US009411256B2

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

(10) **Patent No.: US 9,411,256 B2**
(45) **Date of Patent: Aug. 9, 2016**

(54) **IMAGE FORMING APPARATUS, IMAGE FORMING METHOD, AND METHOD OF PRODUCING PRINTED MATERIAL FOR GENERATING A PARALLEL LINE DITHER PATTERN OF UNIFORM CONCENTRATION**

(71) Applicants: **Muneaki Iwata**, Kanagawa (JP); **Masaaki Ishida**, Kanagawa (JP); **Atsufumi Omori**, Kanagawa (JP); **Hayato Fujita**, Kanagawa (JP)

(72) Inventors: **Muneaki Iwata**, Kanagawa (JP); **Masaaki Ishida**, Kanagawa (JP); **Atsufumi Omori**, Kanagawa (JP); **Hayato Fujita**, Kanagawa (JP)

(73) Assignee: **RICOH COMPANY, LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/597,952**

(22) Filed: **Jan. 15, 2015**

(65) **Prior Publication Data**

US 2015/0125171 A1 May 7, 2015

Related U.S. Application Data

(63) Continuation of application No. 14/268,463, filed on May 2, 2014, now Pat. No. 9,298,122.

(30) **Foreign Application Priority Data**

May 9, 2013 (JP) 2013-099497

(51) **Int. Cl.**
G03G 15/043 (2006.01)
H04N 1/40 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G03G 15/043*** (2013.01); ***G03G 15/04027*** (2013.01); ***H04N 1/4058*** (2013.01); ***H04N 1/40068*** (2013.01); ***H04N 1/4092*** (2013.01)

(58) **Field of Classification Search**
CPC combination set(s) only.
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,438,437 A 8/1995 Mizoguchi
5,650,858 A * 7/1997 Lund 358/3.15
(Continued)

FOREIGN PATENT DOCUMENTS

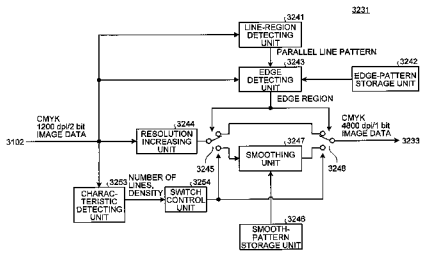
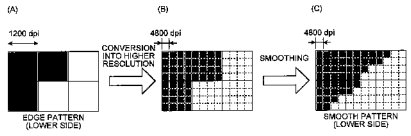
EP 1 018 834 A2 7/2000
JP 2004-282344 * 7/2004 ..... H04N 1/405
(Continued)

OTHER PUBLICATIONS

U.S. Appl. No. 14/072,946, filed Nov. 6, 2013.
(Continued)

Primary Examiner — Barbara Reinier
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P

(57) **ABSTRACT**

An image forming apparatus includes: a pseudo-halftone processing unit that processes input image data to output image data of first resolution; a resolution converting unit that converts the image data of the first resolution into image data of second resolution that is higher than the first resolution; a modulation-signal generating unit that generates a modulation signal obtained by modulating the image data of the second resolution according to a clock signal; and a light-source driving unit that drives a light source according to the modulation signal. The pseudo-halftone processing unit converts a region of pixels having the same pixel value into a parallel line pattern that is formed with a plurality of parallel lines oblique relative to a direction of arrangement of pixels. The resolution converting unit generates the image data o in which each edge of the lines forming the parallel line pattern is smoothed.

11 Claims, 24 Drawing Sheets