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Analysis of iron deficiency anemia in Pregnant women using Artificial Neural Network

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***Abstract*— In this paper a new classification algorithm is proposed for the Classification of five types of abnormal Red Blood Cells (RBCs) called Poikilocytes in Iron deficient blood smears in pregnant women . In order to develop algorithm 160 five type of abnormal Red Blood Cells images have been considered, With a view to extract features from the images after image processing, an algorithm proposes WHT transformed coefficients. The Efficient classifiers based on Generalized feed forward network(GFF) Neural Network. A separate Cross-Validation dataset is used for proper evaluation of the proposed classification algorithm with respect to important performance measures, such as MSE and classification accuracy. The Average Classification Accuracy of GFF Neural Network comprising of one hidden layers with 12 PE's organized in a typical topology is found to be superior (97.50 %) for Training and cross-validation. Finally, optimal algorithm has been developed on the basis of the best classifier performance. The algorithm will provide an effective alternative classification method of five types of abnormal Red Blood Cells (RBCs) in Iron deficient blood smears in pregnant women.**

***Index Terms*— Neural solution, MatLab, Microsoft excel, all five types of abnormal Red Blood Cells (RBCs)**

I. INTRODUCTION

Red blood cells (erythrocytes) are cells, which morphology determines their functional possibilities. Ability of erythrocytes to transport oxygen is defined by interaction of erythrocyte surface square with oxygen rich media and its possibility to deformation while passing thin capillaries. So, the shape of biconcave disk (maximum surface squire under the volume and deformability) corresponds to normal erythrocytes. Investigations, carried out by electron microscopy and digital holographic interference microscopy [1, 2] techniques, have shown that erythrocytes underwent morphological changes not only in hematological diseases but in diseases of different geneses and under influence of outward physical and chemical factors. Erythrocyte morphology investigation is of great interest, because they take part in the processes of homeostasis of the whole organism. So, erythrocytes are the most suitable medical objects for estimation of the whole organism state and its biological response on physical and chemical factors influence.

The most frequent reason of neonatal mortality and sick rate is prenatal hypoxia, which causes asphyxia progressing. Hypoxia is not a disease, but a result of different pathology of mother's and fetus's organisms. Enough supply of a fetus with oxygen is provided by uterine and placental blood circulation intensity, placental barrier penetration and properties of mother's and fetus's erythrocytes. Different diseases can influence blood erythrocytes morphology, morphological changes of blood erythrocytes can be the reason of different
hypoxia pathology of a mother and a child. Diabetes mellitus is a widespread chronic disease. Progressive increase of the sickness rate, frequent development of aftereffects of illness put diabetes mellitus on the level of the leading problem of medicine, which needs all round study. But information on investigation of pregnant women and new-born children blood erythrocytes morphology in norm and pathology is absent in medical literature.

Iron deficiency is a highly prevalent form of under nutrition, affecting around one-fourth of the world's women and children, and is one of the most common causes of anemia. Iron deficiency is one of the most prevalent nutrient deficiencies in the world, affecting an estimated two billion people. Children and Young children and women are the most commonly and severely affected because of the high iron demands. However, where diets are based mostly on staple foods with little meat intake, or people are exposed to infections that cause blood, iron deficiency may occur throughout the life span. Although much is known about iron metabolism, the health consequences of iron deficiency continue to be a subject of research and debate. This is partly because in many regions of the world iron supplements are the standard of care for individuals with anemia.[6]

So Anemia is considered as the most prevalent Hematological disorder and is mainly caused by the lack of Iron in the body. Iron Deficiency Anemia or simply Iron Deficiency Anemia is traditionally determined by Complete Blood Count test (CBC). It would be a sensible and reasonable idea to use image processing techniques for the diagnosis of Iron Deficiency Anemia. In an iron deficient blood smear, the shape and the size of red blood cells change significantly. Shape variation of cells is called **Poikilocytosis** and size variation is known as **Anisocytosis**. Based on the shape of the outer boundary of a cell, five different types of blood cells can be categorized in an iron deficient blood smear including round cells(Discocyte), Dacrocytes, Schistocytes and Elliptocytes, Degmacyte. Samples of these sfive blood types are illustrated in Fig.1.2,3,4,5, Dacrocytes are tear drop like cells and Elliptocytes are similar to ellipses. Round cells have circular outer boundary and include normal blood cells.[3]

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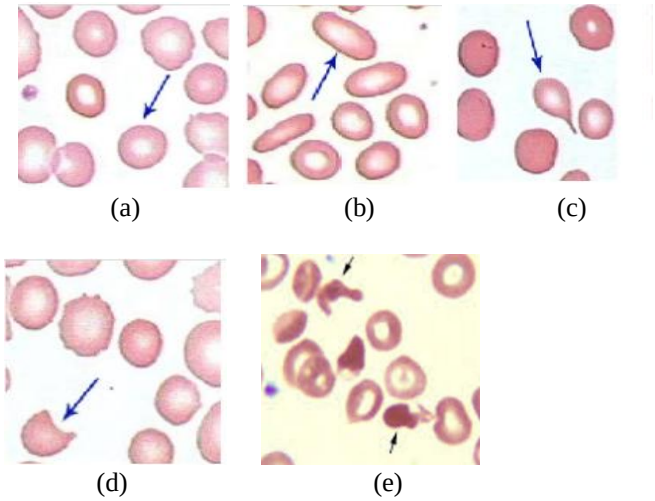

(a) (b) (c)

(d) (e)

Figure.1(a) Round cell(Discocyte) (b)Elliptocyte (c)Dacrocyte (d) Schistocyte (e)Degmacyte,

These Poikilocyte cells (Dacrocytes, Elliptocytes and Schistocytes, Degmacyte, Discocyte) have different shapes which can be used as features for their classification. In this Purposed work, collecting data and preparing cell images for feature extraction, Dacrocyte cells, Elliptocyte cells, Schistocyte cells Degmacyte cells, Discocyte cells and round cells are classified.

Iron Deficiency Anaemia is considered as the most common type of haematological disorder and nutritional deficiency worldwide, it is caused by the deficiency of iron in body leading to reduction in the number of erythrocytes. Iron IS necessary to synthesize erythrocytes, which help to store and carry oxygen via blood. Iron is received in the liver as ferritin and discharges as demand to form new erythrocyte in the bone marrow. When erythrocyte completes its lifetime in the blood circulation (after 100-120 days), they are reabsorbed by the spleen. Iron is maintained by the balance between absorption and body losses and Image daily to maintain equilibrium. Grievous and protracted iron deficiency anemia may increase the risk of evaluative complicacy that affects heart and lungs as a consequence of which tachycardia (abnormally fast heart beat) or heart failure and dysfunction of iron inclusive cellular enzymes may occur. It can cause reduced impact motor and work capacity in adults and mental development in adolescents and children. There are few evidences that prove iron deficiency anemia causes fatigue in adult women and affects realization in adolescent girls. Deficiency generates in stages. In the first stage, iron necessity increase intake, causing onward depletion of bone marrow iron stores. As depository decrease, absorption of dietary iron increase in quid pro quo.

During later stages, deficiency makes worse erythrocyte agglutination, finally causing anemia. Iron Deficiency Anemia is traditionally determined by complete blood cell count test. It would be a sane and proper opinion to use digital image processing techniques for the diagnosis of iron deficiency anemia. In an iron deficient blood smear microscopic images, the shape and size variation of erythrocyte is observed. Shape of cells is called Poikilocyte and size variation is called Anisocytosis.

II. RESEARCH METHODOLOGY

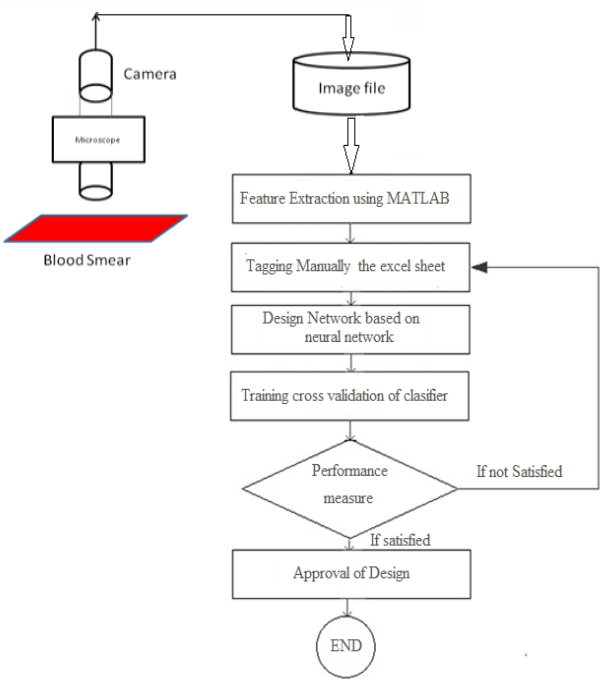

Figure.2 Methodology of work

As per methodology work to study iron deficiency Using Neural Network Approaches.. Data acquisition for the proposed classifier designed for the classification of five different types of blood cells can be categorized in an iron deficient blood smear including round cells(Discocyte), Dacrocytes, Schistocytes and Elliptocytes, Degmacyte. Image data will be Collected from the different- different Pathalogy labs .The most important un correlated features as well as coefficient from the images will be extracted .In order to extract features, statistical techniques, image processing techniques, transformed domain will be used.

1) Neural Networks

Following Neural Networks are tested:

A. Neural Network

Following Neural Networks are tested:

Feed-Forward Neural Networks

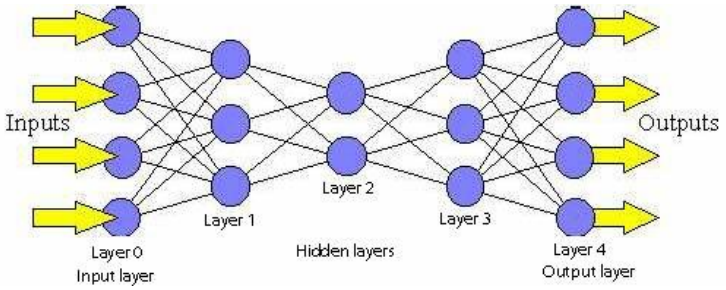

Figure 3. A feed-forward network.

Feed-forward networks have the following characteristics:

A single perceptron can classify points into two regions that are linearly separable. Now let us extend the discussion into the separation of points into two regions that are not linearly separable. Consider the following network:

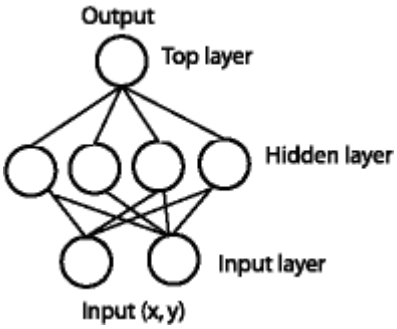

Figure 4. A feed-forward network with one hidden layer.

The same (x, y) is fed into the network through the perceptrons in the input layer. With four perceptrons that are independent of each other in the hidden layer, the point is classified into 4 pairs of linearly separable regions, each of which has a unique line separating the region.

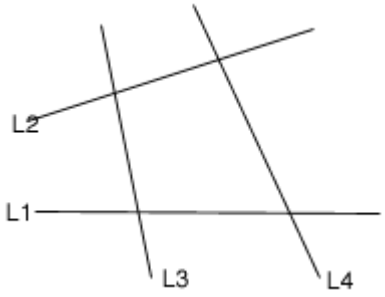

Figure5. lines each dividing the plane into 2 linearly separable regions.

The top perceptron performs logical operations on the outputs of the hidden layers so that the whole network classifies input points in 2 regions that might not be linearly separable. For instance, using the AND operator on these four outputs, one gets the intersection of the 4 regions that forms the center region.

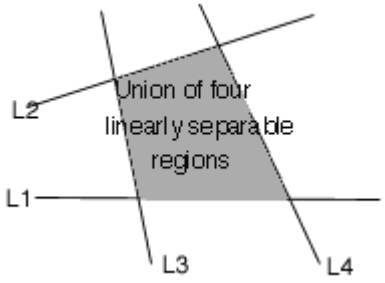

Figure 6.Intersection of 4 linearly separable regions forms the center region.

By varying the number of nodes in the hidden layer, the number of layers, and the number of input and output nodes, one can classification of points in arbitrary dimension into an arbitrary number of groups. Hence feed-forward networks are commonly used for classification.

B. Learing rule used

Momentum (MOM):

Momentum learning rule is an improvement over the straight gradient-descent search in the sense that a memory term, i.e., the past increment in the weight, is set to speed up and stabilize convergence. In momentum learning, the equation to update the weight becomes

$$W_{ij}(n+a) = W_{ij}(n) + n\partial_i(n)\, x_j(n) + n\,[W_{ij}(n) - W_{ij}(n-1)] \quad \ldots(1)$$

Where, η denotes the momentum constant. Normally, η should be set between 0.5 and 0.9. This is called momentum learning due to the form of the last term, which resembles the momentum in machines. It is a robust method to speed up learning. Being a robust method to speed up learning, it is recommended as a default search rule for network with nonlinearities.

III. Result

The GFF neural network has been simulated for 160 five different types of blood cells images of pregnant female out of which 144 images were used for training purpose and 16 images were used for cross validation.

The Best Neural network with maximum accuracy is shown below:

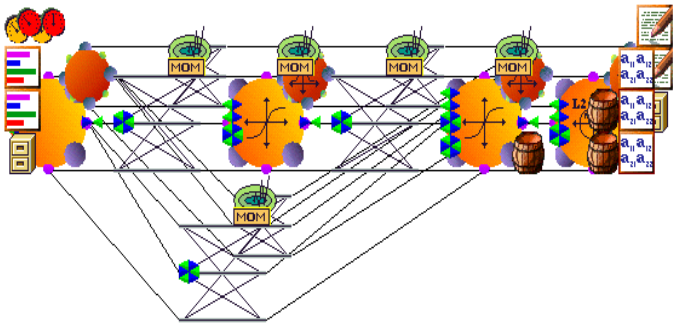

Figure7. The Best Neural network with maximum accuracy (GFF-MOM)

Training Report of the Best Classifier:

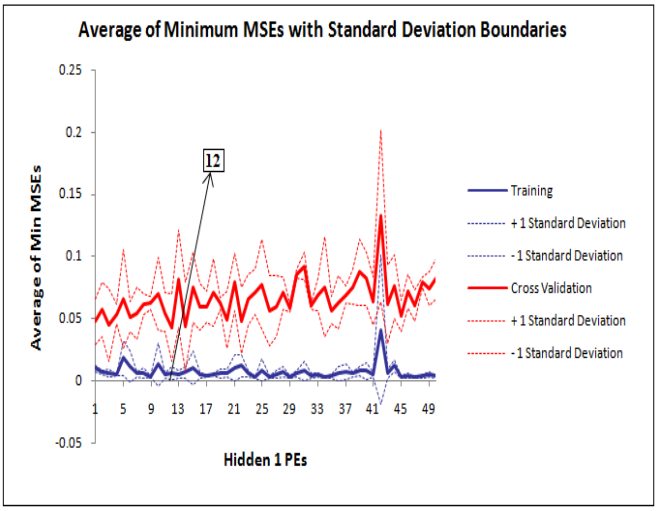

Table 1. Training and cross validation Report of the Best Classifier MLP-DBD

Best Networks	Training	Cross Validation
Hidden 1 PEs	46	12
Run #	1	1
Epoch #	1000	778
Minimum MSE	0.001879883	0.011275761
Final MSE	0.001879883	0.012525131

Test on Cross validation (CV):

Table 2. Confusion matrix table of Cross validation (CV)

Output / Desired	SCHISTOCYTE	DEGMACYTE	DACROCYTE	ELLIPTOCYTE	DISCOCYTE
SCHISTOCYTE	2	0	1	0	0
DEGMACYTE	0	3	0	0	0
DACROCYTE	0	0	3	0	0
ELLIPTOCYTE	0	0	0	5	0
DISCOCYTE	0	0	0	0	4

Table 3: Performance Measures for cross validation

Performance	SCHISTOCYTE	DEGMACYTE	DACROCYTE	ELLIPTOCYTE	DISCOCYTE
MSE	0.080412345	0.002014563	0.00252244	0.02517264	0.0393900
NMSE	0.814174991	0.014504854	0.01459411	0.125475927	0.2278993
MAE	0.131400443	0.042721758	0.04279393	0.082615869	0.0919455
Min Abs Error	0.000740138	0.010985903	0.00207976	0.01839285	0.0277109
Max Abs Error	1.035026824	0.055467339	0.09915130	0.639241081	0.8161661
r	0.681862914	0.997775339	0.99345011	0.94923992	0.9076696
Percent Correct	100	100	75	100	100

Test on Training:

Table 6: Confusion matrix table of Training

Output / Desired	SCHISTOCYTE	DEGMACYTE	DACROCYTE	ELLIPTOCYTE	DISCOCYTE
SCHISTOCYTE	14	0	0	0	0
DEGMACYTE	0	27	0	0	0
DACROCYTE	0	0	27	0	0
ELLIPTOCYTE	0	0	0	38	0
DISCOCYTE	0	0	0	0	36

Table 7: Performance Measures for training

Performance	SCHISTOCYTE	DEGMACYTE	DACROCYTE	ELLIPTOCYTE	DISCOCYTE
MSE	0.001367795	0.001727404	0.001334659	0.002636817	0.002225827
NMSE	0.015390751	0.011217837	0.008667331	0.013453638	0.011761422
MAE	0.032376934	0.036103314	0.032139727	0.050281559	0.043890012
Min Abs Error	0.000398907	0.000904141	0.000254878	0.006895553	0.000378458
Max Abs Error	0.066265735	0.136561015	0.076590101	0.055555553	0.090686506
r	0.994829122	0.995283118	0.996604471	0.999196111	0.996242676
Percent Correct	100	100	100	100	100

IV. Conclusion

A From the results obtained in WHT domain it concludes that the GFF Neural Network with MOM (momentum) and hidden layer 1 with processing element 12 gives best results of 100% in Training while in Cross Validation it gives 100% for all four and 75% for Dacrocyte accuracy so overall accuracy is 97.50%.

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