Pattern Recognition Algorithm using LabView Platform for Color Predominance Detection

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***Abstract*—This paper presents the development and validation of a pattern recognition algorithm for detecting color predominance, implemented using the LabVIEW platform of National Instruments. The proposed system integrates the following key components: image acquisition via a USB camera, digital processing through the NI Vision Acquisition and Vision Assistant libraries, and structured data storage using SQL Server, accessed through the OLE DB driver. The algorithm captures images at predefined intervals, compares them against a reference color template, and stores the results in a tabular format. The experimental results demonstrate a high degree of reliability in matching the acquired images with a predefined color pattern, confirming the accuracy and consistency of the system. It was observed that variations in the camera configuration parameters significantly affected the matching accuracy, emphasizing the need for controlled capture conditions. A Boolean indicator on the VI front panel is used to signal the results of each comparison. Integration with the database provided full traceability of processed records, enabling applications in industrial environments requiring automated visual inspection and real-time decision-making. Overall, the findings confirmed the feasibility and effectiveness of using LabVIEW-based systems for real-time color pattern recognition, with the potential for expansion into more complex classification and quality control scenarios.**

***Keywords*—pattern recogition; image acquisition; color detection; LABView platform.**

I. Introduction

Computer vision is the science responsible for machine vision, the way a computer sees its surroundings, and the extraction of meaningful information from images captured by devices. This information allows us to recognize, manipulate, and think about the objects that constitute an image.

We consider computer vision to be a field of artificial intelligence that seeks to enable computers to see, interpret, and understand images and videos like humans. It combines concepts from image processing, machine learning, and computer science to develop systems capable of recognizing objects and patterns, classifying images, detecting motions, segmenting images, and retrieving information from images.

In the study by FAWWAZ (2020), LabVIEW software was implemented for image capture, vision, and motion functions using NI Vision and Motion tools, where the detection accuracy allowed real-time object reading.

A computer vision system using the LabVIEW platform with the IMAQ NI-IMAQdx library and Vision Assistant module was used by PAMUK (2022) to determine the colors and shapes of a given object. At the end of the study, the researcher pointed out that several algorithms were applied using a webcam, where it was possible to satisfactorily detect colors and shapes, obtaining results of 95.349%. Another study of CHULAKIT (2023) demonstrated that a system based on the Color Learn VI resource could be used to determine the color of an object, resulting in an overall average reliability of 90%.

MOHAPATRA (2024) also used LabVIEW tools to integrate real-time solutions for color identification and actuating devices.

Computer vision-based systems process images obtained from electronic and digital cameras in a similar manner to the human organism, in which the brain acts as a processor and the eyes act as an optical system of the surveillance hardware NIXON & AGUADO (2019). Furthermore, according to WILEY (2018), computer vision is related to the study of image processing and machine learning. Therefore, image processing is beneficial in different areas of technology, especially in the analysis of images to obtain necessary information.

According to JOY et al. (2021), color recognition in computer vision systems is primarily based on the RGB model. This is possible because the images captured by the camera already apply this structure. In this study, the authors proposed an algorithm to identify colors with high precision by comparing the RGB values of each pixel with a predefined database and selecting the closest color based on the smallest calculated distance. This approach is quite effective, with an accuracy rate of 97%, and confirms the applicability of automatic color recognition in future applications.

In the field of computer science, Computer Vision is a subdiscipline that focuses specifically on the computational interpretation of visual data. Historically, this was one of the first problems proposed in the 1950s for the development of AI, followed by the derivation of cybernetics Cardon (2018). With the development of algorithmic models for the interpretation of images, computer vision allows the incorporation of photographs and videos, among other types of records,— as data inputs for robot navigation, forensic science, and information management systems, in addition to military and surveillance applications.

Image processing allows you to perform necessary operations on a specific image to help improve the image or extract information from the image. The image processing system must have an input (sample of an image), a processing and the output (resulting image) which can be the enhanced image or a feature of the image, which helps to identify the content (BASKAR, 2023).

Development in the LabVIEW environment is quite versatile and advanced with its extensive functionalities, making it possible to build a graphical interface accessible to the user, being able to integrate specialists from various areas, and making research multidisciplinary (JIAYU, 2018).

The objective of this study was to simulate and develop algorithm structures within the LabVIEW development platform (National Instruments) using the Vision and Motion Assistant computer vision library to perform capture, connection, and access to a database, storage, and processing, with the aim of detecting the color of a given image.

II. Material and Methods

A. *Platform and Tools used*

The LabVIEW platform was selected because of its graphical programming interface, which facilitates the implementation of computer vision algorithms in a modular and intuitive manner. The integration of different code blocks allows for rapid development and direct visualization of results.

The LabVIEW software provides specific tools for image processing and analysis, allowing pre-processing tasks and initial analysis of the captured images. Several studies using libraries available in the LabView software can be found in the literature. The NI Vision Acquisition tool was used to integrate the USB camera with the platform, whereas the Vision Assistant tool was used for image processing.

B. *Experimental setup*

The experimental setup was performed in a controlled environment, where images were captured from a fixed angle and distance to facilitate image processing. Camera calibration was performed using the NI Vision Assistant calibration tool to ensure accurate measurement and image alignment.

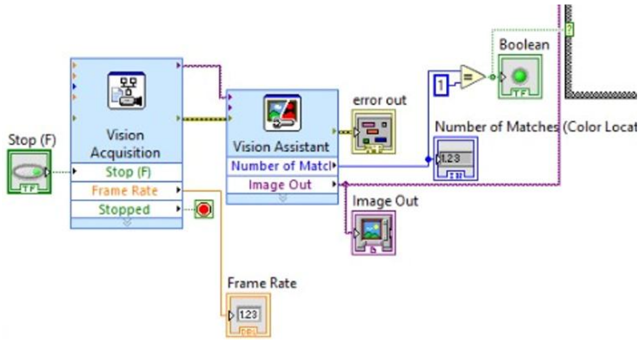
C. *Modules Development VI (Virtual Instruments)*

To carry out the project, a VI was developed, which is a block diagram representation of the project's LabVIEW platform, which we used as an interface between connected systems and the database with interaction with SQL to store system data.

As an “dataflow” type development environment, there is no way to display the lines of code of the complete program but rather presented in parts and with comments on each block.

Figure 1 shows the block diagram of image acquisition and processing for color detection.

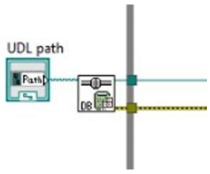
Fig1. Structure of the algorithm of LabVIEW program.



The first part of this diagram is the Vision Acquisition block, which is responsible for capturing an image. In this block, a Boolean stop button (Stop) and a variable to control the Frame Rate per second (frame rate) were configured. The output signal from this block is the input feed to the second block, called the Vision Assistant. This block executes the image processing sequence. In this block, a color template that was used to train the model was defined. In the output signal line of this block, you can see the line number of matches, which is the number of matches found based on the trained pattern, and Image Out, which is the output of the processed image. In addition, regarding the Number of Match lines, a display is connected to indicate the total number of matches detected in the analyzed image on the front panel and a logical comparator equal to 1, where a Boolean LED is connected to the output of the comparator. A display was connected to the Image Out outline, which shows the result of the image processed by the vision-assistant block on the front panel. The output signal from this block feeds the database table processing block, as shown in Figure 2. An error code line is connected to this block, which signals on the screen if any errors occur during processing.

To perform the set of operations of reading, writing, deleting and saving information in the database, it is necessary to connect the OLE DB (Object Linking and Embedding Database) driver to a database management system, which was used as SQL Server. Using OLE technology, the LabVIEW algorithm can access the data. Therefore, it was necessary to create a file with a UDL extension at the LabVIEW interface. Figure 2 shows the integration of the database with the application. The UDL path block represents database access, which is connected to the DB block, which is connected to the database.

Fig2. Database integration block.



The development of the algorithm in the LabVIEW platform allowed images to be captured at predefined time intervals. Indexers of the database table were created for each captured image. These indexes are saved in a table and are named id, image, and directory, which can be seen within the processing block shown in Figure 3. The DB in the signal is the connection input to the database of the structure, as shown in Figure 2. The Error line signal is the error code sequence treated in the first part of the image acquisition block and is accompanied by all the sequential codes of the project. The Image Out output signal is the result of the image processed by the Vision Assistant block, as shown in the second part of Figure 1. Each captured photo was stored in the database. The formatting of each file receives an ID, such as the name of the "photo" file preceded by a "id". This formatting was defined in a database table, where the LabVIEW Front Panel is displayed, as shown in table 1.

Fig3. Main data processing block in LabVIEW program

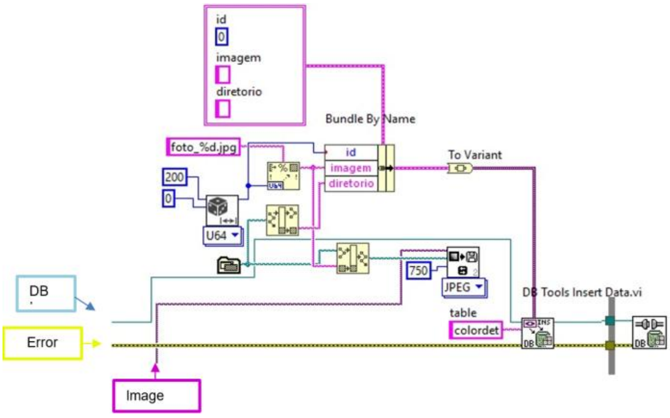


Table1. Data stored in the database.

Data id	Filename id	VI name
71	foto_71.jpg	COLOR_DETECTION.vi
87	foto_87.jpg	COLOR_DETECTION.vi
139	foto_139.jpg	COLOR_DETECTION.vi
123	foto_123.jpg	COLOR_DETECTION.vi

III. Results and Discussion

After executing the algorithm on the LabVIEW platform with integration into the database, it was observed that an image was captured at a time interval as defined in the algorithm structure. Each image is saved in the directory specified in the algorithm. After processing the image and using the Vision Assistant tool, predominant color detection of the original image was performed.

It was also observed that, depending on the application of filters and adjustments to the camera configuration, different output results can be expected for the same input image. In Figure 4a, the predominant color in the input image is black, and the processing results are shown on the right. In Figure 6b, the image was captured in the same scene; however, with some adjustments to the camera parameters, and as result, after processing the algorithm, the result of the correspondence test shows a different color from the first capture.

There are many applications for color analysis in the literature. For example, BEYAS (2021) used a system with LabVIEW and a USB camera to evaluate colorimetry in the agricultural industry. An RGB color plate was used to calibrate the system. The calibration factor results are shown as: ƔR for each of the RGB color channels are 1.161232, 0.506287, 0.432229; the ƔG factors for each of the RGB color channels are 0.519619, 1.025383, 1.201444; finally, the ƔB factors for each of the RGB color channels are 0.600362, 0.714016, 1.413406, respectively.

Fig4a. Black predominant color

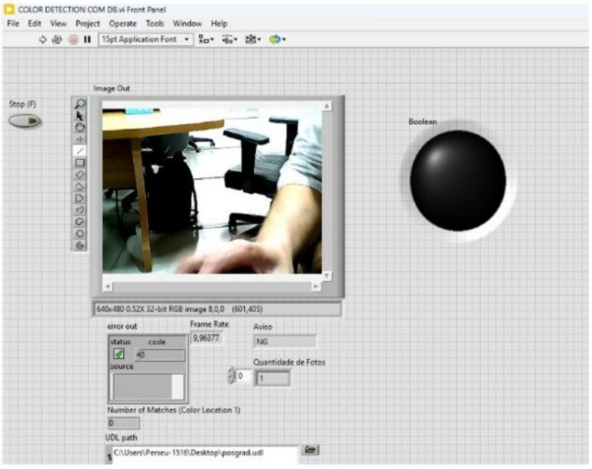
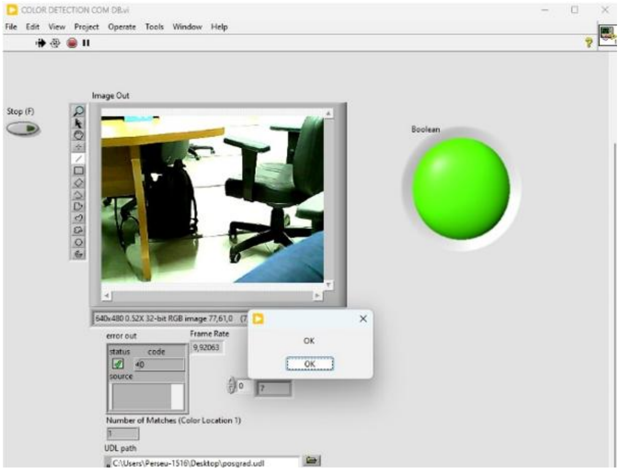


Fig4b. Green predominant color



IV. CONCLUSION

This study demonstrated the use of LabVIEW software interactions through digital image acquisition and processing libraries, with the integration of data stored in database tables. In the experiment, several images were captured and processed using the algorithm under study, where the predominant color in each image was identified and compared with the previously configured template, and the correct correspondence of the chosen color was observed. Additional studies can be conducted to evaluate other camera calibration parameters that may influence the correspondence results of the model.

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