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# THE PHASES OF AUTOMATIC CLASSIFICATION OF VEGETAL PRODUCTS THROUGH MACHINE VISION TECHNIQUES


***NOTE:*** *This paper was presented at the International Symposium "Research and Education in an Innovation Era", Engineering Sciences, November 20-21, 2008, "Aurel Vlaicu" University of Arad, Romania*

## ABSTRACT:

*Shape, colour and size represent the main parameters of vegetal products to assess with view to classifying them. These parameters may also be turned to good account by the machine vision techniques that proved to be applicable in several domains. One can especially apply these techniques in the inspection and analysis systems of industrial products where the parameters vary according to very low limits.*

*Taking into account these facts one has tried to develop a classification system of vegetal products based on machine vision techniques, as well as on decisive algorithms belonging to the artificial intelligence: neural networks and Fuzzy algorithms. The phases of the classification process of vegetal products together with a port of the soft applications developed as well as some of the results obtained are presented in details.*

## KEYWORDS:

*machine vision, shape, colour, classification, image processing, neural network, fuzzy logic.*

# INTRODUCTION

Over the last 30 years, there has been a higher and higher interest focused on the problems of recognition and identification of surfaces and image processing, via machine vision techniques. Using these new technologies in developing classification systems of industrial products brought about various benefits such as: doing away with inconsistency and the dependence on human/manual labour, raising accuracy and labour speed. Focusing on these premises, over the last 10 years, several studies and researches have been carried out that hint to the adjustment of both these techniques and the image processing algorithms to the particularities of vegetal products classification.

Thus, Meyers (1988) presented in a paper the advantages and disadvantages of using human operators in the inspection and classification process of vegetal products, while Deck (1999) pointed out to the disadvantages of using a semi-automatic sorting. The importance of using non-destructive techniques in the process of classifying vegetal products, based on video inspection has been also stated by Baoping (1999), while Laykin (2002) presents a classification system of tomatoes according to the shape and colour. On a classification device for apples Sudhakara (2002) be presents and validates a series of identification algorithms of colour and shape, by mixing up image pre-processing techniques with the algorithms belonging to the artificial intelligence neural networks. The colour, shape, size and surface defect of fruit are important features in classification. For all these reasons a series of algorithms has been developed which, on the basis of shape and colour descriptors, are supposed to establish the degree of health, size and colour of the vegetal products by using neural networks and Fuzzy algorithms as using neural networks and Fuzzy algorithms as part of the decisive algorithms.

# THE EXPERIMENTAL DEVICE THE „MACHINE VISION" SYSTEM

The device of video-inspection has been carried-out around transporters with a belt activated by an electric engine, which ensures the moving of the product in face of the video-inspection system, made of two video cameras with manual focusing.

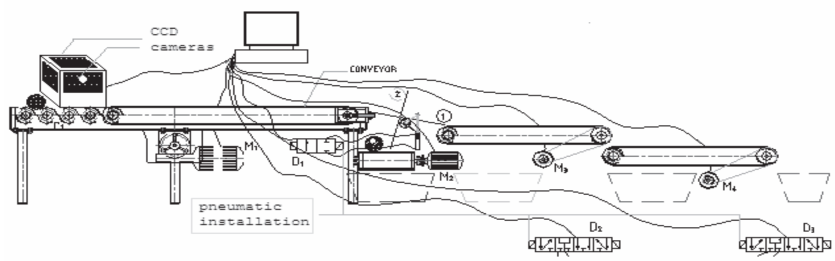


**Figure 1.** Conveyor and device of video-inspection

The cameras are disposed in the same frame, realizing an angle of 600, towards the analyzed object. These allow the acquisition of 4 coloured RGB pictures of 512*512 pixels, which they transmit in a real time, to the analyzing mechanism represented by a PC of Pentium IV/3200 MHZ type.[2][3] The illumination system represents an essential component part of a „machine vision" classification system.

# TRAINING THE DECISIVE ALGORITHMS AND ESTABLISHING THE VARIATION FIELDS FOR EACH TYPE OF PRODUCTS

The applications based on the visual inspection of products and mostly of vegetal products require a high degree of interactivity with the user. This interactivity mainly prevails during the training and identification phase of the variation fields for size and dimension, corresponding to each type and caliber. Taking into consideration all these premises, an application called. Fields Analizor has been projected and then developed allowing to identify in real time the most important parameters for the classification processes. The way of functioning as well as the structure of the application is presented in diagram UML, presented in **Fig.2**, a diagram that was at the origin of carrying out the application.

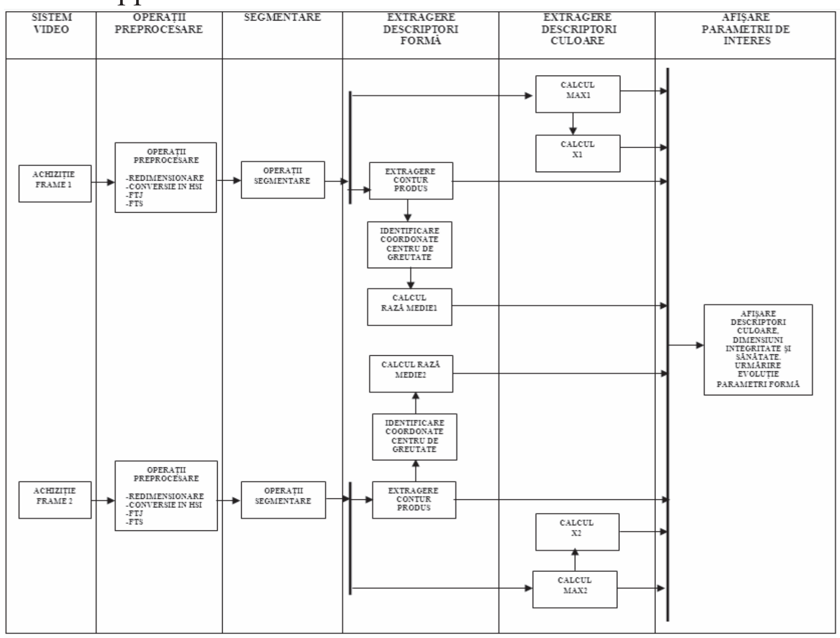


**Figure 2.** Diagram UML according to the colour of activities for the process of training and identification of the variation fields of colours and dimensions

In **Figure 3**, the interface of the application Fields Analizor is presented in the sections “Colour” and “Dimensions” the values of parameters corresponding to the products under analysis are this time presented while in the sections “Shape descriptors” the values of the vectors while are to be used in the neural algorithm of setting the products integrity in the training phase, are extracted.

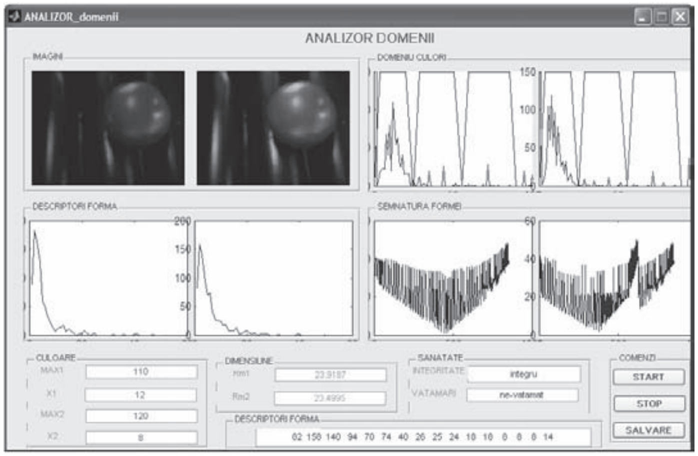


**Figure 3.** The interface of the application Fields Analizor used during the training and identification phase of the variation fields for each class of products.

Since the shape of product, that is its integrity, is difficult to asses from the 16 shape descriptors displayed, the operator has also access to two graphic representations: the evolution of the "Shape descriptors" and "The Signature of the shape".[3]

## THE PRESENTATION OF THE APPLICATION IMAGE ANALIZOR OF CLASSIFYING THE PRODUCTS

Considering the features of both vegetal products and the requirements, the projection of the application **Image Analizor** was carried out on the basis of the diagrams UML, while the activity diagrams of the process out up according to their colour, were presented in **Figure 4**.

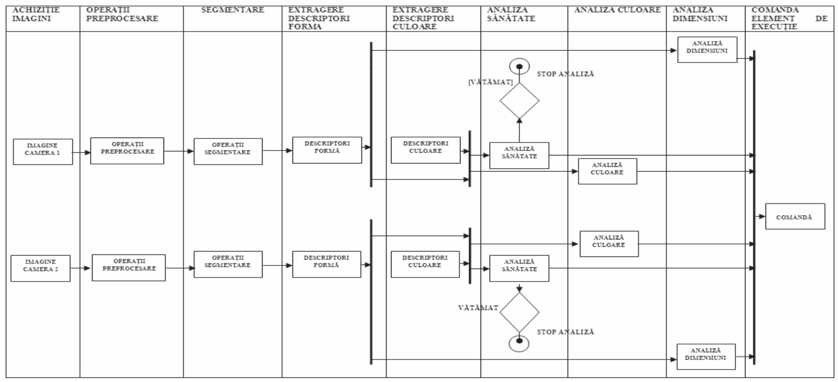


**Figure 4.** Diagram UML of the command process according to the colour of activities

The interface of the application (**Figure 5**) is very simple and it directly leads the operators to the goals of the process the greatest amount of information regarding the colour, size and the health degree, as cared to the images belonging to the product under analysis. Thus, the operator has the opportunity to stop the functioning of the installation if he has any doubts concerning the correctness of the application decisions.

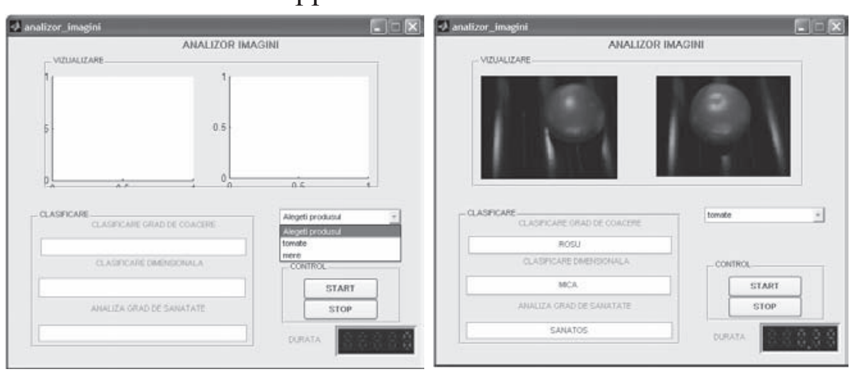


**Figure 5.** The interface of the application Image Analizor

The projected application is giving for analysis four images of the some product, two – two at about 1 second from each other. The lapse of time between the two acquisitions of images may be set by the user according to the speed of the conveyor as part of the function "Button - Acquisition". The four images acquired are subjected to the improving operations and then, on the basis of the shape and colour descriptors, they are going to be classified according to their degree of health, colour and size. In order to meet the demand of accuracy for the image processing algorithms, the latter have been projected so as to roll throughout the frequency field, and only during the last, decision – taking phase, are they supposed to operate in the special field.

## RESULTS AND DISCUSSION

For the training phase, 3 sets of tomatoes have been used. Thus, the first set was composed of 30 tomatoes and it was used to establish the dimensional limits. The affiliation of the tomatoes to the three classes: big, medium and small was materialized by a human operator, ten tomatoes for each of them. The second set was composed of 30 tomatoes as well, ten for each class: ripe (red) medium ripe (pink), unripe (green), while the third set – 15 products, ten of them healthy and the other five having various faults. In order to test the algorithms and the applications projected and carried out, 15 tomatoes of different colours and health degrees have been used, but they belonged to the same type of tomatoes used during the training phase. The results obtained after the test were 100% concerning the accuracy of assessing the colour, 100% concerning the accuracy of assessing the size and 90% when assessing the health degree.

# CONCLUSIONS AND FUTURE WORK

After the test the following conclusions have been formulated:

The algorithms projected for the identification of the ripeness degree, the size and the health degree, based on the analysis of the rays signature and the average of the hue, are very efficiently used as combined to the Fuzzy logic and the neural networks.

Taking into account the numberless amount of forms that the vegetal products can have, the utilization of the classificatory of neuronal type can be considered an important alternative (in comparison with the rest of the techniques of classification).

In the training process of the decision algorithms, based on neural networks, the set of products chosen for training plays a very important part. Thus, chosing an inappropriate set may lead to serios errors in the process of classification.

The fuzzy algorithm, despite of its simplicity, turned out extremely well and was very fast and easily implemented. It is expected to function as well when increasing the number of classes.

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