Article
Journal of Technological Engineering
June, 2021 Vol.5 No.15 1-8

Graphical user interface for the patterns detection in wine crops

Interfaz gráfica de usuario para la detección de patrones en cultivos vinícolas

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DOI: 10.35429/JTEN.2021.15.5.1.8 Received March 14, 2021; Accepted June 29, 2021

Abstract

Considering that our country has an important participation in the grape productive sector for this reason it is one of the crops with the best opportunity areas for the implementation of this technology type. In this paper the design and development of a Graphical User Interface (GUI) generated in the MATLAB programming environment is exposed, through which the pictures acquisition and process from interest information is carried out to implement patter recognition strategies in the wine crops agroindustrial sector to monitor and generate a timely diagnostic of its currently status. The GUI has a section than allows the pictures acquisition in real time to later capture the information to be processed and through the application of filters and color recognition techniques on the crop leaf (study object) it's processed to establish a diagnostic, which will allow the user to apply the appropriate measures contributing in the best way to a crop optimal development.

Graphical User Interface, Pattern detection and Wine crops

Resumen

Nuestro país se caracteriza por tener una importante participación en el sector productivo de la uva y considerado uno de los cultivos con mejores áreas de oportunidad para la implementación de este tipo de tecnología. En el presente trabajo de investigación se expone el diseño y desarrollo de una interfaz gráfica de usuario (GUI) generada en el entorno de programación MATLAB, a través de la cual se realiza la adquisición y procesamiento de imágenes considerando datos de interés con el propósito de implementar estrategias de reconocimiento de patrones con un enfoque hacía el sector agroindustrial, específicamente en los cultivos vinícolas permitiendo monitorear y generar un diagnóstico oportuno del estado actual del mismo. La GUI cuenta con una sección que permite la adquisición de imágenes en tiempo real para posteriormente capturar la información a procesar y por medio de la aplicación de filtros y técnicas de reconocimiento de colores en la hoja del cultivo (objeto de estudio) se procesa para establecer un diagnóstico, lo que permitirá al usuario aplicar las medidas permitentes contribuyendo de la mejor manera a un óptimo desarrollo del cultivo.

Interfaz Gráfica de Usuario, Detección de patrones y Cultivos vinícolas

Citation: JARA-RUIZ, Ricardo, RODRÍGUEZ-PADILLA, Luis Ángel, LÓPEZ-ÁLVAREZ, Yadira Fabiola, and RODRÍGUEZ-FRANCO, Martín Eduardo. Graphical user interface for the patterns detection in wine crops. Journal of Technological Engineering. 2021. 5-15: 1-8

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Introduction

The field of image processing is continually evolving. In recent years there has been a significant increase in interest in fields such as image morphology, artificial neural networks, color and / or grayscale image processing, image data understanding, image recognition, and knowledge-based analysis systems. .

At present, automation in the wine sector tends to replace the hand of man in some of its operational processes, in order to increase productivity and reduce the risk of physical exposure represented by human participation, but there is still a great gap in activities that require emulating the five senses of man, which have as a common purpose the recognition of patterns.

As a solution to the indicated problem, the development of a graphical user interface in the MATLAB programming environment is presented that allows the acquisition of images and their processing by means of pattern recognition and color detection techniques to generate a timely diagnosis. of the current state of the crop to study.

Graphical User Interface

The graphic interface is the "space" or "surface" that connects or articulates the interaction between the human being (user) with the artifact (computer) and the objective of an action (teaching-learning). The objective of the graphical interface is to make the communicative content of the information accessible. (Rivera, 2005)

MATLAB software

The MATLAB platform is optimized for solving scientific and engineering problems. The matrix-based language of MATLAB is the world's most natural way to express computational mathematics. Integrated graphs make it easy to view data and obtain information from it. A vast library of built-in Toolboxes lets you immediately get started with essential algorithms for your domain. The desktop environment invites you to experiment, explore and discover. All of these MATLAB tools and functions are rigorously tested and designed to work together.. (MathWorks, 2020)

Image processing.

The digital processing or treatment of images consists of algorithmic processes that transform one image into another where certain information of interest is highlighted, and / or irrelevant information for the application is attenuated or eliminated. Thus, the tasks of image processing include the suppression of noise, contrast enhancements, elimination of unwanted effects in the capture such as blurring or distortions due to optical or movement effects, geometric mappings, color transformations, etc. (Moya, 2012)

Geometric transformations.

They are carried out taking into account the positions of the pixels in the image, and translation / rotation operations are applied to them (Figure 1). Typical examples are rotation, translation, scaling, and pixel rectification. (Dobernack)

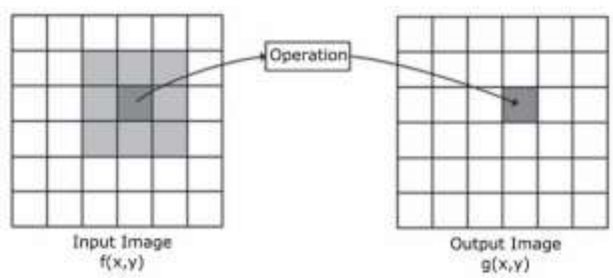

Figure 1 Spatial transformation.
Source: (Dobernack)

Color segmentation

The multispectral segmentation tool uses the RGB image format and its operation is similar to segmentation by thresholds. The only notable difference is that three groups of thresholds must be established, one for each of the spectral bands, which are applied to the corresponding red, green and blue layers that make up the color image. (Grau, 2010)

Artificial vision

Artificial Vision or also called Computer Vision, aims to capture visual information from the physical environment to extract relevant visual characteristics, using automatic procedures. According to Marr, "Vision is a process that produces a useful description for the observer from images of the outside world and does not have irrelevant information". (Dueñas, 2009)

ISSN 2523-6776

Methodology

Problem Statement

There is a great gap in the development of applications that require emulating the five senses of man in the vine sector, which have as a common purpose the recognition of patterns from the leaf. Therefore, the lack of taking advantage of the advantages offered by the implementation of new technologies in the wine agroindustrial sector to improve the conditions of the crops is deficient and little used, being that it is possible to detect external agents and anticipate risks that endanger the health of the entire plantation.

General objective

Generate an intuitive graphical interface capable of capturing and processing information of interest on the status of the crop from an analysis of discoloration or marbling of the leaf using color segmentation to generate a useful diagnosis for the user.

Particular objectives

- Generate a previous study of the object of study.
- Develop a graphical interface for data acquisition.
- Develop programming for information processing.
- Present expected results.

Diagnosis

The previous study is oriented to the design and construction of the system, considering a projective type research, using a descriptive method.

Wine sector

Viticulture is the science, technique and art of vine growing and grape production. (Pszczólkowski, 2007)

Disease Control

Cryptogamic diseases (caused by a fungus or other filamentous organism) of the vine such as powdery mildew, botrytis and mildew can be prevented by preventive applications of organic fungicides such as sulfur, citrus extracts, copper, compost tea, serum or biological fungicides. Among the cultural practices that can be used are leaf removal, grating and chapoda that are used to avoid favorable conditions for the development of diseases. (Torres, 2013)

Virus

The most important viruses that have been found in Spain are the infectious short internode (GFLV) and the coiled one (GLRV). In 1990 a study of virus-transmitting nematodes was carried out with the technical support of the hematology laboratory. Starting in 1992, diagnosis began using the E.L.I.S.A. test technique. the viruses of the short and coiled internode, thus confirming the suspicions raised (LÓPEZ, 1996).

Infectious short internode.

The virus that causes this disease belongs to the group called NEPOVIRUS. It is a virus that presents a wide picture of symptoms but that can be confused with characteristics of the variety, nutritional deficiencies, etc.

In leaves, it is observed that the petiolar sinuses are more open than in healthy strains, greater number of teeth and presence of nervous and yellow type mosaics (LÓPEZ, 1996).

Figure 2 Beige mosaic
Source: (LÓPEZ, 1996)

ISSN 2523-6776

Rolled up

The virus that causes this disease belongs to the group called CLOSTEROVIRUS.

In sheets, the edges are rolled down. These acquire a reddish coloration in the red varieties and in the white varieties a foliar yellowing is observed. (LÓPEZ, 1996).

Figure 3 Leaf curl and reddish coloration
Source: (LÓPEZ, 1996)

Based on the previous investigation carried out and consulting with personnel from the area, the different relevant characteristics were detected:

- Diseases in the vine.
- Pests
- Bacteria
- Virus.
- Mineral deficiency.

From the information obtained, the "leaf discoloration" of the plant is determined as the object of study of this work, which presents different characteristic features of the external agent that affects it.

Interface development.

Based on the information from the previous study, the interface is developed, contemplating providing it with particular characteristics that solve the problem and benefit the user in the best way.

As an initial proposal, a previous design of the graphical interface (Figure 4) is made that is intuitive and easy to use for the user; considering as the first stage the acquisition of the information in which the data corresponding to the captured image is stored for its subsequent filtering and processing using specialized techniques as part of the second stage and finally the interpretation and visualization of the results as the last stage.

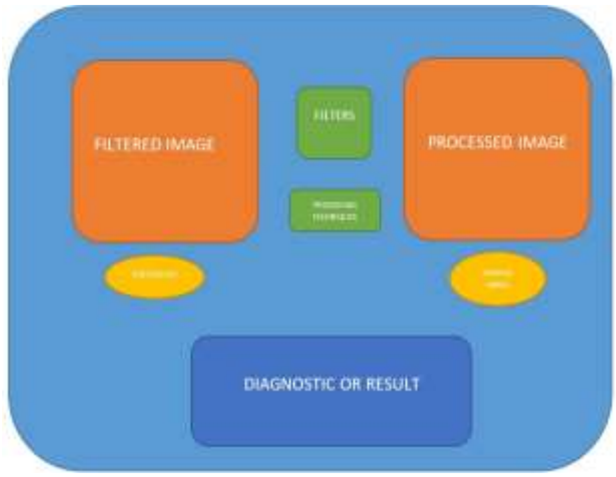

Figure 4 Proposal for the interface design
Source: Own Elaboration [Microsoft Word]

The interface is developed entirely in the MATLAB GUIDE environment, which integrates mathematical computation with visualization functions and a highly efficient language, offering a flexible means to carry out technical computation and taking advantage of the benefits offered by having a A wide variety of "toolbox" with a large number of built-in functions, facilitated the development of the program, reducing experimentation time and avoiding the need to interconnect codes between different programming languages (Figure 5).

Figure 5 Graphical User Interface (GUI)
Source: Own Elaboration [MATLAB]

ISSN 2523-6776

For the development of the GUI, it is considered that it complies with the proposed specifications and requirements, which is why it is divided into the following sections: image acquisition, information processing and diagnostic display, which are described below.

Image acquisition.

In this section the information corresponding to the images to be processed is captured (Figure 6). For this, the following elements are integrated:

- **Home button:** allows the user to initialize the camera power-on process.
- **Image capture button:** allows you to capture an image in real time using the camera.
- **Power off button:** when pressed, the camera turns off leaving a lock mode image.
- **Inset:** the function it gives us is to show the image in real time from the camera.

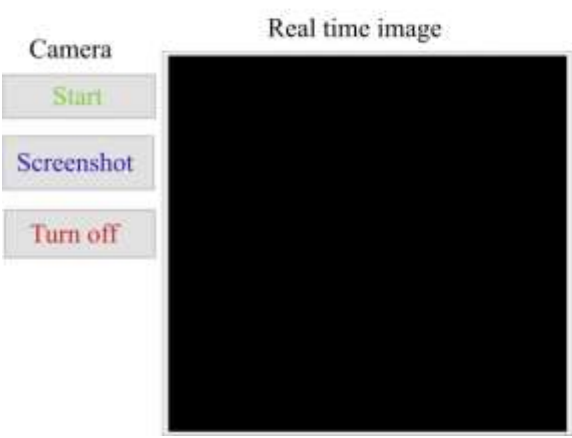

Figure 6 Image acquisition section
Fuente: Own Elaboration [MATLAB]

Information processing.

To store and process the information, the following elements are integrated (Figure 7):

- **Upload Image button:** allows you to choose an image stored as a file.

- **Inset:** displays the image captured by the camera or chosen from the computer when using the upload image button.

- **Filters:** allows you to select a variety of filters manually to better interpret the image.

- **Process button:** by pressing the button, an automatic color segmentation is carried out for the detection of patterns based on the discoloration of the object of study.
- **Clean button:** the action it performs is to delete the processed image and the information in general to be able to perform a new processing.

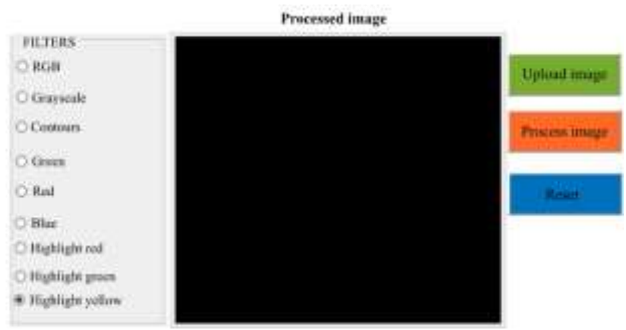

Figure 7 Information processing section
Source: Own Elaboration [MATLAB]

Diagnosis.

It allows us to visualize a diagnosis about the object studied in such a way that it is understandable for the user.

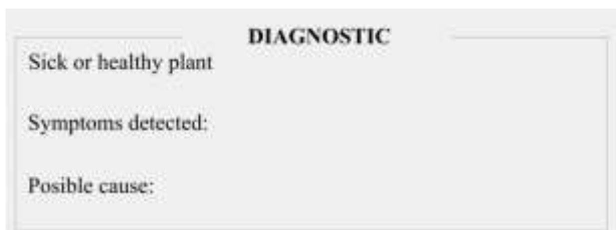

Figure 8 Diagnosis display section
Source: Own Elaboration [MATLAB]

Program development.

In this phase, the program was structured, combining the pre-built functions with written routines. Here are the sequences of the duties and the work they perform.

The initial part of the program is made up of the instructions to start the camera, capture images in real time, turn off the camera, and finally an instruction that allows the image to be viewed in real time.

The second part after acquiring the image is to pre-process it. The pre-processing stage is the application of techniques and tools to transform the image in order to improve it for subsequent processes.

The first step in pre-processing is to make sure that the image contains the regions of interest in the best possible way. For this, the technique of applying filters was used to eliminate noise. There are numerous filters that apply pixel by pixel transformations, which not only depend on the hue of the pixel to be treated, but also on those of its neighbors. The application of these filters occurs through masks, square matrices with an odd number of rows. In the second and last step of the pre-processing, the binarization of the image was used, it is also a contrast enhancement technique. It is an extreme case, where the transfer function for dark and light tones is zero.

Subsequently, the fundamental step is carried out, which is to clearly differentiate all the elements that make up the image, this is achieved with a segmentation of images for this, a multitude of different processes and techniques can be applied, depending on the type of image and the desired result. Typically the segmentation of an image is based on the characteristics of shades of gray, such as discontinuity and similarity. Discontinuity searches for lines, edges, or points based on abrupt changes in the shade of gray, while similarity establishes regions based on the spatial or chromatic relationships that may exist between the pixels that form it.

The next step in recognition is the extraction of characteristics from the objects. This program extracts RGB color information from each object to later send an understandable diagnosis for the user.

All the above described functions were implemented in a graphical environment in order to create an interface that allows easy and comfortable execution of each of the different phases developed in the previous section. In addition, some data is collected and displayed that allow understanding the processing and proper interpretation of the results in said graphical interface.

Behind each interactive element that makes up the graphical interface is its corresponding function called callback. In this function the code that will have to be executed when interacting with the element is written, both the content of the buttons and the static texts and the titles of the panels, are previously configured in MATLAB.

Results

To generate the diagnosis, the information captured as an image of the study object is used in the space of the primary colors R-red, G-green, B-blue (RGB) (Figure 9).

Figure 9 Image to be processed RGB
Source: Own Elaboration [MATLAB]

Subsequently, the image processing is carried out by means of a visual inspection using filtering tools in the spatial domain to detect possible inconsistencies prior to performing the analysis by color segmentation (Figures 10 - 17).

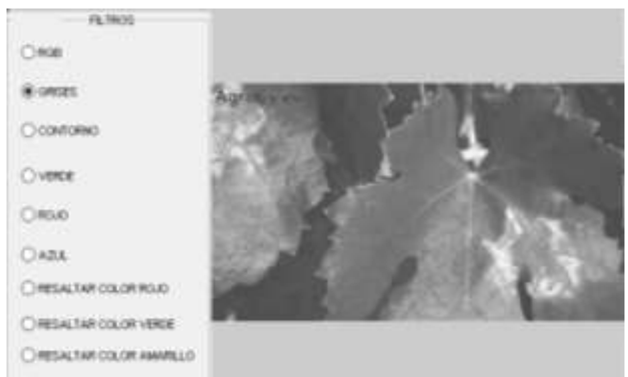

Figure 10 Image applying grayscale filter
Source: Own Elaboration [MATLAB]

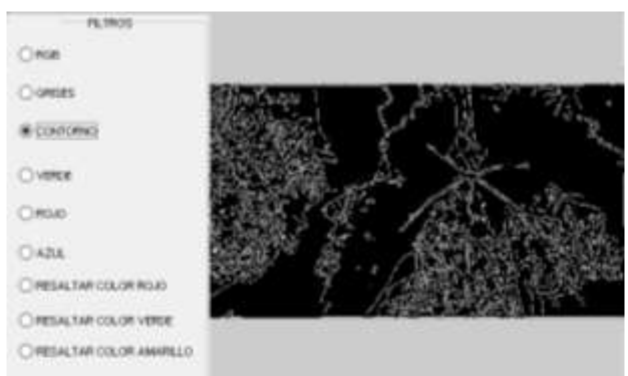

Figure 11 Image applying edge detection filter.
Source: Own Elaboration [MATLAB]

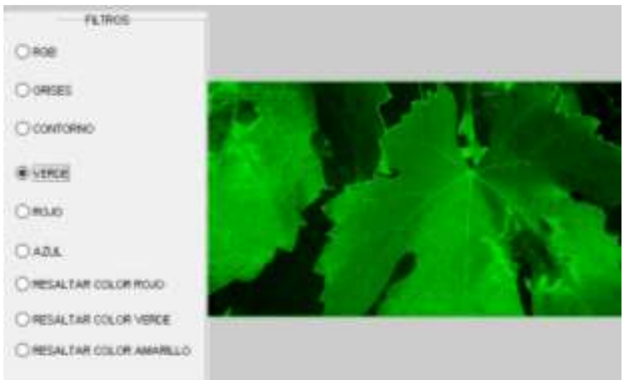

Figure 12 Image applying green filter
Source: Own Elaboration [MATLAB]

Figure 13 Image applying red filter
Source: Own Elaboration [MATLAB]

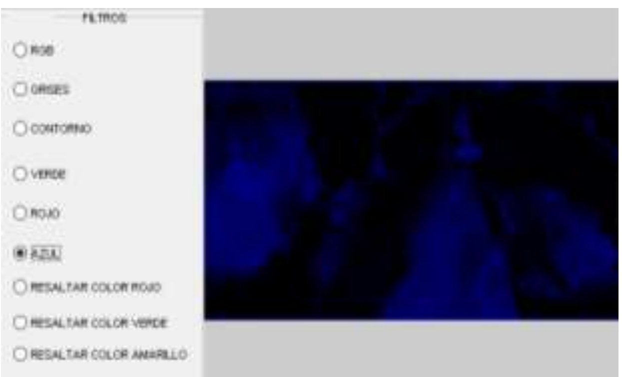

Figure 14 Image applying blue filter
Source: Own Elaboration [MATLAB]

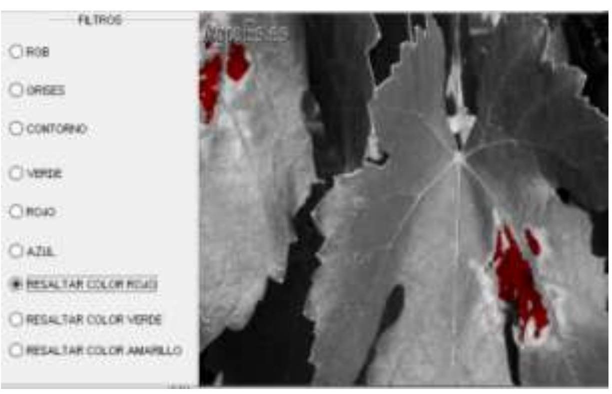

Figure 15 Image applying filter to highlight the red color
Source: Own Elaboration [MATLAB]

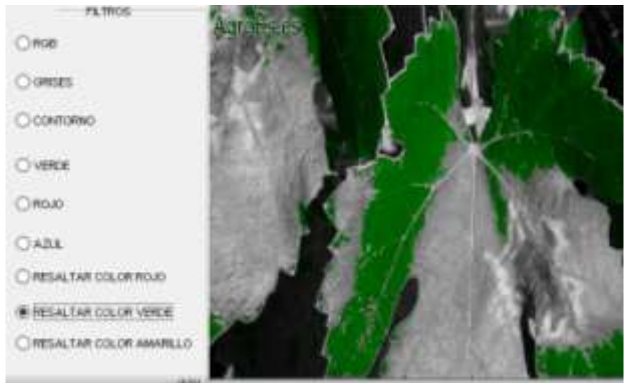

Figure 16 Image applying filter to highlight the green color
Source: Own Elaboration [MATLAB]

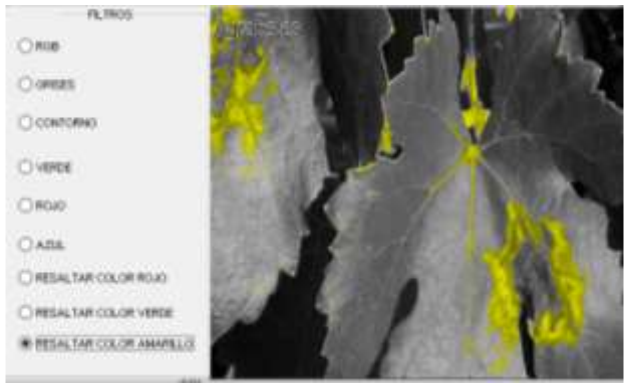

Figure 17 Image applying filter to highlight yellow color
Source: Own Elaboration [MATLAB]

Therefore, it is possible to generate a diagnosis from the detection of patterns by applying color segmentation tools using the graphical user interface. For this, samples with indications of marbling or discoloration on the sheet are analyzed.

In Figure 18, the captured image is processed to generate the diagnosis by detecting by color segmentation of the sections where yellowish mottling caused by a possible nutrient deficiency is present.

Figure 18 Nutrient deficiency diagnosis
Source: Own Elaboration [MATLAB]

ISSN 2523-6776

In Figure 19, the processing is performed from an image captured in file to generate the diagnosis by highlighting the detected sections where there is reddish mottling caused by a possible virus.

Figure 19 Virus Diagnosis
Source: Own Elaboration [MATLAB]

Conclusions

The analysis carried out in this research allowed obtaining relevant information about the object of study (vine leaf) and overcoming different challenges presented where a previous exploration was necessary to allow the correct assimilation of the data obtained and the interpretation of the results obtained.

With the development of this work, the first results were obtained, which will be very useful for later stages, so work will continue to implement new processing and pattern detection techniques that allow adjustments to be made to the results obtained and generate better diagnoses. that provide essential knowledge and tools for decision-making by users or producers.

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