

RESEARCH ARTICLE

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

JUAN P. TORRES¹, ANDRÉS CARO¹, MARÍA DEL MAR ÁVILA¹,
TRINIDAD PÉREZ-PALACIOS², TERESA ANTEQUERA², AND PABLO GARCÍA RODRÍGUEZ¹

¹Department of Computer and Information Systems Engineering, Universidad de Extremadura, 10003 Cáceres, Spain

²Instituto de Meat and Meat Products (IPRO-CITA), Food Technology, Universidad de Extremadura, 10003 Cáceres, Spain

Corresponding author: Andrés Caro (andcaro@unex.es)

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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.

INDEX TERMS Computer-aided system, feature extraction, loin, magnetic resonance imaging, quality parameters, regressor.

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 [1]–[4], 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.

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Physicochemical analysis is one of the methods used to estimate quality characteristics [5]. 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, stickiness, 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 [6]. 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, non-destructive 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

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