AMSE Association for the Advancement of Modelling & Simulation Techniques in Enterprises
IIETA International Information and Engineering Technology Association
Advancing the World of Information and Engineering

Modelling, Measurement and Control C
Vol. 80, No. 2-4, December, 2019, pp. 57-70
Journal homepage: http://iieta.org/journals/mmc_a

Blood Group Identification Based on Fingerprint by Using 2D Discrete Wavelet and Binary Transform

M. Mondal[1], U.K. Suma[2], M. Katun[2], R. Biswas[2*], Md. Rafiqul Islam[1]

[1] Mathematics Discipline, Science, Engineering and Technology School, Khulna University, Khulna 9208, Bangladesh
[2] Department of Mathematics, Bangladesh University, Dhaka 1207, Bangladesh

Corresponding Author Email: rajibkumath11@gmail.com

https://doi.org/10.18280/mmc_c.802-404

Received: 1 April 2019
Accepted: 22 May 2019

Keywords:
discrete wavelets, binary transform, blood group recognition, finger print

ABSTRACT

Fingerprint is becoming the part of our day to day life right from our home to workplace. Now a day for security and safety purpose prime importance is given by it. Also, Fingerprint identification is one of the most popular biometric technologies and which is highly used in criminal investigations, commercial applications, and so on. The performance of a fingerprint image-matching algorithm depends heavily on the quality of the input fingerprint images. It is very important to acquire good quality images to find out gender and blood group. The use of wavelet transform improves the quality of an image and reduces noise level. In this research, different compression techniques are used to overcome this problem. Initially, different finger prints have been collected among the students of Mathematics discipline of Khulna University. Then the fingerprints have been resized to 320*256 and saved in JPEG format. Then, we have used different wavelets transformation for compression of the fingerprint images. Image qualities before compression and after compression are measured by Mean Squared Error (MSE), Signal-to-Noise Ratio (SNR) and Peak Signal-to-Noise Ratio (PSNR). After that the images has been pre-processing and transformed into binary images. Further, from this binary image, pixel calculation such that numbers of black and white pixels have been calculated. After that, some mathematical calculations have been done to identify the genders and blood groups. This work has been done by MATLAB programming.

1. INTRODUCTION

Now a day, Fingerprint is most welcome objects to our human life. In criminal investigation, fingerprint concerns a vital role because every fingerprint has an individual characteristic there was no same pattern found between two persons. Also, fingerprint pattern will remain unchanged for the life of an individual; however, the print itself may change due to permanent scars and skin diseases. Further fingerprints have general characteristic ridge patterns that allow them to be systematically identified. Fingerprint is a made of a series of ridges and valleys on the surface of the finger. Due to this characteristic of fingerprint, this is very essential to justify any criminal. Also, fingerprint is used in gender and blood group identification.

Today, fingerprint recognition has been around the longest, and there are more commercial applications of it than iris recognition. For example, different types of fingerprint recognition devices can be found for network access and physical access entry configurations. A Study of fingerprint patterns in relation to gender and blood group has been presented by Narayana et al. [1]. A study of fingerprints in relation to gender and blood group was studied by Rastogi et al. [2]. Pattern of fingerprints in different ABO blood groups was published by Bharadwaja et al. [3]. Also, finger print identification was discussed by Surinder [4]. Further, relationship between pattern of fingerprints and blood groups was submitted by Smail et al. [5]. These types of work are done by different researcher with different observation as [6-16].

This research work is to be researched the blood group identification based on fingerprint by using 2D discrete wavelet and binary transform. Initially, different fingerprints have been collected, resized and saved in JPEG format. Then from this RGB image, we have found out its binary image and its black and white pixels number. Also, the length of binary number of black pixels, number of 0's and number of 1's are calculated. All have been done by MATLAB programming. After finding these values, we have used 4 steps of calculations. Then these 4 steps of calculations, which is identifies the different blood groups of the given fingerprints.

2. EXPERIMENTAL DATA WITH ALL INFORMATION'S

Table A: Experimental data with all information such as, serial number of fingerprints, name, original fingerprints, Gray scale fingerprints, Black and white fingerprints, gender and blood group has been shown in the following Table A:

Person ID	Original Fingerprints	Gray Scale Fingerprints	Black and White Fingerprints	Gender	Blood Group
1				Male	B+
2				Male	AB+
3				Female	O+
4				Male	AB+
5				Male	B+
6				Male	O+
7				Male	A+
8				Female	B+
9				Female	O+
10				Female	B+

11		Male	B+
12		Male	AB+
13		Female	O+
14		Male	B+
15		Female	O+
16		Male	O+
17		Male	O+
18		Male	AB+
19		Female	A+
20		Male	AB+

21		Male	AB+
22		Male	B+
23		Female	AB+
24		Male	B+
25		Male	B+
26		Male	O+
27		Female	A+
28		Female	AB+
29		Male	B+
30		Male	O+

31		Male	O+
32		Female	AB+
33		Male	B+
34		Male	A+
35		Male	AB+
36		Female	A+
37		Female	A+
38		Male	B+
39		Female	A+
40		Female	A+

41		Female	AB+
42		Female	O+
43		Female	A+
44		Female	O+
45		Male	A+
46		Male	AB+
47		Female	B+
48		Male	O+
49		Male	A+
50		Male	AB+

51		Female	A+
52		Female	B+
53		Male	B+
54		Female	A+
55		Female	O+
56		Female	O+
57		Female	AB+
58		Female	AB+
59		Female	A+
60		Female	A+

3. WORKING PROCEDURE

In this experiment, we have collected 60 fingerprints (30 male fingerprints and 30 female fingerprints) with their only Rh+ ABO blood groups. For blood group identification, we have separated the 4 Rh+ ABO groups like, A+, B+, O+ and AB+. After performed these 4 steps calculations, we have obtained a good result where the following procedure has been done:

(1) At first, we have separated the all fingerprints into 4 Rh+ ABO groups (A+, B+, O+ and AB+) from the obtained prepossessing fingerprints.

(2) Number of White Pixels (NWP) and Number of Black Pixels (NBP) and Binary Length of Black Pixels (BLBP) for each fingerprint has been taken, which is already find out in chapter 3. In this chapter, we have taken those values to do perform the calculations.

(3) Subtraction (NBP-NWP) from Number of Black Pixels (NBP) to Number of White Pixels (NWP), number of 0's (total number of digits 0) and 1's (total number of digits 1) in the Binary Length of Black Pixels (BLBP) has been find out due to proper calculations of blood identification.

(4) All calculations have been done by MATLAB programming.

(5) The following steps has been followed for blood group identification:

Step-1	For identification of blood group A+, Calculate Quotient $=\frac{\text{NBP}}{\text{0'sof BLBP}}$ using MATLAB programming. Also, odd number quotient has been noted among the four blood groups.
Step-2	For identification of blood group B+, Calculate Quotient $=\frac{\text{NWP-NBP}}{\text{B LBP}}$ using MATLAB programming. Also, odd number quotient has been noted among the four blood groups.
Step-3	For identification of blood group AB+, Calculate Modulo $=\frac{\text{NBP}}{\text{1'sof BLBP}}$ using MATLAB programming. Also, even number modulo has been noted among the four blood groups.
Step-4	For identification of blood group O+, Calculate Quotient $=\frac{\text{NWP}}{\text{1'sof BLBP}}$ using MATLAB programming. Also, even number quotient has been noted among the four blood groups.

4. EXPERIMENTAL RESULTS

Experimental results are shown in the following table and discussions have been mention in the end of the Table 1.

Here, in Table 2. Number of Even Quotient =03 and Number of Odd Quotient=12.

So, the percentage of Number of Odd Quotient=80%.

Table 1. Results for step-1 on 15 fingerprints for blood group A+

Person ID	NWP	NBP	BLBP	0's	Quotient	Observation
7	13700	68220	17	11	6201	Odd
19	71431	10483	14	06	1747	Odd
27	70526	11394	14	10	1139	Odd
34	13915	68005	17	10	6800	Even
36	77195	4725	13	06	787	Odd
37	81077	843	10	04	211	Odd
39	69828	12092	14	06	2015	Odd
40	67257	14663	14	06	2443	Odd
43	71680	10240	14	12	853	Odd
45	38205	43715	16	07	6245	Odd
49	22838	59082	16	07	8440	Even
51	69865	12055	14	05	2411	Odd
54	69590	12330	14	08	1541	Odd
59	73640	8280	14	09	920	Even
60	78790	3130	12	06	521	Odd

Table 2. Results for step-1 on 15 fingerprints for blood group B+

Person ID	NWP	NBP	BLBP	0's	Quotient	Observation
1	6849	75071	17	07	10274	Even
5	31095	50825	16	09	5647	Odd
8	78270	3650	12	07	521	Odd
10	78076	3844	12	07	549	Odd
11	32525	49395	16	08	6174	Even
14	28542	53378	16	11	4852	Even
22	9327	72593	17	09	8065	Odd
24	17486	64434	16	05	12886	Even
25	63069	18851	14	06	3141	Odd
29	41857	40063	16	05	8012	Even
33	26842	55078	16	09	6119	Odd
38	19872	62048	16	09	6894	Even
47	29735	52185	13	06	8698	Even
52	67893	14027	14	05	2804	Even
53	16695	65225	16	05	13044	Even

Here, Number of Even Quotient =09 and Number of Odd Quotient=06. So, the percentage of Number of Odd Quotient=40%.

Table 3. Results for step-1 on 15 fingerprints for blood group AB+

Person ID	NWP	NBP	BLBP	0's	Quotient	Observation
2	31004	50916	16	08	6364	Even
4	26925	54995	16	06	9165	Odd
12	24927	56993	16	07	8141	Odd
18	18560	63360	16	08	7920	Even
20	23744	58176	16	10	5817	Odd
21	15086	66834	17	13	5141	Odd
23	80744	1176	11	07	168	Even
28	78256	3664	12	07	523	Odd
32	68948	12972	14	07	1853	Odd
35	31352	50568	16	10	5056	Even
41	76483	5437	13	05	1087	Odd
46	29735	52185	16	06	8698	Even
50	32549	49371	16	08	6172	Even
57	67596	14324	14	04	3582	Even
58	72630	9290	14	06	1548	Even

Here, Number of Even Quotient =08 and Number of Odd Quotient=7. So, the percentage of Number of Odd Quotient=46.67%.

Table 4. Results for step-1 on 15 fingerprints for blood group O+

Person ID	NWP	NBP	BLBP	0's	Quotient	Observation
3	27129	54791	16	08	6848	Even
6	9922	71998	17	09	7999	Even
9	67555	14365	14	07	2123	Odd
13	71480	10440	14	09	1160	Even
15	80744	1176	11	07	168	Even
16	12796	69124	17	12	5760	Even
17	36663	45257	16	09	5028	Even
26	3676	78244	17	10	7824	Even
30	18596	63324	16	05	12664	Even
31	32955	48965	16	06	8160	Even
42	79563	2357	12	06	392	Even
44	79810	2010	11	05	402	Even
48	31004	50916	16	08	6364	Even
55	75560	6360	13	07	908	Even
56	67993	13927	14	05	2785	Odd

Here, Number of Even Quotient =13 and Number of Odd Quotient=02. So, the percentage of Number of Odd Quotient=13.33%.

Table 5. Results for **step-2 o**n 15 fingerprints for blood group A+

Person ID	NWP	NBP	NWP-NBP	BLBP	Quotient	Observation
7	13693	68227	54534	17	3207	Odd
19	71431	10483	60948	14	4353	Odd
27	70526	11394	59132	14	4223	Odd
34	13915	68005	54090	17	3181	Odd
36	77195	4725	72470	13	5574	Even
37	81077	843	80234	10	8023	Odd
39	69828	12092	57736	14	4109	Odd
40	67257	14663	52594	14	3756	Even
43	71680	10240	61440	14	4338	Even
45	38205	43715	5510	16	344	Even
49	22838	59082	36244	16	2265	Odd
51	69865	12055	57810	14	4129	Odd
54	69590	12330	57260	14	4090	Even
59	73640	8280	65360	14	4668	Even
60	78790	3130	75660	12	6304	Even

Here, Number of Even Quotient =07 and Number of Odd Quotient=08. So, the percentage of Number of Odd Quotient=53.33%.

Table 6. Results for step-2 on 15 fingerprints for blood group B+

Person ID	NWP	NBP	NWP-NBP	BLBP	Quotient	Observation
1	6849	75071	68222	17	4013	Odd
5	31095	50825	19730	16	1233	Odd
8	78270	3650	74620	12	6218	Even
10	78076	3844	74232	12	6187	Odd
11	32525	49395	16870	16	1053	Odd
14	28542	53378	24836	16	1551	Odd
22	9327	72593	63266	17	3721	Odd
24	17486	64434	46948	16	2933	Odd
25	63069	18851	44218	14	3158	Even
29	41857	40063	1794	16	113	Odd
33	26842	55078	28236	16	1763	Odd
38	19872	62048	42176	16	2635	Odd
47	29735	52185	22450	13	1725	Odd
52	67893	14027	53866	14	3847	Odd
53	16695	65225	48530	16	3033	Odd

Here, Number of Even Quotient =02 and Number of Odd Quotient=13. So, the percentage of Number of Odd Quotient=86.66%.

Table 7. Results for step-2 on 15 fingerprints for blood group AB+

Person ID	NWP	NBP	NWP-NBP	BLBP	Quotient	Observation
2	31004	50916	19912	16	1244	Even
4	26925	54995	28070	16	1754	Even
12	24927	56993	32066	16	2004	Even
18	18560	63360	44800	16	2800	Even
20	23744	58176	34432	16	2152	Even
21	15086	66834	51748	17	3044	Even
23	80744	1176	79568	11	7233	Odd
28	78256	3664	74592	12	6216	Even
32	68948	12972	55976	14	3998	Even
35	31352	50568	19216	16	1201	Odd
41	76483	5437	71046	13	5465	Odd
46	29735	52185	22450	16	1403	Odd
50	32549	49371	16822	16	1051	Odd
57	67596	14324	53272	14	3805	Odd
58	72630	9290	63340	14	4524	Even

Here, Number of Even Quotient =10 and Number of Odd Quotient=06. So, the percentage of Number of Odd Quotient=40%.

Table 8. Results for step-2 on 15 fingerprints for blood group O+

Person ID	NWP	NBP	NWP-NBP	BLBP	Quotient	Observation
3	27129	54791	27662	16	1778	Even
6	9922	71998	62076	17	3651	Odd
9	67555	14365	53190	14	3799	Odd
13	71480	10440	61040	14	4360	Even
15	80744	1176	79568	11	7233	Odd
16	12796	69124	56328	17	3313	Odd
17	36663	45257	8594	16	537	Odd
26	3676	78244	74568	17	4336	Even
30	18596	63324	44728	16	2795	Odd
31	32955	48965	16010	16	1000	Even
42	79563	2357	77206	12	6433	Odd
44	79810	2010	77800	11	7072	Even
48	31004	50916	19912	16	1244	Even
55	75560	6360	69200	13	5323	Odd
56	67993	13927	54066	14	3861	Odd

Here, Number of Even Quotient =06 and Number of Odd Quotient=09. So, the percentage of Odd Number of Quotient=60%.

Table 9. Results for step-3 on 15 fingerprints for blood group A+

Person ID	NWP	NBP	BLBP	1's	Modulo	Observation
7	13693	68227	17	06	1	Odd
19	71431	10483	14	08	3	Odd
27	70526	11394	14	05	4	Even
34	13915	68005	17	07	0	Even
36	77195	4725	13	07	0	Even
37	81077	843	10	06	3	Odd
39	69828	12092	14	09	5	Odd
40	67257	14663	14	08	7	Odd
43	71680	10240	14	02	0	Even
45	38205	43715	16	06	5	Odd
49	22838	59082	16	09	6	Even
51	69865	12055	14	09	4	Even
54	69590	12330	14	05	0	Even
59	73640	8280	14	05	0	Even
60	78790	3130	12	06	4	Even

Here, Number of Even Modulo =09 and Number of Odd Modulo=06. So, the percentage of Number of Even Modulo =60%.

Table 10. Results for step-3 on 15 fingerprints for blood group B+

Person ID	NWP	NBP	BLBP	1's	Modulo	Observation
1	6849	75071	17	10	1	Odd
5	31095	50825	16	07	5	Odd
8	78270	3650	12	05	0	Even
10	78076	3844	12	05	4	Even
11	32525	49395	16	08	3	Odd
14	28542	53378	16	05	3	Odd
22	9327	72593	17	08	1	Odd
24	17486	64434	16	11	3	Odd
25	63069	18851	14	10	1	Odd
29	41857	40063	16	11	1	Odd
33	26842	55078	16	09	7	Odd
38	19872	62048	16	07	0	Even
47	29735	52185	13	07	0	Even
52	67893	14027	14	09	5	Odd
53	16695	65225	16	11	4	Even

Here, Number of Even Modulo =05 and Number of Odd Modulo=10. So, the percentage of Number of Even Modulo =33.33%.

Table 11. Results for step-3 on 15 fingerprints for blood group AB+

Person ID	NWP	NBP	BLBP	1's	Modulo	Observation
2	31004	50916	16	08	4	Even
4	26925	54995	16	10	5	Odd
12	24927	56993	16	09	5	Odd
18	18560	63360	16	08	0	Even
20	23744	58176	16	06	0	Even
21	15086	66834	17	04	2	Even
23	80744	1176	11	04	0	Even
28	78256	3664	12	05	4	Even
32	68948	12972	14	07	1	Odd
35	31352	50568	16	06	0	Even
41	76483	5437	13	08	5	Odd
46	29735	52185	16	10	5	Odd
50	32549	49371	16	08	4	Even
57	67596	14324	14	10	6	Even
58	72630	9290	14	08	2	Even

Here, Number of Even Modulo =10 and Number of Odd Modulo=05. So, the percentage of Number of Even Modulo =66.67%.

Table 12. Results for step-3 on 15 fingerprints for blood group O+

Person ID	NWP	NBP	BLBP	1's	Modulo	Observation
3	27129	54791	16	08	5	Odd
6	9922	71998	17	08	6	Even
9	67555	14365	14	07	1	Odd
13	71480	10440	14	05	0	Even
15	80744	1176	11	04	0	Even
16	12796	69124	17	05	4	Even
17	36663	45257	16	07	3	Odd
26	3676	78244	17	07	5	Odd
30	18596	63324	16	11	8	Even
31	32955	48965	16	10	5	Odd
42	79563	2357	12	06	5	Odd
44	79810	2010	11	06	0	Even
48	31004	50916	16	08	4	Even
55	75560	6360	13	06	0	Even
56	67993	13927	14	09	4	Even

Here, Number of Even Modulo =09 and Number of Odd Modulo=06. So, the percentage of Number of Even Modulo =60%.

Table 13. Results for step-4 on 15 fingerprints for blood group A+

Person ID	NWP	NBP	BLBP	1's	Quotient	Observation
7	13693	68227	17	06	2282	Even
19	71431	10483	14	08	8928	Even
27	70526	11394	14	05	14105	Odd
34	13915	68005	17	07	1987	Odd
36	77195	4725	13	07	11027	Odd
37	81077	843	10	06	11582	Even
39	69828	12092	14	09	7758	Even
40	67257	14663	14	08	8407	Odd
43	71680	10240	14	02	35840	Even
45	38205	43715	16	06	6367	Odd
49	22838	59082	16	09	2537	Odd
51	69865	12055	14	09	7762	Even
54	69590	12330	14	05	13918	Even
59	73640	8280	14	05	14728	Even
60	78790	3130	12	06	13131	Odd

Here, Number of Even Quotient =08 and Number of Odd Quotient=07. So, the percentage of Number of Even Quotient=53.33%.

Table 14. Results for step-4 on 15 fingerprints for blood group B+

Person ID	NWP	NBP	BLBP	1's	Quotient	Observation
1	6849	75071	17	10	685	Odd
5	31095	50825	16	07	4442	Even
8	78270	3650	12	05	15654	Even
10	78076	3844	12	05	15615	Odd
11	32525	49395	16	08	4065	Odd
14	28542	53378	16	05	5708	Even
22	9327	72593	17	08	1165	Odd
24	17486	64434	16	11	1589	Odd
25	63069	18851	14	10	6306	Even
29	41857	40063	16	11	3805	Odd
33	26842	55078	16	09	2982	Even
38	19872	62048	16	07	2838	Even
47	29735	52185	13	07	4247	Odd
52	67893	14027	14	09	7543	Odd
53	16695	65225	16	11	1517	Odd

Here, Number of Even Quotient =06 and Number of Odd Quotient=09. So, the percentage of Number of Even Quotient=40%.

Table 15. Results for step-4 on 15 fingerprints for blood group AB+

Person ID	NWP	NBP	BLBP	1's	Quotient	Observation
2	31004	50916	16	08	4250	Even
4	26925	54995	16	10	2692	Even
12	24927	56993	16	09	2769	Odd
18	18560	63360	16	08	2320	Even
20	23744	58176	16	06	3957	Odd
21	15086	66834	17	04	3771	Odd
23	80744	1176	11	04	20186	Even
28	78256	3664	12	05	15651	Odd
32	68948	12972	14	07	9849	Odd
35	31352	50568	16	06	5225	Odd
41	76483	5437	13	08	9560	Even
46	29735	52185	16	10	2973	Odd
50.	32549	49371	16	08	4068	Even
57	68570	13350	14	10	6857	Odd
58	72630	9290	14	08	9078	Even

Here, Number of Even Quotient =07 and Number of Odd Quotient=08.

So, the percentage of Number of Even Quotient=46.67%.

Table 16. Results for step-4 on 15 fingerprints for blood group O+

Person ID	NWP	NBP	BLBP	1's	Quotient	Observation
3	27129	54791	16	08	3392	Even
6	9922	71998	17	08	1240	Even
9	67555	14365	14	07	9650	Even
13	71480	10440	14	05	14296	Even
15	80744	1176	11	04	20176	Even
16	12796	69124	17	05	2569	Odd
17	36663	45257	16	07	5238	Even
26	3676	78244	17	07	525	Odd
30	18596	63324	16	11	1690	Even
31	32955	48965	16	10	5495	Odd
42	79563	2357	12	06	13302	Even
44	79810	2010	11	06	13260	Even
48	31004	50916	16	08	3876	Even
55	75560	6360	13	06	12592	Even
56	67993	13927	14	09	7554	Even

Here, Number of Even Quotient =12 and Number of Odd Quotient=03.

So, the percentage of Number of Even Quotient=80%.

5. RESULTS AND DISCUSSION

From the above Table-1, Table-2, Table-3 and Table-4, we can see that the percentage of Odd Number Quotient for blood group (A+) is greater than others blood groups. So, we conclude that, when we apply Step-1 for any one fingerprint whose blood group is unknown, his/her blood group probability (A+) will be 80%.

Also, we can see that the percentage of Odd Number Quotient for blood group (B+) is greater than others blood groups. So, we conclude that, when we apply Step-2 for any one fingerprint whose blood group is unknown, his/her blood group probability (B+) will be 86.67%. This observation is shown in the Table-5 to Table-8.

Further, the percentage of Even Number of Modulo for blood group (AB+) is greater than others blood groups. So, we conclude that, when we apply Step-3 for any one fingerprint whose blood group is unknown, his/her blood group probability (AB+) will be 66.67% all have are presented in the Table-9 to Table-12.

Again, from the above Table-13 toTable-16, we can see that the percentage Number of Even Quotient for blood group O+ is greater than others blood groups. So, we conclude that, when we apply Step-4 for any one fingerprint whose blood group is unknown, his/her O+ blood group probability will be 80%.

Therefore we conclude that, when we apply Step-1 for any one fingerprint whose blood group is unknown, his/her A+ blood group probability will be 80%; for Step-2 probability of B+ blood group will be 80.67%; for Step-3 probability of AB+ blood group will be 66.67% and for Step-4 probability of O+ blood group will be 80% which are shown in the above Table-1 to Table-16.

REFERENCES

[1] Narayana, B.L., Rangaiah, Y.K.C., Khalid, M.A. (2016). Study of fingerprint patterns in relation to gender and blood group. J Evolution Med. Dent. Society, 5(14): 530-533. https://doi.org/10.14260/jemds/2016/144

[2] Rastogi, D.P., Ms Pillai, K.R. (2010). A study of fingerprints in relation to gender and blood group. J Indian Acad Forensic Med, 32(1): 11-14.

[3] Bharadwaja, A., Saraswat, P.K., Agrawal, S.K. (2004). Pattern of fingerprints in different ABO blood groups. Journal of Forensic Medicine and Toxicology, 21(2): 49-52.

[4] Surinder, N. (1984). Finger Print Identification. Gita Press, 1-15. https://doi.org/10.1016/S0140-6736(00)51333-6

[5] Smail, H.O., Wahab, D.A., Abdullah, Z.Y. (2019). Relationship between pattern of fingerprints and blood groups. Journal of Advanced Laboratory Research in Biology, 10: 84-90.

[6] Agrawal, H., Choubey, S. (2014). Fingerprint based gender classification using multi-class SVM. International Journal of Advanced Research in Computer Engineering & Technology, 3(8): 2575-2580.

[7] Arulkumaran, T., Sankaranarayanan, D.P.E., Sundari, D.G. (2013). Fingerprint Based Age Estimation Using 2D Discrete Wavelet Transforms and Principal Component Analysis. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 2(3): 1060-1066.

[8] Balaji, S., Venkatram, N. (2008). Filtering of noise in fingerprint images. International Journal of Systems and Technologies, 1: 87-94.

[9] Bhavana, D., Ruchi, J., Prakash, T. (2013). Study of fingerprint patterns in relationship with blood group and gender- a statistical review. Res J Forensic Society, 1(1): 15-17.

[10] Borra, S.R., Reddy, G.J., Reddy, S. (2014). Fingerprint image de-noising using wave atom transform. International Journal of Computer Science Engineering and Information Technology Research, 4: 69-76.

[11] Chen, G.Y., Kegl, B. (2007). Image denoising with complex ridgelets. Pattern Recognition, 40: 578-585.

[12] Devnath, L., Islam, R. (2016). Fingerprint image de-noising by various filters for different noise using wavelet transform. American International Journal of Research in Science, Technology, Engineering & Mathematics, 13(1): 39-44. https://doi.org/10.13140/RG.2.1.2448.3448

[13] Ganesh, B., Dongre, D.S., Jagade, M. (2015). A review and study on fingerprint based gender classification using classified techniques. International Journal of Scientific Research, 6: 596-599.

[14] Gopinathan, S.K., Thangavel, P.R. (2015). Wavelet and FFT based image de-noising using non-linear filters. International Journal of Electrical and Computer Engineering, 5: 1018-1026. https://doi.org/10.11591/ijece.v5i5.pp1018-1026

[15] Gornale, S.S., Hangarge, M., Pardeshi, R., Kruthi, R. (2015). Haralick feature descriptors for gender classification using fingerprints: A machine learning approach. International Journal of Advanced Research in Computer Science and Software Engineering, 5: 72-78.

[16] Gupta, S., Rao, A.P. (2014). Fingerprint based gender classification using discrete wavelet transform & artificial neural network. International Journal of Computer Science and Mobile Computing, 3(4): 1289-1296. https://doi.org/10.13140/RG.2.2.15292.69769