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A Combined HSV and GLCM Approach for Paddy Variety Identification from Crop Images

M. V. Latte[1], Sushila Shidnal[2], B.S. Anami[3] and V B Kuligod[4]

[1]*Principal, JSSATE, Bangalore*
[2]*Assistant Professor, SMVIT, Bangalore*
[3]*Principal, KLEIT, Hubli*
[4]*Professor, UAS, Dharwad*
mvlatte@rediffmail.com[1], sushram.shidnal@gmail.com[2], anami_basu@hotmail.com[3], vbkuligod@yahoo.co.in[4]

Abstract

Paddy is the staple food of India and many other countries. It is very essential to find out the best variety that promises good yield. This paper presents a methodology to identify variety of paddy field images. In this work, we have considered 22 varieties of paddy field images and they are divided into three classes based on physical features as light green, lush green and pale green. Identification is done using color, texture and combination of both types of features. Color features are extracted using HSV and texture using GLCM. Artificial Neural network (ANN) is used for identification of variety of paddy field images. Considering only color and texture, the results were not satisfactory. Combined features resulted in n accuracy of 85.7% in light green, 83.1% in lush green and 100% in pale green class. The work is an attempt to disseminate knowledge about new variety of paddy crop required to promote the large scale cultivation.

Keywords: *Paddy field images, GLCM, HSV, Artificial Neural Network and Pattern recognition*

1. Introduction

Agriculture is one of the ancient and sacred occupations of mankind and still continues to play a vital role in the lives of all people in the world. Among the several food crops, paddy is most preferred staple food of India. Paddy is the principal and dominant crop of the country. Among the paddy growing countries India has the largest area under cultivation and accounts for 20% of all world rice production. Paddy is found all over the world and in thousands of varieties. In the proposed work 22 varieties of paddy crop images are considered for the study. The 22 varieties of paddy field images are then divided into three clusters namely lush green, light green and pale green which is almost brownish in color. Sample image in each cluster is as shown in Figure 1.

Figure 1. Paddy Variety Images of Light green, Lush green and Pale Green

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The hierarchy of division of total set of paddy field images is as shown in Figure 2.

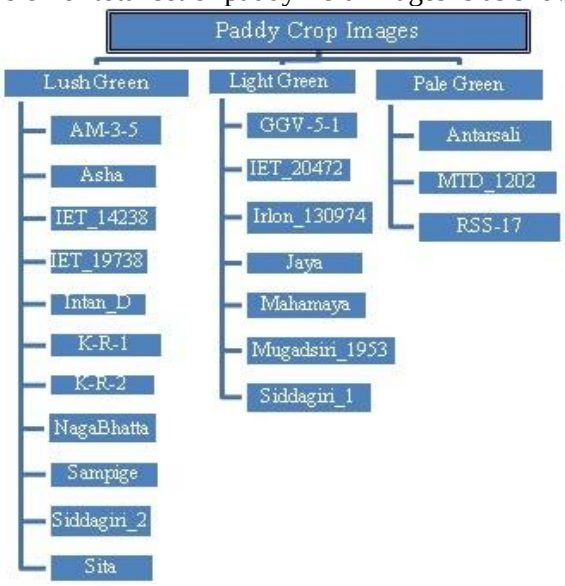

Figure 2. Classification of Paddy Crop Variety

2. Literature Survey

Following is the gist of papers cited in the literature survey is given as under.

Xiaoli Liang *et al*, (2014) have proposed resolution optimal image based on GLCM textures and fuzzy classification. The methodology has used contrast, entropy, homogeneity and angular second moment as texture features with an average accuracy of 93.3%. Mohammad Kazem Moghimi *et al*, (2014) have proposed a synthetic shadow detection algorithm using combination of orthogonal transformation and HSV color space. The results by proposed algorithm demonstrate effectiveness in intelligent transportation system. Dong Ping Tian (2013) has focused on review on the latest development in image feature extraction and provides a comprehension survey on image feature representation technique. Vishaka Metre *et al*, (2013) have proposed an overview of the research on texture based plant leaf classification. In this method a leaf is classified based on different morphological features. P Mohanaiah *et al*, (2013) have proposed a second order statistical texture feature for motion estimation of images. The results show that the texture features have high discrimination accuracy, requires less computation time and can be used in real time pattern recognition application. Qing Liu *et al* (2013) have proposed a method that uses four texture parameters entropy, energy, inertia moment and correlation to identify effectively human virus images. Madhusmita Swain *et al*, (2012) have proposed a technique that focuses on IRIS plant classification using neural network. Use of multi layer feed forward neural network gives an accurate classification which ranges from 83.33% to 96.66%. Abdul Khadir *et al*, (2011) have proposed a methodology that uses shape, vein, color and texture features and probabilistic neural network (PNN) as a classifier. 32 kinds of plant leaves are used with an average accuracy of 93.75%. Abdolvahab Ehsanirad *et al*, (2010) have proposed an image processing technique on leaf images. The algorithm uses GLCM and PCA methods to extract leaves textures, with an average accuracy of 78% for GLCM method and 98% for PCA method. H B kekre *et al*, (2010) have proposed a novel method for image retrieval based on texture feature extraction using vector quantization. The method requires 89.1% less computations compared to GLCM method. Fan-Hui-kong (2009) has proposed a methodology to retrieve image using both color and texture features in combination with color co occurance matrix (CCM). Multi color fusion has obvious advantage. Chia-Ling Lee *et al*, (2006) have used region based features like aspect ratio, centroid, compactness with the

classification accuracy for 1-NN rule as 82.33%. A Vadivel *et al* (2004) have proposed a soft decision approach to the modeling of combined human visual perception of color and texture in a single feature vector called coltex. Sural S *et al*, (2002) have proposed a methodology to apply two distinct approaches to content based image retrieval for both image segmentation as well as histogram generation applications. The results are compared with those generated for RGB color space.

3. Proposed Method

The proposed method on color feature based methodology for classification of variety of paddy field images mainly consists of three steps namely Image acquisition and resizing, color and texture Features and Identification as shown in Figure 3.

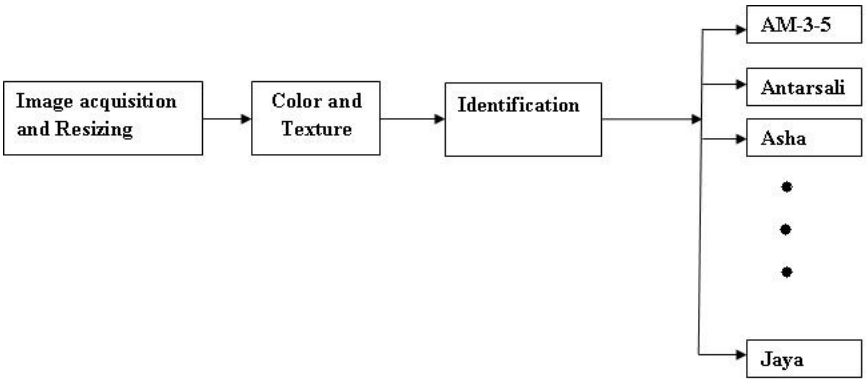

Figure 3. Block Diagram of the Proposed Work

3.1 Image Acquisition and Resizing

The varieties of paddy field images are captured using Sony digital camera 20.1 Mega Pixels. The images are captured under fixed focal length under standard illumination conditions. 22 varieties of paddy field images like AM-3-5, Asha, Nagabhatta, Siddagiri-1, Jaya etc. are used in the present work.

Figure 4. Paddy Field Variety Image Before and After Resizing

The data set consists of 10 images of each variety. A total of 250 images are considered for experimental study. The fields' images captured are of 3456 X 4608 pixels. The images are resized to 512 X 512 pixels. A sample image before and after resizing is as shown in the Figure 4.

3.2 Color and Texture Features Extraction

From literature survey, we found that feature extraction techniques used are color, texture, shape vein etc. In the proposed methodology, an exhaustive experimentation is carried out considering color and later on texture features were considered to improve classification accuracy.

3.2.1. HSV: In Content based image retrieval system color has the major importance. Color is represented in different color spaces like RGB, HSV, YCbCr etc. Our initial study was basically done using HSV color space and then additional features were considered in order to increase the identification rate of different varieties of paddy field images. Computer graphics frequently use HSV color space. It is intuitive method to describe color. The three colors are Hue, Saturation and Intensity also called as brightness. Wavelength within the visible light spectrum at which the energy output from a source is greatest is called hue. Expression for the relative bandwidth of the visible output from a light source is called saturation. And relative expression of the intensity of the energy output of a visible light source is called brightness. It can also be expressed as the amplitude at the wavelength where the intensity is greatest. Figure 5 illustrates the double hex cone HSV color model.

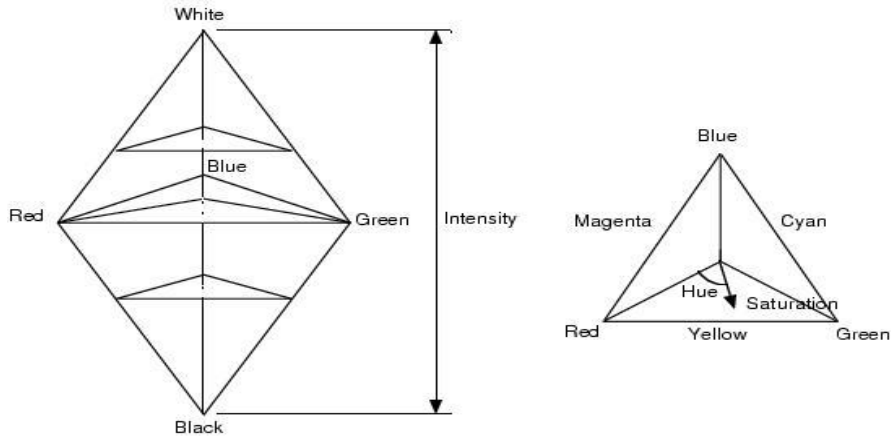

Figure 5. Double Hex Cone HSV Color Model

White color at the top of hex cone corresponds to I=1 and black which is at the base of hex cone corresponds to I=0. Complimentary colors are 180 degrees opposite one another as measures by H, the angle around the vertical axis (I), with red at zero degrees. The value of S ranges from zero on the vertical axis (I) to 1 on the surface of the hex cone. The matrix element P(i,j) is separated from its neighborhood by a pixel distance (Δx, Δy), one with intensity i and the other with intensity j. Number of gray levels is denoted by G. μ is the mean value of P. μ_x and μ_y are the means and standard deviations of Px and Py. The work consisted of 22 varieties of paddy field images each with 10 images in it. A total of 220 images are divided into three main categories depending on the physical features as light green, lush green and pale green images. Light green consists of seven varieties, lush green category consists of eleven varieties and pale green category has four varieties of paddy field images. HSV color features are extracted from these three categories.

Based on Hue, Saturation and Intensity (HSV) color model, mean and standard deviation are extracted. Mean provides average color value in the image and is given by the equation (1).

$$\text{Mean} = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N} Pij \quad (1)$$

Standard deviation is defined as the square root of variance and is given by the equation (2)

$$\text{Standard Deviation} = \sqrt{[\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(Pij - \mu)^2]} \quad (2)$$

The hue, saturation and intensity mean and standard deviation generated for light green images which has seven variety of paddy field images is as shown in the Table 1.

Table 1. Light Green HSV Feature Average Values

HSV Light Green	Hmean	Hstd	Smean	Sstd	Vmean	Vstd
GGV-5-1	0.2197	0.0390	0.4876	0.1481	0.5750	0.1683
IET-20472	0.2292	0.0344	0.5557	0.1712	0.5592	0.1665
Irlon-130974	0.2615	0.0357	0.5884	0.1507	0.6009	0.1842
Jaya	0.2610	0.0338	0.4816	0.1395	0.5615	0.1557
Mahamaya	0.2224	0.0483	0.5300	0.1660	0.5619	0.1620
Mugadsiri-1953	0.2438	0.0388	0.4791	0.1353	0.5662	0.1496
Siddagiri-1	0.2815	0.0363	0.5494	0.1558	0.6317	0.1570

The hue, saturation and intensity mean and standard deviation generated for lush green images which has 11 variety of paddy field images is as shown in the Table 2.

Table 2. Lush Green HSV Feature Average Values

HSV Lush Green	Hmean	Hstd	Smean	Sstd	Vmean	Vstd
AM-3-5	0.2579	0.0305	0.6597	0.1464	0.5965	0.1634
Asha	0.2620	0.0377	0.5798	0.1404	0.6209	0.1629
IET-14238	0.2768	0.0352	0.6086	0.1461	0.6093	0.1193
IET-19738	0.2388	0.0344	0.5595	0.1712	0.5380	0.1758
Intan-D	0.2676	0.0306	0.5852	0.1613	0.6008	0.1269
K-R-1	0.2332	0.0331	0.5656	0.1487	0.5859	0.1246
K-R-2	0.2195	0.0351	0.5653	0.1693	0.5747	0.1589
NagaBhatta	0.2699	0.0306	0.6260	0.1517	0.5996	0.1541
Sampige	0.2704	0.0308	0.5743	0.1665	0.5977	0.1642
Siddagiri_2	0.2551	0.0266	0.7062	0.1458	0.6128	0.1378
Sita	0.2528	0.0316	0.5853	0.1770	0.5901	0.1533

The hue, saturation and intensity mean and standard deviation generated for pale green images which has three variety of paddy field images is as shown in the Table 3.

Table 3. Pale Green HSV Feature Average Values

HSV Pale Green	Hmean	Hstd	Smean	Sstd	Vmean	Vstd
Antarsali	0.1576	0.0379	0.4130	0.1329	0.6577	0.1647
MTD-1202	0.2134	0.0348	0.5161	0.1467	0.5853	0.1469
RSS-17	0.1963	0.0333	0.5626	0.1589	0.5779	0.1523
Doddiga	0.1059	0.0199	0.4894	0.1531	0.6468	0.1631

3.2.2. Gray Level Co-occurrence Matrix (GLCM): A co occurrence matrix, also called as co occurrence distribution is defined as an image which is distributed according to co occurring values at a given offset or it represents the angular spatial relationship and distance over an image sub region of some specific size. GLCM is created from gray scale image[8]. The GLCM depicts how often a pixel with gray level value i occurs either horizontally, vertically or diagonally to adjacent pixels with the value j, where i and j are the gray level values in the image. GLCM directions of analysis are horizontal (0^0), vertical (90^0) and diagonal, bottom left to top right (-45^0), and top left to bottom right (-135^0).

For all the varieties of paddy field images, out of all the 22 features of GLCM which were extracted like autocorrelation, entropy, homogeneity, energy etc [9]. Only five prominent texture features were utilized for the work. The extracted texture features were

autocorrelation, cluster prominence, sum of square of variance, sum of variance and sum of average. Each of them are given by the equations (3:7)

$$\text{Autocorrelation} = \sum_i \sum_j (ij).P(i,j) \quad (3)$$

$$\text{Cluster Prominence} = \sum_i \sum_j P(i,j).(i - \mu x + j - \mu y)^4 \quad (4)$$

$$\text{Sum of squares of variance} = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} (i - \mu)^2 .P(i,j) \quad (5)$$

$$\text{Sum of variance} = \sum_{i=1}^{2G} (1 - \mu)^2 . P(i,j) \quad (6)$$

$$\text{Sum of average (Mean)} = \sum_{k=2}^{2G} k \sum_{ij} P(i,j) \quad (7)$$

The texture features generated for light green images which have seven varieties of paddy field image are as shown in Table 4.

Table 4. Light Green GLCM Feature Average Values

GLCM Light Green	Autoc	Cprom	Sosvh	Svarh	Savgh
GGV-5-1	22.5862	84.9049	22.7863	55.1995	9.25070
IET-20472	20.6318	66.5046	20.9090	49.9513	8.86707
Irlon-130974	22.1515	85.2191	22.3081	53.6846	9.12454
Jaya	20.5704	55.3387	20.7810	50.1766	8.86955
Mahamaya	21.0441	69.3310	21.2618	51.3934	8.95223
Mugadsiri-1953	21.1353	45.4291	21.3267	52.3254	9.01610
Siddagiri-1	23.3644	65.1700	23.4010	59.4842	9.42922

The texture features generated for lush green images which have 11 varieties of paddy field image are as shown in Table 5

Table 5. Lush Green GLCM Feature Average Values

GLCM Lush Green	Autoc	Cprom	Sosvh	Svarh	Savgh
AM-3-5	20.8313	48.8945	20.9874	51.2825	8.92034
Asha	22.8049	50.4242	22.9562	57.4403	9.35738
IET-14238	20.9486	27.1423	20.9803	54.5443	9.01209
IET-19738	19.5580	82.1941	19.8483	45.9977	8.58120
Intan-D	21.1616	28.4059	21.1910	55.1213	9.05229
K-R-1	21.5430	24.8376	21.6309	55.6948	9.14536
K-R-2	21.4647	47.1413	21.6837	53.1926	9.08055
NagaBhatta	20.9272	47.5380	20.9737	52.1660	8.92750
Sampige	21.5001	66.8830	21.5895	52.9820	9.03767
Siddagiri_2	20.9938	28.3395	21.0227	54.0683	9.00589
Sita	21.3673	53.3371	21.4867	52.5989	9.03451

The texture features generated for pale green images which have three varieties of paddy field image are as shown in Table 6.

Table 6. Pale Green GLCM Feature Average Values

GLCM Pale Green	Autoc	Cprom	Sosvh	Svarh	Savgh
Antarsali	28.7784	68.8725	29.0245	75.2221	10.5400
MTD-1202	22.7812	50.2838	22.9396	57.3351	9.3589
RSS-17	22.3701	51.2526	22.5959	55.7038	9.2746
Doddiga	24.6018	70.6528	24.7758	61.7031	9.7032

3.2.3. Combined Features: Color and texture futures when considered alone the results were not satisfactory. When the experimentations were done using combinations of HSV and GLCM features the results were encouraging. A total of seven features are finally deployed in the present work. The combined features classification accuracy for the Light Green category which consists of seven different varieties of paddy field images is as shown in Table 7.

Table 7. Combined Feature Values for Light Green Variety of Images

Combined	Hmean	Hstd	Smean	Sstd	Vmean	Vstd	Autoc	Cprom	Sosvh	Svarh	Savgh
GGV-5-1	0.219	0.039	0.487	0.148	0.575	22.586	84.904	22.786	55.199	9.250	22.586
IET-20472	0.229	0.034	0.555	0.171	0.559	20.631	66.504	20.909	49.951	8.867	20.631
Irlon-130974	0.261	0.035	0.588	0.150	0.600	22.151	85.219	22.308	53.684	9.124	22.151
Jaya	0.261	0.033	0.481	0.139	0.561	20.570	55.338	20.781	50.176	8.869	20.570
Mahamaya	0.222	0.048	0.530	0.166	0.561	21.044	69.331	21.261	51.393	8.952	21.044
Mugadsiri-1953	0.243	0.038	0.479	0.135	0.566	21.135	45.429	21.326	52.325	9.016	21.135
Siddagiri-1	0.281	0.036	0.549	0.155	0.631	23.364	65.170	23.401	59.484	9.429	23.364

The combined features classification accuracy for the Lush Green category which consists of eleven different variety of paddy field images are as shown in Table 8.

Table 8. Combined Feature Values for Lush Green Variety of Images

Combined	Hmean	Hstd	Smean	Sstd	Vmean	Vstd	Autoc	Cprom	Sosvh	Svarh	Savgh
AM-3-5	0.258	0.031	0.660	0.146	0.597	0.163	20.831	48.895	20.987	51.283	8.920
Asha	0.262	0.038	0.580	0.140	0.621	0.163	22.805	50.424	22.956	57.440	9.357
IET-14238	0.277	0.035	0.609	0.146	0.609	0.119	20.949	27.142	20.980	54.544	9.012
IET-19738	0.239	0.034	0.560	0.171	0.538	0.176	19.558	82.194	19.848	45.998	8.581
Intan-D	0.268	0.031	0.585	0.161	0.601	0.127	21.162	28.406	21.191	55.121	9.052
K-R-1	0.233	0.033	0.566	0.149	0.586	0.125	21.543	24.838	21.631	55.695	9.145
K-R-2	0.220	0.035	0.565	0.169	0.575	0.159	21.465	47.141	21.684	53.193	9.081
NagaBhatta	0.270	0.031	0.626	0.152	0.600	0.154	20.927	47.538	20.974	52.166	8.928
Sampige	0.270	0.031	0.574	0.167	0.598	0.164	21.500	66.883	21.590	52.982	9.038
Siddagiri_2	0.255	0.027	0.706	0.146	0.613	0.138	20.994	28.340	21.023	54.068	9.006
Sita	0.253	0.032	0.585	0.177	0.590	0.153	21.367	53.337	21.487	52.599	9.035

The combined features classification accuracy for the Pale Green category which consists of three different variety of paddy field images is as shown in Table 9.

Table 9. Combined Feature Values for Pale Green Variety of Images

Combined	Hmean	Hstd	Smean	Sstd	Vmean	Vstd	Autoc	Cprom	Sosvh	Svarh	Savgh
Antarsali	0.157	0.037	0.413	0.132	0.657	0.164	28.778	68.872	29.024	75.222	10.540
MTD-1202	0.213	0.034	0.516	0.146	0.585	0.146	22.781	50.283	22.939	57.335	9.358
RSS-17	0.196	0.033	0.562	0.158	0.577	0.152	22.370	51.252	22.595	55.703	9.274
Doddiga	0.105	0.019	0.489	0.153	0.646	0.163	24.601	70.652	24.775	61.703	9.703

3.3. Identification of Paddy Variety

Artificial Neural Network is used as a classifier based on the computational simplicity. Feed forward multilayer network is used for the proposed work and back propagation algorithm is used for training the classifier. The development of the back propagation learning algorithm is useful in determining weights in a multilayer perceptron. Recognition is attempted in 3 stages firstly, only with the color features; secondly, with the texture features and lastly with combination of both color and texture features. In case of Lush Green category input layer has seven nodes and output layer has eleven nodes. In case of Light Green category input layer has seven nodes and output layer has seven nodes. In case of pale Green category input layer has seven nodes and output layer has three nodes. The hidden layer is one. The termination error is set to 0.001.

4. Results and Discussion

We have used a total of 220 images. The reduced set of color and texture features is listed. Reduced HSV features = {Mean, Standard Deviation}

Reduced GLCM features = {Autocorrelation, Cluster Prominence, Sum of square of variance, Sum of variance and Sum of average}

Light green class has 70 images out of seven varieties. The average classification accuracy for HSV and GLCM features for light green category is given in Figure 6. Compared to texture features color features had an enhanced performance.

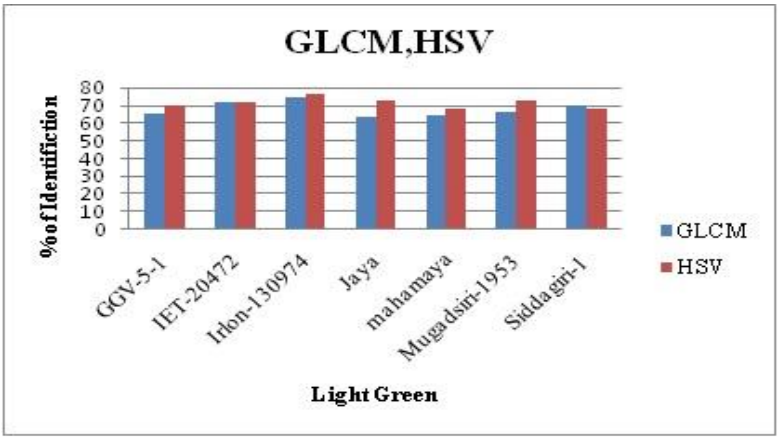

Figure 6. Texture and Color Features for Light Green Class

Lush green class has 110 images out of 11 varieties. The average classification accuracy for HSV and GLCM features for lush green category is given in Fig.7. Compared to texture features color features were more satisfactory.

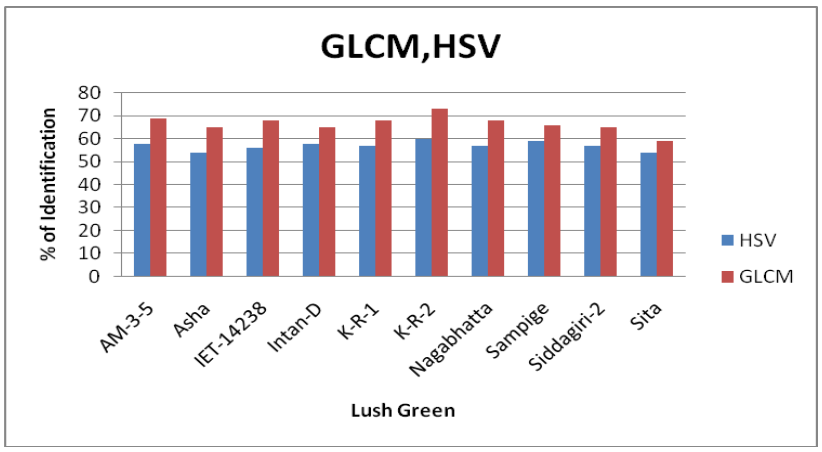

Fig.7 Texture and color features for lush green class

Pale green class has 40 images out of four varieties. The average classification accuracy for HSV and GLCM features for pale green category is given in Fig.8. Both texture features color features were almost equal in identification rate.

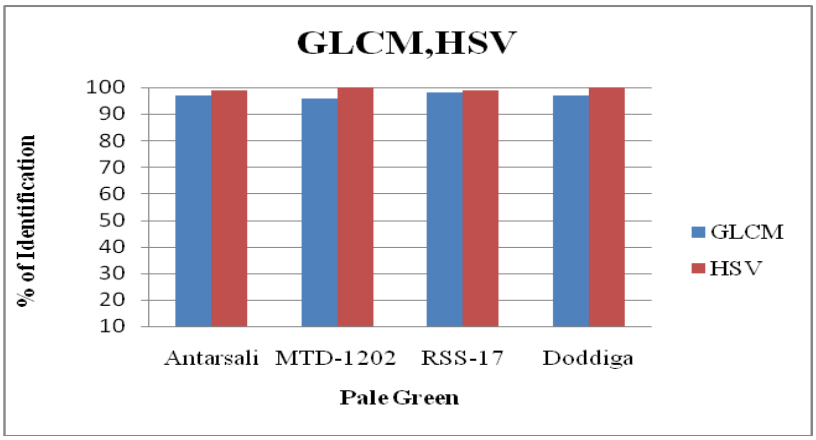

Figure 8. Texture and Color Features for Pale Green Class

Color and texture features (HSV and GLCM) combination has resulted in increased classification accuracy of 85.7% for light green class, 83.1% for lush green class and 100% for pale green class as shown in Fig 9, Fig 10 and Fig 11 respectively. All the varieties in the light green class were found to be accurate in identification of paddy field images with more accuracy in Irlon-130974 variety and less in Mahamaya.

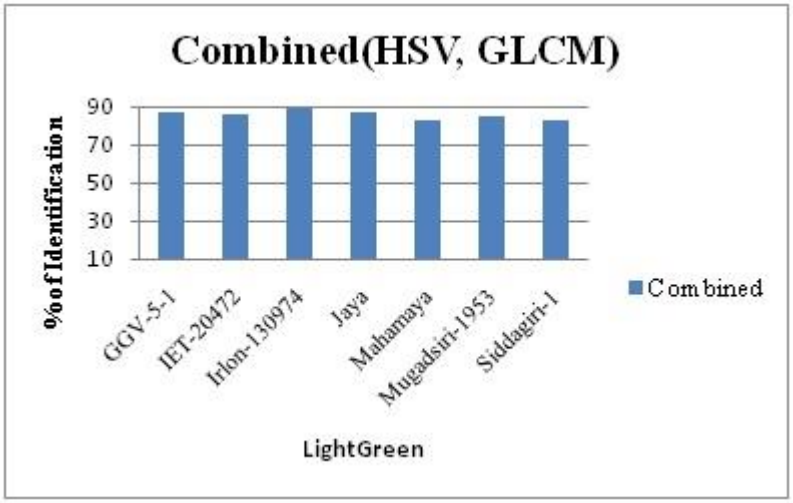

Figure 9. Combined Texture and Color Features for Light Green Class

All the varieties in the lush green class were found to be accurate in identification of paddy field images with more accuracy in K-R-2 and Intan-D variety and less in K-R-1.

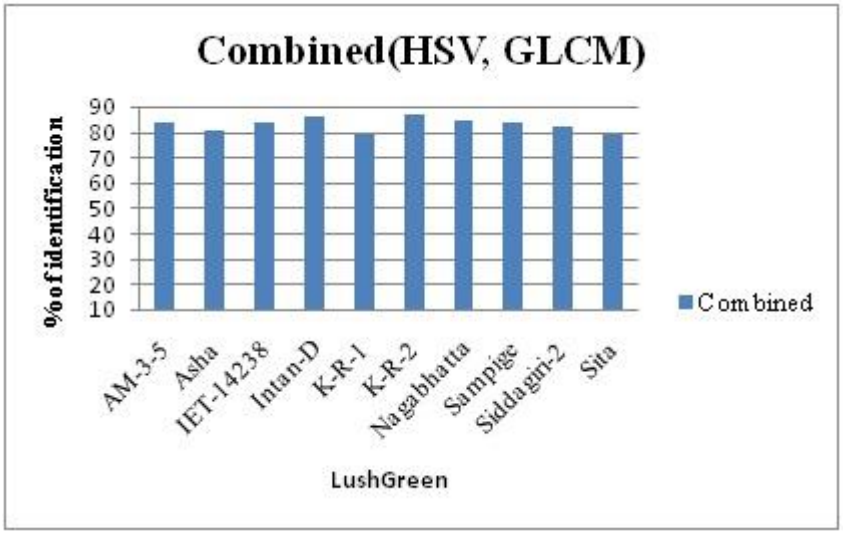

Figure 10. Combined Texture and Color Features for Lush Green Class

All the varieties in the pale green class were found to be accurate in identification of paddy field images.

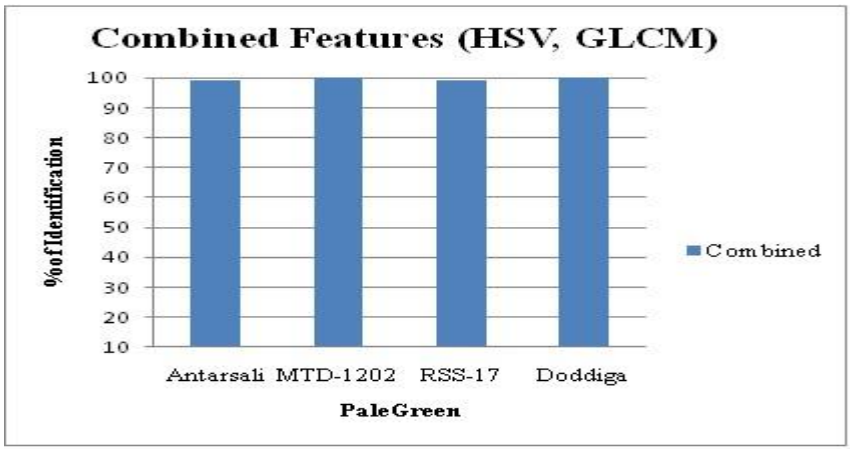

Figure 11. Combined Texture and Color Features for Pale Green Class

5. Conclusion

The classification of 22 varieties of paddy crop images is carried out with combined color and texture features. Individual features, namely, color feature has given a maximum of 76% a minimum of 59% the combination of features has given good results. We have obtained an average accuracy of 85.7% for light green, 83.1% for lush green and 100% for pale green calss. The work finds it application in identifying variety of agriculturl crops.

References

[1] X. Liang, L. Li, G. Cheng and L. Gao, "Underdeveloped village extraction from high spatial resolution optical image based on GLCM textures and fuzzy classification", IEEE, 978-1-4799-4184-1/14, (**2014**).
[2] M. K. Moghimi and H. Pourghassem, "Shadow detection based on combination of color space and orthogonal transformation in surveillance videos", IEEE, 978-1-4799-3351-8/14, (**2014**).
[3] D. P. Tian, "A review on image feature extraction and representation techniques", International journal of multimedia and ubiquitous engineering, vol. 8, no. 4, (**2013**) July, pp. 385-396.
[4] V. Metre and J. Ghorpade, "An Overview of the Research on Texture Based Plant Leaf Classification", IJCSN International Journal of Computer Science and Network, vol. 2, no. 3, (**2013**).
[5] P. Mohanaiah, P. Sathyanarayana and L. Gurukumar, "International journal of scientific and research publication", vol. 3, no. 5, (**2013**) May.
[6] Q. Liu and X. Liu, "Feature extraction of human viruses microscopic images using gray level co-occurrence matrix", IEEE transaction: International conference on computer sciences and applications, 978-0-7695-5125-8/13, (**2013)**.
[7] M. Swain, S. K. Dash, S. Dash and A. Mohapatra, "An approach for IRIS plant classification using neural network", International journal of soft computing, vol. 3, no. 1, (**2012**) February.
[8] A. Kadir, L. E. Nugroho, A. Susanto, P. I. Santosa, "Leaf classification using shape, color and texture features", International journal of computer trends and technology, (**2011)** August.
[9] A. Ehsanirad and S. kumar, "Leaf recognition for plant classification using GLCM and PCA methods", Oriental journal of computer science and technology, vol. 391, (**2010**), pp. 31-36.
[10] H B Kekre, D. Sudeep, T. K. Sarode and V. Suryawanshi, "Image retrieval using texture feature extracted from GLCM, LBG and KPE", International journal of computer theory and engineering, vol., no. 5, 1793-8201, (2013**)** October.
[11] Fan-Hui-kong, "Image retrieval using both color and texture features", IEEE 978-1-4244-3703-0/09, (**2009**).
[12] C. L. Lee and S. Y. Chen, "Classification of leaf images", International journal of imaging systems and technology, vol. 16, no. 1, (**2006**) July.
[13] A. Vadivel, S. Sural and A. K. Majumdar, "Color-texture feature extraction using soft decision from the HSV color space", Proceeding of international symposium of intelligent multimedia, video and speech processing, (**2004**) October 22.
[14] S. Sural, G. Quin and S. Pramanik, "Segmentation and histogram generation using HSV color space for image retrieval", IEEE, 1222-4880, 11-589-11-592 vol. 2, (**2002**).

