Method for the Registration and Analysis of Aerial Images, applied to the Architecture of Construction Sites, using Low-Cost Devices

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Abstract

FPGA-based hardware architectures are being used more frequently in many applications, thanks to the different programming languages that allow us to access them. The applications are also being varied, one of the most common areas of work with aerial images, normally acquired with cameras that are on board drones, the working mode of these configurations, is focused on being able to use visualize the images online As the flight is carried out, if you want to carry out some type of processing, it is necessary to download the image from the camera's memory, this process is already carried out when the drone has finished the flight. In this work we present a methodology to be able to use the low-cost hardware myRIO, since it has a processor and an FPGA included, we present the steps to be able to work with the device, as well as an example of online processing so that the video and images that the drone camera can process on board and transmitted online, so that images and videos are processed while the drone is in flight, thereby improving the performance of the drone and can be applied In special operations, as a result we present the device configuration and the results of an example.

Keywords 1

Aerial image, online process, FPGA, development, video.

1. Introduction

The use of technology is achieving new ways of working and providing new alternatives achieving better results as well as reducing processing times, aided by hardware and software that allow them to be applied to new applications, we find jobs where online processing is performed for the process of signals and images using low-cost and highly integrated devices [1].

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Automatic pilots or also called unmanned aerial vehicles (UAV) have critical systems for safety with reliability and safety requirements, these processes are considered complex, expensive and takes a lot of time, therefore we present an automatic test platform of the system of automatic pilots with the aim of making an improvement on the efficiency and safety of UAVs, for which it proposes a unified modeling of the various types of aerial vehicles which are shared modeling experiences and existing failure modes, a platform was used of real-time simulation using the automatic code generation and the method of hardware simulation in the cycle based on FPGA in order to guarantee the credibility of the simulation at both levels as software and hardware for which a framework of automatic test with evaluating test cases during flight simulation performed in real time where ev We will assess the results of the test, then the verification, precision and credibility of the simulation platform is carried out, obtaining results of the experiment successfully in multicopters that demonstrate the viability of the proposed platform [2].

Works where complex calculations on image filtering are analyzed, which cannot be operated efficiently according to the scenario of each image and videos in real time with large size, for which we present a scheme that was based on the Large Single Image Compute Acceleration Bilateral Filtering (CABFD), the goal is to defog large video in real time by smart tv, at the same time an alternative on simplified filtering and FPGA defog architecture has been introduced, After making the comparison of the proposed method about the fast demisting of large images, it is effective and practical, this architecture is applied directly for the visualization of Full HD video (1920 × 1080) with synchronous demisting in real time [3] .

Applications in precision agriculture, with which fertility can be improved through technical monitoring and cultivation tests, so that the balance will do the job in an essential way with ingredients essential for humans or other sectors, for which a data analysis through nano and automatic learning developed through the Internet, with the Contribution to Smart Farming and Things Internet, which will help to create a viable intelligent agricultural system for the system [4] [5].

We find jobs using unmanned aerial vehicles (UAV) used in civil construction, for which we will analyze alternatives for the implementation of image processing algorithms for the detection of cracks in the facades of buildings, which must be executed on a platform computing integrated and installed in UAV, 2 algorithms have been selected about image processing about crack detection, one of the versions runs in Matlab environment on a desktop computer using an image processing approach which is performed in the ground and the UAV and is only applied for image acquisition taking as a baseline for comparison with the implementations executed in an integrated processor and with implementations in a Xilinx FPGA board installed in the UAV, which have defined various scenarios for the execution of inspection tasks of building facades and the results obtained were presented still at work [6].

Small-scale helicopter unmanned robotic systems (SRURS), robotic systems unmanned using manipulation devices, so the objective of the review is to provide an overview about the manipulation area of the SRURS promoting research, therefore that we provide a review about the literature of the last 10 years about the SRURS, and details the achievements and challenges, from where the state of the art, development, classification and challenges of the SRURS were analyzed, I have also reviewed the Relationship articles which have been organized into 2 categories that are design of mechanical structures and modeling and control, then a summary and classification is made in the form of tables, which has been presented in 7 parts, has been compiled and presents trends and challenges which are used as a resource for researchers who are interested in aerial manipulation of SRURS, considering that the problem at hand About trends and challenges are described in 3 aspects, allowing conclusions to be drawn about the effectiveness of the proposed systems [7] [8].

The methods and technologies used in aerial robotics applications were reviewed about unmanned aerial vehicle platforms, summarizing the different control techniques, where we included control architectures and control methods, artificial vision techniques were also examined [9]

Low bit depth images for image processing applications which offer advantages over full depth, reduced data transmission, elimination of superfluous details and improved compressibility with potential reduction of FPGA resources used on small platforms, thus demonstrating descriptors about the scalable key points considered as binary robust invariables (BRISK) which coincide directly without modifications between images with different number of gray levels where we evaluate the performance obtaining the sufficient number of control points for an image registration, which they can be used to determine the direct equivalence of an unknown, unaligned, reduced palette image as a reference image called the upper bit depth [10].

This proposal analyzes the use of the low-cost Myrio card, which has an integrated FPGA, the device is programmable through the LABVIEW software, the proposal allows the device to be attached to a drone, the video is captured from the drone camera , which can be remotely selected the image to be analyzed, this image is sent to the device and analyzed, and the result is sent to the operator, from where the device can operate in this way instead of sending the video to be analyzed , the process is done on board and only the final result is sent, which is the processed image.

2. Materials and Methods

The materials and methods are based on Figure 1, which indicates the steps to follow to explain in detail the proposed methodology, where each of the procedures will be solved so that it can be applied in other problematic situations.

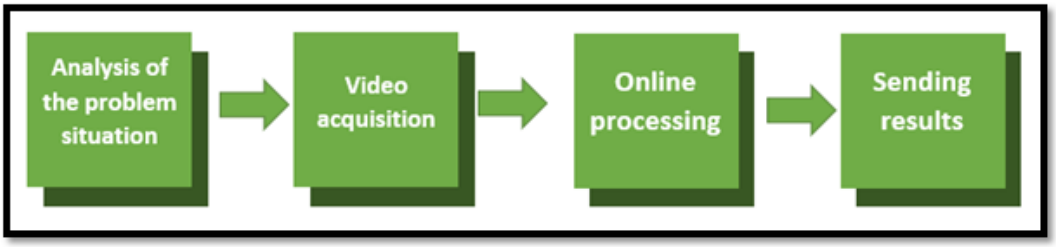

Figure 1: Block Diagram of the Proposal

2.1. Analysis of the problem situation

In the process of using drones, many solutions arise, depending on the problem and the application. In the market we have many solutions based on the use of video recording, to be able to exploit it after the recording, another of the alternatives is the visualization of the online video as the drone is making the flight, the images are visualized by the operator.

Here we present for the mode of operation of drones in a practical way:

- In image 2, the drone is presented ready to go to flight, so it is necessary the configurations and flight patterns, as well as the parameters of the recording and transmission of the video.
- In figure 3, the drone is shown in flight, where a night flight is shown in order to test the transmission of the video.
- In Figure 4, shows the control of the drone, as well as the transmission of the video where the controls such as selection of recording angles, recording times and recording areas are presented.

Figure 2: Image of the drone ready to fly

Figure 3: Image of the drone in flight

Figure 4: Image of the video sent by the drone

2.2. Video Acquisition

The acquisition of the video is composed of the recording in flight and the download for its subsequent analysis and interpretation, the present proposal is characterized in being able to analyze the video in flight and in real time, in such a way that the operator can select the image, this image can be sent to the FPGA device, the architecture of the myRIO device allows a connection via USB,

where the image to be analyzed can be sent, in this sense the device can perform the processing and returns a resulting image ready to be analyzed and interpreted, with this proposal it is not necessary to download the video to be able to be analyzed, the entire process is carried out in flight and in real time.

Figure 5: Aerial view recorded by the drone

The architecture presented in figure 6 is based on the myRIO device, which features a processing unit, a memory unit, an FPGA unit with its internal memory as well as input and output units, this architecture allows to perform the reception of images and videos, the internal processing and the sending of final results. In the application example, the operator captures an image, which is sent to the device, which performs a search for areas of interest, returning a resulting image, so that it can be analyzed and used, the architecture of the device allows this operation, where the FPGA unit is used for image processing.

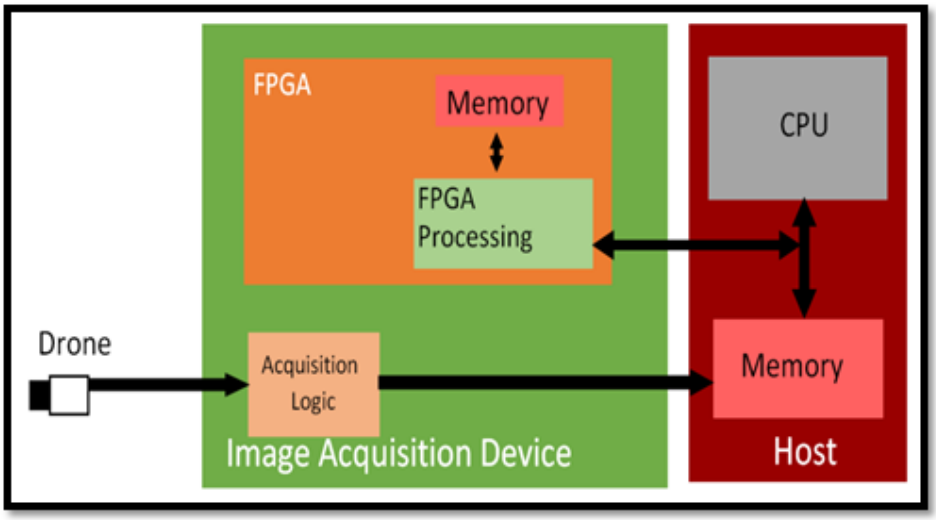

Figure 6: myRIO device architecture

2.3. Online Processing

The process that is carried out in the drone is characterized by the analysis of the color image, as can be seen in figure 7, the process begins with the decomposition of the image in its respective color bands, such as Red, Green and blue. Taking each one of them, the analysis is carried out to obtain the one that presents the most information, in the case of the aerial image that we have, it corresponds to a night shot of the train tracks that passes over the city, in the image of color is presented in black, performing the analysis in each of the color bands, the band that has more information about the train

rails is the red band, it is in this band where the binarization process is carried out, in order to determine the status of the rails in real time, without having to wait for the drone to finish the video.

In figure 7, the diagram of the processes carried out in the image is presented, from the reception of the color image, passing through the decomposition in their respective bands and ending with the result of the binarized image.

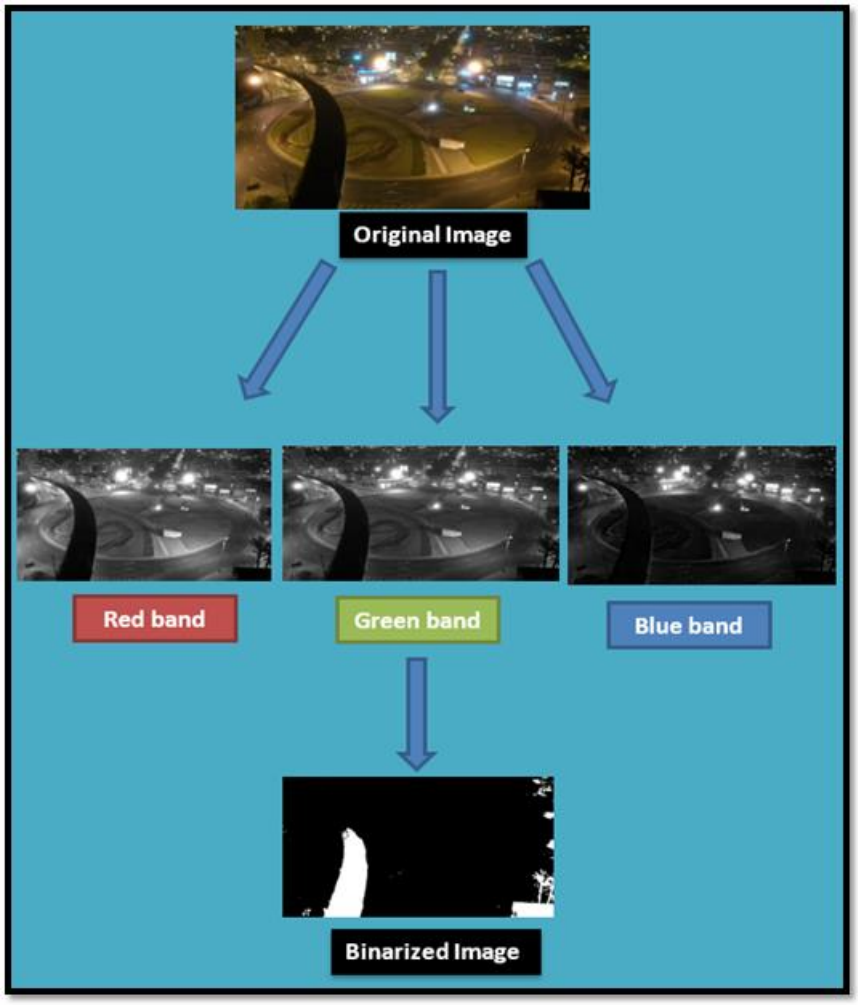

Figure 7: Image process diagram

2.4. Sending Results

The final result of the proposal is the final image, which is a processed image that the device returns after having performed the different algorithms, one of the advantages of the myRIO device is the architecture and ease of programming, thanks to the practicality of its architecture, you can carry out the programming with Labview and download it to the device, with this method it is possible to perform different procedures to treat the image and have as a result an image or a set of images converted into video, this procedure of delivering the result of the procedure is carried out with the outputs of the device, such as the USB interface.

The sending of the processing result is an important factor with which it can be sent directly to the drone operator, so that he can make decisions in case of an emergency situation. The architecture of the device allows a wireless connection through the WIFI protocol, through which the result of the process can also be transmitted either in image or video format.

3. Results

The results that are presented are related to three aspects, first with the procedures to be able to work with the myRIO device, second with the advantages that the device provides and finally with the operation and working mode of the device.

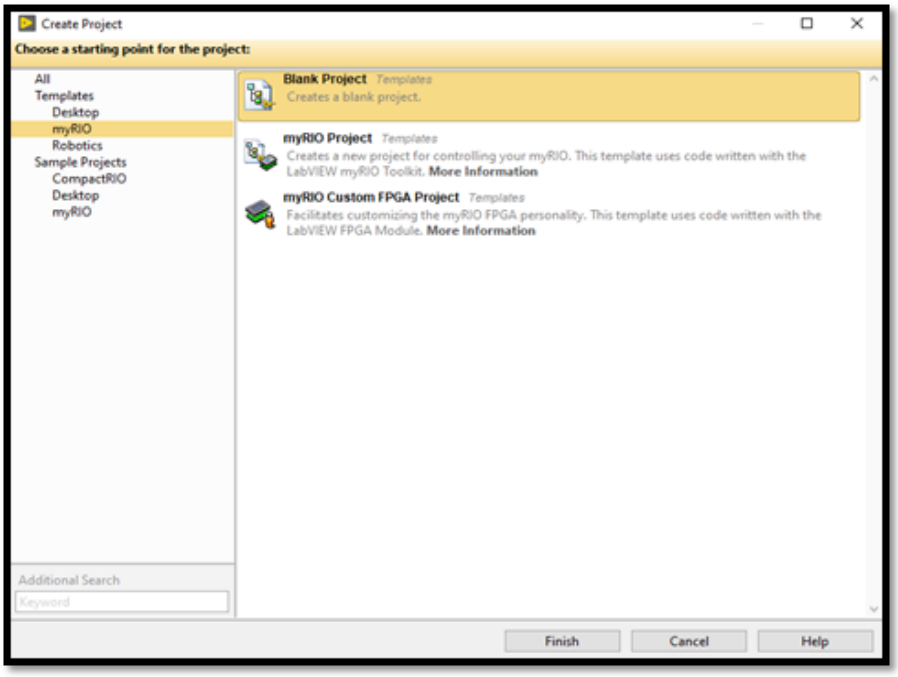

Figure 8: Initial device configuration

Figure 9 shows the start of the myRIO device configuration, where it presents the configuration of two programming modes, if programming is used in the microcontroller, otherwise programming in the FPGA unit, in our case it is necessary to select the FPGA mode, this choice is very important since the programming will be available to use the FPGA resources.

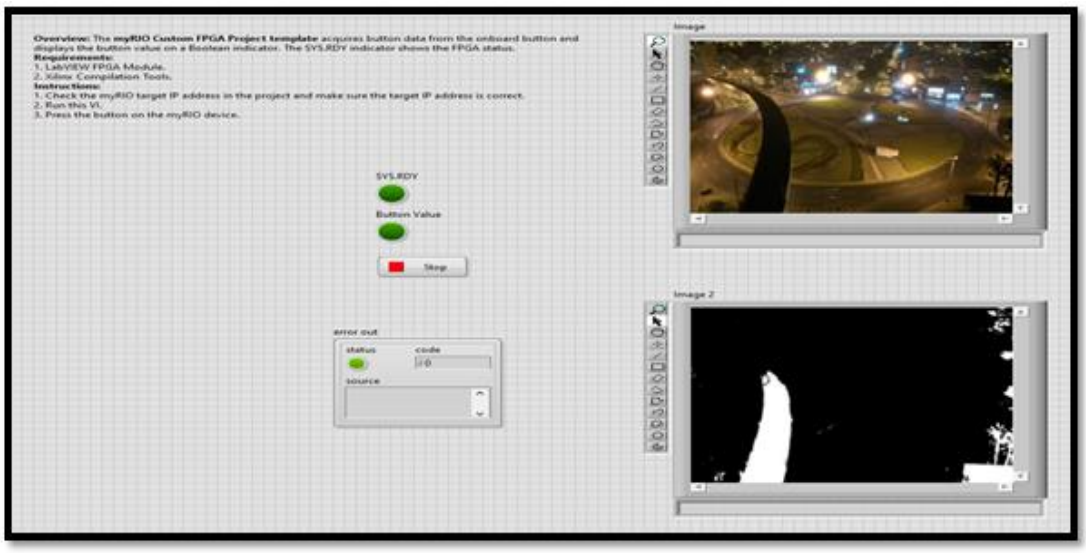

Figure 9: Final application image

In figure 9, we present the programming of the program in Labview where the FPGA control commands appear, as well as the input of the image and the result of the process, this program is the

main program, it must be considered that when the program is executed on the computer and the results are satisfactory, it is downloaded to the device and begins to work online without the need for the device to be connected to a computer and less with a screen, for this reason it is important that the main program is working without problems.

4. Conclusion

We come to the conclusion where among the devices based on the FPGA architecture are diverse, so the device worked with the myRIO is practical both in programming and in the use of the device for the final application, added to the low cost compared to other architectures, But the most important part is the use and the multiple applications that must be considered, based mainly on the programming with Labview, it allows to fully exploit the different input and output units as well as the universal input that it has where you can connect many devices of storage as well as being able to connect cameras.

The application that is presented uses the universal USB input, where an application is presented where it is necessary to process an image online and return a processed image, these applications are recommended when it is necessary to know the status of some situations considered emergency, in the search for some patterns, where it is necessary to know their location as well as their existence, the proposed method is based on the decomposition of a color image, then on the interpretation of each of the bands and finally the processing in one of them, to finally conclude with the delivery of a binarized image with the necessary information to make a decision.

Finally we can indicate that the FPGA architecture helps in the processing as well as in the response time both in the programming level and in the execution, we recommend working with the device to start programming with FPGA as well as in the use of embedded systems where It is required to work alongside other platforms such as drones, in our case the energy consumption is minimal and it receives the power of the drone battery, because the program uses the resources necessary for the application, the method can be widely used as well as scaling to other applications where online and real-time processing is required.

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