Electronic Supplementary Material (ESI) for Lab on a Chip

Wide-field, high-resolution lensless on-chip microscopy via near-field blind ptychographic modulation

Shaowei Jiang,[a] Jiakai Zhu,[a] Pengming Song,[b] Chengfei Guo,[a] Zichao Bian,[a] Ruihai Wang,[a] Yikun Huang,[a] Shiyao Wang,[c] He Zhang,[a] and Guoan Zheng [a,b]

[a]*Department of Biomedical Engineering, University of Connecticut, Storrs, CT, 06269, USA*
[b]*Department of Electrical and Computer Engineering, University of Connecticut, Storrs, CT, 06269, USA*
[c]*Department of Department of Chemical & Biomolecular Engineering, University of Connecticut, Storrs, CT, 06269, USA*

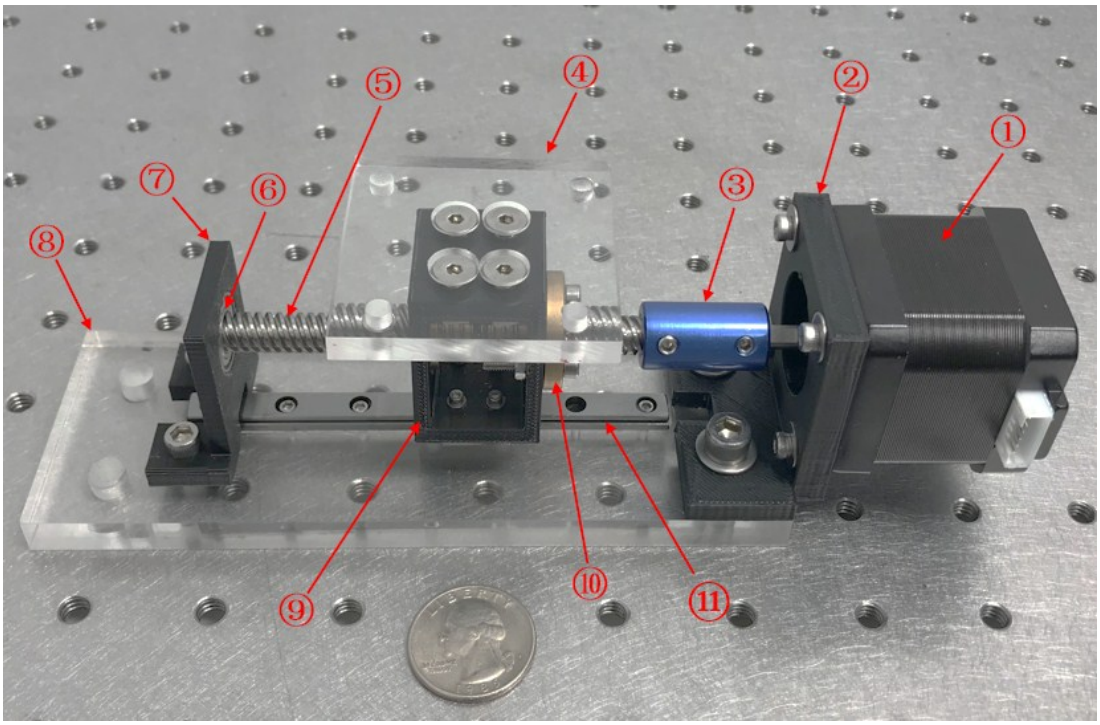

Fig. S1: The y-stage of the lensless prototype platform.

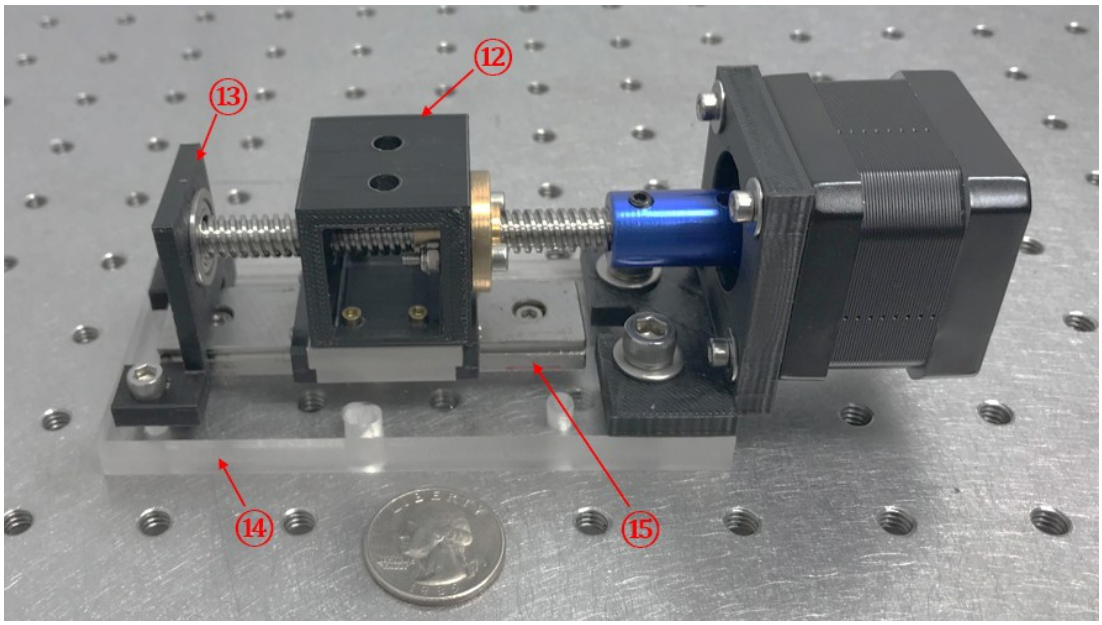

Fig. S2: The x-stage of the lensless prototype platform.

①	Stepper Motor	Nema 17 42 x 42 x 48 mm	2	$13.99	Amazon
②	Motor_Holder	52 x 29 x 47 mm	2	$0.2	3D Printed
③	Shaft Coupling	5 mm to 8 mm	2	$1.8	Amazon
④	Connector Board	Acrylic sheet 52 x 52 x 5 mm	1	$0.5	Amazon
⑤	Lead Screw	Φ=8mm, L=100 mm	2	$5.0	Amazon
⑥	Ball Bearing	Φ=8mm	2	$0.6	Amazon
⑦	Bearing Holder_1	35 x 16 x 38 mm	1	$0.2	3D Printed
⑧	Y-stage Basement	Acrylic sheet 150 x 52 x 9 mm	1	$1.0	Amazon
⑨	Nut Holder_1	25 x 26x 37 mm	1	$0.2	3D Printed
⑩	Copper Nut	Φ=8mm	2	$4.5	Amazon
⑪	Linear Rail Guide_1	MGN7 100 mm	1	$16.99	Amazon
⑫	Nut Holder_2	30 x 29 x 30.4 mm	1	$0.2	3D Printed
⑬	Bearing Holder_2	45.4 x 16 x 38 mm	1	$0.2	3D Printed
⑭	X-stage Basement	Acrylic sheet 114 x 52 x 9 mm	1	$1.0	Amazon
⑮	Linear Rail Guide_2	MGN15 80 mm	1	$27.0	Amazon

Table S1: ①, ③, ⑤, ⑥, ⑩, ⑪, ⑮ are standard parts can be bought from the online store of Amazon. ④, ⑧, ⑭ are are customized parts we made using a milling machine (Roland, SRM-20). ②, ⑦, ⑨, ⑫, ⑬ are 3-D printed parts using a 3D printer.

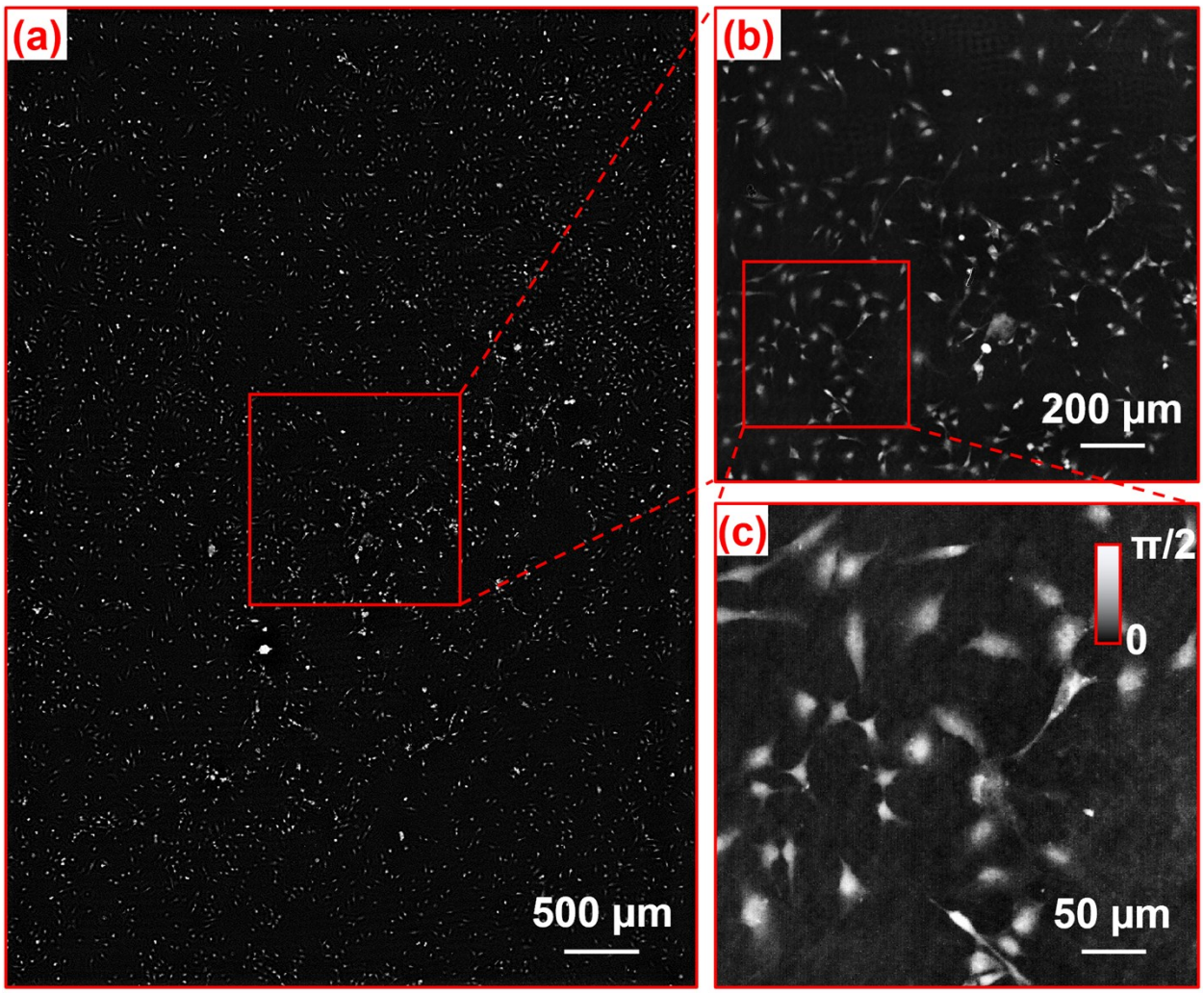

Fig. S3: The recovered phase of HeLa cell culture using the reported lensless imaging platform. We use a matrigel (Corning® Matrigel, 356234) treated glass coverslip in a Petri dish for cell culturing. The HeLa cells are cultured in Dulbecco's modified eagle medium (Gibco, 12320032) supplemented with 10 % fetal bovine serum (Gibco, 10082147) at 37 ºC and 5% CO_2 atmosphere. (a) The recovered phase image of the HeLa cell culture after overnight incubation. (b)-(c) Magnified views of (a).

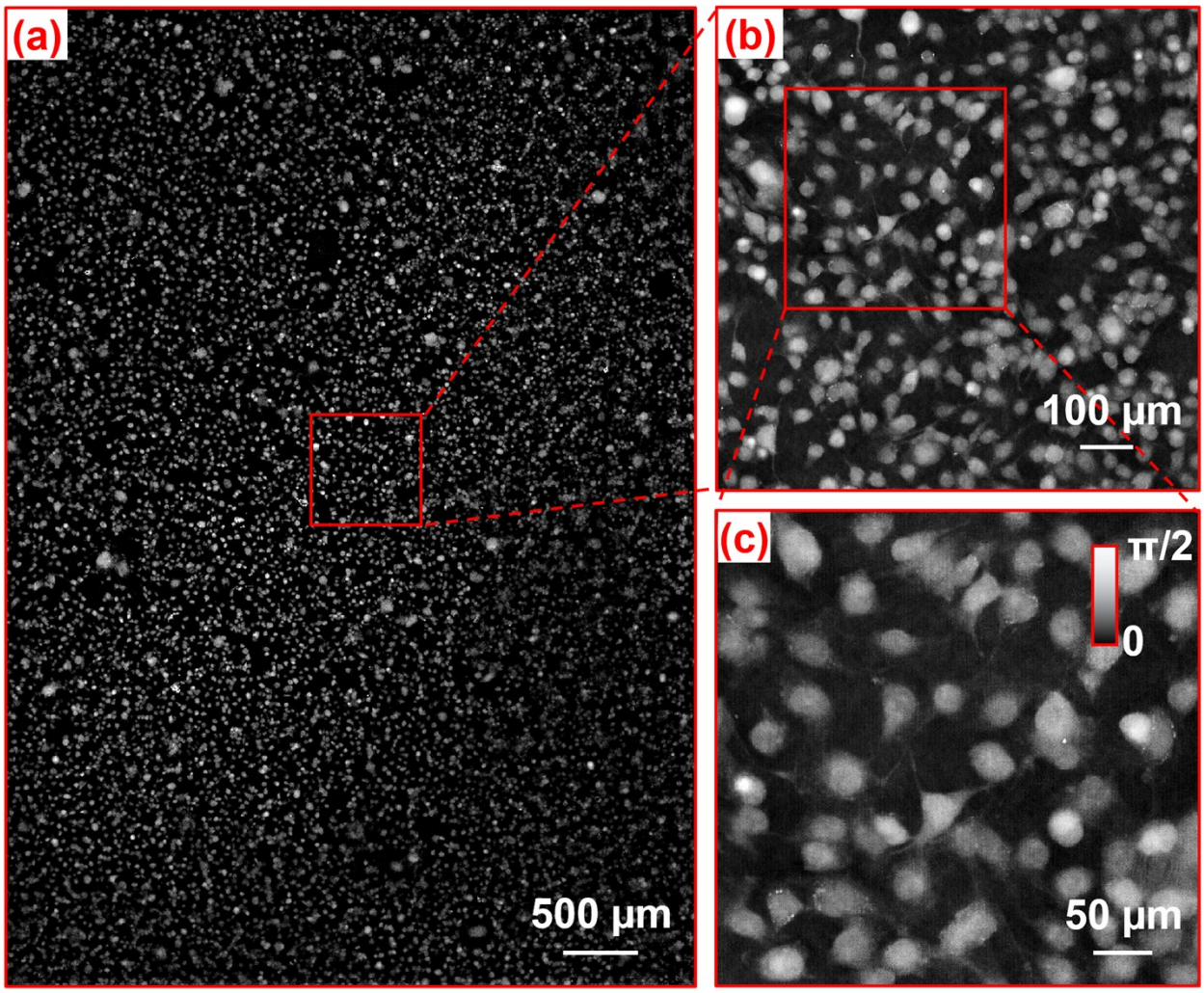

Fig. S4: The recovered phase of U87MG cell culture using the reported lensless imaging platform. U87MG cells were cultured in Dulbecco's modified Eagle medium (DMEM, Thermo Fisher, USA) supplemented with 10% fetal calf serum (Thermo Fisher, USA) and 400 µg/mL G418 (50% activity) and incubated at 37 ^{0}C in a 5% CO_2 atmosphere. (a) The recovered phase image of U87MG cell culture after overnight incubation. (b)-(c) Magnified views of (a).

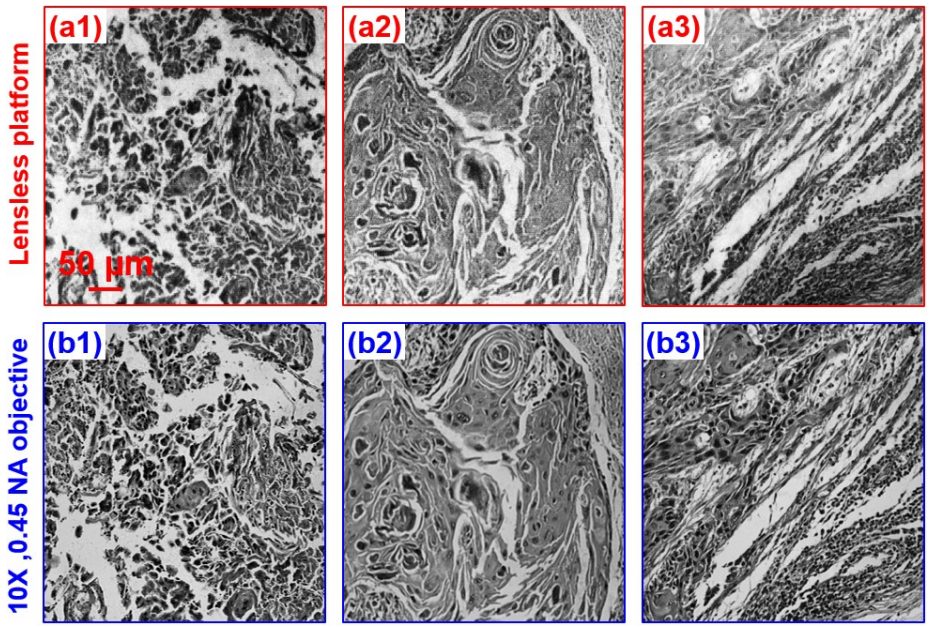

Fig. S5: The comparison between the recovered lensless images and those captured by a standard light microscope. (a) Lensless images. (b) Images captured using a standard light microscope with a 10X, 0.45 numerical aperture objective lens. The difference in contrast is due to the different light sources used in the two imaging modalities.

Movie S1: The three-dimensional design of the lensless on-chip microscopy platform. We use two low-cost, DIY mechanical stages for x-y scanning and use Arduino microcontroller to control the stages. The parts are listed in Table S1.

Movie S2: The operation of the prototype platform. We use two low-cost, DIY mechanical stages to move the diffuser to different x-y positions. The motion step size is 1-2 μm in our experiment (the motion step size has been exaggerated for visualization in Movie S2). A thin diffuser is placed between the object and the image sensor for light wave modulation. The diffuser is made by coating ~1-μm microspheres on a coverslip.

Movie S3: The phase retrieval process of the transparent mouse kidney sample. In this experiment, we directly use the recovered diffuser profile from the previous experiment and capture 100 images with diffuser scanning. In the recovery process, it converges within 3 iteration. In Movie S3, the captured raw images are shown on the left and the recovered quantitative phase images are shown on the right.

Movie S4: The digital propagation process of a thick sample. In this video, we refocus the sample by digitally propagating the exit wavefront to different axial positions.