LOCAL BINARY PATTERN

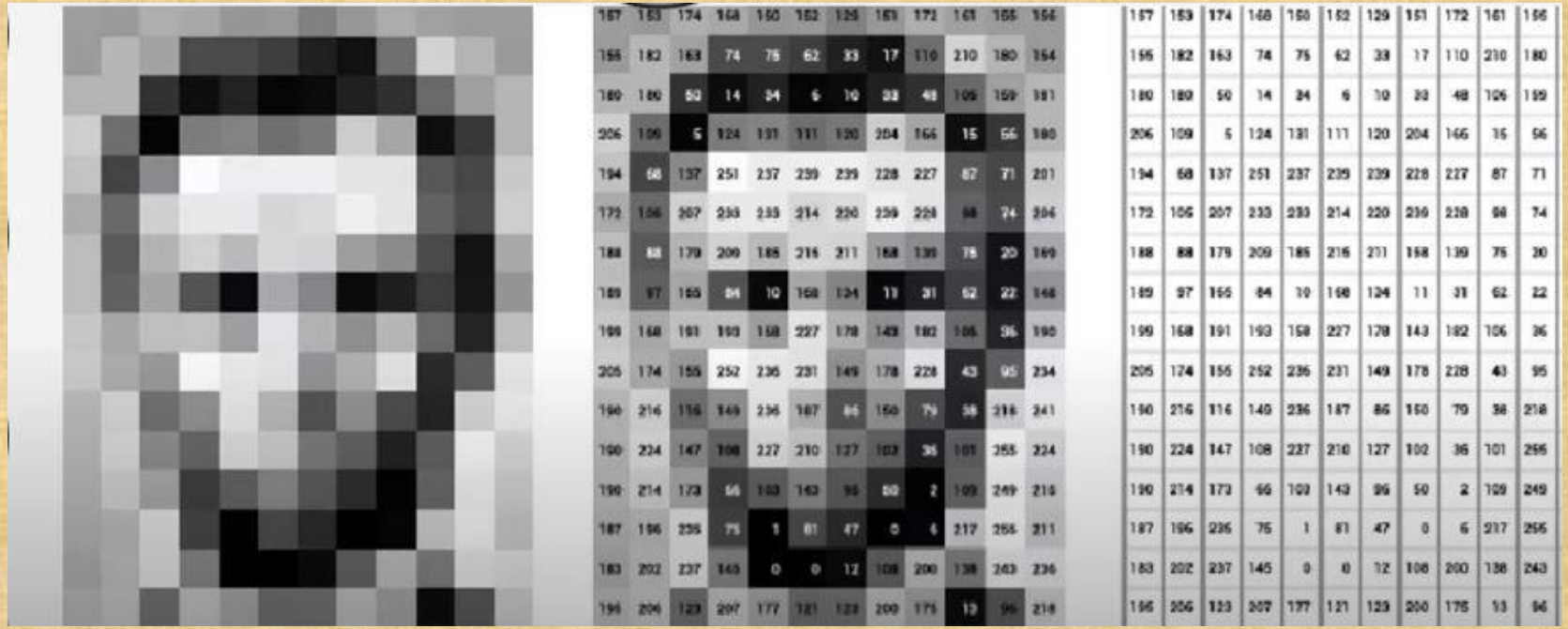
WHERE LOCAL BINARY PATTERNS USED

- Local binary pattern (LBP) is a popular technique used for image/face representation and classification.
- Local Binary Patterns (LBPs) have been used for a wide range of applications
  1. Face detection
  2. Face recognition
  3. Facial expression recognition
  4. Remote sensing
  5. Texture classification
  6. Object detection systems

HOW LOCAL BINARY PATTERN WORKS?

- The most common approach however, dictates that each 3×3 window in the image is processed to extract an LBP code.
- The processing involves thresholding the center pixel of that window with its surrounding pixels using the window mean, window median or the actual center pixel, as thresholds.

How LBP Works ?!



OUTPUT VALUE OF LBP OPERATOR CAN BE OBTAINED AS FOLLOWS:

$$\mathrm{LBP} = \sum_{n=0}^{7} s(i_n - i_c)2^n$$

Here, i_c = Center Pixel Value
i_n = Neighbour Pixel Values

$$s(z) = \begin{cases} 1, & z \geq 0 \\ 0, & z < 0. \end{cases}$$

FOR EXAMPLE

Here, i_c = Center Pixel Value
i_n = Neighbour Pixel Value

$$\sum_{n=0}^{7} s(i_n - i_c)2^n$$

i_0	i_1	i_2
i_7	i_c	i_3
i_6	i_5	i_4

For, n = 0

$s(i_0 - i_c)2^n$ = $(5 - 4)2^0$

= $s(1)$

5	9	1
4	4	6
7	2	3

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i_7	i_c	i_3
i_6	i_5	i_4

For, n = 0

$$s(i_0 - i_c)2^n = s(5-4)2^0$$

$$= s(1)$$

1 > 0
1

$$s(z) = \begin{cases} 1, & z \geq 0 \\ 0, & z < 0. \end{cases}$$

5	9	1
4	4	6
7	2	3

FOR EXAMPLE

Here, i_c = Center Pixel Value
i_n = Neighbour Pixel Value

i_0	i_1	i_2
i_7	i_c	i_3
i_6	i_5	i_4

For, n = 0

1 > 0
1

1	9	1
4	4	6
7	2	3

5	9	1
4	4	6
7	2	3

FOR EXAMPLE

Here, i_c = Center Pixel Value
i_n = Neighbour Pixel Values

$$\sum_{n=0}^{7} s(i_n - i_c)2^n$$

i_0	i_1	i_2
i_7	i_c	i_3
i_6	i_5	i_4

For, n = 1

$$s(i_1 - i_c)2^1 = s(9-4)2^1$$

$$= s(10)$$

10 > 0
1

$$s(z) = \begin{cases} 1, & z \geq 0 \\ 0, & z < 0. \end{cases}$$

FOR EXAMPLE

Here, i_c = Center Pixel Value
i_n = Neighbour Pixel Values

$$\sum_{n=0}^{7} s(i_n - i_c)2^n$$

i_0	i_1	i_2
i_7	i_c	i_3
i_6	i_5	i_4

For, n = 2

$$s(i_2 - i_c)2^2 = s(1-4)2^2$$

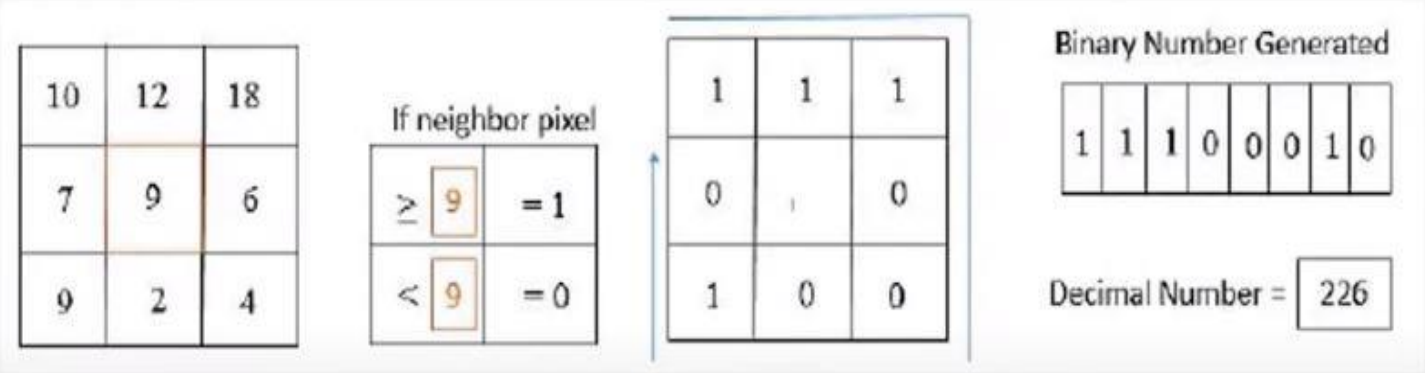
$$= s(-12)$$

-12 < 0
0

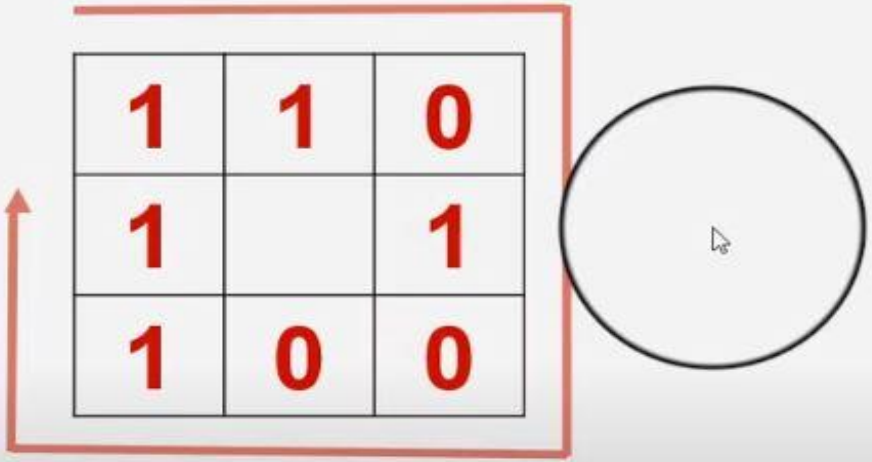
$$s(z) = \begin{cases} 1, & z \geq 0 \\ 0, & z < 0. \end{cases}$$

1	1	0
1		1
1	0	0

FOR EXAMPLE : METHOD 2



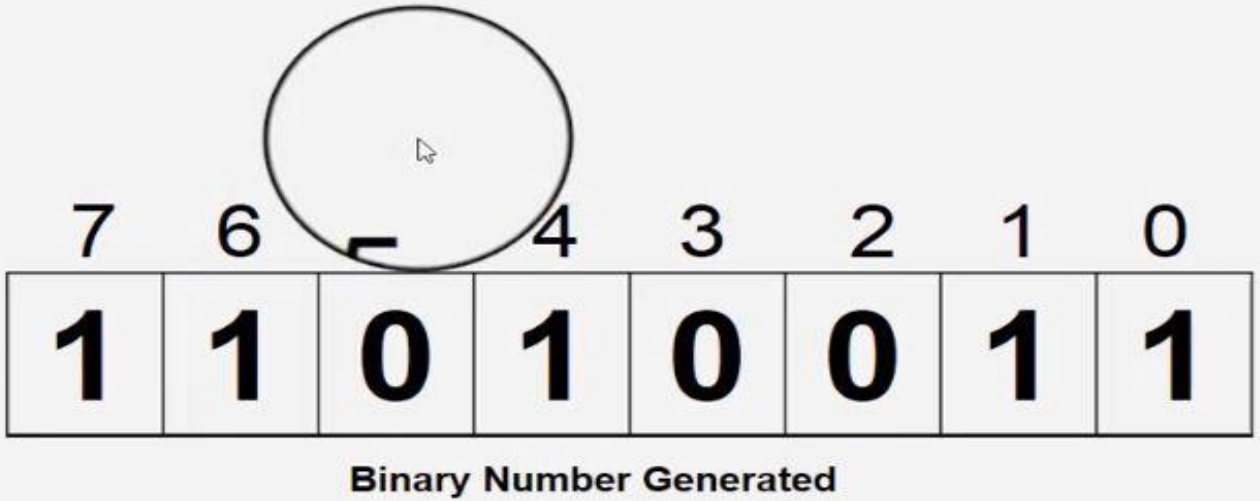
FOR EXAMPLE



1	1	0	1	0	0	1	1

BINARY NUMBER INTO DECIMAL

1	1	0
1		1
1	0	0



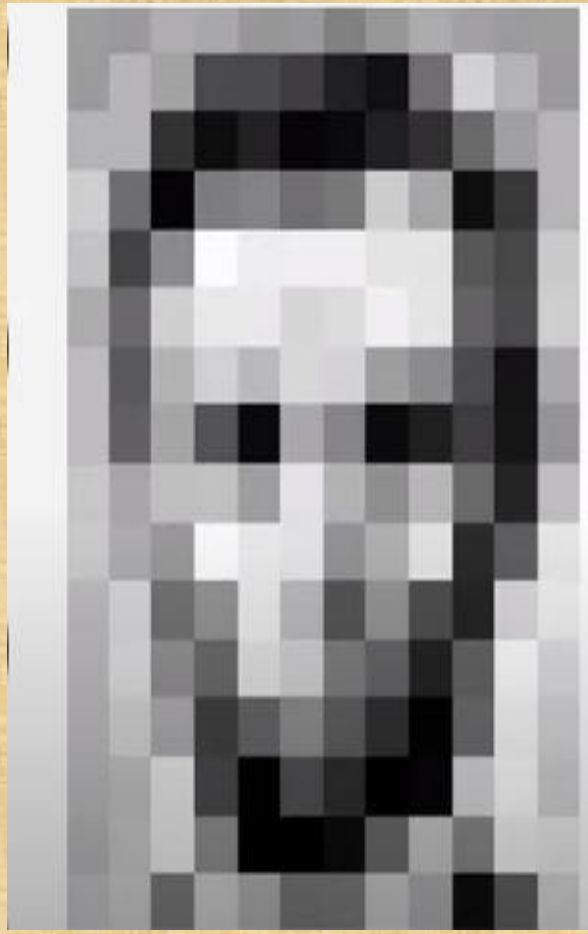
Binary Number Generated

$= 1x\ 2^0 + 1x\ 2^1 + 1x\ 2^4 + 1x\ 2^6 + 1x\ 2^7$

$= 1 + 2 + 16 + 64 + 128$

$= 211$ (LBP Code Generated)

LOCAL BINARY PATTERNS



167	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	216	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	95	50	2	109	249	216
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
196	206	123	207	177	121	123	200	175	13	96	218

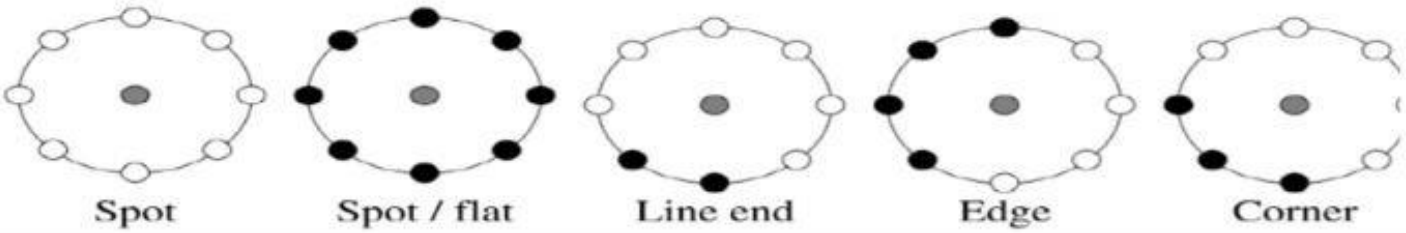
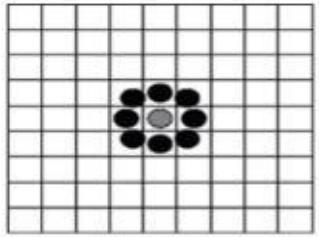


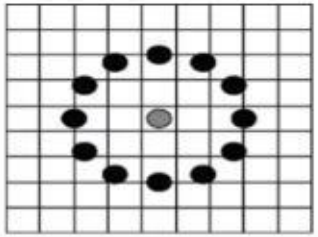
Fig. 2.3 Different texture primitives detected by the LBP

Advanced LBP $_{(P,R)}$

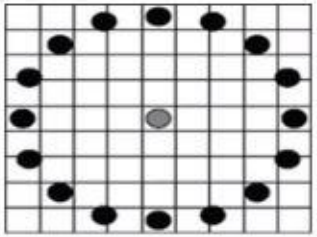
P = Pixels
R = Radius



LBP(8,1)



LBP(16,2)



LBP(20,4)

uLBP

- Uniformity measure U ("pattern") is the number of bitwise transitions from 0 to 1 or vice versa.
- A local binary pattern is called uniform if its uniformity measure is at most 2. i.e transitions between 0 and 1 ≤ 2

Example

- 00000000 (0 transitions)
- 01110000 (2 transitions)
- 11001111 (2 transitions)
- 11001001 (4 transitions)
- 01010011 (6 transitions)

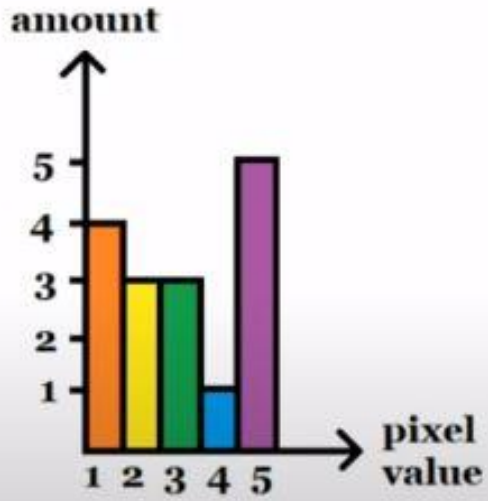
Reasons for omitting non-uniform patterns

- most of the local binary patterns in natural images are uniform
- Ojala et al. noticed that in texture images, uLBP account for
  - 90% of all patterns using the (8,1)
  - 70% in the (16, 2) neighborhood.
- Facial images
  - 90.6% of the patterns in the (8, 1)
  - 85.2% of the patterns in the (8, 2)

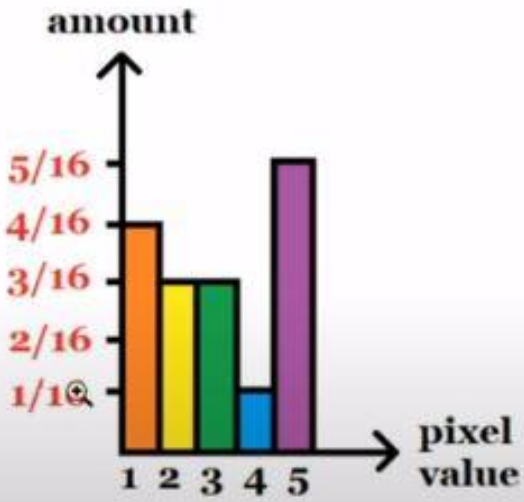
Histogram of LBP (1)

3	1	5	3
5	2	5	1
4	3	1	2
2	1	5	5

LBP



Histogram



Normalized histogram