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EXTRACTION OF BINARY PATTERNS FOR IMAGE DE-NOISING USING DATA MINING

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ABSTRACT

Data mining techniques are very powerful and are widely used for solving problems in image processing applications. This paper identifies the 3X3 decidable, frequently occurring binary patterns from a given set of binary images. The identified patterns are used for image de-noising and are found to be very useful in effective removal of particularly binary noise from binary images. These patterns can also be used in other applications of image processing including image compression and image transmission. To identify decidable frequently occurring binary image patterns 95% of confidence level and 999 frequency support are used to get accurate results. Experimental results of patterns used in binary image de-noising show that patterns are very effective and reliable in removal of noise.

Keywords: *Data Mining, Noise Removal, Patterns, Binary Image, Image Compression, Image Processing.*

1. INTRODUCTION

In this paper, effort is made to identify the decidable frequently occurring patterns. In 3X3 window, arrangement of 8 neighboring pixels is considered as a pattern. If a pattern occurs more than the minimum frequency support, then it is considered as a frequent pattern. In this case minimum frequency support value used is 999. The patterns whose outcome value of central pixel can be calculated using an arrangement of a pattern are considered as decidable patterns; otherwise, they are undecidable patterns.

2. PROBLEM FORMULATION

In this method, a 3X3 window is used to scan the binary images. Center pixel of window is considered as a test pixel. Pixels surrounded by test pixels in window are referred to as neighboring pixels; that is, X1 to X8. Since the proposed system contains test pixel, which is surrounded by eight neighboring pixels X1 to X8 and each pixel contains two possible values 0 or 1 in binary image, the possible patterns are 2^8 =256; that is, P0 to P255. All patterns are framed by taking decimal equivalent value of sequence formed by X1 to X8 neighboring pixel values. Pattern P0 contains eight 0s for X1 to X8. Pattern P255 contains eight 1s so on.

X8	**X7**	**X6**
X1	**TP**	**X5**
X2	**X3**	**X4**

Figure 1: Window Configuration

Table 1: Pattern Formation From 0 To 255

Pattern Number	X1	X2	X3	X4	X5	X6	X7	X8
P000	0	0	0	0	0	0	0	0
P001	0	0	0	0	0	0	0	1
P002	0	0	0	0	0	0	1	0
…	…	…	…	…	…	…	…	…
P254	1	1	1	1	1	1	1	0
P255	1	1	1	1	1	1	1	1

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2.1. Minimization Of Patterns

The available 256 patterns are reduced to only 70 patterns to get more accurate results and to minimize the processing time. To reduce the patterns symmetric property of the window is used. The window used is square one and hence it is a four way symmetric window. Following patterns N1 to N4 are considered as same patterns.

N1 = (X1,X2,X3,X4,X5,X6,X7,X8)
N2 = (X3,X4,X5,X6,X7,X8,X1,X2)
N3 = (X5,X6,X7,X8,X1,X2,X3,X4)
N4 = (X7,X8,X1,X2,X3,X4,X5,X6)

X8	**X7**	**X6**	**X2**	**X1**	**X8**
X1	**TP**	**X5**	**X3**	**TP**	**X7**
X2	**X3**	**X4**	**X4**	**X5**	**X6**
	Pattern N1			**Pattern N2**	
X4	**X3**	**X2**	**X6**	**X5**	**X4**
X5	**TP**	**X1**	**X7**	**TP**	**X3**
X6	**X7**	**X8**	**X8**	**X1**	**X2**
	Pattern N3			**Pattern N4**	

Figure 2: Similar Patterns

Table2: Pattern Formation From 0 To 255

Similar Patterns				**Similar Patterns**				**Similar Patterns**			
N1	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**	**N1**	**N2**	**N3**	**N4**
000	000	000	000	031	124	241	199	087	93	117	213
001	004	016	064	034	136	034	136	090	105	165	150
002	008	032	128	035	140	050	200	091	109	181	214
003	012	048	192	037	148	082	073	094	121	229	151
005	020	080	065	038	152	098	137	095	125	245	215
006	024	096	129	039	156	114	201	102	153	102	153
007	028	112	193	041	164	146	074	103	157	118	217
009	036	144	066	042	168	162	138	106	169	166	154
010	040	160	130	043	172	178	202	107	173	182	218
011	044	176	194	045	180	210	075	110	185	230	155
013	052	208	067	046	184	226	139	111	189	246	219
014	056	224	131	047	188	242	203	119	221	119	221
015	060	240	195	051	204	051	204	122	233	167	158
017	068	017	068	053	212	083	077	123	237	183	222
018	072	033	132	054	216	099	141	126	249	231	159
019	076	049	196	055	220	115	205	127	253	247	223
021	084	081	069	057	228	147	078	170	170	170	170
022	088	097	133	058	232	163	142	171	174	186	234
023	092	113	197	059	236	179	206	175	190	250	235
025	100	145	070	061	244	211	079	187	238	187	238
026	104	161	134	062	248	227	143	191	254	251	239
027	108	177	198	063	252	243	207	255	255	255	255
029	116	209	071	085	85	085	085				
030	120	225	135	086	89	101	149				

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2.2. Decidable Frequently Occurring Patterns (DFOPS)

Confidence level of pattern outcome for 0 and 1 are checked to identify the frequent pattern set. The Patterns processing more than 95% of confidence level and greater than or equal to 999 frequency support are considered as decidable frequently occurring patterns. If confidence level of outcome 0 for frequent pattern is more than 95%, then 0 is taken as expected outcome value for that pattern. If confidence level of 1 is more than 95%, then 1 is taken as expected outcome value. If the confidence level of a frequent pattern is less than 95%, then that pattern is considered as undecidable pattern.

Table3: Confidence Level Of Patterns

Same Patterns				Total Count	0s Count	1s Count	Confidence Of 0s (CZ)	Confidence Of 1s (CO)	Expected Output
N1	N2	N3	N4	(TC)	(ZC)	(OC)			(EO)
000	000	000	000	999	998	001	100	000	000
001	004	016	064	999	990	009	099	001	000
002	008	032	128	999	833	166	083	017	002
003	012	048	192	999	953	046	095	005	000
005	020	080	065	626	623	003	100	000	002
006	024	096	129	999	946	053	095	005	000
007	028	112	193	999	931	068	093	007	002
009	036	144	066	102	072	030	071	029	002
010	040	160	130	157	052	105	033	067	002
011	044	176	194	161	072	089	045	055	002
013	052	208	067	158	147	011	093	007	002
014	056	224	131	999	717	282	072	028	002
015	060	240	195	999	499	500	050	050	002
017	068	017	068	235	231	004	098	002	002
018	072	033	132	118	080	038	068	032	002
019	076	049	196	192	162	030	084	016	002
021	084	081	069	038	037	001	097	003	002
022	088	097	133	159	145	014	091	009	002
023	092	113	197	204	189	015	093	007	002
025	100	145	070	189	155	034	082	018	002
026	104	161	134	157	067	090	043	057	002
027	108	177	198	243	118	125	049	051	002
029	116	209	071	217	198	019	091	009	002
030	120	225	135	999	508	491	051	049	002
031	124	241	199	999	245	754	025	075	002
034	136	034	136	401	029	372	007	093	002
035	140	050	200	157	039	118	025	075	002
037	148	082	073	004	003	001	075	025	002
038	152	098	137	171	038	133	022	078	002
039	156	114	201	105	033	072	031	069	002
041	164	146	074	006	003	003	050	050	002
042	168	162	138	024	000	024	000	100	002
043	172	178	202	010	001	009	010	090	002
045	180	210	075	006	004	002	067	033	002
046	184	226	139	320	022	298	007	093	002
047	188	242	203	146	006	140	004	096	002
051	204	051	204	064	028	036	044	056	002
053	212	083	077	008	008	000	100	000	002
054	216	099	141	123	080	043	065	025	002
055	220	115	205	111	069	042	062	038	002
057	228	147	078	194	088	106	045	055	002
058	232	163	142	282	025	257	009	091	002
059	236	179	206	244	025	219	010	090	002
061	244	211	079	106	043	063	041	059	002
062	248	227	143	999	054	945	005	095	001
063	252	243	207	999	053	946	005	095	001
085	85	085	085	003	002	001	067	033	002
086	89	101	149	014	012	002	086	014	002
087	93	117	213	023	022	001	096	004	002
090	105	165	150	006	003	003	050	050	002
091	109	181	214	005	002	003	040	060	002

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094	121	229	151	107	046	061	043	057	002
095	125	245	215	084	050	034	060	040	002
102	153	102	153	061	024	037	039	061	002
103	157	118	217	121	085	036	070	030	002
106	169	166	154	009	001	008	011	089	002
107	173	182	218	008	002	006	025	075	002
110	185	230	155	273	029	244	011	089	002
111	189	246	219	094	021	073	022	078	002
119	221	119	221	103	083	020	081	019	002
122	233	167	158	154	012	142	008	092	002
123	237	183	222	102	016	086	016	084	002
126	249	231	159	999	048	951	005	095	001
127	253	247	223	999	156	843	016	084	002
170	170	170	170	000	000	000	000	000	002
171	174	186	234	058	002	056	003	097	002
175	190	250	235	607	005	602	001	099	002
187	238	187	238	318	005	313	002	098	002
191	254	251	239	999	006	993	001	099	001
255	255	255	255	999	000	999	000	100	001

2.3. Identified Patterns

Finally, 9 groups of DFOPs are identified for image noise reduction, image compression etc. The Group 1 indicates that text pixel contains 0 if the neighbouring pixels of the text pixel are all 0. The Group 2 indicates that text pixel value is 0 if neighbouring pixels of the text pixel contain seven 0's and one 1 in any corner of the window. The Group 3 and 4 indicate that the text pixel contains 0 if neighbouring pixels of the text pixel contains six 0's and two consecutive 1's. The Group 5 indicates that the text pixel contains 1 if the neighbouring pixels of the text pixel contain five 0's and three consecutive 1‘s. The Group 6 and 8 indicates that the text pixel contains 1 if the neighbouring pixels of the text pixel contain four 1's and two consecutive 0‘s. The Group 7 indicates that the text pixel contains 1 if the neighbouring pixels of the text pixel contain seven 0's and one 1. The Group 9 indicates that the text pixel contains 1 if the neighbouring pixels of the text pixel contain all 1‘s.

Table 4: Decidable Frequently Occurring Patterns

Same Patterns				Total count (TC)	0s count (ZC)	1s count (OC)	Confidence of 0s (CZ)	Confidence of 1s (CO)	Expected Output (EO)
N1	N2	N3	N4						
000	000	000	000	999	998	001	100	000	000
001	004	016	064	999	990	009	099	001	000
003	012	048	192	999	953	046	095	005	000
006	024	096	129	999	946	053	095	005	000
062	248	227	143	999	054	945	005	095	001
063	252	243	207	999	053	946	005	095	001
126	249	231	159	999	048	951	005	095	001
191	254	251	239	999	006	993	001	099	001
255	255	255	255	999	000	999	000	100	001

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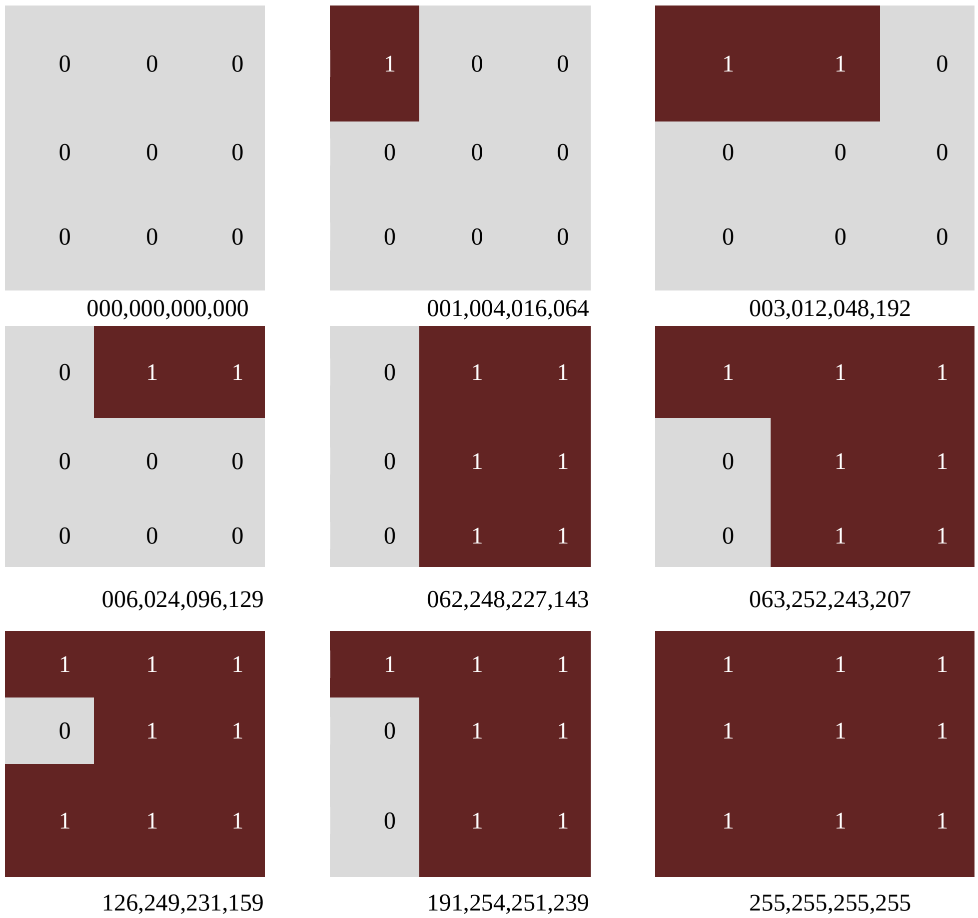

Fig3. Similar Patterns

3. NOISE REMOVAL

Image noise removal is area of concern in image quality enhancement and image restoration. In image noise are classified into so many types [1] but in case of binary image, it is affected by only one type of noise, I.e. binary noise. So many image de-noising algorithms are proposed to effective removal of noise [2-11].

The DFOPs identified above are useful in many applications. The same patterns are used to remove binary noise. Corrupted image is scanned using 3X3 window. In each scan of window, the pattern and central pixel values are compared with table value of DFOPs. If the pattern is definable pattern and, its expected and present values of central pixel are the same then it is considered as correct pixel. If the expected and present central pixel values are different then central pixel is considered as corrupted pixel and it is replaced by the expected value of the pixel using the DFOPs table.

4. PERFORMANCE MEASUREMENTS

To measure the performance of the identified patterns, various corrupted images are used. With the help of the identified patterns, noise present in the corrupted images is removed. The noisy pixels are identified by comparing original image with corrupted image and the restored pixels are identified from corrupted image with restored image. The correctly replaced noisy pixels are called True Positive Pixels (TPPs). The noisy pixels that are not correctly replaced are called False Positive Pixels (FPPs). To check the performance of patterns, Lena, Camera man and vegetable tray images are used. Results of experiment shown in Figures 4, 5 and 6 clearly illustrate the effectiveness of DFOPs.

- *Noise Pixels= Original Image – Corrupted Image*
- *Restored Pixels= Restored Image – Corrupted Image*
- *True Positive=Noise Pixels Intersection Restored Pixel.*
- *False Positive= Restored Pixel- True Positive*

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Corrupted Camera Image With 1% Of Noise *Restored Camera Image With 1% Of Noise*

Figure 4: Results Of Camera Man Image

Corrupted Image 5% Of Noise *Restored Image With 5% Of Noise*

Figure 5: Results Of Vegetarian Tray Image

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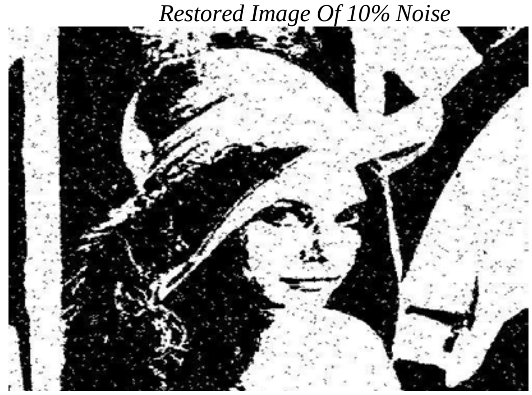
Corrupted Image With 5% Impulse Noise


Restored Image Of 5% Impulse Noise


Corrupted Image With 10% Noise


Restored Image Of 10% Noise


Corrupted Image With 15% Noise


Restored Image Of 15% Noise


Corrupted Image With 20% Noise


Restored Image Of 20% Noise

Figure 6: Results Of Lean Image

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Table 5: Performance Measurements Of Lena Image

SI.No	Noise Percentage	No Of Pixels Corrupted	No Of Pixels Restored	True Positive Pixels	False Positive Pixels	TPP (%)	FPP (%)
01	05	06550	06313	05449	864	87	13
02	10	13072	10751	09926	825	93	07
03	15	19674	14593	13798	795	95	05
04	20	26353	17500	16729	771	96	04
05	25	32673	20119	19349	770	97	03
06	30	39245	21890	21092	798	97	03
07	35	45779	23252	22458	794	97	03
08	40	52616	24168	23341	827	97	03
09	45	58666	24920	23953	967	97	03
10	50	65132	23633	23636	997	96	04

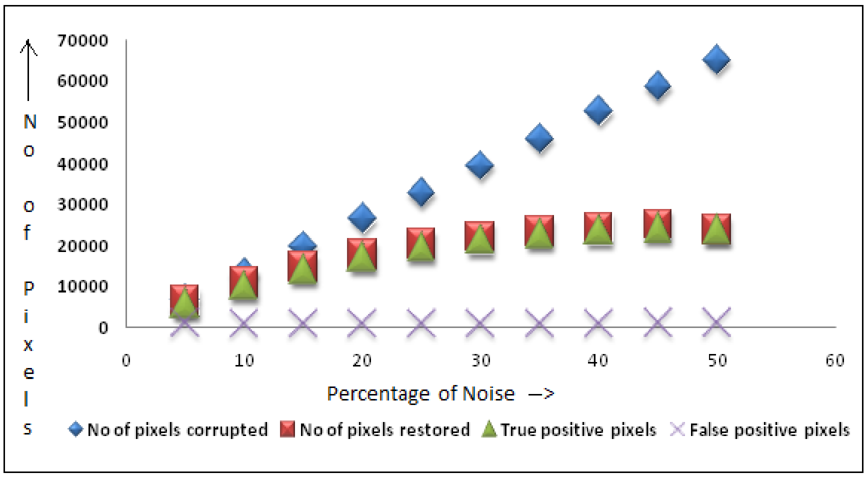

Figure 7: Graphical Representations Of Performance Measurements

The graph in Figure 7 clearly shows the effectiveness of the proposed algorithm. In this graph, as noise ratio increases, number of restored and true positive pixels also increases, indicating that noisy pixels are restored correctly. Constant number of false positive pixels indicates that restoring uncorrected pixels is not increasing linearly with increase in the noisy pixel values.

5. CONCLUSIONS

This paper identified the 9 groups of binary patterns useful for various image processing operations such as image de-noising, compression and transmission, with very high confidence level of 95% and frequency support of 999. Demonstrative use of these patterns in noise reduction gives more than 95% of TPPs and less than 5% of FPPs. Results of experiments clearly show that patterns handle up to 20% of noise very effectively without requiring any additional techniques. Plans for the future work include use of the above identified patterns for image compression, image transmission etc.

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