A Computer-Aided Inspection System to Predict Quality Characteristics in Food Technology

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Abstract- Physicochemical and sensory analyses are commonly used to determine the quality characteristics of food samples in Food Industries. These methods are tedious, laborious, produce chemical residues, and involve the destruction of the samples. For the meat industries, this work proposes a non-invasive and non-destructive computer-aided inspection system, based on computer vision and ensemble machine learning techniques. The paper presents all the possibilities for the development of the system, making an exhaustive comparison of different algorithms used to extract features from the images of the samples, and various machine learning approaches, studying up to 6160 different models, and selecting the top 110 for the ensemble proposal. The system determines all the physicochemical, textural, and sensory quality characteristics of pork and beef loins in four meat states (fresh, thawed, cooked, and cured) with good precision, being a real alternative to the usual methods for the Food Industry.

Keywords—Feature extraction, Predictive models, Prediction algorithms, Food technology, Magnetic resonance imaging, Instruments, Image color analysis.

I. INTRODUCTION

Computer-Aided Inspection (CAI) has acquired great importance today, in different fields, such as mechanical and aerospace industry, textile industry, electrical and electronic industry.These systems have also generated interest in the food industry, mainly in the quality assurance step of the manufacturing process. The possibility of inspecting samples and predicting quality characteristics of the products, in a reliable and non-destructive way, is a great advance for the food industry.

The usual inspection techniques to determine quality parameters in meat industry are tedious, expensive, and involve the destruction of the samples by chemical substances. In addition, these techniques generate chemical waste that must be recycled.

Physicochemical analysis is one of the methods used to estimate quality characteristics. This analysis determines the lipid and salt content, water activity and attributes related to the color of meat samples. Other analyses are related to meat textures, determining factors such as hardness, adhesiveness, strickiness, chewiness, etc. Besides, acceptance by consumers is related to sensory characteristics such as color, odor intensity, tenderness, juiciness, fibrousness. . . which are determined by expert tastings. It is note that sensory analyses can produce subjective values. Through these three types of analysis (physicochemical, instrumental, and sensory) it is possible to create datasets with real values of the quality characteristics of meat products.

CAI system provides a new option for an automated, nondestructive and objective quality determination. The typical stages of CAI system consist of an image acquisition procedure for food samples, the application of feature extraction algorithms on the images, and the evaluation algorithms. Systems based on hyperspectral imaging and machine learning were developed for different applications in food technology.

II. RELATEDWORKS

The Literature review plays a very important role in the research process. It is a source from here research ideas are drawn and developed into concepts and finally theories. It also provides the researchers a bird's eye view about the research done in that area so far. Depending on what is observed in the literature review, a researcher will understand where his/her research stands. Here in this literature survey, all primary, secondary and tertiary sources of information were searched. A literature survey or literature review means that researcher read and report on what the literature in the field has to say about the topic or subject. It is a study and review of relevant literature materials in relation to a topic that have been given.

1. **Title :** Finding the largest volume parallelepipedon of arbitrary orientation in a solid
Author : R. Molano, D. Caballero, P. G. Rodriguez

Description : 3D Computer Vision algorithms are a subject of research and application for several industrial processes. The Volume of Interest (VOI) usually refer to sub-objects with basic shapes for computing these algorithms. However, in many cases the objects are available as irregular shapes with many vertices, and in order to apply algorithms effectively, it is essential to compute the largest volume parallelepipedon contained in 3D objects. There are no other approximation algorithms for finding the largest volume parallelepipedon of arbitrary orientation inscribed in a closed 3D contour with a computational cost better than the algorithm.

2.Title : Filtering for texture classification: a comparative study
Author : T. Randen and J. H. Husøy

Description : we review most major filtering approaches to texture feature extraction and perform a comparative study. Filtering approaches included are Laws masks (1980), ring/wedge filters, dyadic Gabor filter banks, wavelet transforms, wavelet packets and wavelet frames, quadrature mirror filters, discrete cosine transform, eigenfilters, optimized Gabor filters, linear predictors, and optimized finite impulse response filters. The features are computed as the local energy of the filter responses. The effect of the filtering is highlighted, keeping the local energy function and the classification algorithm identical for most approaches. For reference, comparisons with two classical nonfiltering approaches, co-occurrence (statistical) and autoregressive (model based) features, are given. We present a ranking of the tested approaches based on extensive experiments

3.Title : Texture classification by wavelet packet signature

Author : A Gupta and A Bakilwal

Description : This correspondence introduces a new approach to characterize textures at multiple scales. The performance of wavelet packet spaces are measured in terms of sensitivity and selectivity for the classification of twenty-five natural textures. Both energy and entropy metrics were computed for each wavelet packet and incorporated into distinct scale space representations, where each wavelet packet (channel) reflected a specific scale and orientation sensitivity. Wavelet packet representations for twenty-five natural textures were classified without error by a simple two-layer network classifier. An analyzing function of large regularity (D/sub 20/) was shown to be slightly more efficient in representation and discrimination than a similar function with fewer vanishing moments (D/sub 6/) In addition, energy representations computed from the standard wavelet decomposition alone (17 features) provided classification without error for the twenty-five textures included in our study. The reliability exhibited by texture signatures based on wavelet packets analysis suggest that the multiresolution properties of such transforms are beneficial for accomplishing segmentation, classification and subtle discrimination of texture

In Existing system, Regarding the evaluation models in CAI systems, many machine learning models are presented in the scientific literature, being Random Forest (RF) and Support Vector Machines (SVM) some of the most used. Bayesian models or Neural Networks (NN) are also common, which implies a need for studying and comparing the performance of the different techniques.

A right election of the predictive model is critical for a CAI system. Multiple regressors may be needed to predict various attributes, as the numerical distributions of features may produce better predictions in some models than in others. The same algorithm does not necessarily produce the best predictions for all the characteristics. Ensemble models combine several algorithms to form a better model. Each single model produces a different prediction. The predictions of the partial models are combined to obtain a final prediction.

DISADVANTAGES OF EXISTING SYSTEM

- The system is not implemented Quality Parameters In Food Technology.
- It is not built an ensemble CAI system to predict quality characteristics as complete as possible to offer the meat industry an alternative solution to physicochemical and sensory methods.

III. PROPOSED SYSTEM ARCHITECTURE

The aim is to build an ensemble CAI system to predict quality characteristics as complete as possible to offer the meat industry an alternative solution to physicochemical and sensory methods

The main contributions of this project can be summarized as follows:

I) the construction of a generic ensemble CAI model is presented, particularized to predict up to quality characteristics of meat products in various states (fresh, thawed, cooked etc)

II) well-known extraction algorithms and regressors are compared, to determine the best combination of regressor and feature extraction algorithm for the predictions; and

III) a practical application of CAI system to the meat industry is proposed.

ADVANTAGES OF PROPOSED SYSTEM

- The system can make accurate Prediction
- Efficient
- Error Free

In this proposed system there are two modules they are:

1. Admin
2. User

1.Admin

In This Module The Functionalities are as follow:

- Login
- View Food quality type
- View Trained and Tested Accuracy in Bar Chart
- View Trained and Tested Accuracy results
- View Prediction of Food quality type
- View remote user
- Download Predicted datasets
- View Food quality type result
- Logout

2. User

In This Module The Functionalities are as follow:

- Register
- Login
- Predict Food quality type
- View Your Profile

- Logout

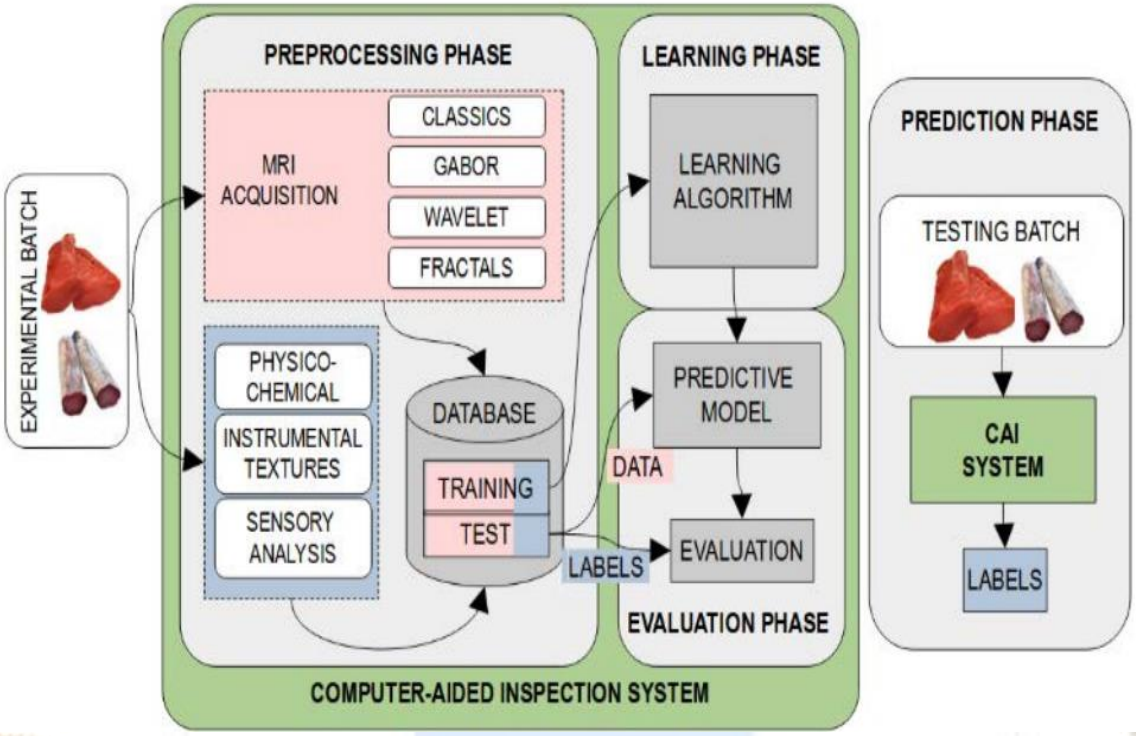

Fig.1 system architecture

IV. RESULTS AND DISCUSSION

The output screens obtained after running and executing the system are shown from Fig.2 to Fig.8

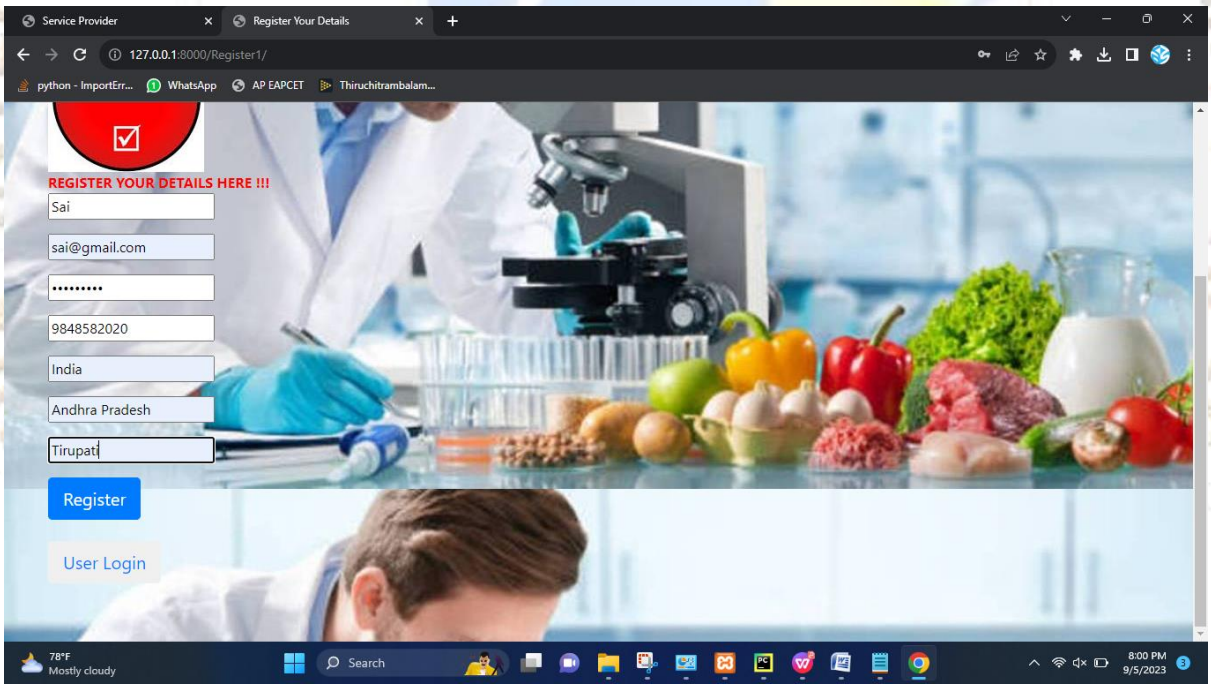

Fig.2 user registration

Fig.3 user login

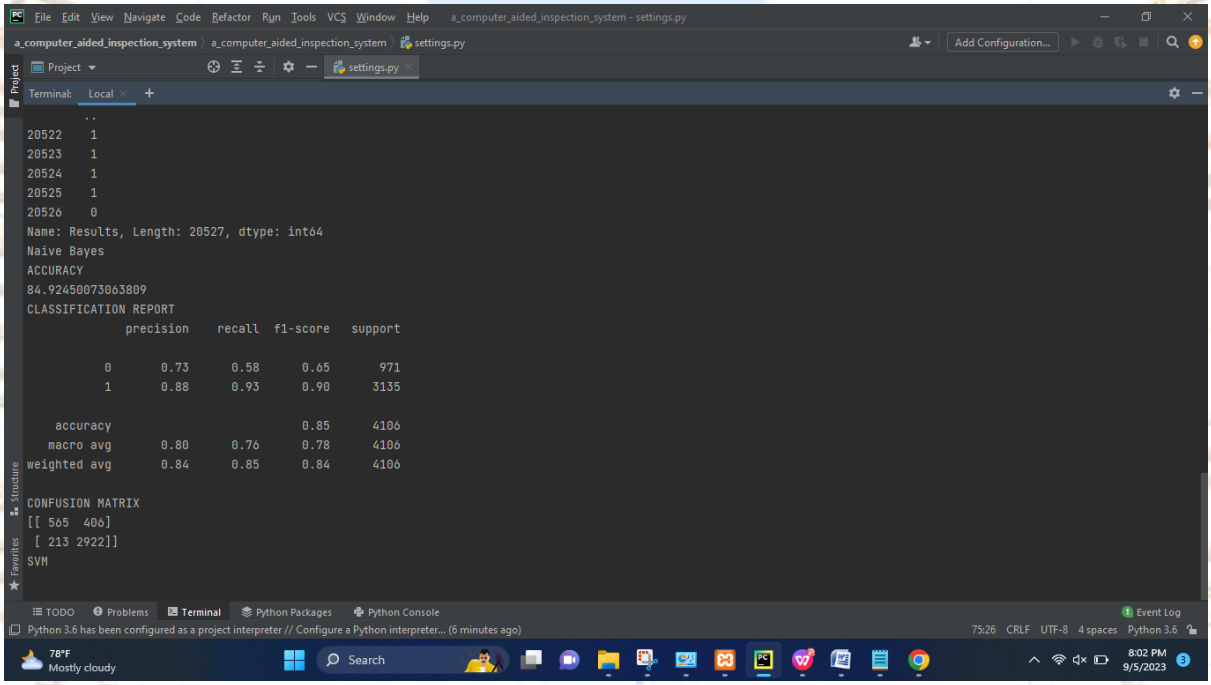

Fig.4 training dataset

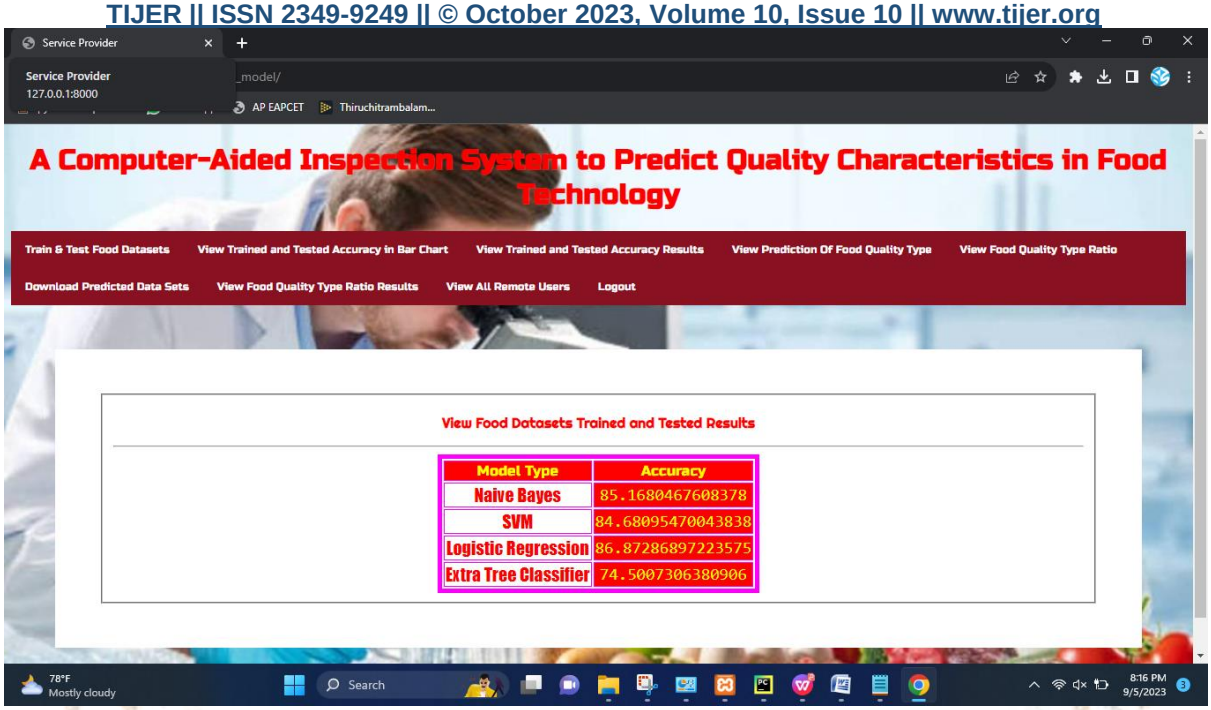

Fig.5 **Generate Trained and Tested Accuracy**

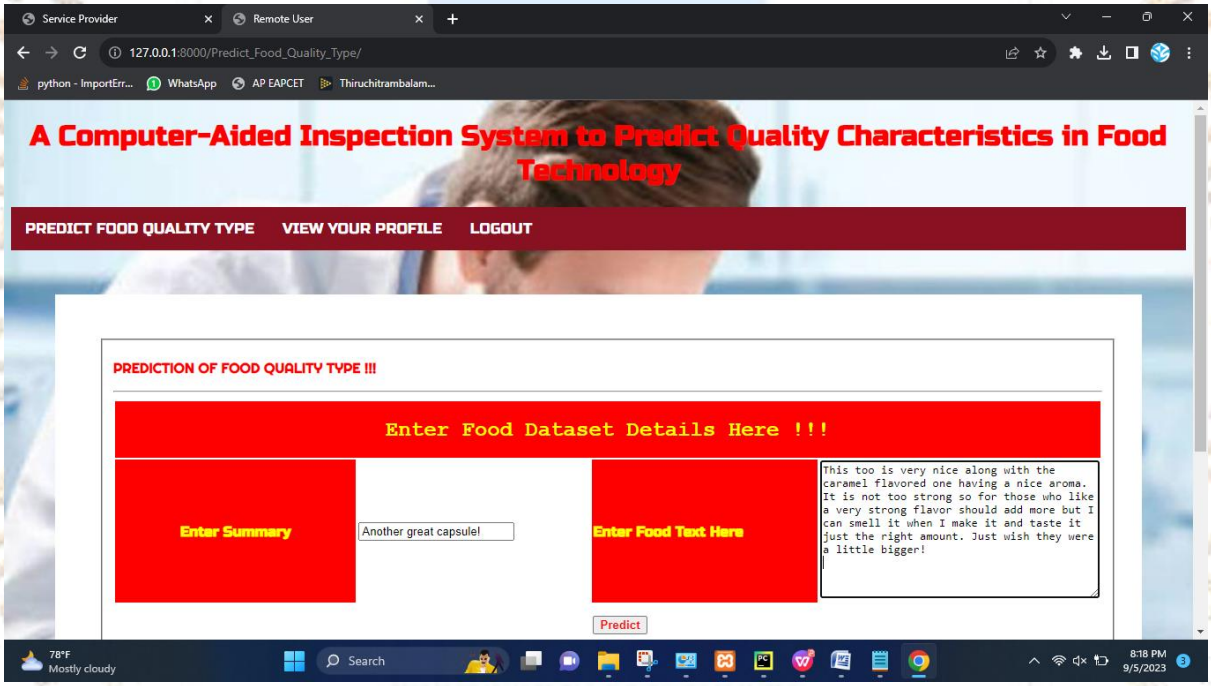

Fig.6 enter value for prediction

Fig.7 prediction result

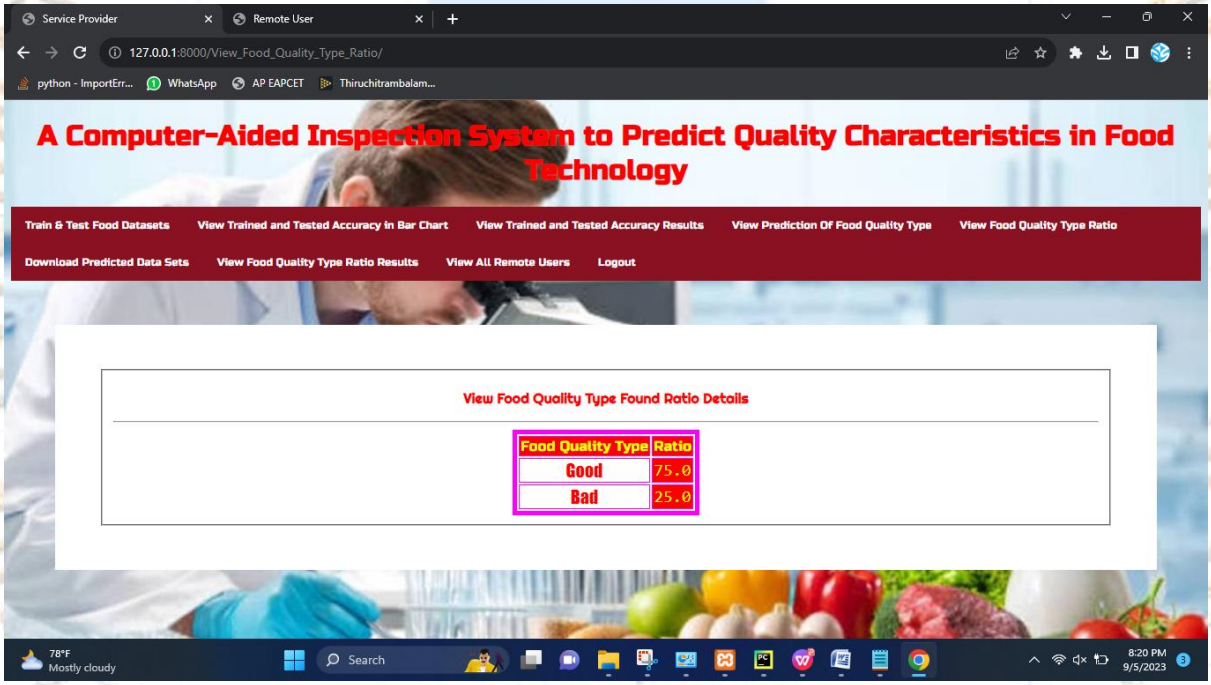

Fig.8 **Food Quality Type Ratio**

V. FUTURE SCOPE AND CONCLUSION

The project presents all the possibilities for the development of the system, making an exhaustive comparison of different algorithms used to extract features from the images of the samples, and various machine learning approaches, studying up to different models, and selecting the ensemble proposal. In the future work , The system determines all the physicochemical, textural, and sensory quality characteristics with good precision, being a real alternative to the usual methods for the Food Industry.

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