack)	$25
Helmet with Visor	$50
Materials for Mechanical structure	$50
Miscellaneous electrical components	$50
Total Cost	$665

The Kinect V2 will be used as both the laser array and sensor. The Kinect requires a USB 3.0 connection and a respectable amount of processing power, so we are choosing the Nvidia development board to fit the needs of power and portability. The Kinect adapter is required for the USB 3.0 connection between the Kinect and development board. For our displaying method, the Pico-Engine and PCB will be used to create a small projector system, which will end up receiving information from the Nvidia board. The mechanical structure will house all of these components and be mounted on top of the helmet.

Funding for this project will come from several different sources. We have already presented and discussed our idea with the Engineering Science Endowment Fund (ESSEF), for 25% funding of the project. Other possible sources include the Wighton Engineering Development Fund, where our project would be reviewed along with other competitive projects.

©2015, Absolute Vision Systems

5. Project Planning

Using a parallel prototyping process, we hope to develop and implement both the software and hardware elements at the same time. Through this process, we hope to save time and better distribute man power to various elements of the design. There is a tremendous amount of work to be completed in a short amount of time and by tackling the two man portions of our design concurrently we hope to deliver a polished prototype by the end of the project timeline.

GANTT CHART

	Task Name	Duration	Start	Finish	Predecessors
1	**Idea and Proposal**	**12 days**	**Fri 9/11/15**	**Mon 9/28/15**	
2	Brainstorm Ideas	3 days	Fri 9/11/15	Tue 9/15/15	
3	Feasibility Study	5 days	Wed 9/16/15	Tue 9/22/15	2
4	Project Proposal	4 days	Wed 9/23/15	Mon 9/28/15	3
5	Proposal Submission	0 days	Mon 9/28/15	Mon 9/28/15	4
6	**Define Specs**	**26 days**	**Tue 9/29/15**	**Tue 11/3/15**	**4**
7	User Specs	2 days	Tue 9/29/15	Wed 9/30/15	
8	Functional Specs	10 days	Thu 10/1/15	Wed 10/14/15	7
9	Functional Specs Submission	0 days	Wed 10/14/15	Wed 10/14/15	8
10	Design Specs	14 days	Thu 10/15/15	Tue 11/3/15	9
11	Design Specs Submission	0 days	Tue 11/3/15	Tue 11/3/15	10
12	**Hardware Rev0**	**12 days**	**Wed 11/4/15**	**Thu 11/19/15**	**6**
13	Schematic	3 days	Wed 11/4/15	Fri 11/6/15	
14	Receive Parts	7 days	Mon 11/9/15	Tue 11/17/15	13
15	Hardware Prototyping	2 days	Wed 11/18/15	Thu 11/19/15	14
16	**Sofware Implementation**	**12 days**	**Wed 11/4/15**	**Thu 11/19/15**	**6**
17	Data capture module	7 days	Wed 11/4/15	Thu 11/12/15	
18	Image display	5 days	Fri 11/13/15	Thu 11/19/15	17
19	**System Integration**	**3 days**	**Fri 11/20/15**	**Tue 11/24/15**	**12,16**
20	Camera Alignment	1 day	Fri 11/20/15	Fri 11/20/15	
21	Display and FOV Alignment	3 days	Fri 11/20/15	Tue 11/24/15	
22	**Final Report and Presentation**	**2 days**	**Wed 11/25/15**	**Thu 11/26/15**	**19**
23	Demo Presentation Prep	2 days	Wed 11/25/15	Thu 11/26/15	
24	Demo Day (TBD)	0 days	Thu 11/26/15	Thu 11/26/15	23

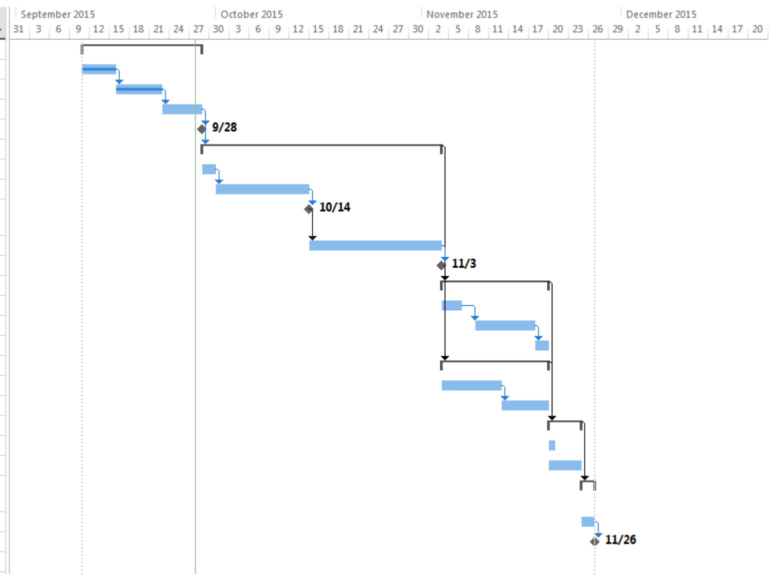


Figure 5 Proposed Schedule and Milestones for True Sight platform

6. Team Profile

Don Labayo – CEO

Don is a fifth year Electronics Engineering student at Simon Fraser University. He has completed two co-op terms with LMI 3D as a Hardware Engineer where he performed hardware tests and design and layout of PBCs. During his time at LMI, he designed an in house cable test jig to test their large set of cables. His education at SFU has provided him skills in analog circuit design, VLSI design and simulation, and FPGA programming. During his free time he enjoys frequenting the gym, watch hockey and football games, and watching movies.

Curtis Rietchel – CFO

Curtis is a fifth year electronics engineering major. He has worked as an I&V engineer at Ericsson, ensuring proper functionality and quality in the synchronization of networking routers. His work at Ericsson gave him skills with the Linux operating system, as well as scripting languages such as Perl and Tcl. At SFU, he has gained experience with analog circuit design, digital signal processing and mathematics. Curtis is also a very hands-on person, who enjoys working on and upgrading his own car. His hobbies include playing tennis and skiing.

Tomasz Szajner – CIO

Tomasz is a fifth-year electronics engineering major. He has done co-op at Optigo Networks, where he worked as a Systems Engineer and developed automated testing for an optical network switch. His time at Optigo Networks exposed him to a multitude of networking and programming concepts. During his free time he enjoys playing sports and going out to movies, as well as his part time job as a finish carpenter, where he has worked on multiple sites throughout Metro Vancouver.

Samson Tam – CTO

Samson is a fifth year Biomedical Engineering student. He has completed work terms at BlackBerry and Verathon Medical. At BlackBerry he carried out many tests as a WLAN Certification engineer, these tests included preparation of test plans and basic scripting in a UNIX environment. At Verathon Medical he developed skills in electrical systems PCB design and implementation. He was also able to pick up much experience in debugging and troubleshooting electrical prototypes. Samson enjoys working through tough engineering problems, his hobbies include photography, skiing and cars.

Jim Tu – COO

Jim is a fifth year systems engineer who has a strong background in IT. He did a full year Co-Op in Powerex as IT Operations analyst, where he developed automated processes to monitor and generate status report for application, database, and servers in the IT department. He is currently working full time in Sage, an accounting software firm, where he troubleshoots CRM system for multiple clients and maintain relationship between existing customer and the company. Jim is socially active in various events, and like to dedicate his free time volunteer for a cause he believes in.

©2015, Absolute Vision Systems

7. Conclusion

Every day, firefighters and emergency responders around the world put themselves at risk to save the lives of others. Their jobs can be grueling and unforgiving as they are constantly being exposed to the harshest of elements. At Absolute Vision Systems, our goal is to aid both the emergency response workers and victims by reducing the time of exposure and navigating in a low visibility environment, through a real time laser mapping system. From our research, True Sight can prove to be a unique way of utilizing laser 3D mapping as vision enhancement. Throughout this document, we have outlined the general scope of the project, including the risks and benefits of our chosen design. A budget and schedule has been meticulously thought out in order to reach our deadlines. Our team displays the motivation and interest in designing and creating such a product that helps make the lives of firefighters just a bit easier. We hope that True Sight will be a unique and innovative addition to the firefighting arsenal.

©2015, Absolute Vision Systems

References

[1] Emergency Management BC Office of the Fire Commissioner, "BC Annual Statistical Fire Report 2012," 2012. [Online]. [Accessed 09 2015].

[2] O. Haciomeroglu, "Tuvie design of the future," Tuvie- Futuristic Technology, 2015. [Online]. Available: http://www.tuvie.com/c-thru-smoke-diving-helmet-future-vision-of-fire-fighting-equipment-by-omer-haciomeroglu/. [Accessed 09 2015].

[3] R. Darell, "Kinect Hack Makes Future Navigation Just Like Minority Report!," Bit Rebels, 2011. [Online]. Available: http://www.bitrebels.com/technology/kinect-hack-makes-future-navigation-just-like-minority-report/. [Accessed 09 2015].

[4] marketsandmarkets.com, "3D Scanner Market by Type (Laser and Structure Light), Industry (Automotive & Transportation, Healthcare, Aerospace & Defense, Architecture & Construction, Energy & Power, Geospatial, and Others) and by Geography - Global Forecast to 2020," MarketsandMarkets, July 2015. [Online]. Available: http://www.marketsandmarkets.com/Market-Reports/3d-scanner-market-119952472.html. [Accessed 09 2015].

[5] TechNavio, "Global 3D Scanning Market 2014-2018," Infiniti Research Limited, 2013.

[6] S. P. G. staff, "3D laser scanning market to hit $4.08 bil' by 2018," SPAR Point Group, 2015. [Online]. Available: http://www.sparpointgroup.com/news/reverse-engineering/3d-laser-scanning-market-to-hit-408-bil-by-2018. [Accessed 09 2015].

[7] TechNavio, "Top 12 3D Scanner Manufacturers," Infiniti Research Limited, 21005. [Online]. Available: http://www.technavio.com/blog/top-12-3d-scanner-manufacturers. [Accessed 09 2015].

©2015, Absolute Vision Systems