

MEMS scanning mirror – Technology demonstrator (Philips Applied Technologies)

General description of the demonstrator.

MEMS technology can be employed to build very small scanning mirrors. When combined with equally small light sources and optics this allows for miniature projection systems, which can be utilized in head-up displays (e.g. for automotive applications), high resolution projection, or ambient lighting applications. The reduced size of the components allows for application of projection systems in both existing and new fields, mainly due to greatly reduced cost and maximum portability. (For example, common automotive head-up displays measure up to 10 liters, whereas common small projectors measure about 2 liters.)

Red and green diode lasers have been introduced years ago, but green lasers have been emerging only recently. In the near future small, powerful and modulatable green lasers are expected to be readily available. Scanning mirrors are still scarce though and do not live up to the expectations. On top of that, such components are only available packaged, which limits the integrateability. Therefore designing a dedicated scanning mirror and integrating it with laser diodes allows for achieving the maximum performance at minimal size and cost.

Description of the technology

From a functional point of view, the scanning mirror must allow displaying at least VGA resolution. Preferably it should match the benchmark as set by MicroVision, achieving SXGA resolution. The specifications are related to these resolutions as follows (please note that the optical scan angle and the mirror dimension are interchangeable):

	VGA	SXGA
Resolution	640x480	1280x1024
Frequency of fast axis [kHz]	16	34.1
Optical angle	11°	11°
Diameter [mm]	2.8	5.7

To scan an image, two 1-degree-of-freedom (DOF) or one 2-DOF scan mirrors are used. Only one of the DOF is oscillating at a high frequency. As MEMS structures are predominantly two-dimensional, out-of-plane vibration modes affecting the image quality are a serious issue at these high frequencies. Balancing this with other conflicting requirements such as size, tilting angle, operating frequency, deformation of the reflective surface, actuation power, thermal stability, etc. requires a well-thought-out dedicated design for each application.

Activities

First, commercially available mirrors will be compared on functionality (dimension, tilting angle, operating frequency, etc) and manufacturability, using first order calculations. The design of the device will be improved upon and compared to the known solutions in detail, using FEM.

Next, the most promising design will be designated (-> fabricated?). The architecture of the projection system might be adapted to match the chosen design, as for example using multiple parallel lasers or using only 1-dimensional tilting mirrors might be beneficial. Likely, the combination of the mirror and architecture requires compromises, which will surface during this design phase. In this design phase much attention will

be paid to the manufacturability, packaging, interconnection, electronics, and integration as these aspects are crucial for the maturity of the mirror-device.

Finally, the mirror will be processed and tested. This will require a lot of effort and is not to be underestimated! Testing will be most easily performed using the current test set-up, for which packaging and electronics are required.

As it is impossible to build such a complex device first-time-right, a redesign is planned.

