Fiber optic Engine for micro projection Display

H. Arabi, K.Oh
Photonic Device Physics Laboratory, Institute of Physics and Applied Physics, Yonsei University
(koh@yonsei.ac.kr)

Introduction:

The rapid growth of the display and projection system industry has made substantial impacts on consumer electronics for decades. Not only do display and projection systems dominate the domestic entertainment market, but they have also been integrated into automobiles and mobile communication [1]. Recently micromechanical mirrors have been introduced in compact projection display systems. This micro machine has several advantages including high accuracy, high switching speed, low power consumption, and the capacity to be mass-produced at low cost . There are commercially available 2 dimensional MEMS mirrors, but the optical engine should be further improved for further integration adapting to various light sources such as LED, LD and other types of lasers.

In this paper we report a monochromatic display system comprising a red LED, hard polymer cladding fiber (HPCF) ,a micro collimator , and a two dimensional micro mechanical mirror. The promising point in this study is using LED instead of LASER which dominantly reduces the price of the display system and also makes it ready for commercialization. HPCFs have played a major role in short-reach optical networks owing to their large core diameters, large numerical apertures, and subsequent easy interconnections in the optical links [2].A Micro collimator is responsible to guide the collimated beam from the tip of HPCF on to the face of the micro mirror. For three reasons we have used the collimator: first, the LED source is an incoherent divergent source, so once light gets out from the fiber tip, it intensively spreads. Second, the spot size which incidents on the micro mirror would be less than the mirror area; otherwise diffraction patterns disturb the reflected beam. Finally, in order to have a high resolution image, the spot size should be kept from the source to the screen. The introduced collimator has dominantly a long working distance in comparison with the conventional models [3].

Experiment and result:

Figure 1 shows schematically the proposed micro projection display system. The 2D Micro-mechanical scanning mirror DM2Dk8 is bonded in an 18 pins ceramic housing. The mirror has a thickness of $30\mu m$ and area of $0.5\times0.5\,mm^2$.The reflection coefficient has been enhanced by a thin layer of aluminum. The oscillating part is excited by an electrostatic force. The 2-D scanning mirror has the potential to achieve a high scan frequency. By using gimbals mounting, the suspended mirror excited independently in x and y directions [4].

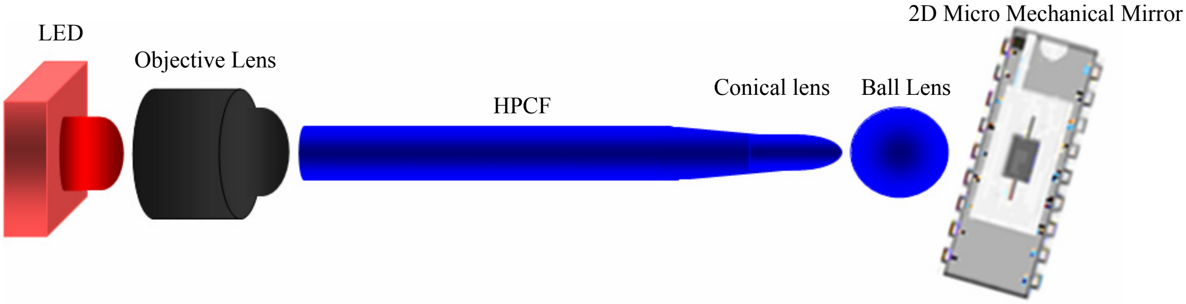

Fig. 1.The micro projection display system. Conical lensed-fiber and ball lens make a micro collimator.

Two plates inside the 2D micro- mechanical mirror are responsible to deflect the mirror in two directions: The mirror plate and the frame plate. The 2D micro- mechanical Mirror plates derived by two 50 VPP squire functions generating through Two function generators .Weak squire functions amplified by a two channels fast high-voltage amplifier. The resonance frequency of 18.365 kHz and 2.615 kHz recorded for the mirror plate and the frame plate respectively.

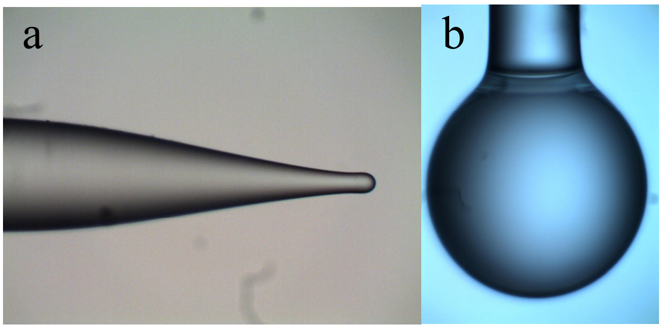

Fig. 2. (a) The conical lensed tip of HPCF with radius of 15 μm.
(b) The ball lens made of silica with radius of 250 μm.

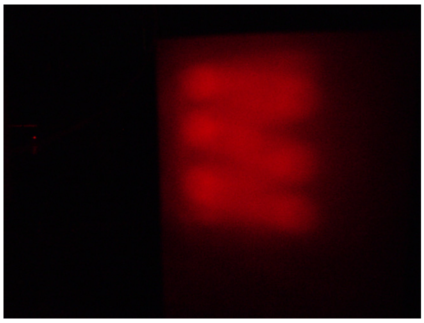

Fig. 3. A typical lissajous pattern of LED collimated beam which has been made by the 2D micro mirror.

The optical fiber used in this experiment is a hard polymer optical fiber (HPCF) with a 200 μm pure silica core and 15 μm thick low index polymer cladding. Typical NA ranges from 0.37 to 0.48. A dome shaped red LED with Luminous intensity of 4500 mcd and total flux of 1.2 cd/lm chosen for the light source. The dominant frequency of 630 nm observed at 2.5 volt applied voltage. The LED coupled to HPCF by an objective lens acting as a telescope system with reduction of 20 times. Figure 2 shows the proposed micro collimator on the output tip of the fiber. It includes of a silicon ball lens with radius of 250 μm and a conical lensed tip of HPCF with an approximated radius of 15 μm. Both the conical lens and the ball lens fabricated through arc discharger of a splicer device. The coupling loss in the coupling area, between the collimator and the fiber, seriously depends on misalignment of the ball lens and the tip of the fiber. The coupling loss for the HPCF is 3 dbm. The spot size at 40 mm from the mirror is roughly 6 mm. this working distance in comparison with the working distance of other resent collimators is an excellent value [3]. Figure 3 shows a typical lissajous pattern of LED collimated beam which has been made by the 2D micro mirror.

Conclusion:

This work demonstrates a monochromatic projection system. We used a simple high flux LED and a chip micro collimator in the hope of commercializing the new display system in the future. The working distance of the collimator is long (more than 40 mm). The development of the proposed technology for three-color-mixing wave guides could be promising especially for portable projection displays such as head-held displays.

Acknowledgments:

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