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Classification of Child Items in a Gold Tree using Support Vector Machine Classifier

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Abstract- Sorting of images has been a challenge in Machine Learning Algorithms over the years. Various algorithms have been proposed to sort an image but none of them are able to sort the image clearly. The drawback of the existing systems is that the sorted image is not clearly identified. So, to overcome this drawback we have proposed a novel approach to sort the children of a tree and match them with the existing designs. The images will be sorted on the basis of the class of the image. The images are taken from the image and manual binning of those images are done. Then the images are trained and tested. GLCM feature is extracted from the trained and tested images which are later on fed to the SVM classifier. The classification of image is then done with the help of SVM classifier. Around 7000 images are trained on SVM and used for classification. More than 300 different classes have been created in the database for comparison. Real-time images of child items are captured and fed to the SVM for classifying. The main application of this image is the use in distinguishing the designs in the ornaments. The various parts of the ornaments can be differentiated clearly. Thus, the proposed method is precise as compared to the existing methods.

Keywords: Support Vector Machine, Gray Level Co-occurrence Matrix, Child Item, Tree, Image Classification.

I. INTRODUCTION

Image classification involves the process of binning images of same category using machine intelligence. One of the most commonly used machine learning approach is Support Vector Machine (SVM). SVM is a supervised machine learning algorithm that can be used for classification or regression problems. It uses a technique called the kernel trick to transform your data and then based on these transformations it finds an optimal boundary between the possible outputs. Simply put, it does some extremely complex data transformations, then figures out how to separate your data based on the labels or outputs you've defined. Finally, classification is done by finding the hyper-plane that differentiate the two classes.

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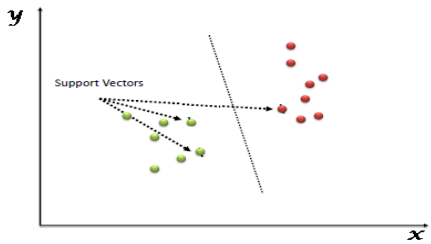

Figure 1 Points classification in SVM

The co-ordinates of individual observation are considered to be Support Vectors. Support Vector Machine is aused to differentiate the two classes (hyper-plane/ line) in effective manner.

Working of SVM

1. Identification of Hyper plane
2. Classification of classes
3. Finding hyper plane to separate classes

An SVM model is the mapping of points in the space so that the segregation of the classes can be easily identified and the gap widens for clear identification of the classes. SVMs can perform linear as well as nonlinear classification. In nonlinear classification the inputs of the classification are extensively mapped to high-dimensional feature spaces.
Consider a set of training examples, let each belong to one another in categories. The work of SVM training is to develop a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier. Support vector machines not only draw a line between two classes, but also considers a region about the line of some given width. The hinge function loss in the SVM is given by the formula given below:

$$C(x, y, f(x))) = \begin{cases} 0, & if\ y * f(x) \geq 1 \\ 1 - y * f(x), & else \end{cases} \quad (1)$$

X and Y are data points and f(x) is hinge function

The loss function is given by the formula as shown below:

$$min_W \lambda\ ||w||^2 + \sum_{i=1}^{499}(1 - y_i\langle x_i\,, w\rangle) \quad (2)$$

W is regularization parameter

The gradient can be calculated as:

$$\frac{\partial}{\partial w_k}\lambda\left|\left|w\right|\right|^2 = 2\lambda w_k \quad (3)$$

$$\frac{\partial}{\partial w_k}(1 - y_i\langle x_i, w\rangle) = \begin{cases} 0, & if\ y_i\langle x_i, w\rangle \geq 1 \\ -y_i x_{ik}, & else \end{cases} \quad (4)$$

Where x and y are data points and W is a regularization parameter.

II. LITERATURE REVIEW

This section elaborates on a few literatures that have been proposed by scientist. It is evident that most of the literatures have proposed approaches for image classification for a variety of problems and not specific to child sorting. Though the application problem appears to be different a review on the image classification algorithms need a worth reading.

Young and et.al [1] proposed a deep neural based system that removes the harmful seeds from mixed product and gives high accuracy. The detection system is divided into localization and classification. The tracking of weed is done based on classification and the wanted seeds are expelled.

Mayar Haggag and et.al. [2] introduced a hybrid CNN-ANN based algorithm and computational results are used to access the real time performance of the proposed algorithm.

Systematic Mapping system [3] highlighted the challenges and research opportunities in the field of cast sorting. The dissemination of the cast sorting is clearly described.

Wei Jia and et.al [4] introduced complete DR method that uses direction information that works in unison with feature selection and learning.

Ti Bai and et.al [5] incorporated 3-D dictionary into regularized iterative reconstruction framework. It introduces a new 3-D dictionary learning method. The system also analyzes the sparsity level curve of different parameters.

Bin Fan and et.al [6] focused on image-based 3D reconstruction by comparative evaluation of the images. It uses recently designed machine learning technique and handcrafted features.

Chen Li and et.al [7] solved a degradation monitoring problem using a microscopic machine vision system. It introduced a learning approach in a compound membrane computing framework.

Mirko Manca and et.al [8] measured the distribution pf fibers using digital images. Image processing and machine learning algorithms to extract the various features of the fibers are have been developed.

Selim S. Sarika and [9] introduces the system to track the anomalies in the vehicle movements. CCTV cameras are used to capture the front and rare side images of the vehicles. The system takes into account the tracking of the vehicle by extracting the features like edges and license plate corner locations. Trained classifier is used to monitor the direction of traffic flow.

Md Mahmudur Rahman and et.al [10] considers the prefiltered images and performs category specific statistical similarity matching system. The query parameters are dynamically updated and the matching functions are adjusted.

Mahdi Hashemi and et.al [11] have proposed a machine learning based map matching algorithm for projection vector to detect and finalize the spatial temporal pattern.

Bin Fan and et.al [12] have proposed machine learning technique for comprehensive evaluation and evaluate local features and handcrafted features. Float type feature and binary feature both are taken into consideration.

Adrin Perez Suay and et.al [13] have taken into consideration the landmark and the effect of cloud contamination in the landmark. It uses meteostat second generation data to detect the presence of cloud over the landmarks using pattern recognition methodology.

Hu Han and et.al [14] have introduced a convolutional neural network to search the tattoos. Tattoo search is more simplified and detection as well as compact representation is made easy with the help of CNN.

Patil Siddhant and et.al [15] have proposed a color matching technique using various platforms. It especially focuses on fabrics in order to control the quality of the fabrics. It uses GigE camera for image acquisition.

Mahdi Hajiaghayi and et.al [16] have detected left ventricle cavity in heterogeneous heart disease using a 3-D active contour method. The segmentation is done using cardium segmentation method.

Jea Woo Park and et. al [17] introduces hotspot detection system based on machine learning algorithm. It takes into account the detailed optical interfaces and sampled the intensity of the latent image. SVM model is trained using various sampling points.

George Retsinas and et.al [18] proposed a method that solves the issue of variation of text images during feature extraction. It considers oriented gradients of modified projections.

Min Gyu Park and et.al [19] have proposed the random forest framework and scrutinized the confidence measures and their characteristics in the framework. Training of data and matching strategies are formulated based on the confidence measures.

Kalaiselvi and et.al [20] have proposed a learning algorithm to create alerts incase of data imbalance during the verification of electronic transactions. In order to secure the transaction a blocking rule is developed. Finally, scoring rule involving pattern matching is designed depending on the data mining techniques.

Sabeenian and et.al [21] have proposed a computer vision-based fabric detection system to detect the defects in the given samples of the fabric. The project focuses mainly in silk fabrics.

III. CHILD ITEMS AND ITS CLASSIFICATION

This section describes about the various child items that are available in a tree and its classification. In any machine based jewelry manufacturing facility, there are more than a lakh child item available. However, this section describes about the child items that are being used in this paper for experimentation.

A. IMAGE OF GOLD TREE

Figure 2 A complete gold tree with childs

Above shown figure is the complete gold tree and child of that prescribed gold trees are shown as child 1, child 2, child 3and child 4. By using this we can clearly understand which is a tree and which one is the child of the gold tree.

B. Pendant

The Pendant is a piece of jewelry that hangs from a chain worn around the neck.

C. Types

- Necklace pendant.
- Letter pendant.
- Fancy pendant.
- Earring pendant.
- Locket pendant.

D. Necklace pendant

A necklace pendant is a part of a necklace which is hanged in necklace that is worn around the neck. It is used for various purposes, from ceremonial to funerary. It signifies status of wealth in the society.

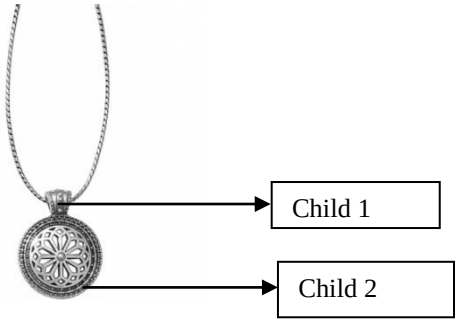

Figure 3 Necklace pendant

E. Letter pendant

Letters are used to represent the name or the significance of that ornaments. The special characters and letters are engraved in the ornament as a memory or precious gift.

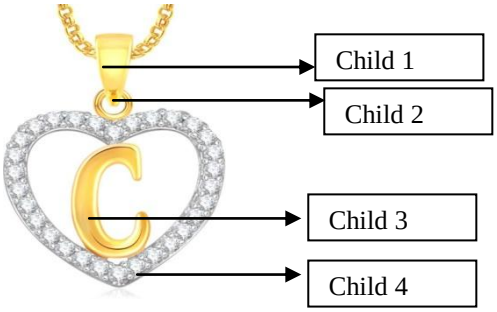

Figure 4 letter pendant

F. Fancy pendant

This kind of fancy pendant's are of many types which can be made worn with rings, necklace, earrings and etc which shows eternal beauty and add some additional beauty to the person whom so ever wears it.

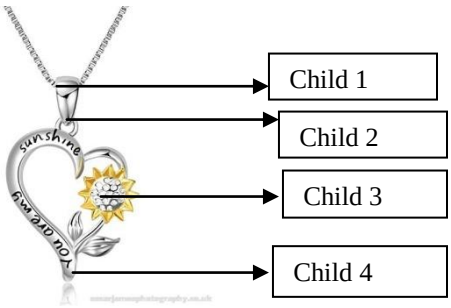

Figure 5 Fancy pendant

G. Earring pendant

Pendants crafted with diamonds, gemstones gives you a fabulous look to your ears on any event. A pair of pendants customized with a pair of earrings will manifest your beauty.

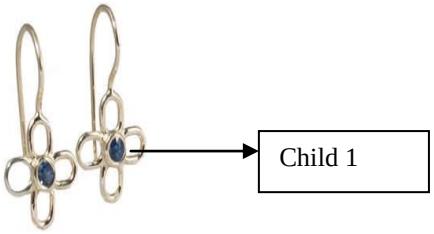

Figure 6 Earring pendant

IV. PROPOSED WORK

The Initial step is to classify a greater number of images into a particular class. Every class has 10 images and out of 10, only 5 images are trained using a vision assistant. The images which are not trained are tested to check if they belong to the same class as actually sorted image. The same image is tested using a lab view. Finally, the obtained result shows that the particular trained image belongs to the class sorted earlier. After that, the gray level co-occurrence features of an image are extracted. The class of the image can be identified by comparing the sorting values with the database.

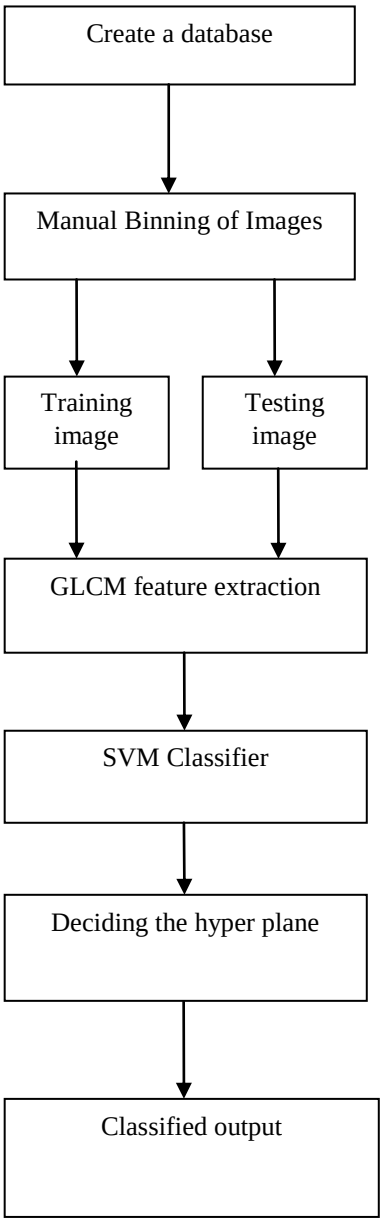

Figure 7 Flow chart of proposed work

A. TRAINING OF IMAGE SAMPLE

Training of the image required three main blocks. The first one is acquiring the image. The next one is selecting the Region of Interest (ROI) of the image. The last one is particle classification. After these steps, every trained sample is stored in the form of a folder so that the sample of the respective classes can be identified.

B. TESTING OF THE TRAINED DATABASE

The trained database consists of some images. Out of those images, only four images are trained. The rest of the images are used for testing. Testing is done with the remaining images after training.

C. METHOD OF IDENTIFICATION

In the training phase, there are 2 scores. They are classification scores and identification scores. If both the score 1000 then it can be concluded that the particular image belongs to the prescribed class that has been stored in the database.

D. Gray Level Co-Occurrence Matrix (GLCM) Texture

GLCM gives the measure of repetition pattern in image intensity taking into account the local variation due to repetition. It is a statistical measure for texture analysis. The construction of GLCM includes pixel intensity and its pairwise estimation. GLCM is based on the hypothesis of repetition of same grey level configuration throughout the image. The image is divided into number of textures viz, coarse texture and fine texture. The pattern of image will vary because of fine texture as compared to fine texture. For GLCM the intensity of image plays an important role. GLCM extracts the second order second order statistical texture features. But, the effectiveness of the GLCM is based on the number of grey levels used.

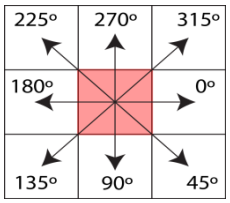

Figure 8 GLCM matrix development

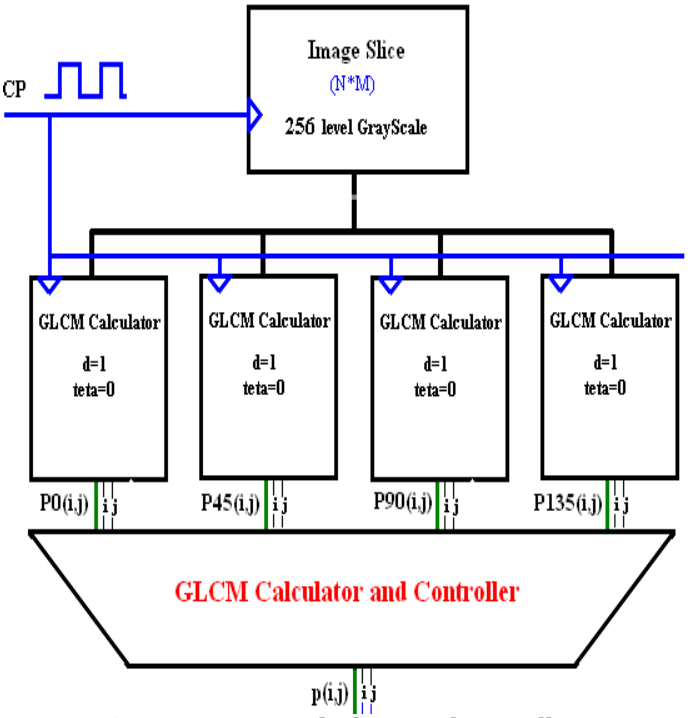

Figure 9 GLCM calculator and controller

E. Features of Grey level co-occurrence matrix

1. Contrast.
2. Energy.
3. Entropy.
4. Mean.
5. Variance.
6. Standard deviation.

7. Maximum and minimum pixel value.
8. Homogeneity.
9. Correlation.
10. Inertia.
11. Cross-correlation.
12. Autocorrelation.

1. Contrast

Contrast measures the variations present in an image locally. This measure of contrast depends on the pixel value. If the pixel value is high then the contrast will be high. Mathematically,

Contrast=

$$\sum_{n=0}^{g-1} n^2 \left\{\sum_{i=1}^{g-1}\sum_{j=1}^{g-1} P(i,j)\right\} \quad (5)$$

2. Energy

Energy describes the uniformity of the image. For a constant image Energy is 1. Mathematically,

$$\text{Energy} = \sum_{i=0}^{g-1}\sum_{j=0}^{g-1} P(i,j)^2 \quad (6)$$

3. Entropy

Entropy is the measure of randomness in the image. Mathematically,

$$\text{Entropy}=\sum_{i=0}^{g-1}\sum_{j=0}^{g-1} P(i,j) * \log\big(P(i,j)\big) \quad (7)$$

4. Mean

Mean is the average value of the total number of data. Mathematically,

$$\text{Mean } (\mu_i) = \sum_{x^2}^{M}(I(x,y)) \quad (8)$$

5. Variance

Variance is the difference between the expected value and the real value. Mathematically,

$$\text{Variance } (\sigma_i^2) = \frac{\sum_{x=1}^{M}\sum_{y=1}^{N}(I(x,y))}{M*N} \quad (9)$$

6. Standard deviation

The standard deviation is the square root of its variance divided by the total number of samples. Mathematically,

$$SD = \sqrt{\frac{\sum |x-\mu|^2}{N}} \quad (10)$$

7. Maximum and Minimum pixel value

Maximum pixel value is the highest number of pixel values contained in an image.

Minimum pixel value is the lowest number of pixel values present in an image. They can be mathematically represented as shown in equations 11 and 12 respectively.

$$\text{Maximum pixel value} = \text{Max } [i,j] \quad (11)$$

$$\text{Minimum pixel value} = \text{Min } [i,j] \quad (12)$$

8. Homogeneity

Homogeneity is the uniformity in the composition of the image. If the composition of the images is same, they are said to be homogeneous. Mathematically,

$$F3 = -\sum_{i=0}^{i-1}\sum_{j=0}^{i-1}\frac{P_{ij}}{1+|i-j|^2}, \; K>=1 \quad (13)$$

9. Correlation

The interdependence of variables due to the change in each other's attributes is called correlation.

$$Y[m,n] = x[m,n] * h[-m,-n] \quad (14)$$

10. Inertia

Inertia is the motion of the body to move at it's own speed unless external force is applied on it.

$$\textbf{Inertia=}\; I = \Sigma\, m_i r_i^2 \quad (15)$$

11. Autocorrelation

The autocorrelation is the total product of the process and its time lagging function.

$$R_x(\tau) = \int_{-\infty}^{\infty} X(t)X(t+\tau)dt \; -\infty < \tau < \infty \quad (16)$$

12. Cross-correlation

cross-correlation is a measure of similarity between a function and its displacement.

$$(f*g)(t) = \int_{-\infty}^{\infty} f^a(\tau)g(t+\tau)d\tau \quad (17)$$

V. CONFUSION MATRIX

A confusion matrix is a table that is often used to describe the performance of a classification model (or "classifier") on a set of test data for which the true values are known. It allows the visualization of the performance of an algorithm.

Table 1 General form of Confusion Matrix

BINARY	DEFECTIVE	NON-DEFECTIVE
DEFECTIVE	TRUE POSITIVE	FALSE NEGATIVE
NON DEFECTIVE	FALSE POSITIVE	TRUE NEGATIVE

Table 2: GLCM feature values

S.N	Mean	Var	SD	Contrast	Entropy	Max	Min	Class name
1	119.24	50.625	2563.04	198	0.00664	255	57	Ring pendant 1
2	123.907	51.7308	2676.28	193	-0.01416	255	62	Ring pendant 1
3	122.343	51.7293	2675.93	205	0.002075	254	49	Ring pendant 2
4	123.645	50.8067	2581.23	195	-0.0047	255	60	Ring pendant 2
5	115.616	50.742	2574.75	200	-0.0026	255	55	Necklace pendant 1
6	115.07	49.1345	2414.19	197	0.026927	254	57	Necklace pendant 1
7	114.747	47.5023	2256.47	202	-0.02752	254	57	Necklace pendant 1
8	115.582	48.5124	2353.46	199	-0.03312	254	55	Necklace pendant 2
9	116.552	46.2806	2141.89	198	-0.02558	255	57	Ring pendant 3
10	82.0182	42.6306	1817.3	213	0.00094	247	34	Ring pendant 3
11	113.886	46.1555	2130.33	196	-0.04082	252	56	Ring pendant 3
12	113.617	44.4408	2193.12	197	0.011404	246	57	Earring pendant 1
13	113.717	46.8308	2193.12	197	0.033617	254	57	Earring pendant 1
14	83.9144	44.2877	1961.4	209	0.003777	247	38	Earring pendant 1
15	113.303	45.347	2056.35	188	0.002018	244	56	Earring pendant 1
16	126.924	52.4722	2753.33	195	0.05412	254	59	Fancy pendant 1
17	91.9753	45.4935	2069.66	177	0.011327	220	43	Fancy pendant 1
18	90.9315	48.349	2337.63	213	-0.01979	251	38	Fancy pendant 1
19	90.0751	48.6334	2365.21	208	0.20245	247	39	Fancy pendant 1
20	119.921	48.9589	2396.98	192	-0.00401	253	61	Fancy pendant 1

Table 3: Confusion Matrix

Class name	RP 1	RP 2	RP 3	RP 4	RP 5	EP 1	EP 2	EP 3	EP 4	NP 1	NP 2	NP 3	NP 4	FP 1	FP 2
RP 1	8	2	1	0	0	0	0	0	0	0	0	1	0	0	1
RP 2	4	9	1	0	0	1	4	2	0	0	1	0	0	0	1
RP 3	2	1	6	1	2	1	1	0	0	0	0	0	0	0	0
RP 4	0	1	0	7	2	1	1	1	1	0	0	0	0	0	0
RP 5	0	1	0	2	8	1	2	2	2	1	0	0	0	0	0
EP 1	0	0	0	0	1	10	2	1	1	1	0	0	1	1	0
EP 2	0	2	1	1	1	0	9	0	1	0	1	1	0	0	0
EP 3	2	2	0	0	0	0	0	8	1	0	0	1	0	1	0
EP 4	0	0	1	0	1	0	1	0	4	0	0	0	0	0	0
NP 1	1	1	0	1	0	0	0	0	0	6	1	1	0	0	0
NP 2	1	4	1	1	2	0	0	0	0	0	9	0	0	0	0
NP 3	0	0	1	0	0	0	0	0	0	0	0	7	1	1	1
NP 4	0	1	0	1	0	1	0	1	0	0	0	0	6	1	0
FP 1	0	0	0	0	1	0	1	0	1	0	0	0	0	7	1
FP 2	1	0	0	0	0	0	0	0	0	1	0	1	1	1	9

- True positive (TP) – Number of defective images correctly classified as a defective image.
- True negative (TN) – Number of non-defective images correctly classified as non-defective image.
- False-positive (FP) – Number of non-defective images wrongly classified as a defective image.
- False-negative (FN) – Number of defective images wrongly classified as non-defective image.

Following are the equations for TRUE POSITIVE, TRUE NEGATIVE , FALSE POSITIVE and FALSE NEGATIVE.

TRUE POSITIVE = X_{AA} (18)

TRUE NEGATIVE = $\sum_{i=1}^{4} Xii - XAA$ (19)

FALSE POSITIVE = $\sum_{i=1}^{4} XiA - XAA$ (20)

FALSE NEGATIVE = $\sum_{i=1}^{4} XAi - XAA$ (21)

By using the above illustrated equations we can arrive at the values called as TRUE POSITIVE, TRUE NEGATIVE, FALSE POSITIVE and FALSE NEGATIVE.

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TABLE 4: VALUES FOR PENDANT CLASSES

Class name	True positive	True negative	False-positive	False-negative
Ring pendant 1	8	48	0	13
Earring pendant	7	49	1	14
Letter pendant	4	52	4	17
Neck pendant	3	53	5	18
Ring pendant 2	8	48	0	13

The Above table illustrates the values of true positive, true negative, false positive, false negative values of 5 classes which have been made found by using the above formula.

By using the confusion matrix some of the performance metrics can be calculated so that we can classify the images very easily using the confusion matrix values.

VI.PERFORMANCE METRICES

1. Sensitivity.
2. Specificity.
3. False-positive rate (FPR).
4. False-negative rate (FNR).
5. Precision.
6. Accuracy.
7. F- score.

1. SENSITIVITY

Sensitivity is also referred to as true positive rate, recall, and the probability of detection. It is a measure of actual positives. It gives specifies measures to the quantity.

$$\textbf{Sensitivity}=\frac{TP}{TP+FN}*100 \qquad (22)$$

2. SPECIFICITY

Specificity is also referred to as a true negative rate. It measures the actual negatives. High sensitivity reduces type-I error.

$$\textbf{Specificity}=\frac{TN}{TN+FP}*100 \qquad (23)$$

3. FALSE POSITIVE RATE

The False-positive rate is also called a false alarm rate. It is also the ratio between the misclassified negative samples to the total negative samples.

$$\textbf{False Postive}=\frac{FN}{TP+FN} \qquad (24)$$

4. FALSE NEGATIVE RATE

The False-negative rate is also known as the miss rate. It is the ratio between misclassified positive samples to the total positive samples.

$$\textbf{False negative}=\frac{FN}{TP+FN} \qquad (25)$$

5. PRECISION

Precision is also referred to as positive predictive value (PPV). It is a measure of test that gives the ratio between actual positives concerning the total positive gives specific measures to the quality or exactness of the test.

$$\textbf{Precision}=\frac{TP}{TP+FP} \qquad (26)$$

6. ACCURACY

Accuracy is the measure of the efficiency of the classification system. It is evaluated as the ratio of correct predictions to the total number of predictions.

$$\textbf{Accuracy}=\frac{TP+TN}{TP+FP+TN+FN}*100 \qquad (27)$$

7. F – SCORE

F score is the harmonic mean of sensitivity and precision. It is a unique measurement of test for the positive class.

$$\textbf{F- score}=\frac{2*TP}{2TP+FP+FN} \qquad (28)$$

Table 5: PRECISION METRICS VALUE

Class name	Accuracy	Sensitivity	Specificity
RP 1	81.11	38.095	100
EP	78.9	33.33	98
LP	72.72	19.04	93
NP	70.88	15	92
RP 2	81.1	38.095	100
RP 3	75	23.8	97

Calculation shows the value for F-score, precision, negative predictive rate is 1 for all the pendants. It also shows the vale of false positive rate and false negative rate is zero for all the pendants.

VII. CONCLUSION

Thus, the proposed system sorted the image on the basis of class of the image. The classification of the image is based on the class of the image after applying the trained and tested image to the SVM classifier. Finally, the image sorting of the child of the gold tree was done with the help of an SVM classifier using machine learning.

The test result shows the high precision of the proposed system. And the efficiency is also high while compared to the previous work.

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