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ANALYSIS OF PADDY SEED CLASSIFICATION BASED ON DEEP LEARNING METHODS AND MACHINE LEARNING TECHNIQUES

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Abstract

Most of the peoples in the world paddy is one of the cereal crop and staple food. During the cultivating information about the grain types, grain quality is wanted at each stage in hand before the start of the next process. Information which get in this way is subjective and so is not reliable, measurement of some characters as color, texture or some of morphological features are simple. The digital picture processing techniques extended its supporting hand in categorizing the seeds, recognize the right seed for cultivation and maximize the crop production. Since, digital image analysis is the method to solve the problem. Correct choice of paddy variety for cultivation, categorizing the paddy seeds and to give better proposal for the farmers to motive of this research analysed the deep learning methods and Machine learning techniques of paddy seed classification.

Keywords: Datamining Techniques, Deep learning Techniques, Machine Learning, Paddy Seed

I.INTRODUCTION

Paddy is quintessential in India. Therefore, they cultivate it more than other crops all over India. A lot of distinct varieties of paddy-seeds are found here. They are identifiable by their

differences in shapes, sizes, textures and so on, in a manual manner, which makes it seem like a dull quest. Therefore, a duly skilled or experienced person is needed for such a quest involving lots of time, money and efforts. The agency's significant quests include controlling of the rice's standard. Contaminations cause much issues like variety-impurity, rice-mutation and crossbreeding, likely leading to below-standard produce. Traditionally, rice-experts have been examining if the seed-breeding process is contaminated. Paddy-seeds are a tad bit tiny, making them hard to be classified at times, as it gets hard to notice the distinctions in their various kinds. Duly skilled people utilise their skillset in considering morphological-structures, shapes, textures, and colors of the many a part of such seeds for making decisions. After examining, these people distinguish a particular kind of rice-seeds as belonging to a particular region. First, seed-samples, that should be a distinct kind, are placed on a surface and examined using a huge magnifying-glass, a light, and tongs. After that, the seed(s) of physically unalike traits, the contaminating ones, are found and separated from the rest of the kinds. Within humanly limits, many a seed-inspector takes a while in accomplishing it, as the human-eye finds it hard to identify tiny distinctions in certain seeds out of a wide array of seed-samples.

During these last ten years, computer-vision has become a highly utilised technology in many areas. Many techniques in the area of computer-vision were altered from techniques regarding statistics to deep-learning techniques, as quests like object-detection and image-recognition are rendered more accurately this way. Computer-vision could aid computer-scientists in developing quests in many areas quickly. Computer-vision is able to pick up on traits, contained in the database provided, in an automated manner, when conventional machine-learning techniques require feature-engineering one-by-one. Computer-vision is able to deal with the prospects of almost alike information varying and deviating. But, deep-learning is complex, thanks to its huge network-structure, requirement of a great deal of training-data, time-consumption, and high-performance-computing-resources. Here, we are experimenting with the techniques of categorisation utilised by rice-cultivators and comparing the efficiency of those categorisation techniques between conventional machine-vision techniques and deep-learning techniques.

II. STRUCTURE OF PADDY

Every paddy seed encloses a rice kernel. A paddy has multiple layers. The last or outer-most layer is the **husk**. The husk has two partition which is inter-connected.

The other layers or parts of the paddy are the **hull**, which is also an outer layer it serves to protect the seed, and the **rice caryopsis** [14]. The paddy is rich with the following nutrients: **carbohydrates, proteins and small quantities of fat, ash, fibre and moisture**.

The bran and germ is enclosed with the vitamins and minerals [15].

The most consumed variety of rice, the polished white rice, is the most processed or re-fined raw-rice. During the processing, the important parts of the rice are eliminated or polished. Those important parts are the bran and the germ. They are named the important parts as they encloses a significant amount of **fibre** and other nutrients. Addition to this, the processing may also eliminate the aleurone layer, which encloses **vitamin, proteins, minerals and essential fats.**

As the polished white rice has the limitations, coloured rice are preferred. These coloured rice includes brown rice, red rice etc. They have similar harvesting process of white rice. They normally come de-hulled or half-hulled with a whole or complete bran and germ. While the brown rice is popular across the world, the red rice is known only to the north-east and south India, Bhutan, Himalayas, Southern Tibet. Regardless of the elimination of the outer-most layer, husk, the brown rice has various layers: the pericarp, seed-coat and nucellus; the germ or embryo; and the endosperm. The endosperm encloses aleurone layer, the subaleurone layer and the starchy or inner endosperm (Fig. 1).

The aleurone layer consists of the embryo while the pericarp layer contains the pigments [15]. The outer layers hull or husk contains twenty percentile of the rough rice weight, which varies from sixteen to twenty eight percentile. The aleurone layer typically encloses 1 to 5 cell-layers. It is usually thicker at the dorsal-side and short grain, and thinner at the ventral-side and long grain [12]. As for the aleurone and embryo cells, they consist a good amount of protein and lipid bodies [11]. The nutrients ant the ratio of nutrients varies layer to layer. Layers like Bryan are rich in nutrients while layers like aleurone are not comparatively. The last layer, endosperm consists of carbohydrate, protein, amino acids [13].

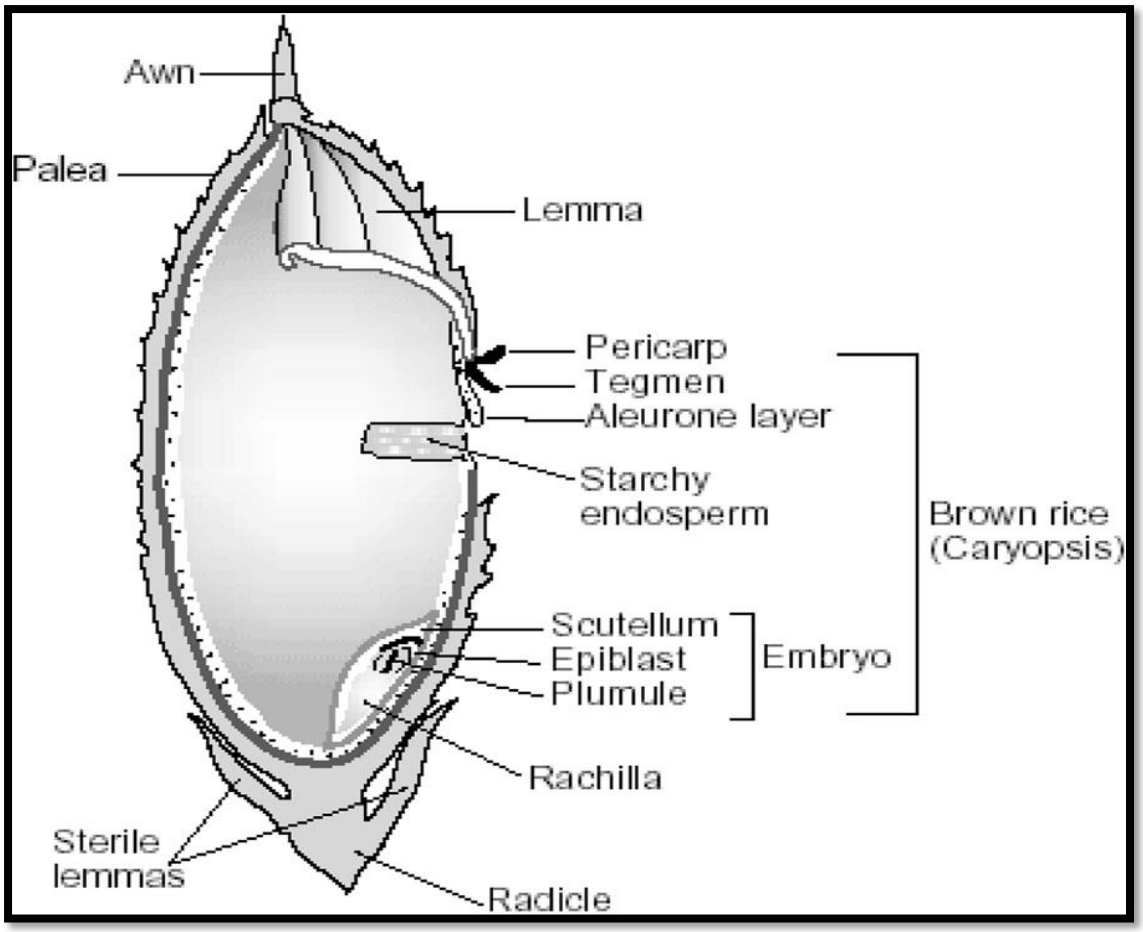

Figure 1 Structure of Paddy Seed

III EXISTING WORK

Ansari-et.al(2021)[3]Seed-varietal-purity is essential to create a uniformity in the plants produced. The impurity of seeds can lead to the production of a crop-group that is not healthy, which in turn, gives way to a laborious process of crop-cultivation. Here, a quick examination technique was set up for classifying paddy-seeds on the basis of varietal-purity by utilising a machine-vision method comprising of multivariate-analysis techniques. They chose 3 kinds of paddy-seeds - BR-11, BRRI-dhan-28 and BRRI-dhan-29.

A single paddy-seed picture was taken by utilising RGB-camera with white-LED light inside the lab. An image-processing code was created to extract twenty significant traits (7 traits relating to colouring, 9 traits relating to morphology, and 4 traits relating to texture) by way of three hundred and seventy five paddy-seed pictures. In the following stage, the important distinctions in the information relating to the traits observed in the categories of paddy-seeds was scrutinized by utilising variance-analysis. And, the principal-component-analysis was executed to analyse the distinguishability of paddy-seed categories.

In accordance, the paddy-seed-variety-classification frameworks were created to combine paddy categories and chosen information on traits by utilising partial-least-squares-discriminant-analysis, Support-vector-machine-classification and K-Nearest-Neighbors codes. While developing the framework, they saw that the traits of the picture relating to the morphology of paddy-seeds were the most important. Chosen traits relating to colouring for the partial-least-squares-discriminant-analysis code, those relating to morphology for the support-vector-machine-classification code and those relating to texture for the K-Nearest-Neighbors code were utilised to get eighty three point eight, ninety three point nine, and eighty seven point two percentiles of accurate information. Lastly, it was declared that the support-vector-machine-classification code with chosen traits relating to colouring, morphology, and textures can be utilised to categorise the paddy-seed categories.

Panmuang-et.al(2021)[4] The experimentation employed the Deep-Convolutional-Neural-Networks and utilised the VGG-16 framework to distinguish rice categories via pictures. The rice categories chosen in the investigation encompass 5 categories: KorKhor-23, Suphanburi-1, Pathum-Thani-1, Chainat-1, and Hom-Mali-Rice-105, with a total of thousand and five hundred pictures. The end-results of the investigations and model-testing revealed that they could train the pictures of rice-seeds and obtain eighty five percentage accurate information, the reliability of which is high. So, the framework was utilised to create a web-site that people can access through web-browsers and mobile-apps in which cultivators or others in association could send rice-seed pictures to the network for it to assess which category of rice it is and in accordance with an assessment of this network, it came to be known that the network could make a precise fore-cast of rice categories.

Kiratiratanapruk et. al(2020)[5] focused on using machine-vision-technology that helps in classifying fourteen Oryza-sativa-rice varieties. The cultivar made use of three thousand five hundred to fifty thousand seeds which was put under 3 major processes. They are pre-processing, feature-extraction, and rice-variety-classification. Process one was carried out with the help of seed-orientation-method which helped to arrange the seeds similarly. After this, quality-screening-method was used to eliminate the seeds with ineligible physical-features. This elimination was based on the physical eligibility such as shape, color, and texture. Statistical-machine-learning-techniques like LR, LDA, k-NN, SVM and deep-learning-techniques like VGG16, VGG19, Xception, InceptionV3, and InceptionResNetV2 were used to classify. For keen observation, the rice data-sets were divided into sub-groups and collective-groups. The results of the observation shows that: Under SVM-method, sub-group shows

ninety point sixty one percent accuracy while sub-group two shows eighty two point of seventy one percent and collective-group shows eighty three point nine percent. But compared to SVM-method, the deep-learning-techniques shows better accuracy rate which was ninety five point fifteen from Inception-Res-Net-V2-models.

Maheswari, S., & Devi, M. R. (2019). [6] focused on establishing accuracy and efficiency in the classifying process, feature-extraction algorithm for paddy-seed-image-analysis. After being pre-processed using hybrid median-gaus-transform algorithms, the paddy images are classified using Paddy-seg-match algorithm. The selection process of the processed image's features are done with the help of rapid-SURF-feature-extraction algorithm. Then, the seeds are categorised by using the proposed Random-Assessment-Classification-algorithm. The results of the experiments conducted to test the accuracy shows that the proposed method is more accurate and efficient than some of the standard algorithms such as SVM and KNN.

Sethy, P. K., & Chatterjee, A. (2018). [8] identified the six varieties of rice namely, Asan Chudi, Bada Kadalia, Babulal, Chit Pagalia, Radha Jugala and Sahabhagi. These varieties can be found in the western part of odisha where they are cultivated. To be precise, it is the district of Bargarh, which is known for its variety, quality, quantity of rice. The research used geometrical and texture-feature with multi-class SVM to achieve the classification of the six varieties of rice grains. It also focuses on the performance-analysis. While the texture can be similar, the geometrical feature is unique. The method in talk has attained the accuracy rate of ninety two percentile based on the geometical and texture feature.

Huang, K. Y., & Chien, M. C. (2017) [9] classified the six varieties of rice namely, Taikong 9, Tainan 11, and Taikong 14 of foundation-paddy-seeds. The purity inspectors are unable to differentiate between the seeds mentioned during the purity-inspections. To overcome this difficulty, the proposed method utilizes image-segmentation and a key-point-identification algorithm which is used to classify and select seed-features. A back-propagation-neural-network was helpful in setting up the classifier that classifies the seed according to the seven-features. The classifier showed the accuracy rate of ninety two point sixty eight percentile for Taikong 9, ninety seven point thirty five percentile for Tainan 11, ninety six point fifty seven percentile for Taikong 14. The method was successful as it could differentiate among the three seeds methodically.

Chaugule, A. A., & Mali, S. N. (2016)[10] The primary aim of their research was to define a new method for extraction for the classification of the paddy seeds by the usage of feature-extraction-algorithm to get the expected results that is horizontal-vertical and front-rear angles. This method has used different combinations of angle features to classify the seeds. After the classification, they are put to comparison of shape, size, colour and texture. The results produced by the experiments conducted states that the features are efficient than other existing features in discriminating property for seeds. The said discriminating power of these features was tested with the help of the neural-network-architectures to identify the seeds among the four-Paddy grains they are, Karjat-6(K6), Karjat-2(K2), Ratnagiri-4(R4) and Ratnagiri-24(R24). The results of the experiments conducted to check the accuracy states that the proposed-method has got the highest accuracy level which is ninety seven point six percentile while the colour shape texture method showed ninety five point two percentile.

IV. ANALYSIS OF MACHINE LEARNING AND DEEP LEARNING METHODS

Author & Year	Methods	Contribution	Accuracy
Díaz-Martínez et.al (2023) [1]	3D CNN	Classification of six varieties of paddy using Hyperspectral images	Accuracy-91% Precision-0.564 Recall-0.634 F1-Score-0.525
Poudel, A., & Devkota, B. (2022) [2]	Hybrid CNN-SVM	Prediction of 3 New varieties of paddy such as chhomorong, Macchpucha, Lumeli	Accuracy-91% Precision-0.645 Recall-0.675 F1-Score-0.543
Ansari-et.al (2021) [3]	Hybrid method SVM and KNN	Prediction of paddy seed varieties such as BR-11, BRRI-dhan-28 and BRRI-dhan-29	Accuracy-83.34% Precision-0.546 Recall-0.623 F1-Score-0.562
Panmuang et.al(2021)[4]	Deep Convolution Neural Network(DCNN)	Classification of KorKhor-23, Suphanburi-1, Pathum-Thani-1, Chainat-1, and Hom-Mali-Rice-105	Accuracy-85.34% Precision-0.582 Recall-0.634 F1-Score-0.578
Kiratiratanapruk et. al(2020)[5]	Res-Net-V2-models.	Classified 14 Oryza-sativa-rice varieties	Accuracy-95.15% Precision- 0.845 Recall-0.923 F1-Score-0.924
Maheswari, S., & Devi, M. R. (2019)[6]	Random-Assessment-Classification-algorithm	Classified 32 IR20 paddy seed varieties	Accuracy-90.25% Precision-0.734 Recall-0.836 F1-Score-0.878
Ibrahim et.al(2019)[7]	Multi-class Support Vector Machine (SVM)	Classification of three varieties of basmathi, ponni and brown rice.	Accuracy-92.22% Precision- 0.897 Recall-0.856

			F1-Score-0.867
Sethy, P. K., & Chatterjee, A. (2018)[8]	Modified Texture features with Multi-class SVM Modified (MT-SVM)	six varieties of rice namely, Asan Chudi, Bada Kadalia, Babulal, Chit Pagalia, Radha Jugala and Sahabhagi	Accuracy-92% Precision-0.789 Recall-0.757 F1-Score-0.795
Huang, K. Y., & Chien, M. C. (2017) [9]	back-propagation-neural-network	Classified 6 varieties of paddy Taikong 9, Tainan 11, and Taikong 14	Accuracy-92.65% Precision-0.784 Recall-0.867 F1-Score-0.886
Chaugule & Mali, S. N. (2016)[10]	neural-network-architectures(ANN)	Classification of 4 varieties of paddy Karjat-6(K6), Karjat-2(K2), Ratnagiri-4(R4) and Ratnagiri-24(R24).	Accuracy-97% Precision-1.234 Recall-1.342 F1-Score-1.423

V.PERFORMANCE METRICS

The existing methods are evaluated by using following metrics such as precision, Recall, F1 score and Accuracy.

True Positives (TP) - These are the correctly predicted positive values which mean that the value of the actual class is yes and the value of the predicted class is also yes

True Negatives (TN) - These are the correctly predicted negative values which means that the value of the actual class is no and value of the predicted class is also no.

False positives and false negatives, these values occur when the actual class contradicts with the predicted class.

False Positives (FP) – When actual class is no and predicted class is yes.
False Negatives (FN) – When actual class is yes, but predicted class is no.

Based on these four parameters, Accuracy, Precision, Recall and F1 score values are calculated

i. Precision

Precision is the ratio of correctly predicted positive observations of the total predicted positive observations.

Precision = TP/TP+FP

ii. Recall

The recall is the ratio of correctly predicted positive observations to all observations in actual class is yes.

Recall = TP/TP+FN

iii.F1-Score

F1 score is the weighted average of Precision and Recall. Therefore, this score takes both false positives and false negatives into account.

F1 Score = 2*(Recall * Precision) / (Recall + Precision)

iv. Accuracy

Accuracy is the most intuitive performance measure, and it is simply a ratio of correctly predicted observation to the total observations.

Accuracy = TP+TN/TP+FP+FN+TN

VI.RESULT AND DISCUSSION

The performance of the existing algorithm evaluated based on the five performance metrics such as precision ,Recall, F1 score and accuracy. Figure 2 shows the comparison of precision values of existing deep learning and machine learning algorithms such as 3D CNN, Hybrid CNN-SVM, Hybrid SVM &KNN DCNN,ResNet-V2,Random Assessment, MSVM, MT-SVM,BP-NN and ANN. The precision values of ANN is 1.234. It gave highest values than all other algorithms.

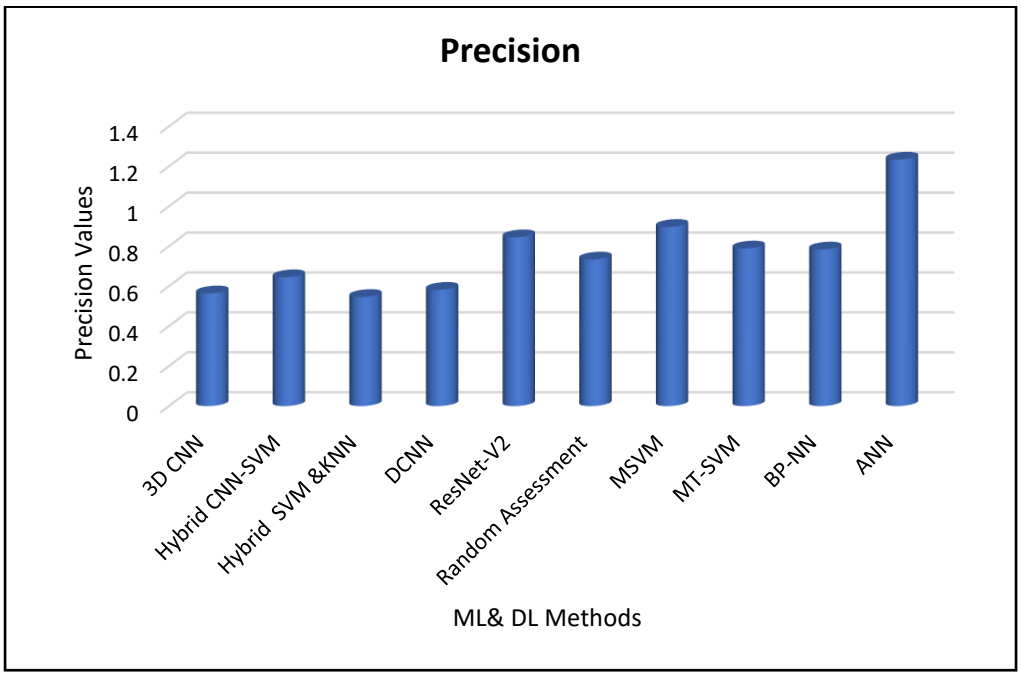

Figure 2. Comparison of Precision values

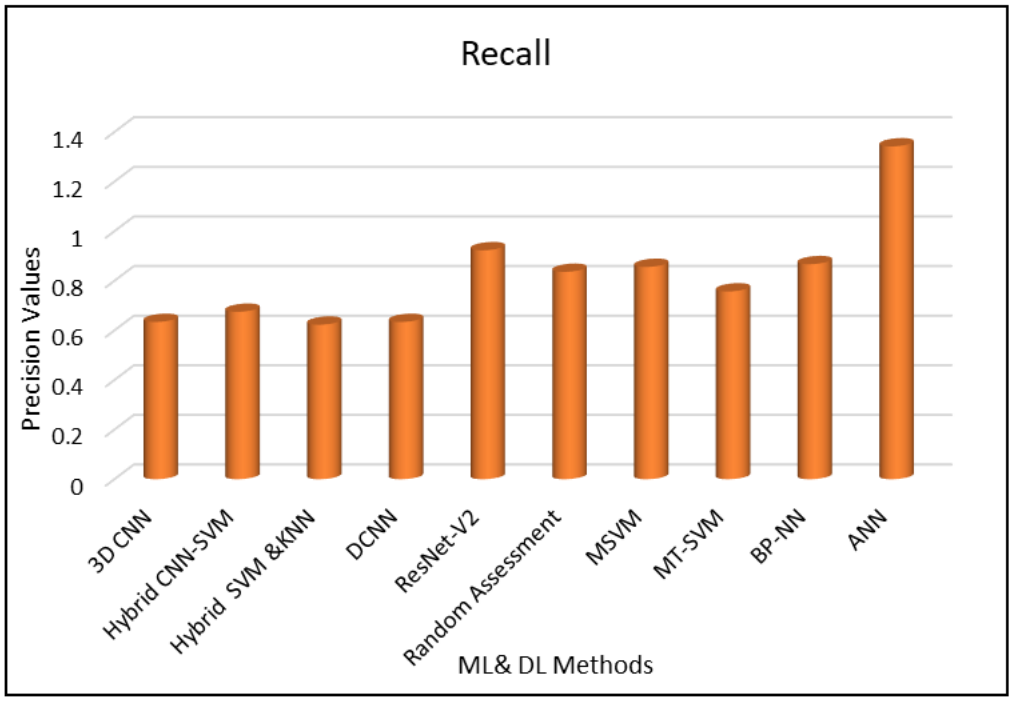

Figure 3. Comparison of Recall values

Figure 3 shows the comparison of recall values of existing deep learning and machine learning algorithms such as 3D CNN, Hybrid CNN-SVM, Hybrid SVM &KNN DCNN,ResNet-V2,Random Assessment, MSVM, MT-SVM,BP-NN and ANN. The recall value of ANN is 1.342. It gave highest values than all other algorithms. Hybrid SVM &KNN and DCNN obtained the lowest value than all other algorithms. ResNet-V2 scored the next highest value 0.923.

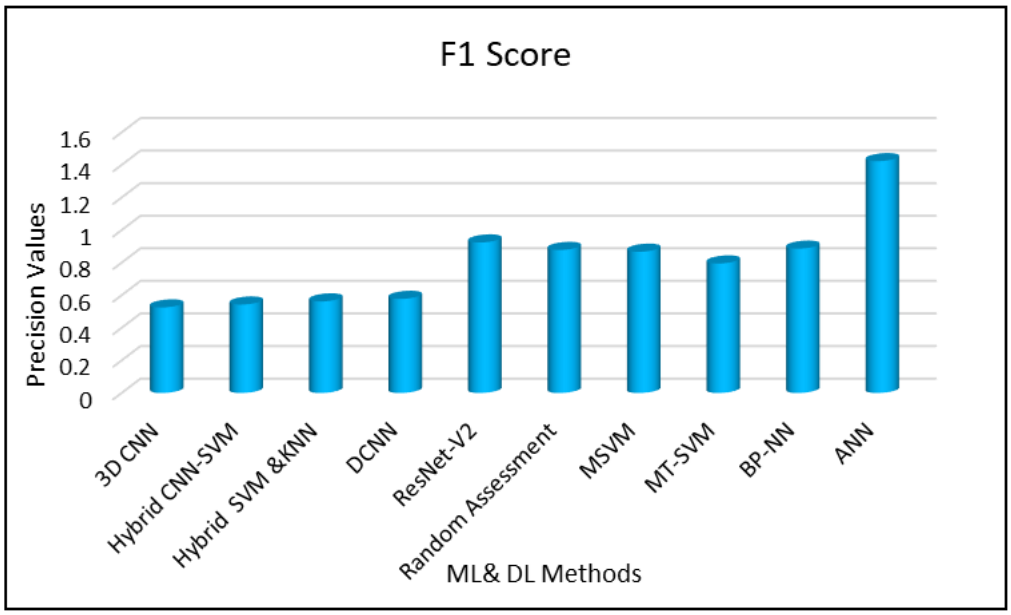

Figure 4. Comparison of F1 Score values

Figure 4 shows the comparison of F1 Scores values of existing deep learning and machine learning algorithms such as 3D CNN, Hybrid CNN-SVM, Hybrid SVM &KNN DCNN,ResNet-V2,Random Assessment, MSVM, MT-SVM,BP-NN and ANN. The F1-score value of ANN is 1.423. It obtained highest values than all other algorithms. 3D CNN, Hybrid CNN-SVM, Hybrid SVM &KNN and DCNN obtained the lowest value than all other algorithms. ResNet-V2 scored the next highest value 0.924.

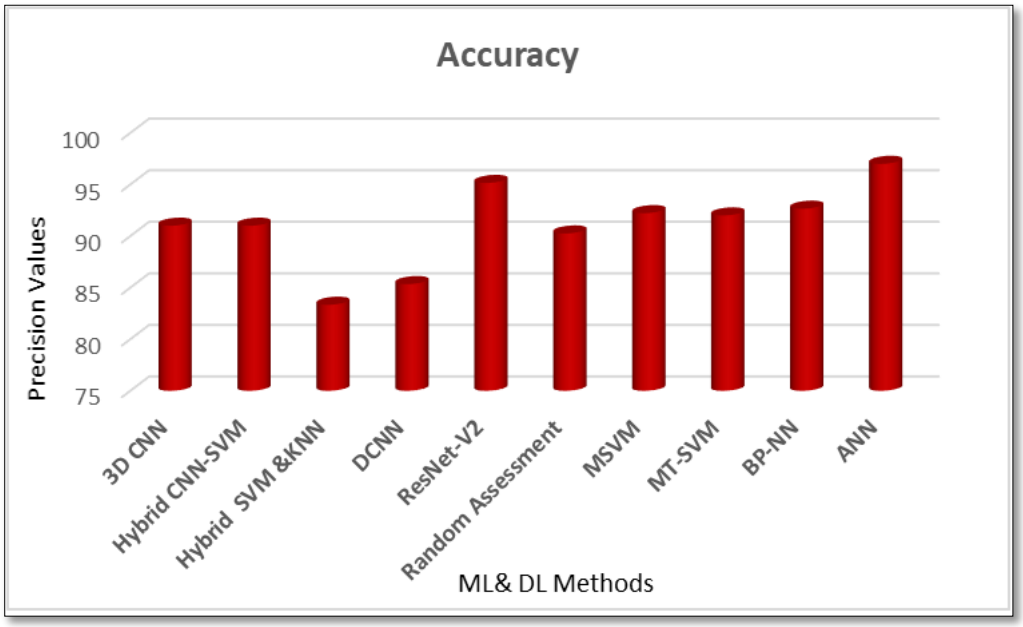

Figure 5. Comparison of Accuracy

Finally, accuracy of all existing algorithm compared with each other. The accuracy of ANN is highest than all other existing methods. Next ResNet-V2 scored 95.15% of accuracy. The accuracy of Hybrid SVM&KNN very low when compared with all methods. Figure 5 shows the comparison of accuracy.

VII Conclusion

In this research paper tried to identify the alternate and best method to classification of paddy seed. Seed quality is important to improve the crop yield percentage for the former. The Machine vision system will help to improve the accuracy of classification. This research studied and analysed widely used paddy seed classification techniques based on deep learning and machine learning to predict the best method. This research studied the following methods such as 3D CNN, Hybrid CNN-SVM, Hybrid SVM &KNN DCNN,ResNet-V2,Random Assessment, MSVM, MT-SVM,BP-NN and ANN. When compared with all other method the prediction accuracy of ANN is high. But it focused only 4 varieties of paddy. In future we can classify 32 varieties of paddy of IR20.

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