



(12) **United States Patent**
Sun et al.

(10) **Patent No.:** **US 12,198,305 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

(54) **GPU-ACCELERATED DATA PROCESSING METHOD FOR RAPID NOISE-SUPPRESSED CONTRAST ENHANCEMENT**

(71) Applicant: **National Taiwan University**, Taipei (TW)
(72) Inventors: **Chi-Kuang Sun**, Taipei (TW); **Bhaskar Jyoti Borah**, Taipei (TW)

(73) Assignee: **National Taiwan University**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 382 days.

(21) Appl. No.: **17/827,816**

(22) Filed: **May 30, 2022**

(65) **Prior Publication Data**
US 2023/0385988 A1 Nov. 30, 2023

(51) **Int. Cl.**
G06T 5/70 (2024.01)
G06T 5/20 (2006.01)

(52) **U.S. Cl.**
CPC **G06T 5/70** (2024.01); **G06T 5/20** (2013.01); **G06T 2207/20224** (2013.01)

(58) **Field of Classification Search**
CPC ... G06T 5/70; G06T 5/20; G06T 2207/20224; G06T 5/90
USPC 382/254
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,536,337 B1 * 1/2017 Erickson G06T 5/73
2010/0142790 A1 * 6/2010 Chang G06T 5/70
382/274
2020/0250797 A1 * 8/2020 Park G06T 5/75

FOREIGN PATENT DOCUMENTS

CN 112488958 A * 3/2021
CN 109785264 B * 11/2021
WO WO-2017166301 A1 * 10/2017 G06T 5/00

* cited by examiner

Primary Examiner — Tom Y Lu

Assistant Examiner — Pardis Sohraby

(74) *Attorney, Agent, or Firm* — Chun-Ming Shih; HDLS IPR SERVICES

(57) **ABSTRACT**

The present disclosure relates to a data processing method, and more specifically, to a digital image processing method to enable a rapid noise-suppressed contrast enhancement in an optical linear or nonlinear microscopy imaging application. The disclosed method digitally mimics a hardware-based feedback-driven adaptive or controlled illumination technique by means of digitally resembling selective laser-on and laser-off states so as to selectively optimize the signal strength and hence the visibility of the weak-intensity morphologies while mostly preventing saturation of the brightest structures.

13 Claims, 9 Drawing Sheets

