Moving to improve automotive safety with MEMS scanning mirror technology

Steve Taranovich - November 18, 2016

MicroVision and STMicroelectronics recently announced that they plan to work together to develop, sell, and market laser beam scanning (LBS) technology. Right now both companies are addressing the pico projection and heads-up display (HUD) markets with their LBS solutions. Both companies are also very interested in the further pursuit of targeting emerging markets and applications including virtual and augmented reality (VR, AR), 3D sensing, and advanced driver assistance systems (ADAS).

In addition, MicroVision and ST anticipate exploring options to collaborate on future technology development including a joint LBS product roadmap. This cooperation would combine the process design and manufacturing expertise of ST with the LBS systems and solutions expertise of MicroVision.

This product is featured in EDN’s Hot 100 products of 2016. See all 100 here.

This is a hot topic in the industry and big players are positioning themselves to get a big piece of the pie. Infineon has acquired LIDAR expertise in October with the recent Innoluce takeover. Analog Devices has also just announced, on November 17, the acquisition of LBS Technology from Vescent Photonics for the purpose of enabling mainstream adoption of automotive LIDAR systems. I expect more companies to make similar announcements soon as this market heats up.

During the MEMS & Sensors Executive Congress US 2016, I met with Jari Honkanen, MicroVision Director of Systems Engineering and Advanced Applications, who showed me MicroVision’s amazing MEMS moving mirror technology.

**Figure 1** I held the tiny, single MEMS scanning mirror assembly in my hand.
Figure 2 The MEMS mirror assembly consists of a reflector suspended in a gimbal frame which contains a micro-fabricated electrical coil. Permanent magnets are assembled around the MEMS die which supply a magnetic field. By applying an electrical current to the MEMS coil, a magnetic torque is generated on the gimbal frame with components along both of the desired axes of rotation. (Image courtesy of Reference 1)

A key feature of this design is that there is only one drive signal input to MEMS. In order to create the biaxial motion, the waveforms for both the vertical and horizontal motion are simply superimposed.

Figure 3 One component of torque generates the gimbal frame rotation about its flexure suspension (left): the other component is used to excite a scanning mirror resonant mode of vibration where the reflector will rotate about its flexure suspension to the gimbal frame (right). (Image courtesy of Reference 1)

The composite mirror drive waveform is composed of the superposition of the 60Hz vertical scan sawtooth function with a high frequency sine wave that excites the horizontal scan resonance (Figure 4).
Position feedback for both desired scan angles is created using piezo-resistive (PZR) strain sensors which are micro-fabricated on both the reflector suspension flexures and the gimbal frame suspension flexures (Figure 5).

Red, blue, and green laser diodes are integrated with the MEMS scanning mirror to form a compact color display engine, as shown in Figure 6. By using MEMS in conjunction with compact lasers, the scanning mirror system including light sources enable the design to have an overall volume of less than 5 cubic centimeters, and a height of just 6 mm.
How PicoP laser beam scanning technology works

The lasers in this system are turned on according to the need to display an individual pixel of a certain color; when one of the three lasers is not needed due to the image content, it is turned off to minimize power consumption. The system generates a 720p, an 1280×720 graphics display resolution with a brightness of 25 Lumens, along with a diagonal image size of about 1m at a projection distance of 1.1m. This design features low power and small size. Another advantage of the
use of laser light sources is that the image is in focus at any projection distance without any adjustment. The use of laser light sources also provides a display with wide color gamut and ability to produce vivid colors, as shown in the CIE Chromaticity diagram in Figure 8.

**Figure 8** Laser light sources provide wide color gamut and ability to produce vivid colors. (Image courtesy of MicroVision)
Figure 9 The display engine is integrated with a video and MEMS drive electronics. This system forms the PicoP scanning engine. (Image courtesy of MicroVision)

Figure 10 Shown here is an engine based upon the MicroVision PicoP scanning technology. The device is not much larger than a coin, but delivers an amazing capability to project images on any surface without distortion. It can also act as an image capture device. (Image courtesy of MicroVision)

A scanning engine is comprised of two elements:

- Integrated Photonics Module (IPM)
- Electronics Platform Module (EPM)

MicroVision’s embedded solution acquires and processes signals from a data source to control and synchronize the color mix and placement of the individual pixels. The intensity of each laser light source is varied to create a complete palette of colors and shades. One example is in pico projectors where the MEMS scanning mirror will direct the light beam towards the projection surface (Figure 11).

In HUDs, proprietary optical elements direct the beam of light toward optics external to the scanning engine that enable the image to be viewable within the driver’s immediate, forward-looking field of view.
Figure 11 Coupled with red, blue and green laser light sources which can create virtually all visibly identifiable colors, the MEMS scanner is able to create a bright projected image that is always in focus. (Image courtesy of MicroVision)

High-definition images

To create vivid HD images, the embedded solution arranges the pixels through repetitive horizontal and vertical scanning motions. This process produces rich content without an increase in footprint (device size) or power (Figure 12).
At the MEMS & Sensors Executive Congress, Honkanen presented MicroVision’s automotive applications of their technology using HUD overlays to project critical information on the car windshield as part of the driving scene ahead so that the driver can observe the information without taking their eyes off the road (Figure 13).

Honkanen also presented how MicroVision’s Laser Beam Scanning technology equipped with near infrared (IR) lasers and IR photodetector can be utilized to develop MEMS based scanning LIDAR systems.
The advantage of MEMS based scanning LIDAR is high horizontal and vertical resolution and the ability to dynamically change the detection resolution and frame rate. The same scanning LIDAR can do both slower high resolution and faster lower resolution captures depending on the application or driving situation.

I fully expect to see much more progress with the STMicroelectronics and MicroVision partnership, especially in the areas of automotive LIDAR. Stay tuned for more in this effort.

References

2. Creating a Virtual Touchscreen Anywhere with MEMS Scanning Single Mirror Laser Projectors, P. Selvan Viswanathan1, Senior Member IEEE; David Lashmet2 and Jari Honkanen3, Senior Member IEEE, MicroVision, Inc., 2012 IEEE International Conference on Consumer Electronics (ICCE)

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