Artificial Vision System for Meat Quality Gradation

B. Tech Major Project Report

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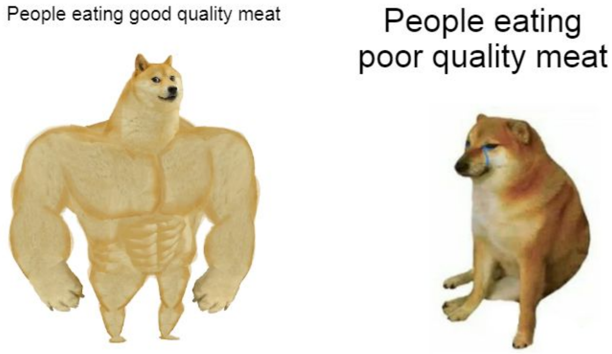
Problem statement

- A rapid system for meat quality assessment is needed to guarantee the quality of meat.
- We plan to solve this problem by developing a mobile application to help users determine meat freshness in real-time.



Importance of work

- In today's world, food spoilage is a crucial problem as consuming spoiled food is harmful for consumers.
- Meat is a kind of perishable food that easily decays.
- As the number of meat consumers increases in the meat industry, the demand for meat supplies also rises. Determining meat freshness, therefore, is the primary consideration of the meat customers.
- Due to covid, many people are ordering food items online. This has increased the necessity for real-time meat quality assessment through images.
- It will be helpful for customers who don’t know how to check meat quality by seeing or touching it.

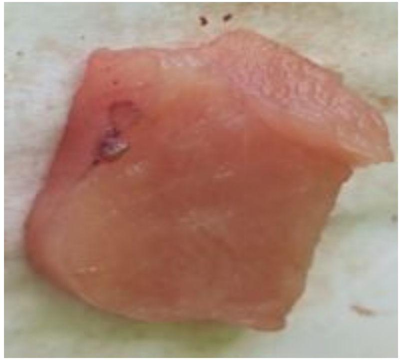
Dataset Preparation

1. Chicken

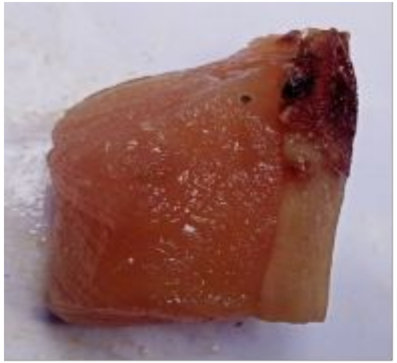
a. Breast meat portion was used as a sample for the dataset. The chicken breast was cut to various lengths and widths but with almost uniform thickness

b. The chicken meat images were captured starting from day 1 and at every 2 days' interval till 13th day. Chicken was stored in a freezer in the intermediate days with a temperature of 0 degree Celsius.

c. Meat images classified as consumable were taken till 5-6 days from day one of death, and meat classified as non-consumable were taken from 5-6 days of death till the 13th day.



Consumable



Non-Consumable

Dataset Size -
1) Consumable - 188
2) Non Consumable - 122

Dataset Preparation

2. Fish

a. The live Fish (Pabda) were sampled live from market.
b. The fish images were captured starting from day one of death and at every two days' interval till the 10th day. Fish was stored in a freezer in the intermediate days with a temperature of 0 degree Celsius.
c. Fish images classified as consumable were taken till 4-5 days from day one of death, and fish classified as non-consumable were taken from 5-6 days of death till the 10th day.

Consumable

Non-Consumable

Dataset Size -
1) Consumable - 60
2) Non Consumable - 80

Dataset Preparation

3. Prawn

a. Fresh white-leg prawn were sampled live from market.
b. The prawn images were captured starting from day one of purchase and at every one day interval till 7th day. It was stored in a freezer in the intermediate days with a temperature of 0 degree Celsius.
c. Images classified as consumable were taken till 3-4 days from the day one of death, and images classified as non-consumable were taken from 3-4 days of death till the 7th day.

Consumable

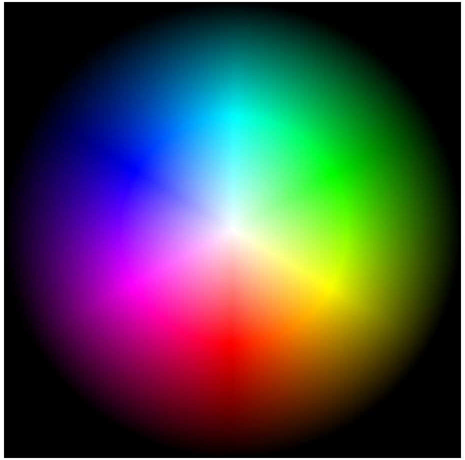
Non-Consumable

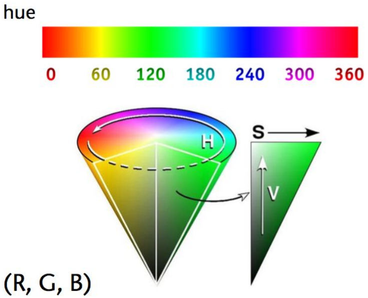
Dataset Size -
1) Consumable - 52
2) Non Consumable - 70

Methodology

1. Color Spaces

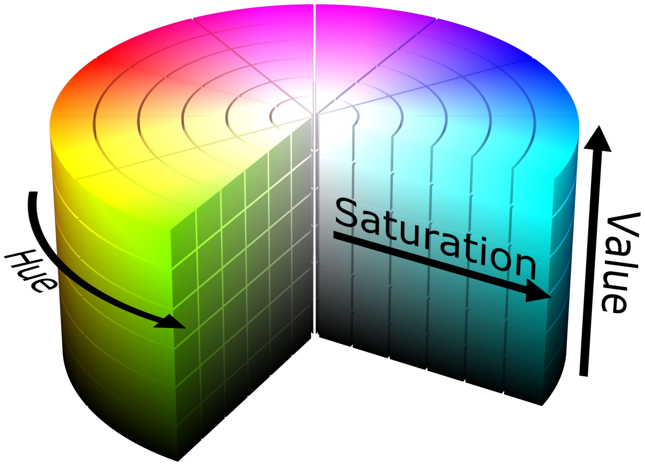
- RGB (Red, Green, Blue)
- HSV (Hue, Saturation, Value)





- colour cone
  - H = hue / colour in degrees $\in [0,360]$
  - S = saturation $\in [0,1]$
  - V = value $\in [0,1]$
- conversion RGB → HSV
  - V = max = max (R, G, B), min = min (R, G, B)
  - S = (max – min) / max (or S = 0, if V = 0)
  - $$H = 60 \times \begin{cases} 0 + (G - B) / (max - min), & \text{if } max = R \\ 2 + (B - R) / (max - min), & \text{if } max = G \\ 4 + (R - G) / (max - min), & \text{if } max = B \end{cases}$$

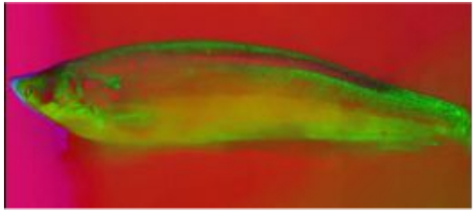
  H = H + 360, if H < 0



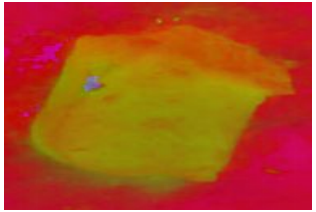
Methodology

1. Color Spaces

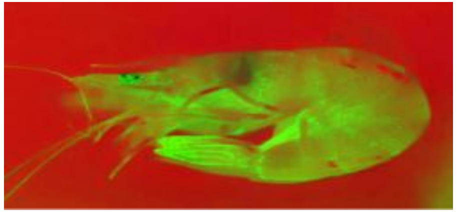
- The use of HSV rather than RGB space is beneficial in texture analysis. Paschos [7] demonstrates that perceptually uniform spaces, such as HSV, outperform non-uniform RGB.



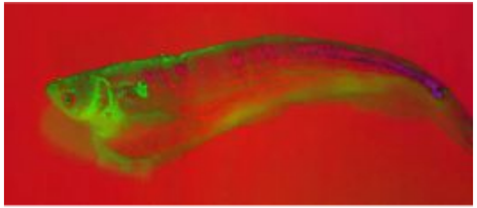
Consumable (HSV)



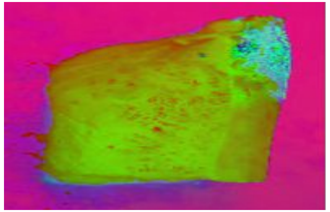
Consumable (HSV)



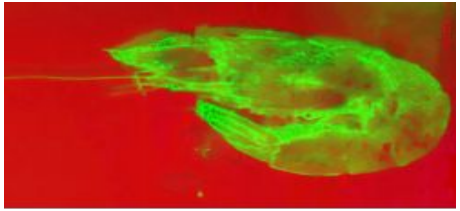
Consumable (HSV)



Non - Consumable (HSV)



Non - Consumable (HSV)



Non - Consumable (HSV)

Methodology

2. Machine Learning Methods

a. Naive Bayes

When we pass the dataset in the model we can see that Chicken and Prawn provided a better accuracy than Fish. Chicken in HSV Color Space provided the best accuracy.

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

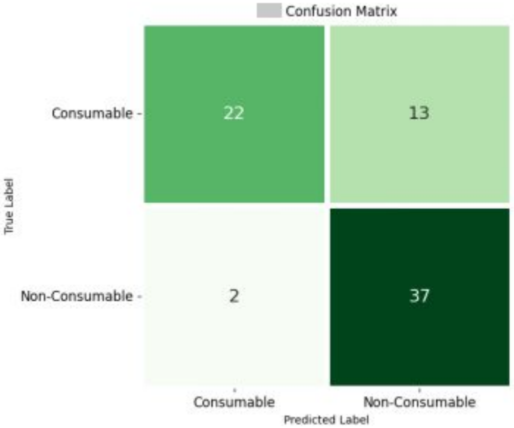


Fig. 2.1.1 Chicken Dataset (RGB)

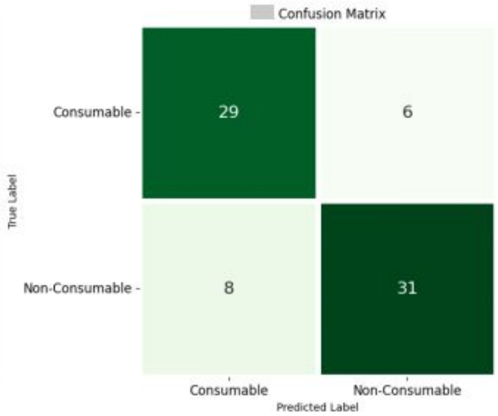


Fig. 2.1.2 Chicken Dataset (HSV)

Methodology

2. Machine Learning Methods

b. K-Nearest-Neighbours (KNN)

When we pass the dataset in the model we can see that all three datasets provide almost the same accuracy in RGB but in HSV color space Chicken provides better results than the other two.

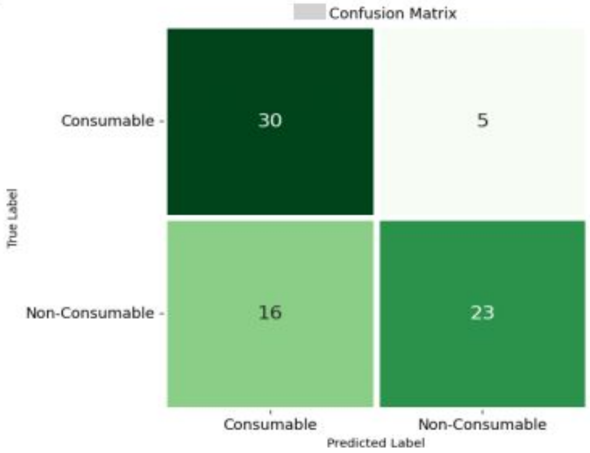


Fig. 2.2.1 Chicken Dataset (RGB)

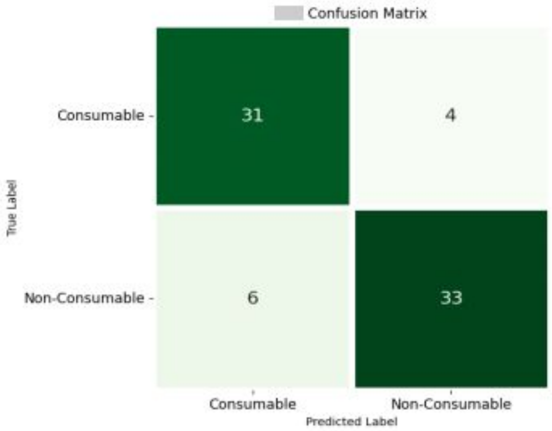


Fig. 2.2.2 Chicken Dataset (HSV)

Methodology

2. Machine Learning Methods

c. Support Vector Machine (SVM)

When we pass the dataset in the model we can see that prawn dataset provided excellent accuracy under this model in both color spaces. The other two datasets also provided good output in both color spaces.

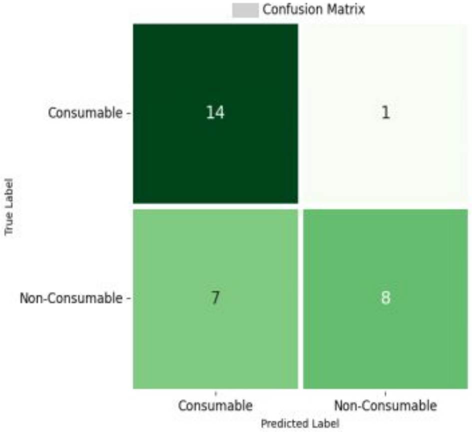


Fig. 2.2.5 Prawn Dataset (RGB)

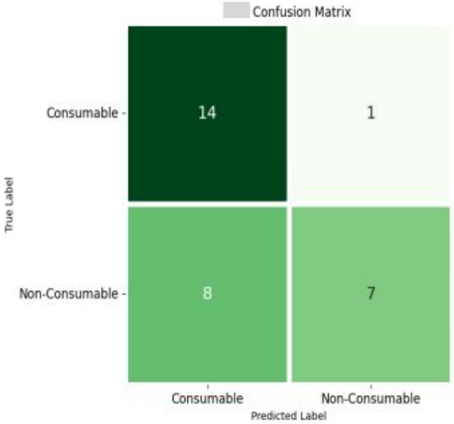


Fig. 2.2.6 Prawn Dataset (HSV)

Methodology

2. Machine Learning Methods

d. Random forest

When we pass the dataset in the model we can see that Chicken and Fish equally provided good results under this method mainly in HSV color spaces. Prawn gave somewhat intermediate accuracy in HSV Color space.

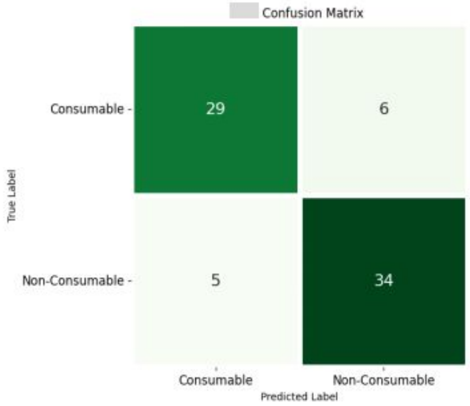


Fig. 2.4.1 Chicken Dataset (RGB)

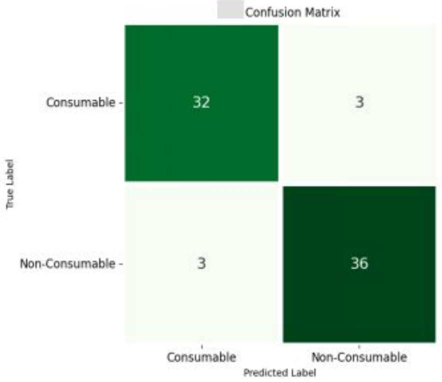


Fig. 2.4.2 Chicken Dataset (HSV)

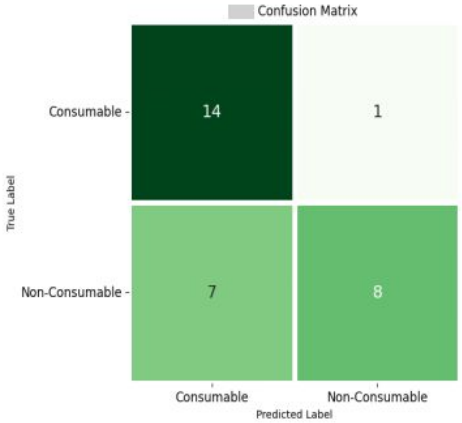


Fig. 2.2.5 Prawn Dataset (RGB)

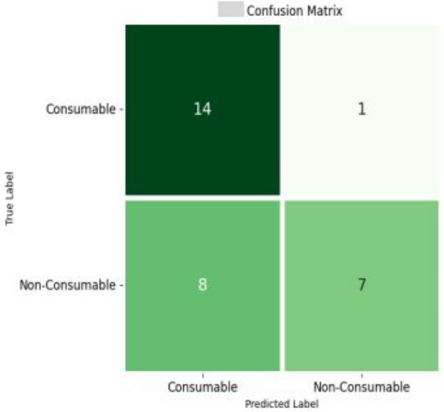
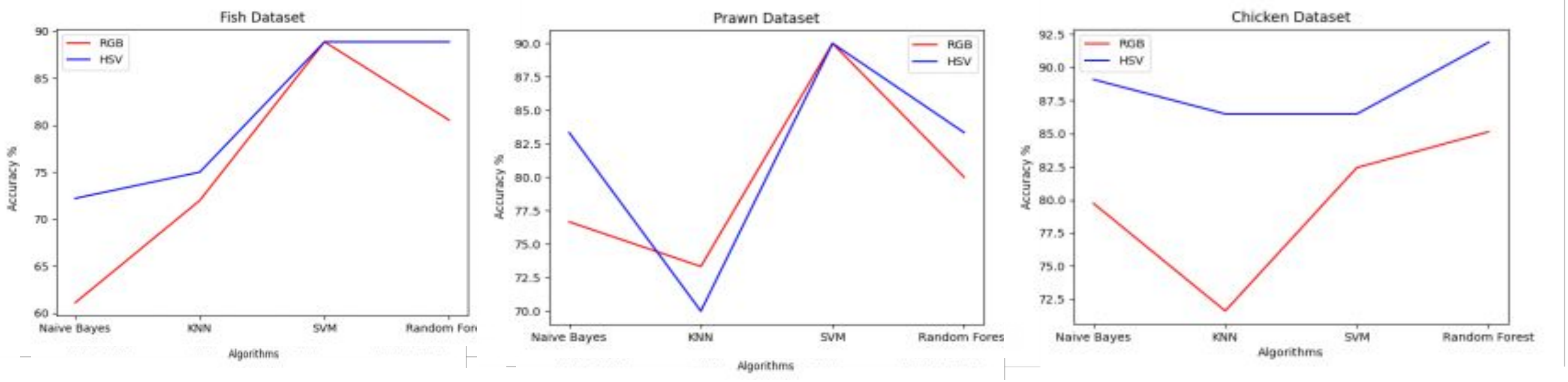


Fig. 2.2.6 Prawn Dataset (HSV)

Results

1. The experiment was to predict the freshness of meat on a given color space, and the results are the accuracies on the different dataset.
2. The results show that image classification can be used to classify good (consumable) and bad (non-consumable) meat.
3. One of the important results was quality of image and color space played a vital role in predicting the quality of meat.
4. The biggest strength of the study was the model was simple, but are less accurate compared to deep learning models, which are very complex. The variables were like, Random Forest being the best model for chicken classifier whereas for prawn the best was SVM.

Summary



Fish Dataset
RGB
HSV
90
85
80
75
70
65
60
Accuracy %
Naive Bayes
KNN
SVM
Random For
Algorithms
Prawn Dataset
RGB
HSV
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
Accuracy %
Naive Bayes
KNN
SVM
Random Fores
Algorithms
Chicken Dataset
RGB
HSV
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
Accuracy %
Naive Bayes
KNN
SVM
Random Forest
Algorithms

Conclusion

- We observed for all the datasets and Machine Learning methods except Naive Bayes, HSV color space gave better accuracy than RGB color space.
- Machine learning models used for the above problem for each of the dataset some particular models provided better accuracy than the others. For example, Chicken dataset in HSV Color Space and in Random Forest model provided the maximum accuracy which is over 90% whereas Prawn and Fish in both RGB and HSV color space provided maximum accuracy of over 85% on SVM Model.
- To conclude, artificial vision and machine learning is a reliable technique, and it has shown its efficiency in many applications related to meat assessment.

Future Work

- We will optimize these particular models for those datasets to provide better results for far more wide instances of those datasets.
- Addition to that we will try more complex deep learning models for better accuracy.
- Model will be chosen accordingly for further experimentation, keeping in mind the computational complexity and the platform in which the project will be implemented.

References

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