

Printer Characterization and Signature Embedding for Security and Forensic Applications

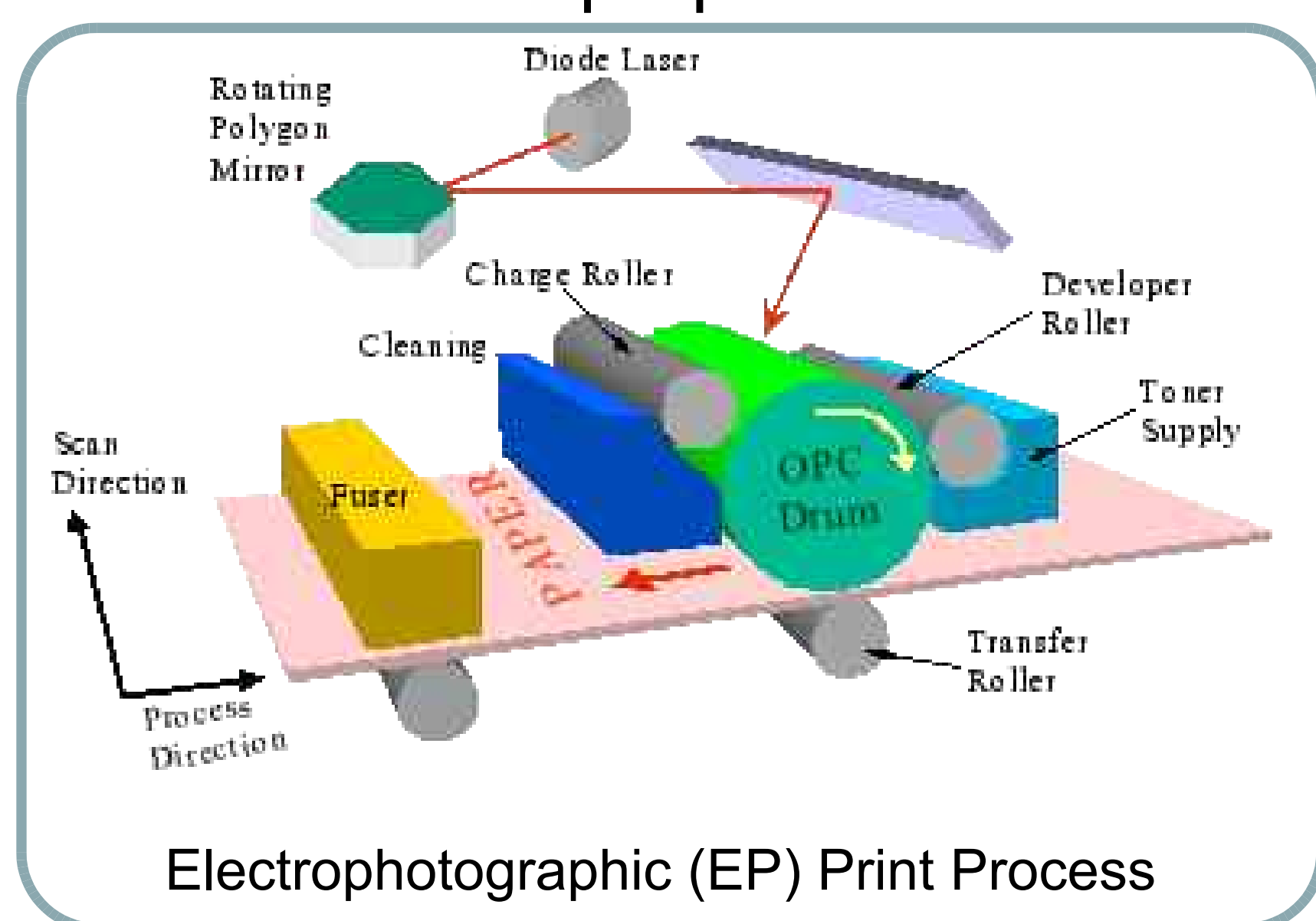
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Document Protection & Forensic Analysis

- Investigate methods that will allow one to determine if a given document was printed on a particular digital printer, model, manufacturer
- Use our experience in characterizing and improving print quality of ink-jet and electrophotography (laser printing) to develop techniques to authenticate a printer and a document

Protect & Prevent

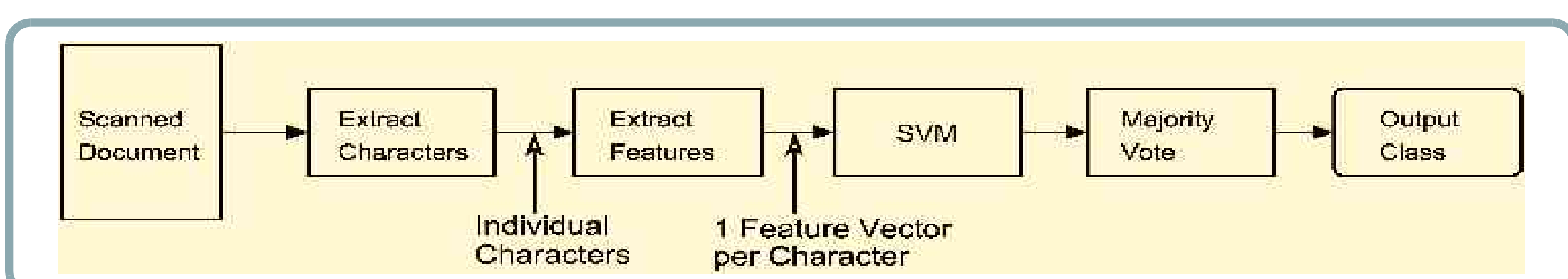
- Copying – scan and print
- Forgery - Alterations – additions and deletions
- Fingerprint and Trace
- Authentication – is this a proper document?



Goals

Develop methods to embed security features in printed documents by exploiting how the printer actually places marks on the paper to form the printed document
 Can be very robust and/or can be very fragile and tamperproof
 Use *intrinsic signature* of printer to identify as much information as possible from printed document about printer that produced it
 Embed auxiliary information in document at time of printing via *extrinsic signature*
 Intrinsic and extrinsic signatures are based on extraction and modulation of features generated by the physical characteristics of the printer mechanism

Intrinsic Printer Identification

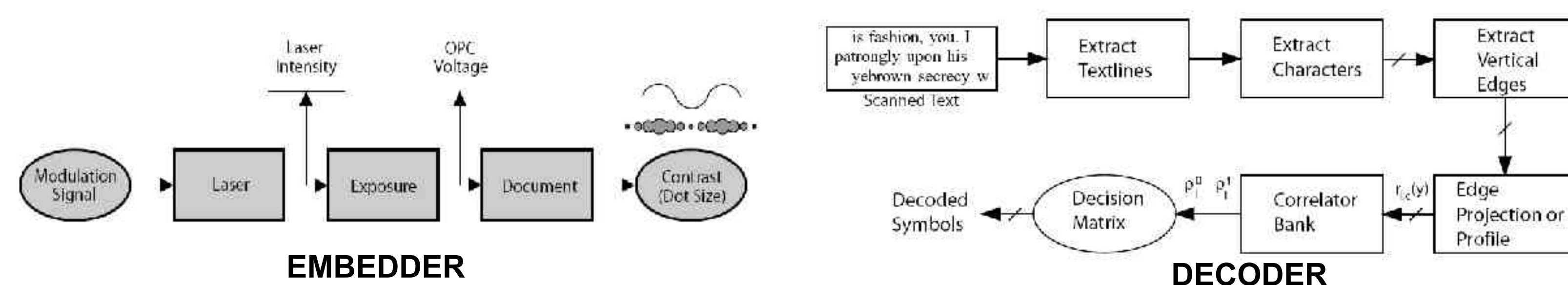


- Graylevel co-occurrence texture features estimated from printed regions within individual text characters
- System works across various font types and sizes, paper types, and consumable age when trained with same font and paper type
- 90% classification accuracy when training on new data and testing on old data
- Similar technique is promising for forensic identification of inkjet printers

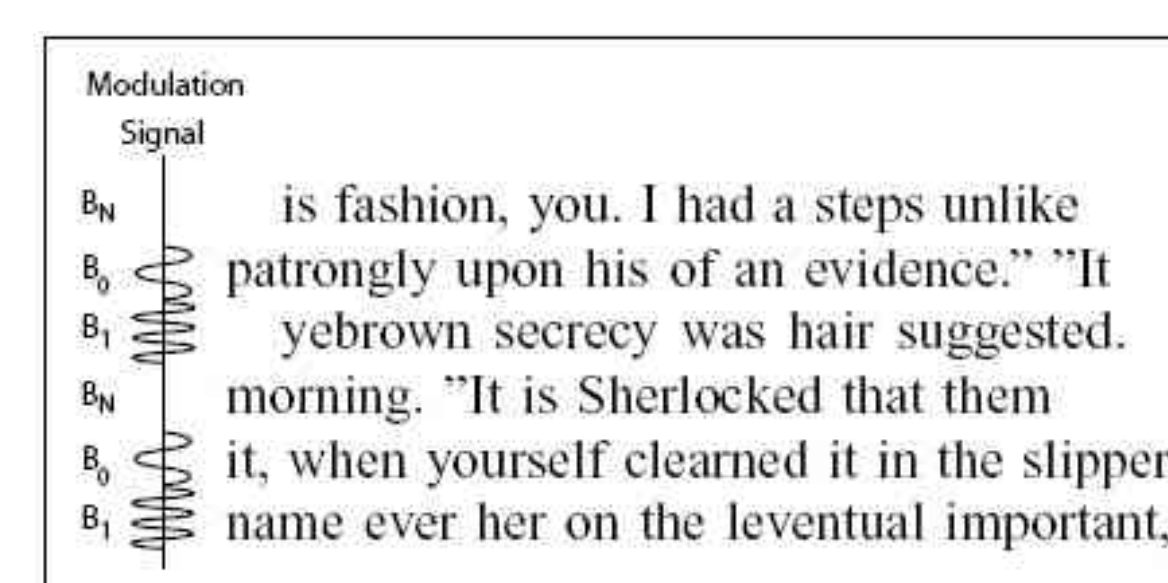
train/test	lj5m	lj6mp	lj1000	lj1200	E320	ml1430	ml1450	hl1440	1250w	14e	Output class
lj5m	296	2	0	1	0	1	0	0	0	0	lj5m
lj6mp	1	256	6	0	17	0	0	15	5	0	lj6mp
lj1000	2	2	284	12	0	0	0	0	0	0	lj1000
lj1200	7	2	2	289	0	0	0	0	0	0	lj1200
E320	0	0	0	0	300	0	0	0	0	0	E320
ml1430	1	0	0	0	0	299	0	0	0	0	ml1430
ml1450	0	0	0	0	0	0	300	0	0	0	ml1450
hl1440	0	28	0	0	0	5	2	259	6	0	hl1440
1250w	0	0	0	0	0	0	0	3	292	5	1250w
14e	0	0	0	0	0	0	0	17	67	216	14e

Classification results using 22 features. Test and training documents consist of 300 'e's printed with 12pt Times Roman font.

Extrinsic Signature Embedding



- Generate extrinsic signature by modulating laser intensity
- Ability to synchronize with individual text lines and embed different signals on a per line basis
- Embedded signature does not affect perceived image/text quality, but is still detectable from the scanned document



$$B_N(y) = 0$$

$$B_0(y) = A * \text{sign} \left(\sin \left(\frac{2\pi f_0 y}{R_p} \right) \right)$$

$$B_1(y) = A * \text{sign} \left(\sin \left(\frac{2\pi f_1 y}{R_p} \right) \right)$$

Character Level Decoding Error

$(f_0/f_1) \setminus A$	0.1V	0.2V	0.3V
15/30	3.6	0.2	0.0
30/60	7.9	2.1	0.2
60/120	14.5	8.2	3.0

Line Level Decoding Error

$(f_0/f_1) \setminus A$	0.1V	0.2V	0.3V
15/30	12.1	3.0	0.0
30/60	3.0	0.0	0.0
60/120	36.4	6.1	3.0

- Test document generated using our Forensic Monkey Text Generator (FMTG) with 12pt Times Roman font (50 lines per page)
- 2 bits embedded every three lines (33 bits in 50 lines of text)
- All bits can be correctly detected with well chosen embedding parameters
- Tradeoff between embedding frequency/amplitude and detection error

References available at <http://shay.ecn.purdue.edu/~prints>