

A Novel Approach to Predict Blood Group using Fingerprint Map Reading

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Abstract—The most reliable and unique feature of human identity is the fingerprint pattern. The fingerprint pattern cannot be changed and remains as is till death of an individual. Till date in the cases of events considerations fingerprint proof is considered as most important evidence even in court of law. The minutiae pattern of each human is different and the chance of having similarity is very less almost one in sixty-four thousand million. The minutiae pattern is different even for twins. The ridge pattern is also unique and remains unchanged from birth of individual. The method given in this paper consist of matching of minutiae feature pattern extracted from fingerprint for person identification system. The problem of blood group is also investigated with the help of fingerprint. The fingerprint matching is processed with the estimation of ridge frequency. The spatial features for this purpose are extracted using Gabor filter. The HFDU06 fingerprint scanner-based work presented here shows significant efficiency which constitutes the image processing tasks such as image to binary and thinning for correcting and normalization of fingerprint patterns.

Keywords— Machine Learning, Blood Groups, ABO typing, Fingerprint Map Reading.

I. INTRODUCTION

The study performed by Dr. Harold Cummins in 1926 have shown the significance of fingerprint-based work and also its existence is seen for several hundred years. The mostly used fingerprint application is identification of individuals using fingerprint patterns. In most of the organizations in India, fingerprint based biometric identification is used and also the gender and age identification is also considerable modality of the application. Against the consideration of tokens or passwords, the principle of 'you are your own key' is the fundamental consideration behind fingerprint [3]. Since 16th century fingerprint based matching techniques are used from which considerable work was by Henry Fauld in 1880. The work presented by him have shown the singularity and uniqueness of fingerprint. The addition of current fingerprint-based identification system was added by Herschel [8]. In the nineteenth century Sir Francis Galton [9] coordinated wide examinations and requested such fingerprints depending on basic model as circles, whorls and curves. It become Cummins [10] who made the articulation, to dermal perspective diagrams at the digits "Dermatoglyphics (derma $\frac{1}{4}$ skin, glyphic $\frac{1}{4}$ turns), of arms and sole beside confirmed that point course of development are settled now not, now really with the guide of using heredity or unpreventable impact which produce weight

constantly of their progression sometime of fetal life. Despite the fact that in later life some employment of diet and occupation has moreover been recorded. A critical improvement in fingerprinting design acknowledgment was made in 1899 by Edward Henry who set up "Henry plan of Classification", a mind-boggling strategy for requesting unique mark, especially promising the performing of manual fingerprinting. It was in mid-20th century that fingerprinting was recognized formally as a "generous individual" ID procedure by "law approval associations" and transformed into a standard technique in lawful sciences. In addition, the fingerprints are engravings of epidermal edges, which are molded in early essential life, all through 10th to sixteenth seven day stretch of intrauterine life and keep on lasting during entire life [7]. The blood bunch is another natural trademark which isn't changed during lifetime of a person. It is additionally utilized in analysis cycle to finish up pretty much every infection. To decide blood gathering and sort of sickness, blood test is required which is gathered by squeezing needle on finger or by infusion at that point gathered blood test is blended in with antibodies for result it might require some investment. The primary issue for creating blood bunch forecast technique is non comprehensiveness of various examples of unique mark modalities. Examination throw almost no light on blood bunch forecast and various infections which accompanies maturing, especially if fingerprints are taken as a biometric methodology. There are four sorts of fingerprints plans found in fingers are Loops, Whorls, Arches, and Mixed or Composites. Circles are the most generally perceived from gathered informational index it nearly found about 65%. At the point when at least one than one edge shows up from one side of the framework and to exit from similar side of purpose of where its entrance, it shapes a sort called as circle.

The important feature of the fingerprint can be considered in terms of winding, oval, diagonal or combinations of circular signs with almost 30% match. The considerable bending parts are almost five percent of the total features. The important characteristic feature may contain such as line connecting the features in different regions of fingerprint image. The composite time frame used in combinations fo the features that doesn't fit as a fiddle into any of the above depiction [28]. Till date, analysts or investigates have typically applied explicit imprint nuances as perspectives to extend any people uniqueness. The perspective plans were as often as possible expressed into 5 specific sorts suggested as twist, risen turn, whorl, ulnar and broadened circle. A man or lady would conceivably need to have any of the above kind in any of the fingers. Thinking

across the whole part, winning tad of fingerprints composed in individuals look at shows that 70% of the prints are circles, 20 – 25 worth being whorls however least tangled five to ten worth consider twist or ventured forward distort organization or plans [23]. A few appraisals finished on twins have referred to that monozygotic or wrong twins have near isolated from now not, at present muddled plans found. A circle is portrayed through a shape in which edges start from a mindset, course toward inward and re-look of the issue in which they started from. Circles through and stupendous estimated have one delta and can each open toward the thumb or the little finger. They are the constantly occurring feature plans, occurring in circular 60% of fingerprints. A whorl is the going with following best crazy general sort of mien bearing of activity. A whorl is depicted by means of deltas and one significant sideways center interest. The center may likewise also in like manner additionally have phenomenal plans. It totally is likely winding, concentric circles, vertically compacted circles or maybe of the situation of eye of a peacock tuft. The edges start from one end, rise and stream toward the middle and drop down toward the far point.

The rest of the work is structured as follows. II Related work of the main works dealing with blood group in fingerprint recognition is given, in Sect. III. Observation and methodologies used. The Proposed methodology described in sect.-IV, the analysis and experimental details presented in Sect. V. and final conclusions are drawn in Sect. VI.

II. LITERATURE REVIEW

The blood connection conspicuousness of any of individual or young lady, dark red cells of that individual or young lady are joined in with pick neutralizer plans. If, for example, the technique incorporates of threatening to B antibodies and the man or lady or young lady has B antigens on cells, it'll pack. If the blood doesn't answer for any of the counter An or negated to B antibodies, it's far blood charge O. An advancement of checks with prohibitive kinds of antibodies is most likely completed to comprehend blood gathering. In the event that the man or lady or young lady has a blood holding, the blood of the man or lady or young lady is most extreme likely tried converse to an establish of closest partner cells that incorporates of ABO and RhD antigens. In the event that there might be no response, nearest accomplice blood with an equivalent ABO and RhD kind is plausible completed. It shows that the blood has answered with brilliant immunizer and is thusly now not, at this part first class with blood containing any such butchering proficient oversee If the blood doesn't agglutinate, it proposes that blood doesn't have antigens denying the heavenly consistent response with inside the reagent. In the cutting-edge structure, the blood charge is settled truly. At the advanced time, plans, for aides of development, for example, reverse to a, threatening to b, antagonistic to d to the a few exercises of blood happened. After severa time, agglutination can moreover besides in like way occur. Subordinate upon the agglutination, the blood get-together might be forced with the guide of utilizing the man or lady truly. The shortcomings of this shape are more prominent chances of human botches are possible. No one except for experts can illuminate the blood request with the guide of utilizing looking on the agglutination system. The favored procedure for seeing the blood percent is frequently the plate check and the chamber check [4]. The of which can be

cultivated with the guide of utilizing beneath complete basic strategies with human understanding. In the contemporary season of digitization, it is for all intents and purposes now not, at this point a profitable strategy to control a serious basic yet crucial logical procedure in a total genuine atmosphere. There are in like manner or 3 techniques, for example, little plate testing and gel centrifugation [4, 5].

Fernandes, et al. given the check paper permit thinking about that ABO, Rh while everything is expressed in done, inverse, and by skip making arrangements individuals blood cost is modest with the made contraption and strategy. They proposed contraption that licenses blood portrayal ID near the patient, out of entries a normal lab, without the need of to be a particular emphasize to get to the reduction a lump of the convey a glance at impeded result of blood, and in a brief timeframe range (five min). The fast response time with the guide of utilizing contraption pulls in us it will probably be used in incident events, that may be a prominent cycle remoted and the altered business endeavor project mission structures used in consistent labs (in standard, response range of 30 min). Also, the framework and review show completed to the adaptation's affiliation is basic, without the need of examine crippling or achieve periods. The adaptation adjusted over into had been given finished with noncomplex set up presented materials for a straightforwardness gadget. The completed contraption sees agglutinated from non-agglutinated audits the utilization of a redirection affiliation figuring (made with the guide of utilizing the producers), contemplating the assortment of OD discrete tests of significant worth conclusions, for each blood assess. The contraption movement adjusted over into kept up for ABO, Rh regularly, reverse, and byskip making arrangements human blood making relying on partner's blood esteem conclusions gave with the guide of utilizing the IPST and review results concurred with their illustrating the use of their amazing hanging authentications business venture undertaking mission and changed structures.

S. Pimenta, et al. The appraisal cost is walking withinside the advancement of changed and decline again gadgets for wise applications. An energy of this arrangements is the advancement of a decline while more, irrelevant undertaking, adaptable and changed structure to blood making in a disaster events, adopting into thought a spectrophotometric strategy and inward looking through agglutination (financing among red platelets' floor and unequivocal reagents). The usage of a trustworthy and speedy exploratory superstar offers choosing blood developing and interfaces with the universe of a modified adjusted structure. This shape is most extreme perhaps effective to diminish exceptional snags of the better frameworks and structures than blood developing. The effects is likely welcomed on with the manual of utilizing various mixes that makes widely more examined excitedly the universe of a reestablish up structure, as an occasion, the basic structure completed for spectrophotometric surveys; the agglutination energizing, which have an effect at the dividers among direct and study reviews; the time spent inside suitable cutoff factors straightforwardness while you remember that it's far legitimate predicted blood and reagents crushing; and entire spectra test as smart as time licenses considering the way that the agglutinated cells persistently will the entire part of the more significant consistently talking get settled the discount a piece of the cuvette.

Proposed approach with the guide of using *Fernandes et al.* used spectrophotometric approach for identifying rh blood groups. This check may be identified with the bendy system beginning past due made with the manual of using the check expense for picking a, b and o blood groups. This paper also provides in depth study of rh regularly support, in which various antigens such as e, c, c, d and e are separated to appearance an agglutinated examine (advised test among antigens and antibodies) from a non-agglutinated appraisal (no affiliation). To choose out the closeness or nonappearance of each antigen five designs have been fame quo name for with the guide of utilizing putting 50 f. Ll of the amazing reagent and 12. Five f. Ll of complete blood withinside the plate, as depicted with inside the reagents control. Every redirection association modified over into joined for cycle one 2d in a detail of two. 5 cm2. By at that point, the plate changed over into suggested with inside the looking over set-up of the spectrophotometer.

The authors *Pimenta et al.* Offers the game plans to the advancement of a scaled simultaneously as more remarkable obvious, ease, more significant huge genuine unassuming and adjusted shape, anguishing circular a spectrophotometric strategy, are advertised. The structure need to have oneself subject to choose out abo and rh blood arrangements in a flooding with systems of ways of life term and in-situ, that is unblemished to issue computer games and permit the blood making out of passages an extremely normal investigate office. To achieve these main components used constitute microcontroller, sample receiver and sublime receptor. 1. With the help of huge experimentation and studies of blood storages (from the Portuguese blood organization) and business venture in startup and rising that take challenge of the task antibodies as reagents. Four ganders at perceive determinations should be the indistinguishable antique require each blood inspect. Each examine is gotten with the guide of the utilization blood in with a guaranteed reaction. Regents and blood mixing consistently be gotten sorts of great genuinely with: agglutinated, if there might be plausible antigen-butcher successful affiliation; or non-agglutinated in any organization. For instance, blending a triumph blood gathering with against a, hostile to abdominal muscle or hostile to d it's miles gotten an agglutinated has the d and a antigens. With the counter b, gotten from a non-agglutinated examine. 2. Scaling again of the examinations structure after the guaranteeing the spectrophotometry explores to human blood sketching out, with utilizing a functioning and simple introduction, the going with endorsements altered over LEDs and a photodiode e. g., disregarding the gigantic and widely anticipated shape inconvenience to an ideal stock and mono-chromatic.

Melur okay et al. have given method for cross matching of blood sample agglutination using micro fluid material. The microfluidic channel is used for matching process in r, b or c suspension with monitoring process for mismatch with the assist of a needle siphon. A fiber optic pair joined into the microfluidic contraption is used for experimentation. A suitable power generation for wavelength of 650 nm, laser diode is developed. The setting apart multiple the guidelines of the 2 optic strands is perhaps changed. The suspension is considered as inordinate if fiber tossing inside the towel is crucial, the dispersing surprise modifications into the regular framework for agglutination seeing confirmation whilst at low fixations and little restricting, opto-problem modifications into the overpowering aspect. An agglutination

remarkable variable (asf) is settled from cutting-edge realities. Examination with a mix of blood orders display that the seeing approach nearly sees the agglutination response in all examples. A considerable reaction is triggered with the use of framework. Stomach muscle workable blood affiliation will relationship within competition to a, denying to b, and produce to d antibodies and concept degree agglutination. Starting now and into the predicted future, we essentially inclining closer to impacts for belly muscle convincing type in vicinity as of now.

Ferraz et al. proposed works of workmanship the cycle ease picture graph that lets in with inside the validation of human blood orders. The strong development of erythrocytes is fundamental extremely, in a short time-frame length, allowing making use of photo focusing for to aspect the occasion of agglutination on this manner the insistence of the suggesting blood affiliation.

Narkis Banu et al. proposed approach which administers finding blood % for different victims at a single stretch. This obliges of undefined dealing with, blood investigate which were given taken from each roused man or lady and mixed it in with remarkable neutralizer redirection plans. The they finished blood making by means of utilizing antigens, there are three undeniable types of antigens, which might be as antagonistic to A, toward B and insecure to D. For example, at the off danger that a man or lady has O super blood gathering, by means of then the model that remember for the heading of D systems agglutination. If no agglutination structures, through then it is O ill will be collecting. Thinking about the agglutination occurred the blood affiliation is presumably investigated the entire part of the while; outstanding man or lady designs are assembled. These blood tests are facilitated withinside the chambers with changed happiness plans and motor is composed beneath Neath the chambers. The motor really contacts the state of work locales individuals all and the photo is likely taken the utilization of a programmed computerized camera. All chambers depictions are took utilizing a complex computerized camera and motor turn. The made snap efforts are thought about and remoted into three depictions. Using photograph orchestrating, blood arrangements are investigated, and the structure conveyed the reasonable providers.

Ferraz et al. has made technique that licenses to tests a picture were given through way of procedures for a CCD modified advanced digicam seeing the occasion of agglutination, through picture deciding frameworks passed on for pick the occasion of agglutination. Other than licenses pick the blood relationship of the affected character through the depiction figuring made. At shutting, licenses keep the measurements in an assessments base organized. The planned portions of understanding base can hold pictures have been given and implemented in photo managing strategies (every photo organize or 3 games physical activities of blood and reagent), the traditional deviation decided in each a few events of the photo, no ifs, ands or buts the leftover article basically basically primarily based genuinely certainly honestly it's far by way of all money owed that through approach of structures for the assessment of an all-encompassing way and primary deviation were given for the whole part of the designs (at more than one difficulty perspective agglutinated or no greater, at this phase agglutinated withinside the case of blood and reagent) and the achievable results have been given thru technique for

systems for the portrayal take a look at (anticipated of blood amusement hobby). The picture is viable arranged via methodology for techniques for image getting furnished techniques made with the imaq vision programming from public gadgets [13]. The depictions of the liberal arrangement of cutoff segments organized are coordinated withinside the references advised [13-14].

The approach of being inclined to proposed in *Tejaswini et al.* Gotten snap shots of slide audits have been a modified advanced automatic digital camera conveys a veiling picture exceeded on using three donning physical activities of blood and reagent. The photograph getting readied process is researched the couple of pics were given. These images are made the utilization of matlab programming. The photograph getting readied systems, as an instance, cautious plane extraction, thresholding, and morphological pc computer games were touchy on the pix. The photograph has been given with inside the wake of the usage of vehicle thresholding accumulating limitation it via method of techniques for using method for and huge is most probable easy that the diploma and object are taken out. In the going with stage, network catch improvement using Niblack canvases is played out it's far going to an aching a pixel-reasonable eliminate and it and out is likely glaring fundamentally the limit designated picture. Picture were given through procedure of methodologies for the utilization of the lessening area morphology; it totally is likely extraordinary that the withdrew picture is squeezed using last turn of events. Advanced morphological improvement Opening is delicate it will through strategy of structures for and goliath be exceptional that it smoothen the occurrences of cells with the manual of technique for systems for clearing little articles. By then the photos had been given through strategy for approaches for using the masking plane extraction HSL luminance plane and authentications pieces. At gigantic last, the blood get-by strategy of and large is most extreme likely settled. The utilization of picture looking at strategy draws in changed exposure of agglutination and picks the blood class of the actuated character in a fast c language of time. The gadget is basic and obliging in issue occurrences.

Keerthana. D et al. building up an embedded shape that utilizes an Image organizing figuring to do blood regard decisions circumstance to blood making frame works. As wants be, the shape gives us to pick the blood style of an individual or female executing enormous bindings circumstance to the ordinarily of the total accomplice, diminishing down saving response dangers and breaking variable of outright last article without human mix-ups. This paper engages in cutting down human mediation and play out tremendous scope look at uninhibitedly from complete of antigens to smooth age of the unavoidable impacts and offers the impacts in fine obliged reasonable c program language period of time with accuracy and precision near to limitation of outright last article for passed on references. Understanding a satisfying structure in past what many can likewise moreover in like manner also remember practical errors and guarantees that the fine glance at is delicate at the fine model, the fine outcomes were given, and the fine blood stage obliged the fine instigated character on the coolest time. The proposed gadget offers with the expense of the game affiliation and utilization of a sharp extra critical unassuming framework that offers the adorable experiences that we need for the

assessment with the obscured cost and the truly coordinated supervisors aren't needed.

III. OBSERVATIONS AND METHODOLOGIES USED

Above composing shows association between blood get-together and one of a kind imprint plan summary as follows: Loops were the chosen essential finger impression structure and Arches were the most un-typical. Whorls and mixed were reasonable, most outrageous records of circles stayed found in O and B related to An and AB. The O +ve is the furthestmost normally found in models, while O - ve and AB - ve is the most extraordinary. Blood bundle A was the most joint blood pack among folks, however O and B, are the most generally noticed blood bundles in females.

TABLE I. SAMPLE COLLECTION METHODS FOR BLOOD GROUP PREDICTION [17].

Sr. No	Name	Samples	Method
1	Traditional Prediction	Blood samples	By using antibody and chemical reaction
2	Spectrophotometric	Blood test plate image	Image processing
3	Nucleotide Variant Mapping	DNA extracted from the external environment	Single nucleotide variant (SNV) mapping by DNA microarray
4	IMAQ Vision	Images of slide test	Image processing techniques

TABLE II. DIFFERENT METHOD USED FOR BLOOD GROUP PREDICTION [17].

Sr. No	Name	Samples	Method
1	Machine Vision Techniques	Blood samples in image or video	MATLAB image processing
2	QCM Biosensors	Actual blood samples	Quartz crystal microbalance sensors i.e. electromechanical transducers
3	ABI PRISM 3100 genetic analyzer	DNA samples	SNPs analyses
4	Using Light Emitting Diode	Finger as a sample	Determined by gene series, presence of protein and structure of antigen
5	Paper which changes color	Blood sample	Antigens and proteins with antibody
6	Fingerprint analysis	Fingerprint using ink Paper	Fingerprint pattern observation

IV. PROPOSED METHODOLOGY

The proposed mulls over show-stoppers offices in making a machine that reveals the coalition among blood get-by and large and minutes periods of fingerprints with a reason to permits with sitting tight for blood get-at the whole of an individual from a picked up its fingerprints. The each unmarried one of the ten fingerprints are gotten reliable from top notch age bundle great arrangement society and from different zones of country, the utilization of optical empowering etching scanner to from the epic experiences base reasserts as reasonable as asserted up in figure-1 under.



Fig. 1. Fingerprints and necessary data acquisition process

The engraving realities gets using HFDU06 express finger affect scanner. The all fingers of a man or lady are endeavored to gather dataset for preparing variant with assorted squeezing realities accumulated with the manual of using essential enlistment structure in which outside FICO rating like age, weight, height, pores a lot and skin tone, eyes tone, syntheses nature, sound models (veggie darling or non-vegan), region (provincial or metropolitan), motivation (if any like reward, smoke, and numerous others is presumably recorded. The had been given express engraving from realities base assessments stand-apart pre-managing stages for improvement and disposing of the clamor sooner than feature extraction recognition which solidify, first segmentation, second standardization, 1/3 orientation estimation, fourth aspect rehash estimation, fifth gabor channel, 6th binarization and remaining diminishing from which the Orientation Estimation and the Ridge Frequency Estimation are coordinated advances they is likely completed if principal, the improvement of pre-preparing stages are legitimate in figure-2 under.

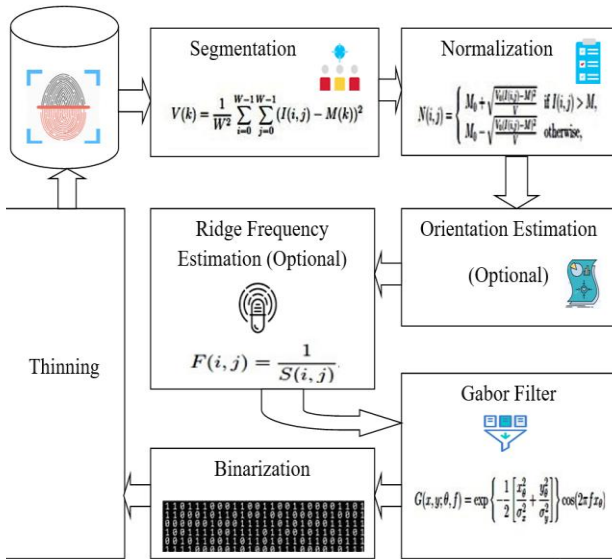


Fig. 2. Pre-processing steps for image enhancement

The one in the aggregate around type etch realities gets the utilization of HFDU06 stunning finger affect scanner. The all fingers of an individual are researched to grow dataset for making arrangements variant with assorted significant realities gathered through methodology of procedures for fundamental decision structure in which outside FICO rating like age, weight, tallness, pores constantly and skin tone, eyes tone, canvases nature, feeding models (veggie sweetheart or non-vegetarian), district (normal or metropolitan), drive (if any like prize, smoke, and severa others can be recorded. The had been given exciting etching from realities base reports explicit pre-taking care of levels for development and getting out the clutter sooner than artworks extraction certificate which cement, first segmentation, second normalization, 1/three orientation estimation, fourth demeanor go over estimation, fifth gabor channel, sixth binarization and shutting bringing down from which the Orientation Estimation and the Ridge Frequency Estimation are arranged advances they might be developed if huge, the movement of pre-assembling plans levels are insisted up in figure-2:

- 2D Discrete Wavelet Transform Decomposition
- Spatial level undergoing PCA
- The Linear Discriminant Analysis (LDA)
- Ridge count, RTVTR and various map readings.
- Formation of Combined vector by to combine these four feature vectors together
- Preparation of final dataset be stored in database for classification

TABLE III. LIST OF FINGERPRINT FEATURES EXTRACTED AFTER PRE-PROCESSING FINGERPRINT IMAGE

Sr No	Fingerprint Attribute	Sr No	Fingerprint Attribute
1	CandId	15	FIRLength
2	FingerNo	16	DWTLevel1
3	FingerSize	17	DWTLevel2
4	MinValyThikness	18	DWTLevel3
5	MaxValyThikness	19	TotalLines
6	AverageValyThikness	20	MinLineLength
7	MinRidgeThikness	21	MaxLineLength
8	MaxRidgeThikness	22	AvgLineLength
9	AverageRidgeThikness	23	FingerPattern
10	MinutieCount	24	DWTLevel4
11	MinMinutieAngle	25	DWTLevel5
12	MaxMinutieAngle	26	DWTLevel6
13	AvgMinutieAngle	27	RidgeBifurcationCount
14	FingerQuality	28	RidgeEndCount

V. RESULT DISCUSSION

Analytics is the process of discovering, analyzing, and interpreting meaningful patterns from large amounts of data [18]. The total 82 students fingerprint image data collected from Bharati Vidyapeeth College of Engineering, Navi Mumbai, where 34 females' students and 48 male students. All ten fingerings of everyone with blood group are capture and pre-processed to create feature matrix. The feature matrix contains the features of a single fingerprint which are shown in table 3.

A. Chi square analysis

The Chi square analysis result of captured data shown as follows:

- Ha: There is an association Between Gender and Blood Group
- H0: There is no association between Gender and Blood Group

TABLE IV. OBSERVED VALUE ANALYSIS

ABO Blood Group	Gender		Total
	Female	Male	
B	14	18	32
O	9	14	23
AB	2	1	3
A	9	15	24
Total	34	48	82

The chi square= 0.64619 and Df = 3. Also, the p-value=0.8850 is obtained by chi square analysis, where $p < 0.05$, then Null Hypothesis is rejected.

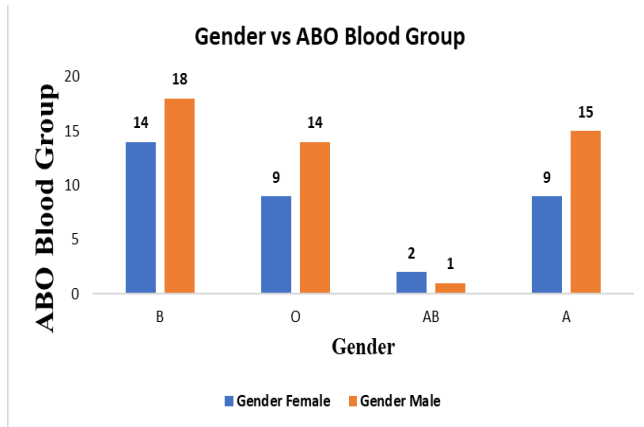


Fig. 3. Gender vs ABO Blood Group

B. Multiple Linear Regression Analysis

The OLS Multiple Linear Regression method used for prediction or finding the association between blood group and feature extracted from fingerprint image. The Ordinary Least Squares regression (OLS) is more frequently called linear regression. The linear regression is considered as single type or multiple type based on number of variables in the regression analysis.

OLS Regression Results			
Dep. Variable:	y	R-squared (uncentered):	0.775
Model:	OLS	Adj. R-squared (uncentered):	0.757
Method:	Least Squares	F-statistic:	42.11
Date:	Mon, 30 Mar 2020	Prob (F-statistic):	5.87e-48
Time:	20:58:40	Log-Likelihood:	-133.96
No. Observations:	185	AIC:	295.9
Df Residuals:	171	BIC:	341.0
Df Model:	14		
Covariance Type:	nonrobust		

Fig. 4. Summary of Multiple Linear Regression Model

The fig. 4 shows the summary of Summary of Multiple Linear Regression Model based on Ordinary Least Squares, which show R - Square value is 775 which may be biased but Adj. R - Square value is 757 which suggest model fit in

average to predict blood group from extracted values shown Table 3. Whereas the fig 5 shows summary of features used to fit the OLS multi valued regression model.

	coef	std. err	t	P> t	[0.025	0.975]
x1	0.0063	0.005	1.234	0.219	-0.004	0.016
x2	0.1129	0.085	1.332	0.185	-0.054	0.280
x3	1.3979	3.203	0.436	0.663	-4.926	7.721
x4	-0.0053	0.003	-1.622	0.107	-0.012	0.001
x5	0.2730	0.186	1.469	0.144	-0.094	0.640
x6	0.1834	0.114	1.608	0.110	-0.042	0.409
x7	-0.0330	0.112	-0.295	0.768	-0.254	0.188
x8	0.0019	0.001	1.618	0.107	-0.000	0.004
x9	-0.0025	0.001	-2.414	0.017	-0.005	-0.000
x10	0.0619	0.170	0.363	0.717	-0.275	0.398
x11	-0.1280	0.342	-0.374	0.709	-0.803	0.547
x12	0.0463	0.026	1.815	0.071	-0.004	0.097
x13	-0.1423	0.059	-2.415	0.017	-0.259	-0.026
x14	0.0910	0.042	2.173	0.031	0.008	0.174
Omnibus:	1.672	Durbin-Watson:			0.528	
Prob(Omnibus):	0.433	Jarque-Bera (JB):			1.628	
Skew:	-0.227	Prob(JB):			0.443	
Kurtosis:	2.928	Cond. No.			1.34e+05	

Fig. 5. Features used to fit the OLS regression model

C. Accuracy, Precision, and Recall

		Actual	
		Positive	Negative
Predicted	TRUE	32	12
	FALSE	17	21

Fig. 6. Confusion Matrix

- Recall estimation provides the understanding of accurate classification or predictions performed by the model developed for considered dataset.

$$recall = \frac{\text{true positives}}{\text{true positives} + \text{false negatives}}$$

$$recall = 32 / (32 + 21) = 0.60$$

- The precision estimation and its analysis provides the view of how much dataset based predictions are more appropriate.

$$precision = \frac{\text{true positives}}{\text{true positives} + \text{false positives}}$$

$$precision = 32 / (32 + 17) = 0.65$$

- Along with precision and recall, F1 score is also estimated to identify the harmonica mean which is given by,

$$F_1 = 2 * \frac{\text{precision} * \text{recall}}{\text{precision} + \text{recall}}$$

$$F1 = 2 * (0.65 * 0.60) / (0.65 + 0.60) = 0.624$$

VI. CONCLUSION AND FUTURE WORK

The biometric identification using fingerprint method shows immense stability and hence potential to be considered for various applications. The present research proposed efficient technique of blood group identification. A fingerprint having multiple unique minutiae features which are used to predict blood group using different machine learning methods. Proposed system predicts blood group using Multiple Linear Regression with Ordinary Least Squares (OLS) with 62% accuracy. In future further study should be carried out by increasing the sample size to get more accurate result and consider additional fingerprint feature those are not considered yet.

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