Immersive Mobile Gaming with Scanned Laser Pico Projection Systems

P. Selvan Viswanathan[1], *Senior Member IEEE*;
David Lashmet[2] and Jari Honkanen[3], *Senior Member IEEE*
MicroVision, Inc., Redmond, WA 98052
[1]*selvan@ieee.org;* [2]*david_lashmet@microvision.com;* [3]*jari_honkanen@microvision.com*

***Abstract*—A scanned laser pico projector's advantages, in the space of motion sensed and/or mobile gaming, is explored in this paper. In order to better appreciate the applications, we first briefly delve into the operation of a MicroVision MEMS-based scanned laser pico projection engine. From there we described how we accomplish immersive gaming by citing as an example a novel prototype system that we have constructed. We further go on to present the key findings on user experience of this system in a survey conducted at the CeBIT, 2011 in Hannover, Germany.**

Keywords—Immersive Gaming, Pico Projection, MEMS scanning mirror, Laser Projection

I. INTRODUCTION

MOBILE gaming, traditionally, is thought of having a device or accessory that is mobile and which can either be a single-function gaming platform or a multi-function device capable of serving as a gaming platform [1]. Examples of the former would be a handheld game console like the Nintendo DS and an example of the latter would be an iPod Touch, which is a portable media player, PDA, handheld game console, mobile internet device and a few other functions rolled into one. In this sense of mobile gaming, the game controller and the display are tightly coupled. Another related concept that has seen recent evolutionary strides is that of motion sensing games or motion gaming [2]. In this, the controller is mobile or in motion and the display itself is decoupled from the controller. The Nintendo Wii is a good example of this model.

Motion sensing game controllers give a semblance of immersion during game play (e.g., you can mount the controller to a racquet and then move the racquet around to simulate control of the racquet in a game played on a real court). However, it is restrictive in that the display is static and two dimensional. Mobile gaming platforms on the other hand allow the display to move in tandem with your gaze. This too facilitates a certain level of immersion into the game, however it is restrictive in that the display/panel size is limited to what you can effectively hold in your hand during game play.

MEMS-based single mirror scanning laser pico projectors [3] enable rewriting the concept of mobile and motion sensing gaming, by bridging and expanding on the advantages of both models.

II. BACKGROUND

The MicroVision pico projection engine [4] comprises of a bi-axial silicon MEMS mirror whose gimbaled frame is set in a magnetic field generated by permanent magnets. The suspended mirror which is about 1mm in diameter is set into resonance in the horizontal axis and which in newer generations of the MEMS mirror assembly oscillates at rates upwards of 27KHz. The vertical axis is driven by a saw tooth signal at 60Hz, which is then the frame refresh frequency. The combination of the two drives effectively allows the mirror to scan a raster pattern of the design resolution (480p, 720p, etc.).

Light from three independently modulated laser sources is combined in an optical chamber and the new beam of 'white' light is shone upon the scanning mirror. Effectively an image is then painted, a pixel at a time, in the projection cone, which itself is a subset of the entire angular space that is scanned by the mirror. This is seen in Fig. 1.

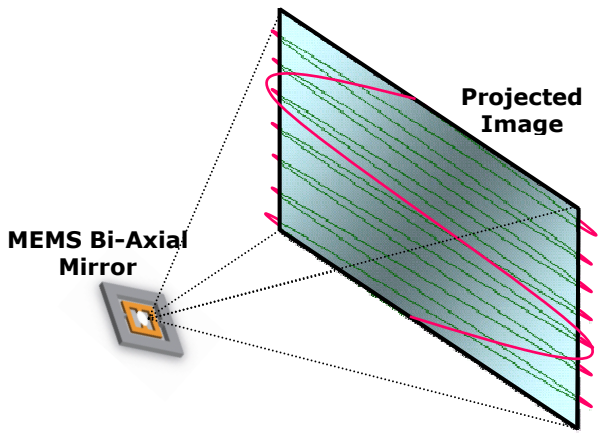

Fig. 1. Raster scan pattern generated from the bi-axial scanning mirror.

The laser light modulation and intensity is derived from the content in the output video frame buffer on a per pixel basis. This is an important concept and is a key differentiator

between single mirror scanned laser pico projection systems and DLP or panel based projection solutions and is also the reason why the gaming concepts addressed in this paper are feasible only with scanned laser projection systems.

III. System Architecture

Reiterating the concepts : mobile gaming allows the display to move along with the controller and motion sensing gaming allows the design of a controller that is more life-like but leaves the user virtually tethered to a display surface that is not in motion.

And that is where, mobile motion-sensed gaming enabled by single mirror scanned laser pico projection comes in. The video or game host in Fig. 2. is considered to be the main processing subsystem that renders the game scenario in real-time and many times, reactively to user inputs. The game host can be a remote laptop or desktop computing machine that then beams the rendered content wirelessly to a receiving unit where the pico projection engine (alternatively termed as a pico display engine) is integrated. In an alternate instantiation, the game host and the pico display engine can be integrated into the same embedded design and thereby would not need a wireless video or the user interface radios. This would be an instantiation of a fully self-contained gaming device.

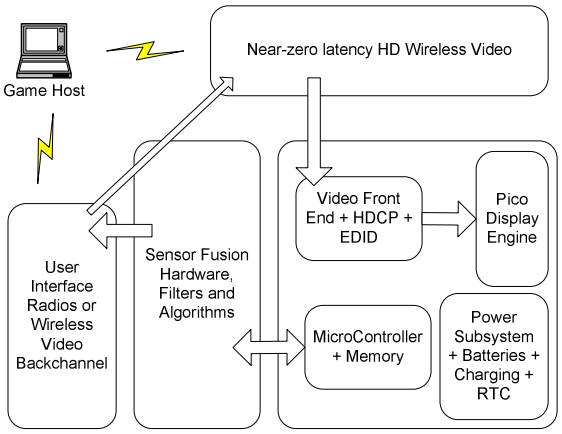

Fig. 2. An illustrative architecture that combines a gaming platform with a scanned laser pico projector.

IV. Prototype Design

In Fig. 3. we present a design that was the culmination of a prototype development effort codenamed Project Tuatara. The real to life looking device shown is a game controller that was designed to be used in PC based first-person perspective games. It is self-contained to the extent that it is a controller and a display unit rolled into one. The game itself is played on a gaming laptop and the video is beamed wirelessly in HD to the device.

A user holding this controller would see his or her field of view projected on the surface directly in front of them. Game play is intuitive and if the user were to follow or track a target to the left, the user would just have to physically turn to the left causing the sensors to relay back to the game host the relative displacement which would then be reflected instantaneously by the changing field of view in front of the user.

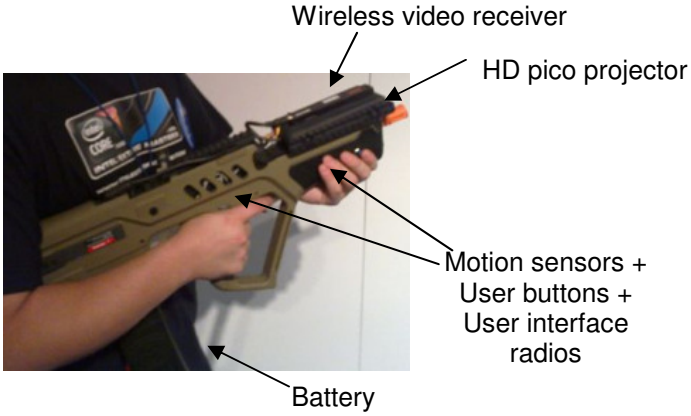

Fig. 3. Components of Project Tuatara

So now we are not tethered any more to a static display nor are we limited to a display size that can only be as big as what you can hold comfortably in your hands during game play. With this, now the entire 360 degree game-world can be unwrapped in front of the user. Trigger pulls and other keyboard shortcuts are effected via the buttons and trigger on the controller. And this is how we have bridged the gaps in the total immersive experience that both mobile gaming and motion-sensed gaming inherently have.

V. Advantages

Following from the above description of device operation, it follows that painting an image pixel-by-pixel is what exposes inherent advantages over alternative projection solutions (viz., DLP or LCOS). Alternative projection solutions, especially in the pico format, flash the primary colors sequentially over the entire frame in a cycle. And so a phenomenon that occurs with an image created when the projector is in motion with these technologies, is called the rainbow effect or motion blur due to color break up. Both of these result in the constituent color planes separating and also of causing the image tearing between frames causing a nearly unusable projected display in mobile motion-sensed gaming.

In comparison, with the single mirror scanned laser projection system, because all the color information necessary for each pixel is created simultaneously, there is no color breakup if the projector is in motion. Indeed, given an average pixel dwell-time of ten nanoseconds, there are no motion artifacts either.

Additionally these scanning laser systems can be alternatively classified as enabling the system to be focus free at infinity and be surface agnostic. Image distortions on any uneven surface will not deem the image to be out of focus at any image extent. And this is illustrated in the following image (Fig. 4.). In the image, the dotted lines are drawn over the various edges of the adjacent walls and ceiling to make the edges clearer to the reader. Needless to say, this is an invaluable asset and might

even be considered a requirement for mobile motion-sensed gaming.

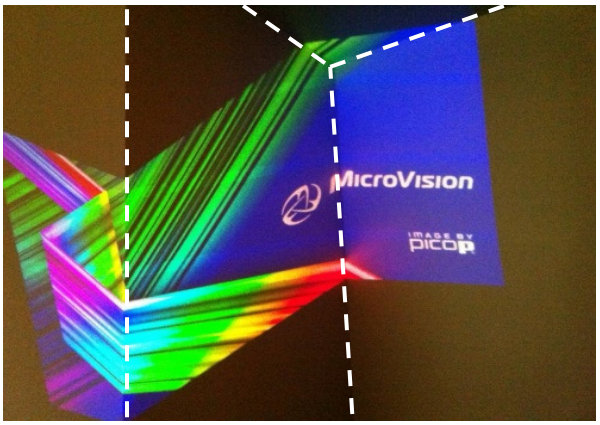

Fig. 4. Picture of content from a single scanned laser source, projected onto multiple surfaces shows that all points are effectively in focus. The dotted lines are coincidental over the actual edges in the room and are superimposed onto the image to make it clearer to the reader as to where the edges are.

VI. Case Study

Video gaming is one key example application that makes laser projectors superior to competing panel or DLP based pico projection solutions when we think of a mobile and motion sensed paradigm, which is what would be needed to make for a truly immersive gaming experience.

MicroVision demonstrated Project Tuatara at the CeBIT 2011 (Hannover, Germany) inside the Intel “Game Changer” Exhibition. As a recap, this is a design with an HD laser scanned projector that creates images pixel by pixel and captures a user’s movement with accelerometers, gyroscopes and magnetometers and can therefore effectively immerse users inside a first person perspective video game.

An anonymous survey was requested on a voluntary basis from all visitors who had a chance to experience this new gaming paradigm and an overwhelming 98% of surveyed users (sample size = 188) said they enjoyed this experience (Fig. 5.).

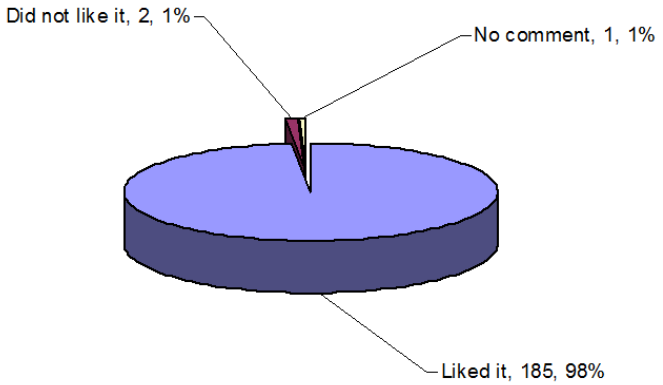

Fig. 5. Survey responses to the question of whether the users enjoyed the experience offered by our novel game controller + display design

As these users represent the 200 million person avid video gamer market, we think this is a considerable asset in the mobile gaming space. More important, the motion sensors we used are already included in most smart phones, and as graphical rendering capability improves, this high-end gaming experience can emerge in handsets.

And our survey went further to quiz the respondents who said "Liked it" to the first question. The intent was to determine what aspect of the experience did the users really like. The questions were specific but diverse and the intent was to be able to bin the responses into four major categories as shown in Fig. 6. What we wanted to understand was how immersive the experience with Project Tuatara was. So in essence both "Realism" and "Immersion" can be clubbed into the same category. However, there were quite a few users who were just awed by the combination of technologies and experience but unfortunately for us that cannot be definitively said as being a vote for the "immersion" aspect we were looking for. That said, a majority of respondents (67% of the total) who liked the overall experience also felt this design offered more realism and immersion than they had experienced before in any form of video gaming.

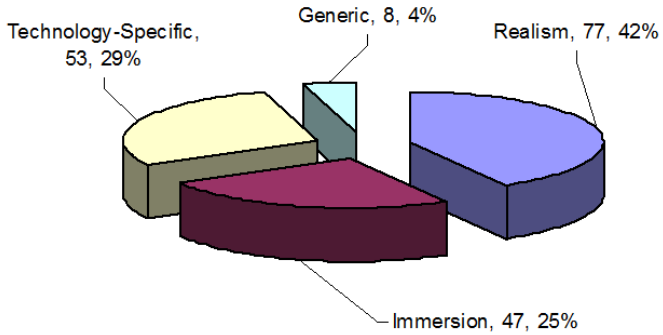

Fig. 6. Further categorization of responses from all respondents who said they liked the overall experience

Acknowledgment

The authors thank A. T. Rosen for his unwavering commitment to this novel gaming paradigm and for his involvement in Project Tuatara while employed at MicroVision, Inc.

References

[1] [1] Feijóo, C. et al., “An analysis of mobile gaming development”, IEEE International Conference on Intelligence in Next Generation Network, October 2010.

[2] [2] P. E. Ross, “Benedetto Vigna: The Man Behind the Chip Behind the Wii", IEEE Spectrum, March 2007.

[3] [3] R. Sprague et al., “Mobile Projectors Using Scanned beam Displays”, from Mobile Displays, Technology and Applications, Bhowmik, Li, and Bos editors, John Wiley and Sons, Chapter 21, 2008.

[4] [4] W. Davis et. al. “MEMS-Based Pico Projector Display”, Proc. of IEEE/LEOS Optical MEMS & Nanophotonics, Freiburg, Germany, 2008.