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(54) **AUTOMATED CELL IDENTIFICATION USING SHEARING INTERFEROMETRY**

(71) Applicant: **University of Connecticut**, Farmington, CT (US)

(72) Inventors: **Bahram Javidi**, Storrs, CT (US); **Adam Markman**, Orange, CT (US); **Siddharth Rawat**, Storrs, CT (US); **Arun Anand**, Gujarat (IN)

(73) Assignee: **University of Connecticut**, Farmington, CT (US)

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(56) **References Cited**

U.S. PATENT DOCUMENTS

4,555,179 A 11/1985 Langerholc et al.
5,299,035 A 3/1994 Leith et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101894276 A 11/2010
CN 101894276 B 9/2012
(Continued)

OTHER PUBLICATIONS

Ma, Lateral Shearing Common-Path Digital Holographic Microscopy, Jun. 12, 2017, Optics Express, vol. 25, pp. 13659-13667 (Year: 2017).*
(Continued)

Primary Examiner — Tarifur R Chowdhury
Assistant Examiner — Omar H Nixon
(74) *Attorney, Agent, or Firm* — Michael Best & Friedrich LLP

(57) **ABSTRACT**

The present disclosure provides improved systems and methods for automated cell identification/classification. More particularly, the present disclosure provides advantageous systems and methods for automated cell identification/classification using shearing interferometry with a digital holographic microscope. The present disclosure provides for a compact, low-cost, and field-portable 3D printed system for automatic cell identification/classification using a common path shearing interferometry with digital holographic microscopy. This system has demonstrated good results for sickle cell disease identification with human blood cells. The present disclosure provides that a robust, low cost cell identification/classification system based on shearing interferometry can be used for accurate cell identification. For example, by combining both the static features of the cell along with information on the cell motility, classification can be performed to determine the type of cell
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