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Analysis of Digital Signal Features Extraction Based on LBP Operator

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Abstract: Digital voice signal is one of the most widely used type of digital data, it is an important and applicable type of data, & it is used in various applications such human identification systems. Digital voice file usually has a big Size, which means increasing the complexity of the recognition system and decreasing the identification system efficiency. To simplify the recognition system and to increase the system efficiency and accuracy we will introduce a method based on LBP to create a unique voiceprint for each wave file, these voiceprints can be used in a recognition system to identify the person and the spoken voice, we will also discuss how the wave file parameters such as amplitude and sampling rate affect the voiceprint.

Keywords: Digital signal, LBP, CSLBP, MLBP, voiceprint, throughput, efficiency, unique features

I. INTRODUCTION

Biometric identification, or biometrics, refers to the process of identifying an individual based on his/her distinguishing characteristics or extracted features, which are a set of values, this set must be unique for each person. It comprises methods for uniquely recognizing humans based on one or more intrinsic physical or behavioural traits [1], [2], and [3]. Identity authentication becomes a challenging procedure when it has to be automated with high accuracy and hence with low probability of break-ins and reliable non-repudiation. The user should not be able to deny having carried out the transaction and should be inconvenienced as little as possible, which only makes the task more difficult [1], [3]. In biometrics, there are two distinct authentication methods and they are:

1. Verification: It is based on a unique identifier which singles out a particular person (e.g. an ID number) and that individual's biometrics. It is based on a combination of authentication modes.
2. Identification: It is based only on biometric measurements. It compares these measurements to the entire database of enrolled individuals instead of just a single record selected by some identifier.

This paper seeks to analyse biometric technology for speaker recognition (voice signal), its advantages and disadvantages. Speech signal is a continuous, non-stationary signal, it can be assumed stationary on short segments of time, and Perception of speech signal is influenced by three factors: volume, pitch and timbre. Volume is a measure of sound intensity and corresponds with the amplitude of the signal. Pitch is given by the fundamental frequency of the speech signal and represents a measure of how a specific subject perceives the sound. Timbre is determined by the harmonics of the sound and corresponds with frequency components of the signal spectrum.

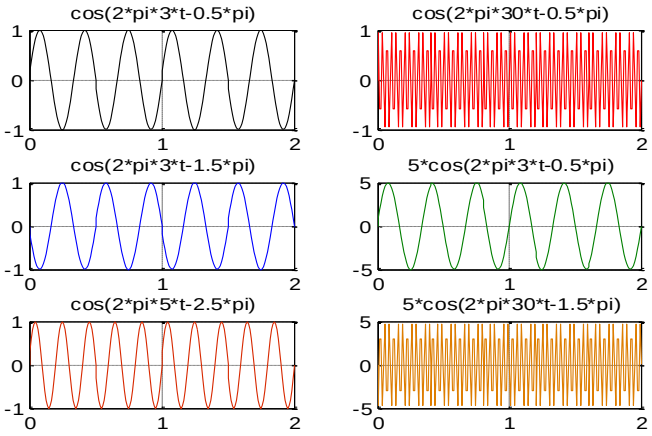

Figure 1: Voice parameters

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In this paper we will focus on voice signal features analysis, and we will select the local binary pattern (LBP)[4], [5], [6] which is widely used for digital image processing and features extraction, we will adopt this method to create a unique features for each wave signal, we will study how each of the following parameters affect the features: voice amplitude, frequency, phase shifting and sampling rate (frequency), figure 1 and 2 show these parameters[7-12]:

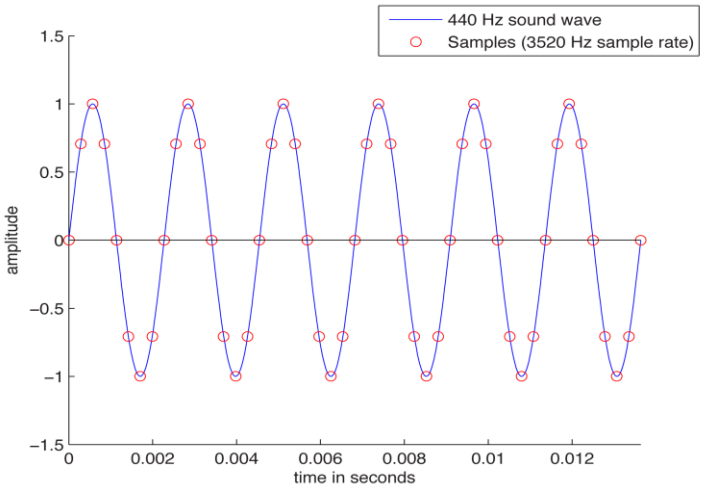

Figure 2: Voice sampling

II. LOCAL BINARY PATTERN METHOD OF FEATURES EXTRACTION

Digital images and digital voices are digital signals which are presented by matrices (2D matrix for gray image, 3D matrix for color image, 1-column matrix for mono voice signals, 2-column matrix for stereo voice signals). Many methods were proposed to create features for various digital signals [10], 13]. [32], [33].
Various authors proposed LBP and CSLBP (center symmetric LBP) methods [14-31], these methods were directed for image manipulation, and sometimes they were used to extract features for both gray and digital images [20] [21], Figure 3, 4, and 5 show how these method work.

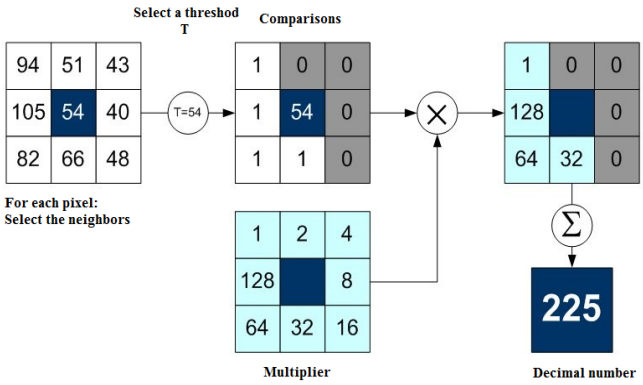

Figure 3: Calculating LBP for a pixel

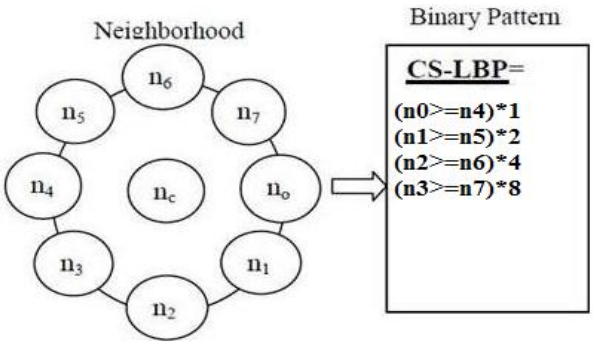

Figure 4: Calculating CSLBP for a pixel

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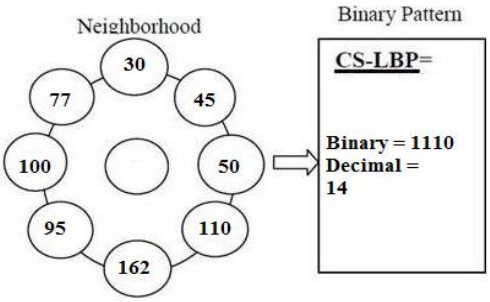

Figure 5: CSLBP calculation example

Based on LBP [20-30] we introduce a modified LBP (MLBP) method to create a voiceprint for a digital voice signal, these voiceprint can be used in a recognition system to find a classifier that can identify the voice signal, MLBP can be implemented applying the following steps:

1. Get the wave file.
2. If the wave file is a stereo file then convert it to one column matrix.
3. Initialize the voiceprint (features) array to zeros (8 elements array).
4. For each sample in the wave file do the following (as shown in figure 6):
   a) Select a window of 9 samples with the selected sample in the centre.
   b) Compare each sample in the upper half of the window with the associated sample in the window lower half (see figure 6).
   c) Based on the comparison set the bit to 0 or 1.
   d) Convert the 4 bits binary number to decimal.
   e) Use the decimal number as an index of the voiceprint array.
   f) Add one to index of voiceprint array.
5. Save voiceprint array.

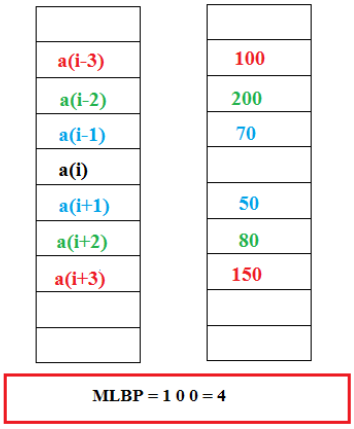

Figure 6: MLBP calculation

The generated voiceprint looks like a histogram with 8 element, each element points to the repetition of the histogram [21], [23], [24], [27] index, figure 7 shows a implementation example of MLBP method.

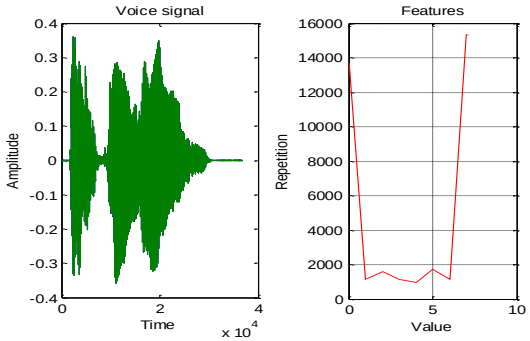

Figure 7: Voice signal example and voiceprint

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III. IMPLEMENTATION AND EXPERIMENTAL RESULTS

The proposed MLBP method was implemented using various wave file, several experiments using matlab were implemented as follows:

Experiment 1: using the same spoken word for various persons: 6 persons were taken, one spoken word was selected, and table 1 shows the results of this experiment:

Table 1: Experiment 1 results

Voice	Bye-bye-1	Bye-bye-2	Bye-bye-3	Bye-bye-4	Bye-bye-5	Bye-bye-6
Features	14792	13690	83288	16855	23748	11450
	706	1126	8354	1367	2797	1809
	1470	1614	9609	1389	2197	4891
	776	1161	7437	1216	2554	523
	648	944	6540	1033	2343	454
	1587	1741	9925	1528	2396	4959
	728	1143	7862	1417	2790	1883
	16074	15362	90586	19334	25914	13755
Size(samples)	36787	36787	223607	44145	64745	39730
Extraction time(s)	0.002000	0.001900	0.019000	0.002300	0.002600	0.002100
Average samples		74300				
Average time		0.0050				
Throughput(samples/second)		14860000				

Experiment 2: 5 spoken words for the first person: Table 2 shows the results of this experiment:

Table 2: Experiment 2 results

Voice	Bye-bye-1	Okay-1	Yes-1	No-1	Zero-1
Features	**14792**	**11927**	**6643**	**7971**	**3262**
	706	**1209**	**2448**	**864**	**722**
	1470	**1955**	**2067**	**2817**	**255**
	776	**488**	**4647**	**390**	**785**
	648	**522**	**4601**	**388**	**405**
	1587	**2138**	**2341**	**2996**	**535**
	728	**1305**	**2561**	**991**	**751**
	16074	**12823**	**8530**	**8593**	**5823**

Experiment 3: 5 spoken words for the second person: Table 3 shows the results of this experiment:

Table 3: Experiment 3 results

Voice	Bye-bye-2	Okay-2	Yes-2	No-2	Zero-2
Features	13690	31497	7169	11742	3668
	1126	5527	2228	889	688
	1614	1732	1300	2578	276
	1161	2999	3788	425	818
	944	2861	3738	353	404
	1741	2018	1551	2623	625
	1143	5645	2421	877	712
	15362	32600	8700	12880	6883

Experiment 4: 5 spoken words for the third person: Table 4 shows the results of this experiment:

Table 4: Experiment 4 results

Voice	Bye-bye-3	Okay-3	Yes-3	No-3	Zero-3
	83288	59829	8709	16627	4642
	8354	8477	2520	1995	1119
	9609	11116	3626	5538	609

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Features	7437	5438	4116	730	1269
	6540	5600	4065	737	752
	9925	11291	3989	5687	927
	7862	8626	2733	2131	1161
	90586	61780	11438	19522	8459

Experiment 5: 5 spoken words for the fourth person: Table 4 shows the results of this experiment:

Table 5: Experiment 5 results

Voice	Bye-bye-4	Okay-4	Yes-4	No-4	Zero-4
Fea-tures	16855	11624	19929	13137	3753
	1367	1218	4685	1874	894
	1389	3632	5823	5826	485
	1216	586	3419	430	1094
	1033	522	3401	349	797
	1528	3813	6159	6247	798
	1417	1330	4828	2357	1087
	19334	12585	23853	15390	6958

Experiment 6: 5 spoken words for the fifth person: Table 6 shows the results of this experiment:

Table 6: Experiment 6 results

Voice	Bye-bye-5	Okay-5	Yes-5	No-5	Zero-5
Features	23748	12761	6114	12690	3922
	2797	1550	3615	1287	642
	2197	4625	1068	2748	288
	2554	692	2770	566	1061
	2343	589	2700	546	515
	2396	5107	1900	2830	676
	2790	1961	4530	1357	860
	25914	15382	9330	13286	8414

Experiment 7: 5 spoken words for the sixth person: Table 7 shows the results of this experiment:

Table 7: Experiment 7 results

Voice	Bye-bye-6	Okay-6	Yes-6	No-6	Zero-6
Features	11450	20259	18930	35338	2470
	1809	3787	1833	4041	920
	4891	10957	6052	7314	1042
	523	1250	1123	579	1450
	454	1213	1042	409	620
	4959	11253	6180	8081	1783
	1883	4115	1946	5157	1435
	13755	23677	20276	46493	7170

Experiment 8: Varying sampling rate for word 1 for person 1: Table 8 shows the results of this experiment:

Table 8: Experiment 8 results: Bye-bye-1

Sampling rate	44100	22050	20000	15000	10000
Features	**14792**	14792	14792	14792	14792
	706	706	706	706	706
	1470	1470	1470	1470	1470
	776	776	776	776	776
	648	648	648	648	648
	1587	1587	1587	1587	1587
	728	728	728	728	728
	16074	16074	16074	16074	16074

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Experiment 9: Varying amplitude for word 1 for person 1: Table 9 shows the results of this experiment:

Table 9: Experiment 9 results: Bye-bye-1

Amplitude	Original amplitude	Amplitude multiplied by 2	multiplied by 3	Divided by 2	Divided by 3
Features	**14792**	14792	14792	14792	14792
	706	706	706	706	706
	1470	1470	1470	1470	1470
	776	776	776	776	776
	648	648	648	648	648
	1587	1587	1587	1587	1587
	728	728	728	728	728
	16074	16074	16074	16074	16074

From the obtained results shown in tables 1 thru 9 we can see the following:

- ✓ Using the voiceprints obtained by MLBP method we can classify the person and the spoken word.
- ✓ Each voice print for each person word is a unique.
- ✓ Using the voice prints we can identify a person.
- ✓ Using the voiceprints we can identify the spoken word (voice).
- ✓ Adjusting the voice sampling rate does not affect the signal voiceprint.
- ✓ Adjusting the voice amplitude does not affect the signal voiceprint.
- ✓ MLBP method provides a high efficiency, it provide a throughput with average 14860000 samples per second.

IV. CONCLUSION

MLBP method of voice signal features extraction was proposed, and implemented. It was shown that this method is accurate and highly efficient. The generated voiceprint for each file is a unique and it can be used in a recognition system to identify the human and to identify a spoken words.

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