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</tr>
<tr>
<td>$\phi$</td>
<td>Gradient orientation angle</td>
</tr>
<tr>
<td>$\cap$</td>
<td>Intersection</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Learning rate</td>
</tr>
<tr>
<td>$\mu_{RC}$</td>
<td>Mean value of feature matrix</td>
</tr>
<tr>
<td>$\Psi$</td>
<td>Prototype wavelet function.</td>
</tr>
<tr>
<td>$\wedge$</td>
<td>Rotated image</td>
</tr>
<tr>
<td>$\varnothing$</td>
<td>Scaling parameter of wavelet transform</td>
</tr>
<tr>
<td>$\psi$</td>
<td>Steepness factor</td>
</tr>
<tr>
<td>$\theta_t$</td>
<td>Threshold limit value</td>
</tr>
<tr>
<td>$\subseteq$</td>
<td>Translation</td>
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</table>
### Abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ANN</td>
<td>Artificial Neural Network</td>
</tr>
<tr>
<td>ARM</td>
<td>Advanced RISC Machine</td>
</tr>
<tr>
<td>ASIC</td>
<td>Application Specific Integrated Circuits</td>
</tr>
<tr>
<td>ATM</td>
<td>Automated Teller Machine</td>
</tr>
<tr>
<td>B</td>
<td>Structuring element</td>
</tr>
<tr>
<td>b, Bm</td>
<td>Biasing element</td>
</tr>
<tr>
<td>BCD</td>
<td>Binary Coded Decimal</td>
</tr>
<tr>
<td>BFGS</td>
<td>Broyden Fletcher Goldfarb Shanno</td>
</tr>
<tr>
<td>BPN</td>
<td>Back Propagation Network</td>
</tr>
<tr>
<td>CASIA</td>
<td>Chinese Academy of Science, Institute of Automation</td>
</tr>
<tr>
<td>CDTWT</td>
<td>Complex Dual Tree Wavelet Transform</td>
</tr>
<tr>
<td>CGF</td>
<td>Conjugate Gradient Fletcher-Reeves</td>
</tr>
<tr>
<td>CGP</td>
<td>Conjugate Gradient Polak</td>
</tr>
<tr>
<td>CLB</td>
<td>Configurable Logic Blocks</td>
</tr>
<tr>
<td>D</td>
<td>Dimension</td>
</tr>
<tr>
<td>DAL</td>
<td>Dynamic Array Logic</td>
</tr>
<tr>
<td>DCT</td>
<td>Discrete Courier Transform</td>
</tr>
<tr>
<td>delta_x</td>
<td>Size of weight change</td>
</tr>
<tr>
<td>DFT</td>
<td>Discrete Fourier Transform</td>
</tr>
<tr>
<td>DNA</td>
<td>Deoxyribonucleic Acid</td>
</tr>
<tr>
<td>DSP</td>
<td>Digital Signal Processor</td>
</tr>
<tr>
<td>DWT</td>
<td>Discrete Wavelet Transform</td>
</tr>
<tr>
<td>DWT</td>
<td>Discrete Wavelet Transforms</td>
</tr>
<tr>
<td>dx</td>
<td>Change in weight and bias value</td>
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</tbody>
</table>
dx_old - Previous weight and bias value
e - Error signal
ECG - Electro Cardio Gram
EEG - Electro Echo Gram
EEPROM - Electrically Erasable Programmable Read Only Memory
EigenTensor - Eigen tensor matrix
EMD - Empirical Mode Decomposition
EMP - Elementary Multilinear Projection
e-Shakti - Electronic Shakti
f - Function
\( F_0 \) - Output of low pass synthesis filter
\( F_1 \) - Output of high pass synthesis filter
FAR - False Acceptance Rate
FF - Feed Forward
FFBPNN - Feed Forward Back Propagation Neural Network
FFNN - Feed Forward Neural Network
FFT - Fast Fourier Transform
FIR - Finite Impulse Response
FN - False Negative
FP - False Positive
FPGA - Field Programmable Gate Array
FPLA - Field Programmable Logical Array
FRR - False Rejection Rate
FSM - Finite State Machine
\( G_0 \) - Low pass synthesis filter coefficient
\( G_1 \) - High pass synthesis filter coefficient
GDX - Gradient Decent with momentum
\( G_x \) - Partial derivative gradient in the direction ‘x’
gx - Gradient parameter
gx-1 - Previous gradient parameter
G_y - Partial derivative gradient in the direction ‘y’
H - Hessian matrix
H_0 - Low pass analysis filter coefficient
H_1 - High pass analysis filter coefficient
HDL - Hardware Descriptive Language
HH - Diagonal frequency component
HL - Horizontal frequency component
H_x - Horizontal prewitt mask matrix
Hz - Hertz
I/O - Input / Output
ICA - Independent Component Analysis
ICE - Iris Challenge Evaluation
I_{inter} - Current gray scale intensity Value
IIR - Infinite Impulse Response filter
IITD - Indian Institute of Technology, Delhi
I_{maxnew} - New maximum gray scale intensity value.
I_{minnew} - New minimum gray scale intensity value.
I_{minold} - Old minimum gray scale intensity value.
I_{new} - Normalized gray scale intensity value.
IR - Infra Red
ISP - In-System-Programmer
J - Jacobian matrix
JTAG - Join Test Action Group
k - Canny high threshold constant value
L^2 - Sub set
LBP - Linear Binary Pattern
LCD - Liquid Crystal Display
LDA - Linear Discriminant Analysis
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>LDPC</td>
<td>Low Density Parity Check</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>LFDA</td>
<td>Local Fisher Discriminant Analysis</td>
</tr>
<tr>
<td>LH</td>
<td>Vertical frequency component</td>
</tr>
<tr>
<td>LM</td>
<td>Levenberg-Marquardt</td>
</tr>
<tr>
<td>LSSC</td>
<td>Linear Separable Sub Code</td>
</tr>
<tr>
<td>LVQ</td>
<td>Linear Vector Quantization</td>
</tr>
<tr>
<td>m</td>
<td>Canny sigma constant value</td>
</tr>
<tr>
<td>M</td>
<td>Weights between input and hidden layer.</td>
</tr>
<tr>
<td>mc</td>
<td>momentum coefficients</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter</td>
</tr>
<tr>
<td>MMU</td>
<td>Multimedia University</td>
</tr>
<tr>
<td>MPCA</td>
<td>Multilinear Principle Component Analysis</td>
</tr>
<tr>
<td>MSL</td>
<td>Multilinear Subspace Learning</td>
</tr>
<tr>
<td>MWT</td>
<td>Multi-resolution Wavelet Transforms</td>
</tr>
<tr>
<td>N</td>
<td>Hidden neurons</td>
</tr>
<tr>
<td>N_input</td>
<td>Input of the neural hidden layer</td>
</tr>
<tr>
<td>N_output</td>
<td>Output of the neural hidden layer</td>
</tr>
<tr>
<td>NICE</td>
<td>Noisy Iris Challenge Evaluation</td>
</tr>
<tr>
<td>nm</td>
<td>Nano meter</td>
</tr>
<tr>
<td>NN</td>
<td>Neural Network</td>
</tr>
<tr>
<td>NPV</td>
<td>Negative predictive value</td>
</tr>
<tr>
<td>NUID</td>
<td>National Unique Identification card</td>
</tr>
<tr>
<td>OSIRIS</td>
<td>Open Source for IRIS</td>
</tr>
<tr>
<td>OSS</td>
<td>One Step Secant</td>
</tr>
<tr>
<td>p</td>
<td>Scaling parameter</td>
</tr>
<tr>
<td>PAL</td>
<td>Programmable Array Logic</td>
</tr>
<tr>
<td>PCA</td>
<td>Principle Component Analysis</td>
</tr>
<tr>
<td>PLA</td>
<td>Programmable Logical Array</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>PPV</td>
<td>Positive predictive value</td>
</tr>
<tr>
<td>q</td>
<td>Shifting parameter</td>
</tr>
<tr>
<td>r</td>
<td>Radius</td>
</tr>
<tr>
<td>RANSAC</td>
<td>Random Sample Consensus</td>
</tr>
<tr>
<td>RBF</td>
<td>Radial Basis Function</td>
</tr>
<tr>
<td>RFID</td>
<td>Radio Frequency Identification</td>
</tr>
<tr>
<td>$R_{\text{iris}, r_i}$</td>
<td>Iris radius</td>
</tr>
<tr>
<td>RNCV</td>
<td>Relative Number of Conjunctival Vessels</td>
</tr>
<tr>
<td>ROI</td>
<td>Region of Interest</td>
</tr>
<tr>
<td>RP</td>
<td>Resilient back Propagation</td>
</tr>
<tr>
<td>$R_{\text{pupil}, r_p}$</td>
<td>Pupil radius</td>
</tr>
<tr>
<td>SBS</td>
<td>Sequential Backward Search</td>
</tr>
<tr>
<td>SCG</td>
<td>Scaled Conjugate Gradient</td>
</tr>
<tr>
<td>SFS</td>
<td>Sequential Forward Search</td>
</tr>
<tr>
<td>SR</td>
<td>Specular Reflection</td>
</tr>
<tr>
<td>SVM</td>
<td>Support Vector Machine</td>
</tr>
<tr>
<td>t</td>
<td>Time</td>
</tr>
<tr>
<td>$t_{\text{target}}$</td>
<td>Target output</td>
</tr>
<tr>
<td>Tensor$_{\text{RC}}$</td>
<td>Reduce weight elements of tensor</td>
</tr>
<tr>
<td>TN</td>
<td>True Negative</td>
</tr>
<tr>
<td>TP</td>
<td>True Positive</td>
</tr>
<tr>
<td>TQFP</td>
<td>Thin Quad Flat Package</td>
</tr>
<tr>
<td>TTP</td>
<td>Tensor to Tensor Projection</td>
</tr>
<tr>
<td>TVP</td>
<td>Tensor to Vector Projection</td>
</tr>
<tr>
<td>UBIIRIS</td>
<td>University of Beria IRIS</td>
</tr>
<tr>
<td>UPOL</td>
<td>University of Palacky in Olomouc</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
</tr>
<tr>
<td>V</td>
<td>Version</td>
</tr>
<tr>
<td>$V_{j}$</td>
<td>Orthogonal complement</td>
</tr>
</tbody>
</table>
\( V_y \) - Vertical prewitt mask matrix
\( W \) - Weights between hidden and output layer.
\( W_{HH\_IMAG} \) - Imaginary part of diagonal frequency components
\( W_{HH\_REAL} \) - Real part of diagonal frequency components
\( W_{HL\_IMAG} \) - Imaginary part of horizontal frequency components
\( W_{HL\_REAL} \) - Real part of horizontal frequency components
\( W_j \) - orthogonal difference
\( W_{LH\_IMAG} \) - Imaginary part of vertical frequency components
\( W_{LH\_REAL} \) - Real part of vertical frequency components
\( W_{RC} \) - Elements of tensor matrix
\( WVU \) - Western Virginia University
\( X, I \) - Input image matrix
\( X_{A0} \) - Output of low pass analysis coefficient
\( X_{A1} \) - Output of high pass analysis coefficient
\( X_c \) - Row value of pupil centre
\( X_i \) - Row value of iris centre
\( X_{iris} \) - Rectangular co-ordinate of iris with respect to row
\( X_{pupil} \) - Rectangular co-ordinate of pupil with respect to row
\( X_{S0} \) - Output of low pass interpolation
\( X_{S0} \) - Output of high pass interpolation
\( Y \) - Output image matrix
\( Y_{A0} \) - Output of low pass decimator
\( Y_{A1} \) - Output of high pass decimator
\( Y_c \) - Column value of pupil centre
\( Y_i \) - Column value of iris centre
\( Y_{input} \) - Net input of the neural network
\( Y_{iris} \) - Rectangular co-ordinate of iris with respect to column
\( Y_{out} \) - Output of neural network
\( Y_{pupil} \) - Rectangular co-ordinate of pupil with respect to column
$Z_{\text{input}}$ - Input of the neural output layer

$Z_{\text{output}}$ - Output of the neural output layer

$\Delta M$ - Change in weight between the input and hidden layer

$\Delta W$ - Change in weight between the hidden and output layer