Nano-Illumination Microscopy as a fast-low-cost chip-sized technique to face pandemics

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Over the past few decades, virologists, epidemiologists and other health sectors have issued alerts about new viruses that could lead to global pandemics. The need for rapid and effective methods to diagnose viruses is of paramount importance to prevent its massive spread among the population. Most viruses vary in size from 20 nm to 250-400 nm, but only the largest ones (700 nm-1 µm) can be seen with a traditional optical microscope. Although some optical super-resolution techniques achieve a resolution of tens of nm, these are complex and require expensive setups. Lensless microscopy is a low-cost alternative, but its resolution is limited by the pixels size on the camera. Recently, a new type of microscope based on nano-illumination microscopy (NIM), was presented [1, 2]. The NIM setup consist in a 2D array of GaN based nano-LEDs used to illuminate the sample while the resulting light is sensed by a photodetector. The sample is placed on top of the light source and the photodetecting device close to the sample (< 1 mm). The LEDs in the array can be switched individually or forming custom patterns, and can be used to observe the transmitted light through the sample or excite fluorescent dyes on it. So, by mapping the sample with the LEDs, morphological as well as molecular information can be obtained. The resolution in NIM microscopy is given by the LED pitch, which can be reduced to the pixel size with an adequate setup. The important aspect of NIM microscopy is that it relies on the LED size and this is continuously being reduced [3]. In this work, we will present a microscope built by using a 2D array of nano-LEDs with a state-of-the-art size of 5 µm LEDs, emitting at ~465 nm. But we will demonstrate how super-resolution with smaller LEDs than the diffraction limit will be obtained in no time. Figure 1 shows the principle of operation of the NIM microscope with a fly wing sample. The LEDs are switched one by one and the light is measured by a photodetector camera. At the same time the NIM image is reconstructed by associating the intensity measured at the photodetector to each LED position. As no lenses or expensive setups are involved the microscope is affordable by anyone. In addition, a complete setup can be produced on a chip size, available to be plugged in mobile phones. We acknowledge the European Union by the support through the European project ChipScope (737089).

REFERENCES

[1] http://www.chipscope.eu/
[2] https://www.youtube.com/watch?v=pePTwFz1x8s&feature=youtu.be
[3] H.S. Wasisto, J.D. Prades, J. Gülink, A. Waag, “Beyond solid-state lighting: Miniaturization, hybrid integration, and applications of GaN nano- and micro-LEDs”, Appl. Phys. Rev. 6, 041315 (2019).

FIGURES

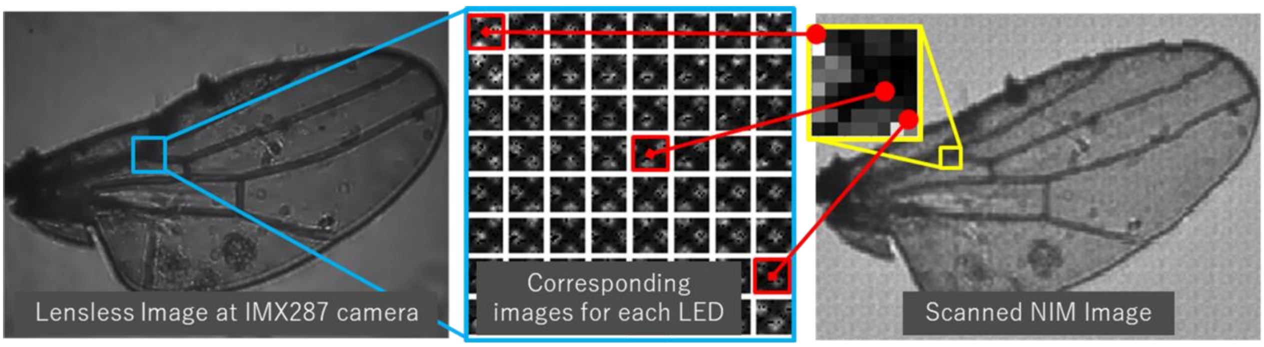

Figure 1: NIM method and extended image of a wing fly obtained by scanning with piezo motors.