Water-tightness Airborne Detection Implementation

D4.2 - Software user's guide

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Technical references

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Executive Summary

The document describes the carried out activities to develop and reengineer the Graphical User Interface (GUI) for acquisition and processing the imagery from the integrated cameras (Infrared and Thermal) mounted in the manned airplane as described and developed in D.4.1. Thanks to the work done in the tasks described in that document with the selection of state of the art development technology and industrial machine vision standards like GigE Vision and GenICam, it has been possible to advance in the development of the GUI.

In the document we can see that actually two GUIs have been developed. These new two GUIs are organized in two software solutions, one is the acquisition GUI and is called WADIFI and the other is the data processing GUI and is called WADIleaks, that is also complemented with the existing AIRMON ground segment software. In any case the two GUI accomplish the WADI requirements and have full functionality and potential to be considered a powerful and innovative concept in airborne water leaks detection.

For developing the new GUI we have changed the typical approach of conventional detection procedures of just using high resolution imagers for visual photointerpretation, to an innovative one that incorporates advanced thermal and multispectral sensors and new data processing and surveillance techniques. For achieving this objective, we have reengineered with a new GUI, the board acquisition and processing software.

Table of Content

List of Acronyms

GCP	Ground Control Point
IMU	Inertial Measurement Unit
IR	InfraRed
LWIR	Long Wavelength InfraRed
SMC	Soil Moisture Content
MAV	Manned Air Vehicle
NDVI	Normalized Difference Vegetation Index
OSAVI	Optimized Soil-Adjusted Vegetation Index
SWIR	Short Wavelength InfraRed ([1.0-2.5 µm] waveband)
VNIR	Visible and Near InfraRed ([0.4-1.0 µm] waveband)
WPn	Work Package n
D.n	Deliverable n
GUI	Graphical User Interface
SHP	Shapefile
CLI	Common Language Infrastructure
ECMA	European Computer Manufacturers Association
GDAL	Geospatial Data Abstraction Library
MSVC	Microsoft Visual C++
SDK	Software Development Kit
IDE	Integrated Development Environment
HCI	Host Controller Interface
RGB	Red, Green, Blue

Foreword

WADI is a H2020 funded project (Grant Agreement No. 689239) aimed to develop an airborne water leak detection surveillance service in water transportation infrastructures. The project relies on innovative concept of coupling and optimising off-the-shelf optical remote sensing devices and their application on two complementary aerial platforms - manned and unmanned - used for distinctive purposes in infrastructure performance observation, i.e.: long distance and strategic infrastructure monitoring, and difficult and/or dangerous areas observation.

The current deliverable D4.2 "*Software user's guide - user's manual for the resulting software after the smart improvement of WADI sensor data processing*" belongs to Work Package 4 viz. "*Smart data processing and standardization*", whose primary aim is to implement the software reengineering and GUI development of WP4.3.

Deliverable D4.2 specifically refers to the outcomes of Task 4.3, which comprises Subtasks 4.3.1, 4.3.2 and 4.3.3 as detailed below.

- Task 4.3. Software reengineering and graphical user interface development
    - Subtask 4.3.1 On-board processing software reengineering.
    - Subtask 4.3.2 Data processing software reengineering.
    - Subtask 4.3.3 Graphical User interface (GUI) and User's Guide development.

The report's preparation has been coordinated by NTGS, with active collaboration from GG and ONERA and LNEC.

1 Introduction

WADI develops an airborne water leak detection surveillance service in water transportation infrastructures. The project relies on innovative concept of coupling and optimising off-the-shelf optical remote sensing devices and their application on two complementary aerial platforms - manned and unmanned - used for distinctive purposes in infrastructure performance observation, i.e.: long distance and strategic infrastructure monitoring, and difficult and/or dangerous areas observation.

The task is to reengineer the existing software beyond the state of the art and to develop an ergonomic graphical user interface (GUI). The operations include all processing, described in Tasks 4.1 and 4.2 as well as launching and monitoring the execution and showing and managing the results when necessary, according to the standards and platform definition requirements.

1.1 AIRMON background

AIRMON is an enhanced linear monitoring modular system designed for pipeline monitoring. It allows full database compatibility between image-based surveillance and direct visual surveillance. It is a global system process composed of a precise flight plan software, an on board monitoring equipment, a ground detection equipment and a customer report interface.

SURVAIR is flight planning software designed for surveillance missions.

The on board AIRMON monitoring equipment is an ergonomic console fully equipped with: an imager, a gyroscopic platform, a calculator, an image capture software, a georeferencing software, a detection software, an HCI, a data transfer system, etc.

The AIRMON ground detection segment is based on a human visual analysis software for anomalies' detection.

The VIEWAIR solution allows customers to access and review any images of anomalies, comments and analysis.

2 On-board processing software reengineering.

The surveillance missions proposed by the WADI project differ significantly from pipeline monitoring missions. Although both surveillance activities are oriented to pipeline monitoring, the AIRMON approach is focused on pipeline integrity whereas the WADI approach is based on leaks detection not necessarily visible at naked eye. The first approach requires the use of very high resolution imagers for visual photointerpretation while the second requires the use of equipment and procedures much more complexes. The adaptation to the proposed equipment, surveillance technics and data processing requires the reengineering of the on board acquisition and processing software.

The software associated to monitoring and on-board process defined in Task 4.1 has been reengineered according to the sensor system defined in Task 3.1 and the associated relevant requirements.

2.1 Relevant requirements

2.1.1 Surveillance mission requirements

The leaks detection surveillance requires photogrammetric quality spectral mapping. This kind of surveillance is based on the automatic acquisition of multispectral and thermal IR images with a certain overlap that makes possible to obtain spectral registered orthomosaics as primary products to obtain data processing products of higher level like a cartography of leaks areas.

The reengineered software must allow a more autonomous acquisition process which allows the parameters' configuration of both cameras (exposure, gain, trigger mode, etc.), the trigger of both cameras simultaneously, the acquisition of inertial and geographic position data for each acquired image, and which ensure the compliance of the required front and side overlap.

2.1.2 Selected equipment requirements

The proposed payload increases the number of sensors to two for acquiring multispectral and thermal IR images simultaneously. Both sensors are scientific/industrial grade and the communication between the operator control equipment and the sensors is done through a standard industrial BUS and protocol. The two sensors have a GigE port GigE Vision compliant and are accessed by means of the GeniCam protocol. Although GigE Vision and GeniCam are widely used industrial standards, the complexity faces to consumer products like RGB cameras increases.

2.2 Technology and tools selection

The providers of the cameras usually offer an SDK to allow the integration of their products in the customer's software. Noxant, manufacturer of the NoxCam thermal IR camera, offered a customised Linux ARAVIS based SDK. Despite the SDK is provided for the Win32 platform, ARAVIS is a Linux SDK which makes use of the Gnome Library Glib among other Linux libraries recompiled under Win32. This SDK was rejected due to an unsatisfactory integration test because of the low quantity of sample code and the lack of proper documentation to shorten the learning curve of this technology.

Pixelteq, manufacturer of the SpectroCam, offered its own SDK running on an old version of the JAI cameras SDK. The SDK has only two examples with a very pour documentation. The launch of the examples failed under Win10/64 bits. The provider confirmed that the SDK works only on Win7 with the old version of the JAI SDK (v1.4.1) and using the MSVC 2013 (C++) as the most recent IDE. The use of the Pixelteq SDK was also rejected.

A primary version of the software interface was programmed in .Net C# using the ActiveGige commercial SDK as an alternative to these rejected SDKs. Unfortunately, the Pixelteq provider did not provide the support of a software programming team with the low level information necessary to make the filter wheel of the SpectroCam work. The software interface was then reprogrammed in C++ using MSVC 2013 under Win7 to be able to use the Pixelteq SDK to access and control the SpectroCam.

The current version of the software interface is called WADIFI (WADI Flight Interface), runs under Win7 and has been programmed in C++ using MSVC 2013. It makes use of the ActiveGige SDK to access and control the NoxCam and the Pixelteq/JAI SDK to access and control the SpectroCam.

2.3 WADIFI

A new GUI has been designed assuring the optimal interaction of users with WADI sensor devices integrated for the best performance and collection of the information on leaks. The interface comply ergonomics guidelines for harmonizing the interaction between users and sensors.

The WADIFI software allows:

- The real-time monitoring of both cameras.
- The configuration of the cameras (exposure time, gain, trigger mode, etc.).
- The calculation of relevant mission planning parameters such as the time and the distance between two camera shots or the distance between flight lines.
- The selection of trigger mode (maximum frame rate or timed).
- The acquisition of attitude and geographic position data associated to each picture.
- The storage and the transfer of the images to an external drive.

WADIFI is optimised for photogrammetric surveillance although it allows also the visual surveillance.

An in depth WADIFI user guide is provided in the section 4 of this document.

3 Data processing software reengineering

The data pre-processing and data processing must be accomplished at ground segment to generate the outputs that will be analysed by the leaks detection operator.

Although the anomalies detection is performed by visual analysis in the ground segment, the current AIRMON photointerpretation software allows the load of raster and vector data in the most usual file formats like GeoTiff and SHP respectively. In these terms, the photointerpretation software can be reused.

The data processing and model defined in Task 4.2 must provide to the existing photointerpretation software the necessary inputs to provide operators with the orthomosaic and the automatically generated leaks information layer.

The validation cases delivered in D4.1 (subtask 4.2.3) provide the necessary feedback to assess and validate the relevance of the reengineering process undertaken (see 4.4).

3.1 Pre-processing and (post-) processing pipeline

The data processing pipeline was described in Tasks 4.1 and 4.2 and is summarized by the Figure 1. The pre-processing step takes the acquired images and generates the necessary inputs for the data processing step (orthomosaics).

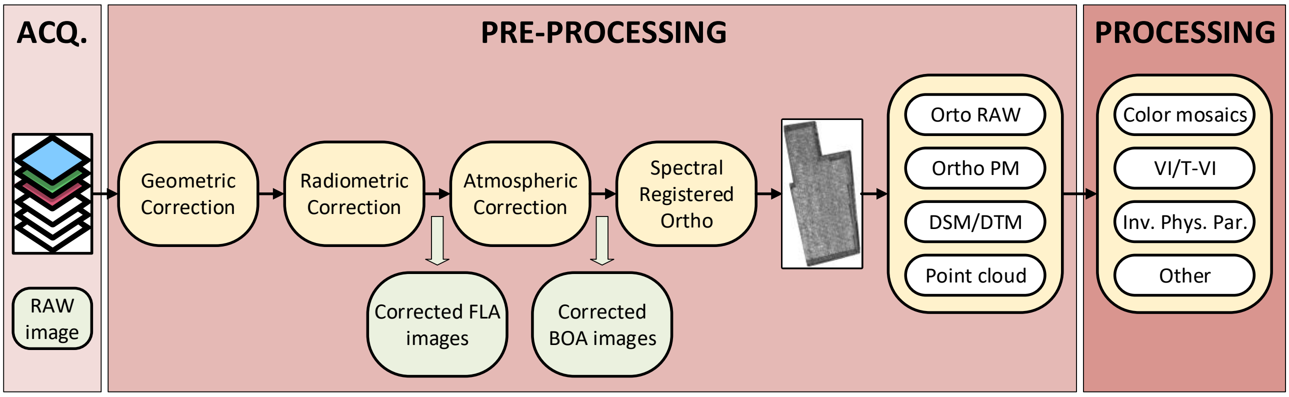

Figure 1 - Data processing pipeline.

The processing step consists on the generation of the necessary vegetation index (NDVI, OSAVI), the generation of a temperature-vegetation index scatterplot, the manual or automatic set up of the cold and warm edges, the generation of the water index orthomosaic and the threshold range segmentation of the water index orthomosaic. The segmented water index orthomosaic shows the areas corresponding to possible leaks.

The pre-processing step is done by a commercial photogrammetric software like Pix4D Desktop, Agisoft Photoscan or Correlator 3D. The processing step must be carried out by the proposed software solution.

3.2 Relevant requirements

The data processing pipeline of the Figure 1 is a sequence of complex data processing steps only available for remote sensing professionals. To overcome this fact, it is necessary to develop a software tool which abstract the user from the underlying complexity. The GUI must be capable of calling the pre-processing software in a transparent way to the user.

The execution flow must be simple without losing the flexibility of manual data processing.

The data processing software must provide the products generated by the intermediate steps and at the end of the execution:

- Spectral co-registered orthomosaics (multispectral and thermal IR).
- Vegetation index orthomosaics.
- The T-VI scatterplot.
- The water index orthomosaic.
- The segmented water index orthomosaic in raster and vector format.

3.3 Technology and tools selection

The data processing GUI did not have specific technical constraints regarding the development technology. A preliminary version has been coded in C++ under MSVC 2017 using Microsoft Foundation Classes libraries. The final version can be coded in .Net C# under MSVC 2017 because of the greater amount of COM components available.

GDAL libraries have been used to make it possible to work with georeferenced raster and to generate vector output data.

3.4 WADILeaks

A new GUI called WADILeaks has been designed assuring the ease of use to the anomalies detection operators.

The WADILeaks allows:

- The pre-processing from multispectral and thermal IR images.
- The import of pre-processed data.
- The selection of bands to be used for the generation of the vegetation indexes orthomosaics.
- The generation of vegetation indexes orthomosaics.
- The import of generated vegetation indexes orthomosaics.
- The generations of the T-VI scatterplot.
- The manual or automatic set up of the warm and cold edges.
- The generation of the water index orthomosaic.
- The specification of threshold ranges of water index combined with vegetation index for segmentation of the water index orthomosaic.
- The final save of the results in raster and vector format.

WADILeaks is complementary to the current AIRMON visual analysis software.

4 Graphical User interface (GUI) and User's Guide development

4.1 Development tools

The selected development tools (MSVC 2013/17) and programming languages (C++/C#) are well known, modern, powerful and robust. Both C++ and C#, are efficient, rapid and convenient to create the required software package. Microsoft Visual Studio (MSVS) is a visual IDE very intuitive focused on the visual development through the Windows Forms Designer and associated Toolboxes. Windows Forms controls are reusable components that encapsulate user interface functionalities and are used in client side Windows based applications. A control is a component on a form used to display information or accept user input. The Control class provides the base functionality for all the controls that are displayed on a Form.

Windows Forms are the Graphical User Interface (GUI) libraries of the Microsoft .NET Frameworks. The Windows Forms library contains most of the graphical controls familiar to GUI programmers. All of the concepts learned in previous chapters are applied when doing GUI programming. Of special significance is the use of events to connect GUI controls, such as buttons, to the code that implements the program's behaviour related to that control.

Windows Forms is not included in the proposed Common Language Infrastructure (CLI) submission to European Computer Manufacturers Association (ECMA). However, it is of such importance to development that its coverage is provided here. Specific emphasis is placed on how C# is used to produce GUIs, and the language constructs involved. The same C# language features are likely to be applied to any future GUI implementations.

The basic element of most GUI programming in Windows Forms is the window. Essentially, everything on a GUI screen—buttons, text boxes, and icons—are windows. Because of this, most of the windows and controls in the Windows Forms package have the same characteristics. For instance, they all have a Text property. How they use the property is up to the specific type of window.

4.2 WADIFI GUI

Developing an efficient and robust lightweight graphic user interface (GUI) for the WADI airborne computer monitoring of water leakages has been a challenging task. Current implementation methods for on-board GUI are with the matters of real-time processing and ergonomics performance. To address the issue, an on-board lightweight GUI reengineering was proposed for the project.

In the Figure 2, we can see a general view of the GUI main window accomplishing all the requirements for the WADI concept and also the mentioned ergonomics performance.

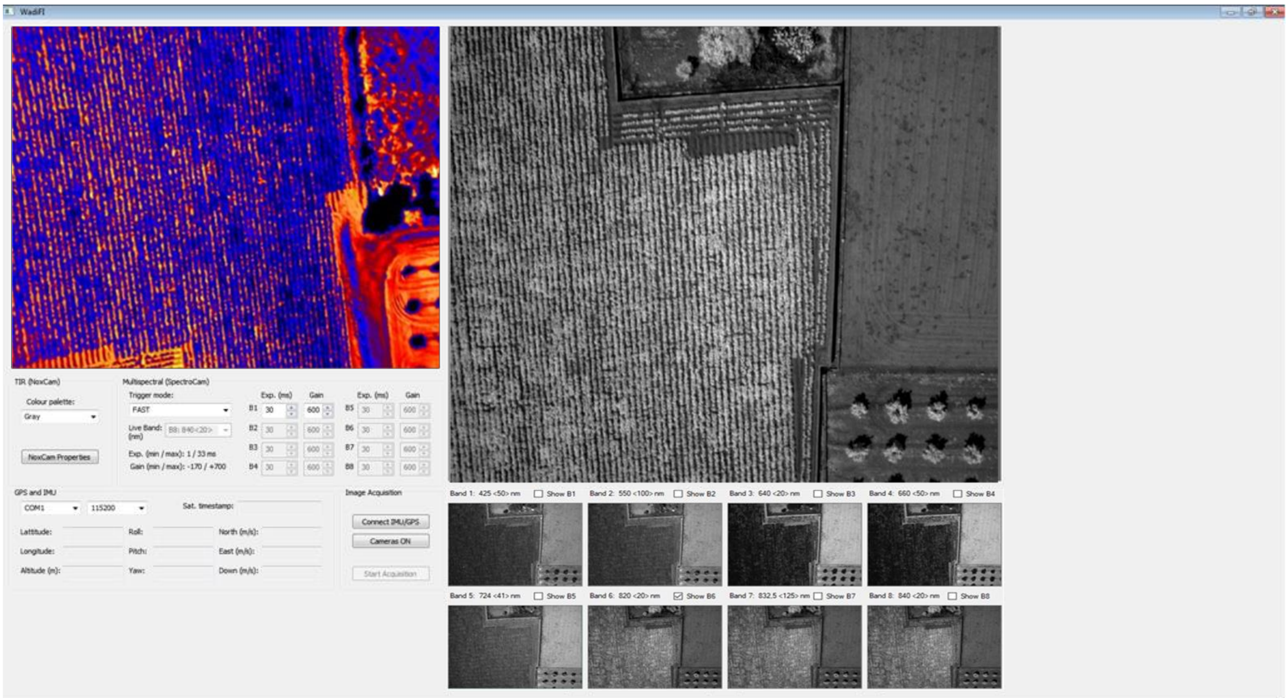

Figure 2 - General view of the GUI main window.

The GUI main window shown in the Figure 2 present two main pictures, from left to the right, the first image shows a NoxCam thermal IR camera real-time view and the second image shows a real-time view of the selected SpectroCam band. The GUI shows also the thumbnail pictures acquired for each band.

The GUI allows the rapid configuration of both cameras to suit the needs of each mission. Other operations like the mission planning, the acquisition mode change or the external data transfer can be also performed. The IMU and GPS navigation parameters are displayed in real-time and stored with each trigger of the cameras.

4.2.1 NoxCam thermal IR camera

The GUI shows a nadir shot of the NoxCam thermal IR camera mounted in the manned airplane from Air Marine (Figure 3).

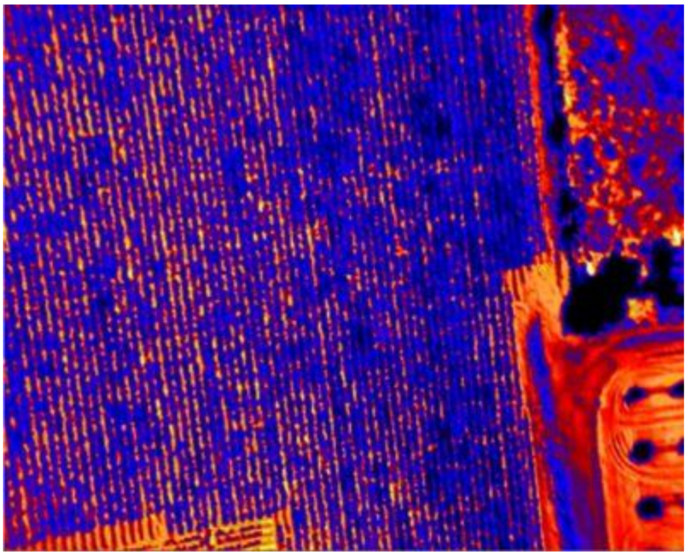

Figure 3 - Thermal IR image capture (NoxCam).

The colour of the image in the Figure 3 is just an example, it can be changed depending on the mission requirements. The use of the rainbow or fusion palette (warmer pixels in red and colder pixels in blue) is very common in thermography visual analysis although it is not recommended for the purpose of WADI. The best choice in the frame of this project is to use the Gray palette (grayscale). Although the colour palette only affects the visualization. The acquired data are always acquired in grayscale.

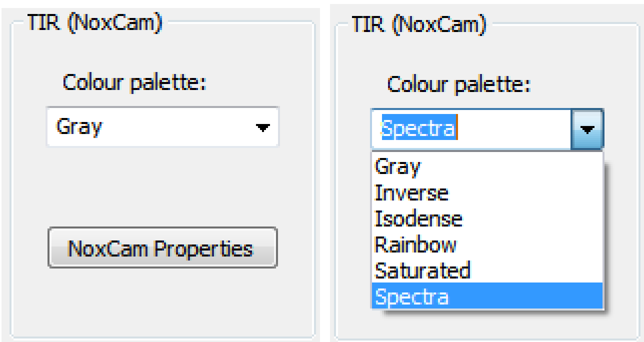

Figure 4 - Colour palette configuration for the NoxCam thermal IR camera

The camera properties are covered in depth in section 5.

4.2.2 SpectroCam multispectral camera.

The top center part of the Figure 2 shows a nadir view of one of the bands of the SpectroCam.

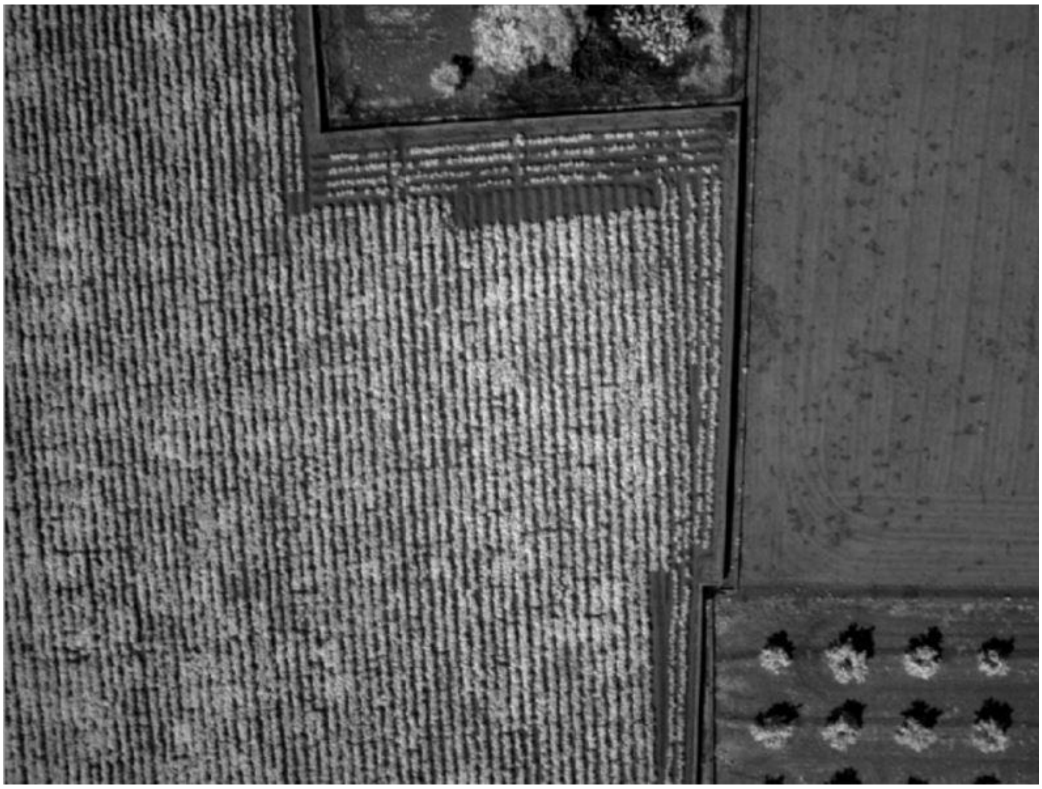

Figure 5 - Multispectral image capture (SpectroCam).

The SpectroCam captures eight bands (425, 550, 640, 660, 724, 820, 832.5, 840 nm) thanks to a filter wheel that makes available each filter sequentially. The central image view can be selected among the eight available bands as shown in the Figure 5.

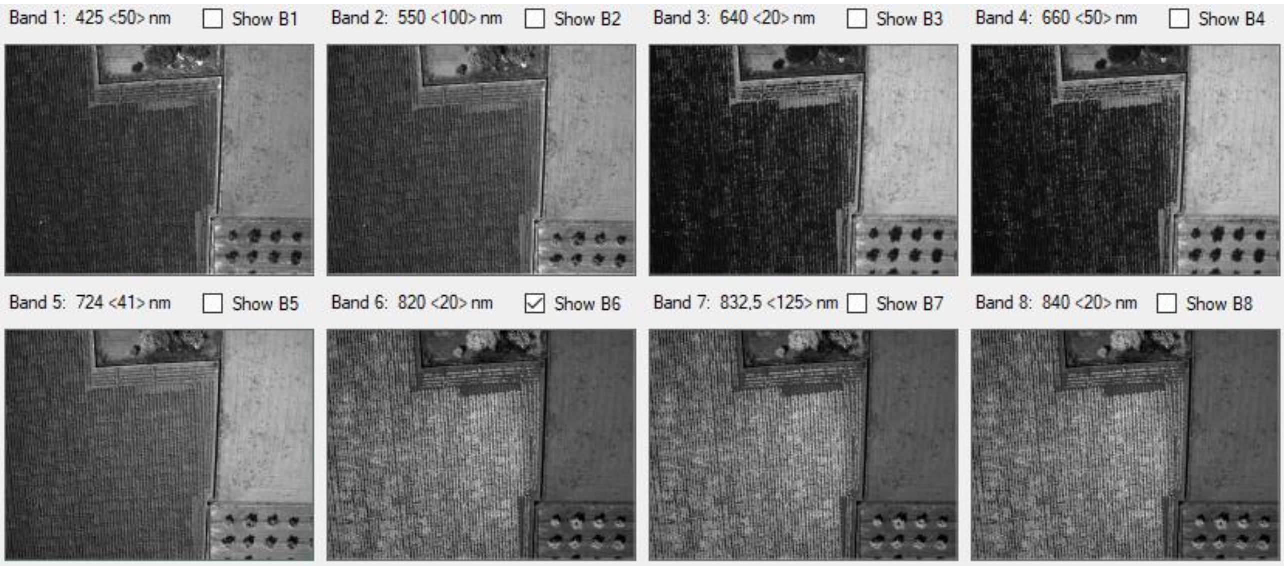

Figure 6 - Images from SpectroCam filters.

The Figure 6 shows the thumbnails of the images of each band in every acquisition.

The SpectroCam can be triggered in different modes. Three of these modes have been implemented, FAST, SEQUENTIAL and LIVE. The fast mode acquires the images at the maximum frame rate. The Figure 7 shows the SpectroCam configuration section.

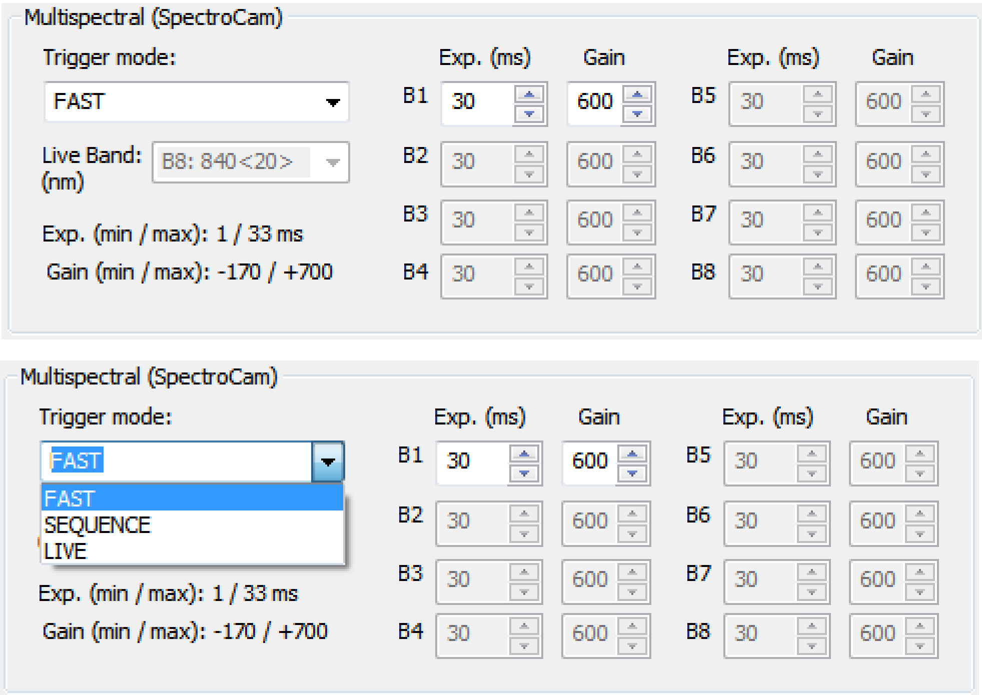

Figure 7 - Capture mode and bands configuration.

When the FAST mode is selected, only the parameters (exposure and gain) of the first band are enabled. In this mode all the bands have the same exposure time and gain settings.

The sequential mode is slightly slower but allows to set a different exposure time and gain for each band.

The live mode allows to see in live mode with the selected filter/band.

4.2.3 Image acquisition

The image acquisition is always done at maximum frame rate (in FAST mode 20 fps (multispectral camera), 5 fps (TIR camera)) of the cameras. The acquisition section shown by Figure 8 allows connection with the IMU and GPS, the start/stop of the cameras and the start/stop of the image acquisition.

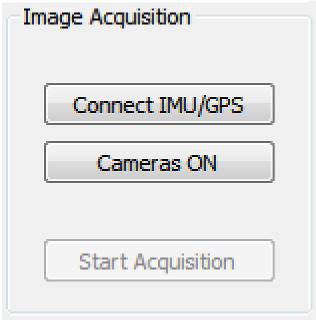

Figure 8 - Image acquisition.

To start an acquisition, the IMU/GPS must be connected first. The cameras must be activated only when the interface start receiving IMU and GPS data. If the interface is receiving data from the IMU/GPS and the cameras are ON, the "Start Acquisition button" is automatically enabled and the acquisition is ready. The "Start Acquisition" button, starts the acquisition of images from both cameras as well as geographic and attitude data from the IMU/GPS.

4.2.4 GPS and IMU

This section allows to setup the COM port and the speed of the serial port. The interface displays geographic data (Lattitude, Longitude and Altitude), attitude data (Roll, Pitch and Yaw), the speed components (Noth, East and Down) and the timestamp once the settings of the COM port are correct and the "Connect IMU/GPS" button is pressed.

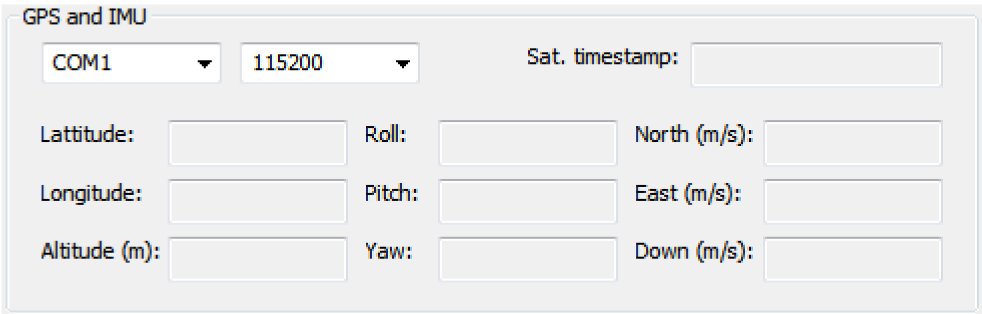

Figure 9 - External disk storage option.

4.3 WADILeaks GUI

WADILeaks is a tool created in Matlab in the frame of the WADI project to process the spectral orthomosaics in order to obtain a water index orthomosaics. The processing tool has been implemented in a simple, friendly and intuitive way following the real data processing work flow. The tool has been implemented in Matlab to take advantage of its powerful image processing libraries. This graphical user interface implements all the steps of the processing pipeline. It allows the creation of orthomosaics from the raw image folders, the data range limitation, the background extraction, the normalization, the vegetation index generation, the visualization of images and histograms, the creation of scatterplots, the generation of the water index orthomosaics throw the setup of the cold and warm edges and the multirange segmentation (by water index and vegetation index ranges) of the water index orthomosaics. The Figure 10 shows the dialog window of this powerful tool.

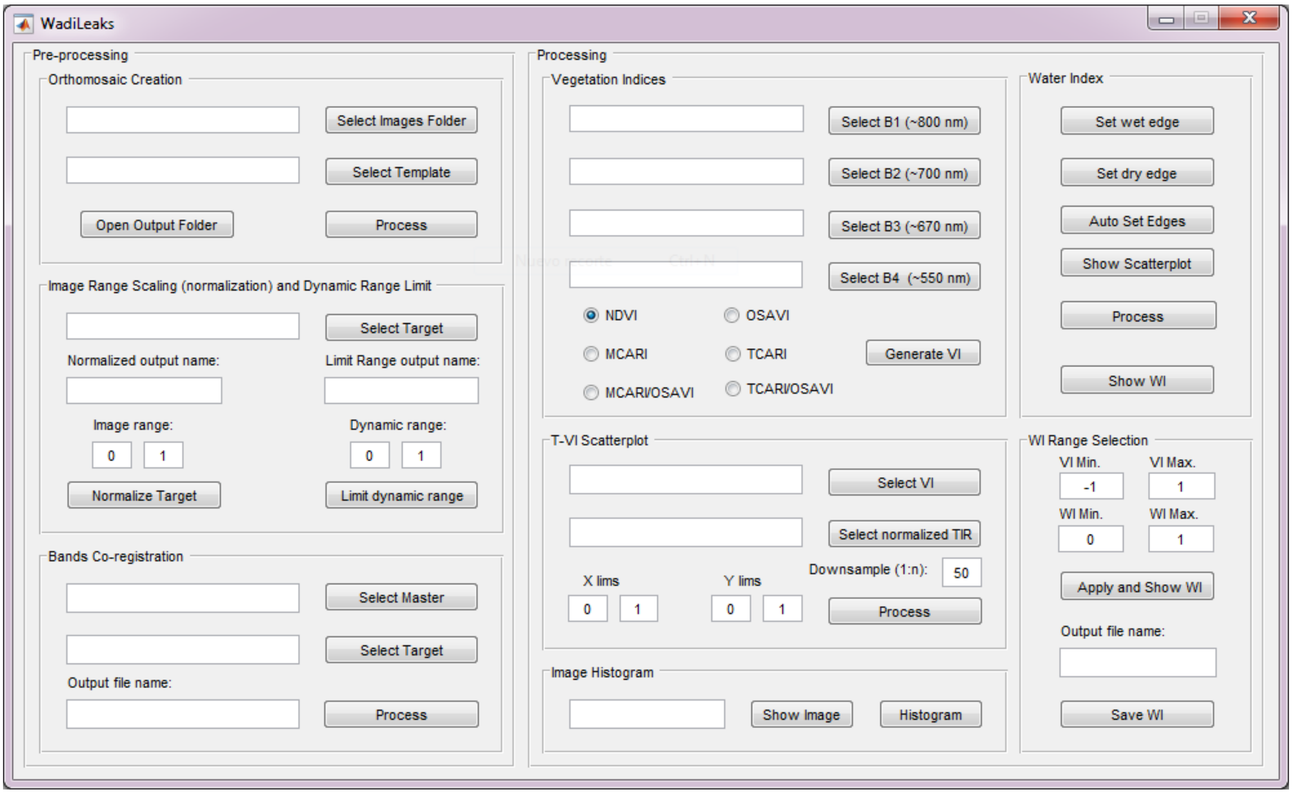

Figure 10 - WADILeaks GUI main window.

The controls have been grouped in eight sections following the five steps of the data processing and the results saving:

Pre-processing

Allows the specification of the folder path of the raw images (either multispectral or thermal) and the pre-processing template used to launch the pre-processing software in background. The commercial software Pix4D is used to make the preprocessing step (creation of the orthomosaics). Even if Wadileaks implements a front-end for the pre-processing or the orthomosaics in Pix4D, it is highly recommended to perform this step directly in Pix4D.

Image Range Scaling (normalization) and Dynamic Range Limit

This section allows to make a generalized normalization (range scaling) of the target image, that is to say, it allows to scale the range to the desired range. When the desired range is [0, 1], the range scaling is called normalization.

The range limit allows to limit the range of the values of the image. This is extremely useful to remove pixels with outlier values or the tricky background value prior to a normalization, the plot of an histogram or to any kind of process value dependent.

Bands Co-registration

This section allows the geographic alignment of two different images. This section is based in the Gefolki Matlab software created by ONERA. First of all, the algorithm performs the resize and the resampling of the target image to match the master image. The master image must be the image with the lowest resolution in order to avoid the generation of interpolated data whose will add noise in future processing steps (i.e. scatterplot). The co-registration of two images is size dependent and can require significant computing resources and/or can be very time consuming.

Vegetation Indices

Allows the generation of the specified vegetation index of two, three of four bands. The available indices are NDVI, OSAVI, MCARI, TCARI, MCARI/OSAVI and TCARI/OSAVI. The most used index is NDVI and it will be the best choice in most of the cases. Other indices like OSAVI or TCARI/OSAVI can be useful when the ground contribution is high enough to distort or mask the results.

Temperature-VI scatterplot

This section allows the generation and visualization of a scatterplot between an orthomosaics of normalized temperature and an orthomosaics of a vegetation index (NDVI or any other). The tool allows to setup the X and Y axes limits and to specify a downsample factor. This factor will be of special interest in the case of big images that entail very massive point clouds. The default downsampling factor is 50. The Figure 11 shows a scatterplot generated by this section of Wadileaks.

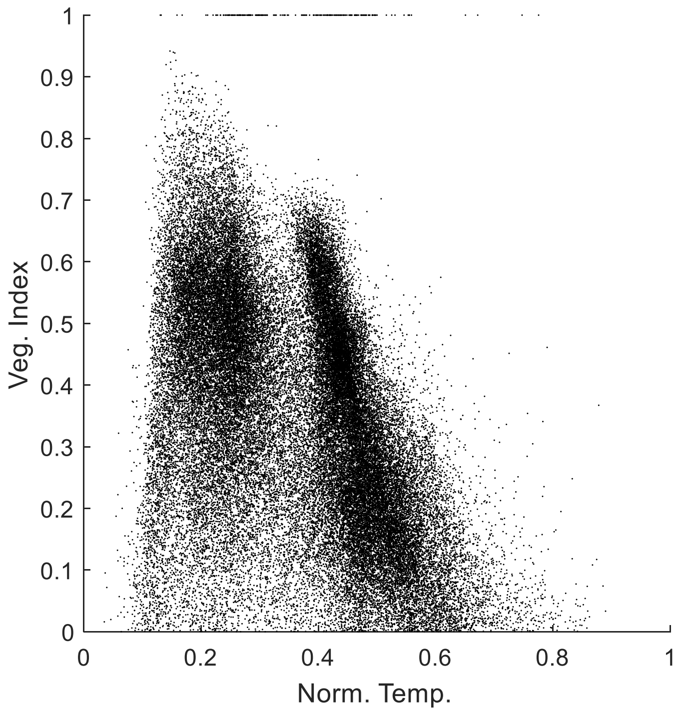

Figure 11 - Scatterplot between the normalized temperature and the vegetation index.

Image Histogram

It allows the visualization of an image or the generation of its histogram. When the histogram is generated the Matlab console shows the maximum and minimum pixel values of the image. The Figure 12 shows the histogram of an image created from this section.

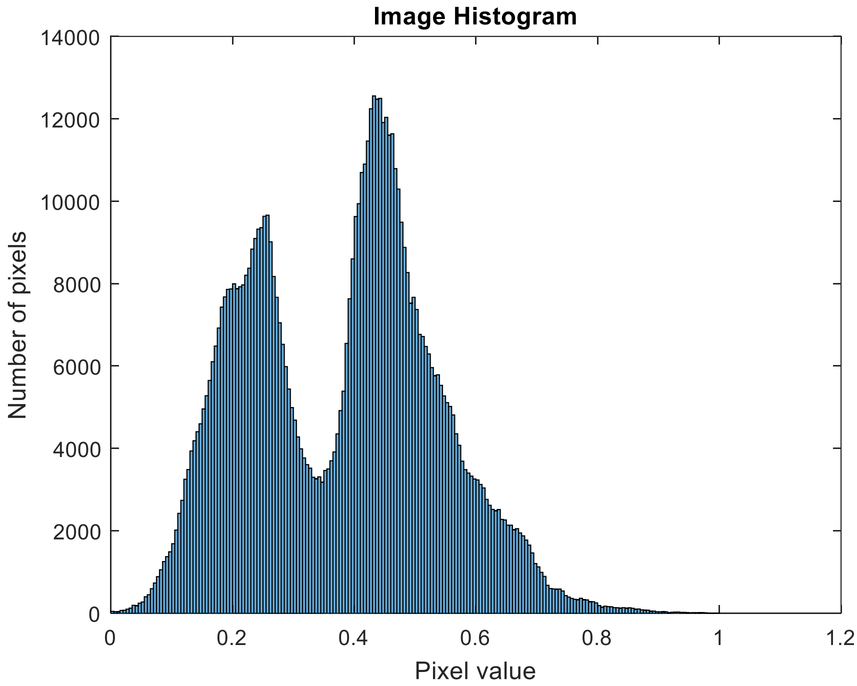

Figure 12 - Histogram of an image created from the Image Histogram section.

Water index

Allows the generation of the water index orthomosaics by establishing the cold and warm edges necessary for the triangle/trapezoid algorithm. The cold and warm edges can be setup either manually or automatically even though the better results are obtained by setting the edges manually. The Figure 13 and the Figure 14 show respectively the setup of the cold/wet edge in blue and the warm/dry edge in red in the scatterplot and the resulting water index orthomosaics in blue scale color.

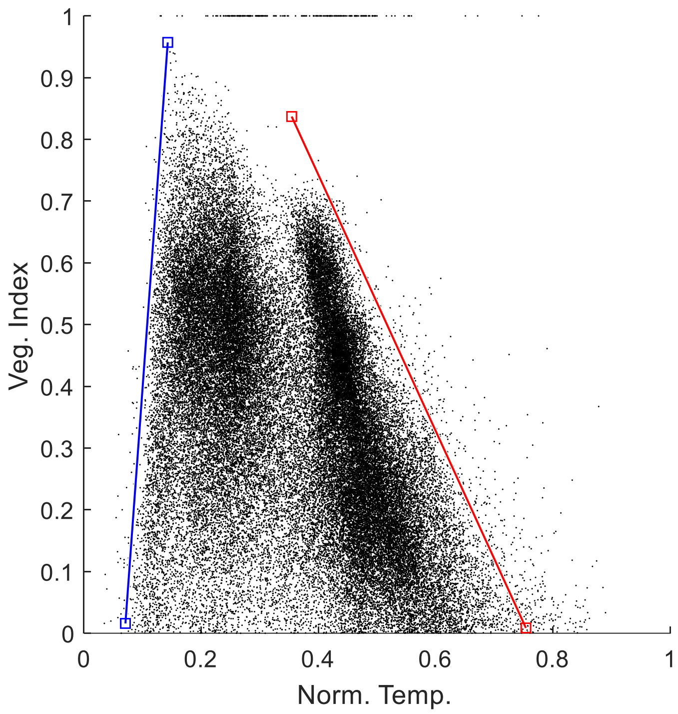

Figure 13 – Manual setup of the cold/wet (blue) and the warm/dry (red) edges.

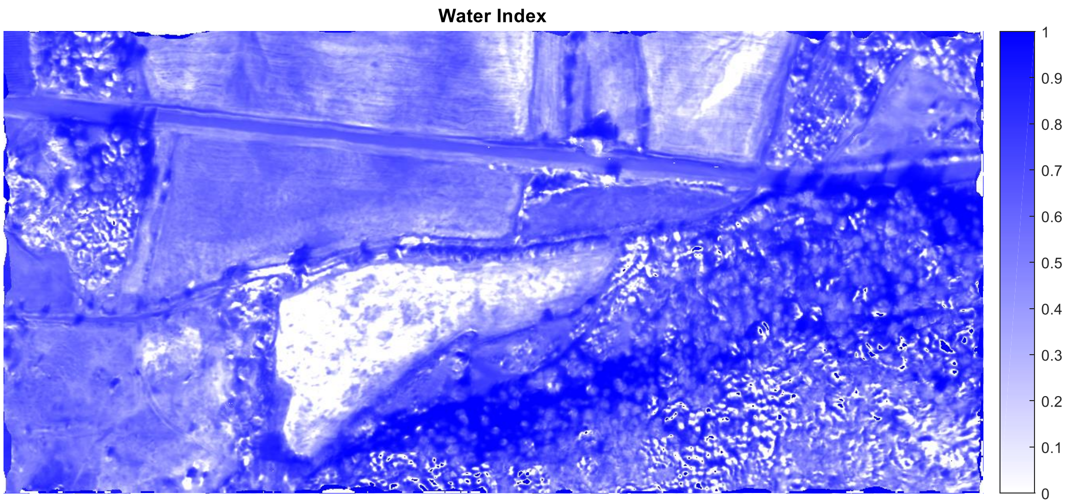

Figure 14 – Resulting water index orthomosaics.

An interpretation of the water index orthomosaic is needed to find possible water leaks due to the parasitic presence of elements in the image which can lead to a bad interpretation of the image. For instance, the vegetation with diferent leaf area index (leaf density), the shadows or a combination of both can give high values of the water index without any presence of water.

WI Range Selection

In this last section, the water index mosaic can be segmented by value ranges of water index and vegetation index. That said, after introducing the range values, the tool will show the pixels which are only in a water index range and in a vegetation index range. Finally when the result is satisfactory with or without segmentation, the water index can be saved in TIFF format.

Conclusions

Two software GUIs for the acquisition (WADIFI) and the data processing (WADILeaks) have been designed and implemented focusing on ergonomics compliancy and ease of use.

The AIRMON GUI for the acquisition of images has been replaced by the proposed solution. The GUI for data processing complements the AIRMON ground segment software without any change on the current software tool.

Both interfaces have reached the compromise between all the requirements and a powerful functionality which establish a new concept in leaks detection.

The implementation has been possible with the selection of state of the art development technology and industrial machine vision standards like GigE Vision and GenICam.

5 Annex I: Property page

The following annex describes the property page provided by the ActiveGige class. This is an extract of the ActiveGige SDK user manual. Not all the properties are available to all the cameras. Each manufacturer implements the GenICam parameters necessary to its specific product.

5.1 Source

This property page is used to select the properties specifying the source for the video input.

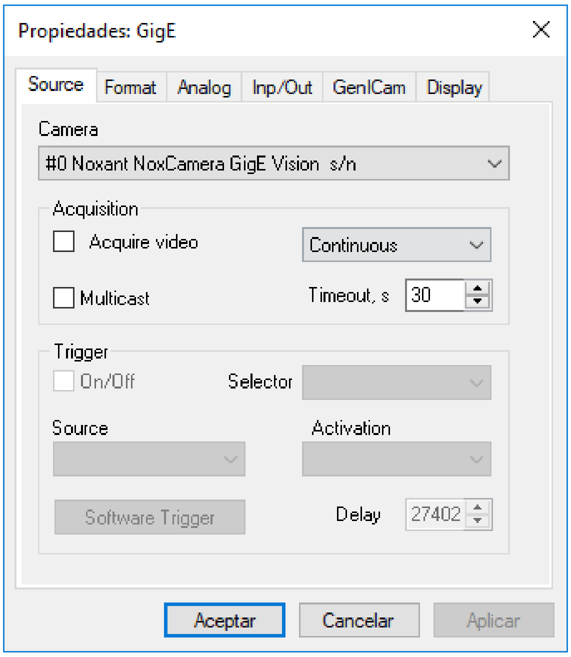

Figure 15 – Properties of the source video input.

Camera

Displays the vendor's name and model of the currently selected camera. If you have more than one GigE Vision™ camera connected to your system, you can switch to another camera by choosing the corresponding camera name in the list. Equivalent to the Camera property.

Acquire

Allows to enable the continuous acquisition mode. If this box is checked, the camera will continuously acquire the video into the internal image memory. If the control is visible, the live video will be displayed in the control window. Equivalent to the Acquire property.

Multicast

Check this box to enable the Multicast mode which allows multiple computers and applications on the network to receive the video feed from the same camera. Only the first application that connects to the camera can enable or disable the Multicast mode. All other *ActiveGige* based applications launched in the network can acquire and display the video in the slave mode, but will have no control over the camera settings. This option is equivalent to the Multicast property.

Timeout

Use this option to set the number of seconds to wait for a frame to be acquired. Typically used to assign the timeout when the Trigger mode is active. If the timeout expires, the Timeout event event will be raised. Equivalent to the Timeout property.

Acquisition mode

Allows to select the desired acquisition mode from the list. The acquisition mode defines how many frames will be captured when the **Acquire** option is enabled. Equivalent to the AcquisitionMode property.

Trigger Source

Allows to select the configuration of a trigger signal. The rest of the options in the Trigger group are dependent on this selection. Equivalent to the TriggerSelector property.

Trigger

Check this box to enable the selected trigger. This mode is typically used with an asynchronously resetable camera. An acquisition will occur upon receiving a signal from an external hardware **Trigger Source**. Equivalent to the Trigger property.

Trigger Source

Allows to select the source for the selected trigger. Depending on a camera, there may be one or more hardware trigger inputs as well as the software trigger. If the software trigger is available and selected, use the **Software Trigger** button to simulate the trigger event. If the camera doesn't support trigger source selection, this option will be unavailable. Equivalent to the TriggerSource property and SoftTrigger method.

Trigger activation

Allows to change the activation mode (trigger signal polarity) for the selected trigger. Equivalent to the TriggerActivation property.

Trigger delay

Allows to select the value for the trigger delay which defines the time between the arrival of the trigger signal and its effective activation. Equivalent to the TriggerDelayRaw property.

5.2 Format

This property page is used to select the properties specifying the format of the video stream.

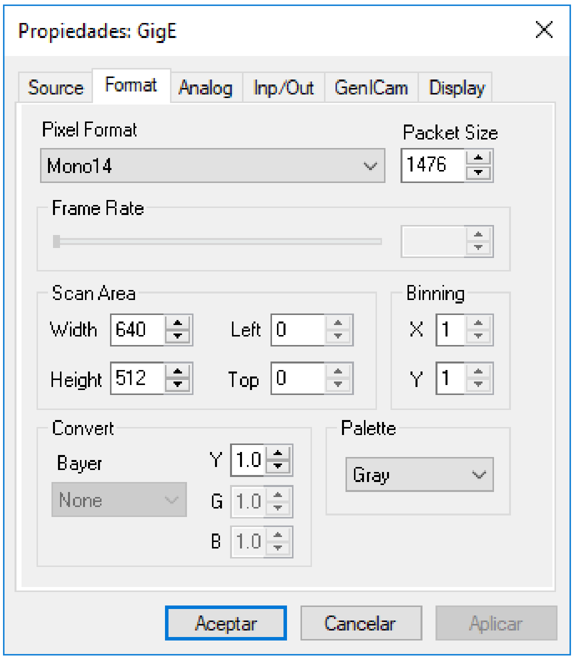

Figure 16 – Properties of the image format.

Pixel Format

Use this option to select the desired pixel format from the list of modes available for the current camera. Equivalent to the Format property.

Packet size

Use this option to select the number of bytes in the image data packet. To lower the overhead of the packet transmission, it is recommended to set this property to the maximum packet size allowed by your network card and network configuration (typically 1500 if Jumbo packets are disabled and 9014 if Jumbo packets are enabled). Equivalent to the PacketSize property.

Frame rate

Use this option to set the acquisition frame rate in frames per seconds. Note that the actual frame rate can also depend on the exposure time. Equivalent to the AcquisitionFrameRateAbs property. If the camera doesn't support this property, the Frame rate option will be unavailable.

Scan Area

Allows to change the size and position of the image window on the camera's sensor. To modify the size and position of the window, enter the desired values for the image width, height, left coordinate and top coordinate in pixels. Equivalent to the SizeX, SizeY, OffsetX , OffsetY properties.

Binning

Allows to change the number of horizontal and vertical photo-sensitive cells that must be combined together. This property has a net effect of increasing the intensity (or signal to noise ratio) of the pixel value and reducing the horizontal size of the image. If the camera doesn't support the binning, this option will be unavailable. Equivalent to the BinningX and BinningY properties.

Bayer

Select this option to activate the real-time color conversion of a monochrome raw video generated by a Bayer camera and select the specific Bayer conversion algorithm. Select one of the following options:

- *None* - Bayer conversion is disabled. The camera will output a monochrome raw image.
- *Nearest* - Nearest Neighbour filter. Missing pixels are substituted with adjacent pixels of the same color.
- *Bilinear* - Bilinear filter. Calculates the values of missing pixels by performing bilinear interpolation of the adjacent pixels.
- *Bilinear HQ* - High Quality Linear filter. Calculates the values of missing pixels based on the Malvar, He and Cutler algorithm.

See the Bayer property for more information.

R, G , B , Y

Allows to adjust the gain factors for individual color channels or the intensity factor for a monochrome video. Equivalent to the SetGains property.

Palette

Allows to select one of a few predefined palettes to be applied to a grayscale live video. The palettes represent choices that may be useful in viewing different kinds of video in pseudo-colors. Choose among the following palettes:

Gray

Applies the standard 256-level grayscale palette. This is a regular mode of viewing a grayscale video.

Inverse

Applies the inverted 256-level grayscale palette. The video will be displayed in the negative

format.

Saturated

Applies the grayscale palette with colorized upper entries. The saturated palette allows you to control the dynamic range of the video signal by bringing it slightly below the saturation level of the video camera or video amplifier. To achieve the maximum dynamic range, adjust the intensity of the light source and/or the gain and zero level of the video amplifier so that the red color corresponding to the brightest pixel values just barely shows up.

Rainbow

Applies a color palette where the entries are evenly distributed along the Hue axis. This allows for assigning different color pigments to different levels of intensity.

Spectra

Applies a color palette where the entries are distributed along the Hue and Luminance axes. That allows for assigning different color pigments to different levels of intensity while preserving the luminance scale.

Isodense

Applies the 256-level grayscale palette, each 8-th entry of which is colorized. The isodense palette allows you to clearly see transitions between different levels of intensities as isolines on a topographic map.

Multiphase

Applies the multiphase palette. Entries in the multiphase palette are at opposite ends of the color model so even small changes in gray levels are highlighted.

Random

Applies the random color palette whose entries are filled with random values each time you select it from the list.

This option is equivalent to the Palette property.

5.3 Format

This property page is used to select the properties specifying the analog features of the camera.

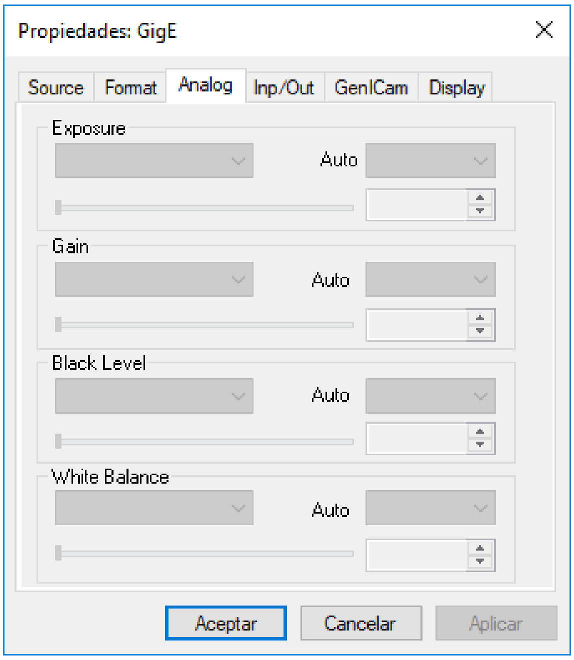

Figure 17 – Analog features of the camera.

Exposure Mode

Allows to select the operation mode of the exposure (shutter). See ExposureMode for more details.

Exposure Auto

Allows to select between the automatic (AE) or manual exposure control mode. Depending on the camera, the following selections can be available:

- *Off* - exposure is manually controlled using **Exposure Value** option.
- *Once* - the camera sets the optimal exposure level and returns to the "Off" state.
- *Continuous* - the camera constantly adjusts the exposure level.

The availability and possible values of this option depend on the ExposureAuto property.

Exposure Value

Use the slider and spin controls to adjust the integration time of the incoming light. You can also enter the desired exposure value in the corresponding text box. Note that this option is available only for the cameras that support the manual exposure control. Equivalent to the ExposureTimeRaw or ExposureTimeAbs property.

Gain Selector

Allows to select the color channel to be controlled by the **Gain Value** and **Gain Auto** options. See GainSelector for more details.

Gain Auto

Allows to select between the automatic (AGC) or manual gain control mode. Depending on the camera, the following selections can be available:

- *Off* - gain is manually controlled using **Gain Value** option.

- *Once* - the camera sets the optimal gain level and returns to the "Off" state.
- *Continuous* - the camera constantly adjusts the gain level.

The availability and possible values of this option depend on the GainAuto property.

Gain Value

Use the slider and spin controls to adjust the camera's video signal amplification. You can also enter the desired gain value in the corresponding text box. Note that this option is available only for the cameras that support the manual gain control. Equivalent to the GainRaw or GainAbs property.

Black Level Selector

Allows to select the color channel to be controlled by the **Black Level Value** and **Black Level Auto** options. See BlackLevelSelector for more details.

Black Level Auto

Allows to select between the automatic or manual black level control mode. Depending on the camera, the following selections can be available:

- *Off* - black level is manually controlled using **Black Level Value** option.
- *Once* - the camera sets the optimal black level and returns to the "Off" state.
- *Continuous* - the camera constantly adjusts the black level.

The availability and possible values of this option depend on the BlackLevelAuto property.

Black Level Value

Use the slider and spin controls to adjust the black level (brightness) of the video signal. You can also enter the desired black level value in the corresponding text box. Note that this option is available only for the cameras that support the manual black level control. Equivalent to the BlackLevelRaw or BlackLevelAbs property.

White Balance Selector

Allows to select the color channel to be controlled by the **White Balance Ratio** option. See BalanceRatioSelector for more details.

White Balance Auto

Allows to select between the automatic (AWB) or manual white balance control mode. Depending on the camera, the following selections can be available:

- *Off* - balance ration for a selected color channel is manually controlled using **White Balance Ratio** option.
- *Once* - the camera sets the optimal white balance level and returns to the "Off" state.
- *Continuous* - the camera constantly adjusts the white balance level.

The availability and possible values of this option depend on the BalanceWhiteAuto property.

White Balance Ratio

Use the slider and spin controls to adjust the ratio (amplification factor) of the selected color component. You can also enter the desired balance ratio in the corresponding text box. Note that this option is available only for the cameras that support the manual balance ratio control. Equivalent to the BalanceRatioAbs property.

5.4 Inp/Out

This property page is used to select the properties specifying input/output operations.

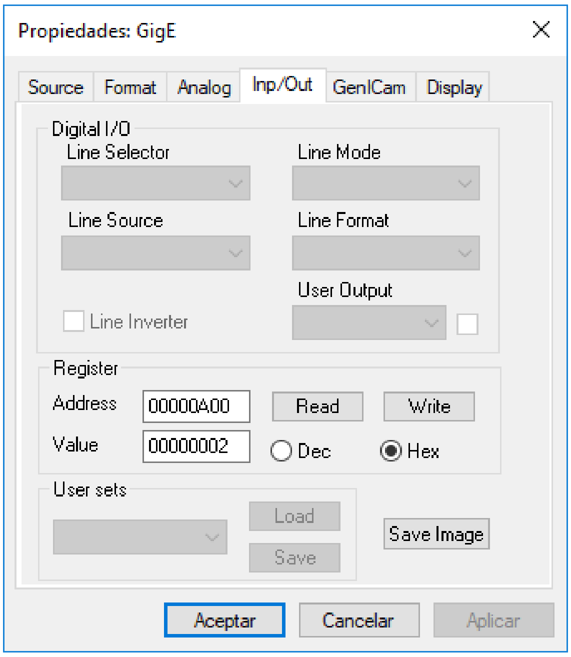

Figure 18 – Input/output operations.

Line Selector

Allows to select the physical line (or pin) of the external device connector to configure. Equivalent to the LineSelector property.

Line Mode

Allows to select the input or output mode for the currently selected line. Equivalent to the LineMode property.

Line Source

Allows to select the source of the signal to output on the selected line when the line mode is *Output*. Equivalent to the LineSource property.

Line Format

Allows to select the electrical format (TTL, LVDS, OptoCoupled etc) of the selected line. Equivalent to the LineFormat property.

Line Inverter

Select this option to have the electrical signal on the selected line inverted. Equivalent to the LineInverter property.

User Output

Allows to configure the bits of the User Output register. Checking/unchecking the box will set the selected bit to the High or Low state respectively. Equivalent to the UserOutputSelector and UserOutputValue properties.

Register

Allows to perform reads and writes to a selected register in the camera bootstrap address space. To perform the read operation, enter the desired hexadecimal address to the Address filed and click the Read button. The result will be displayed in the Value box. Depending on the Dec/Hex radio boxes, the result will be displayed either in decimal or hexadecimal form. To perform the write operation, enter a desired address and value to the Address and Value fields respectively, and then press the Write button. Equivalent to the ReadRegister, WriteRegister methods.

User set

Allows to load or store camera settings under the specified user set. Use the list box to select the desired user set. Use the Save button to store the current camera settings in the selected set. Use the Load button to load the setting from the selected set into the camera. See UserSetSelector for details.

Save image

Allows to save the current frame buffer in an image file. When you click this button, the Save As dialog box will appear where you can select the file name and one of the image file formats: BMP, TIF and JPEG. Note that BMP and TIF files will be recorded with no compression while JPEG files will be recorded with quality 75. Equivalent to the SaveImage method.

5.5 GenICam

This property page is used to access all the camera features per GenICam standard.

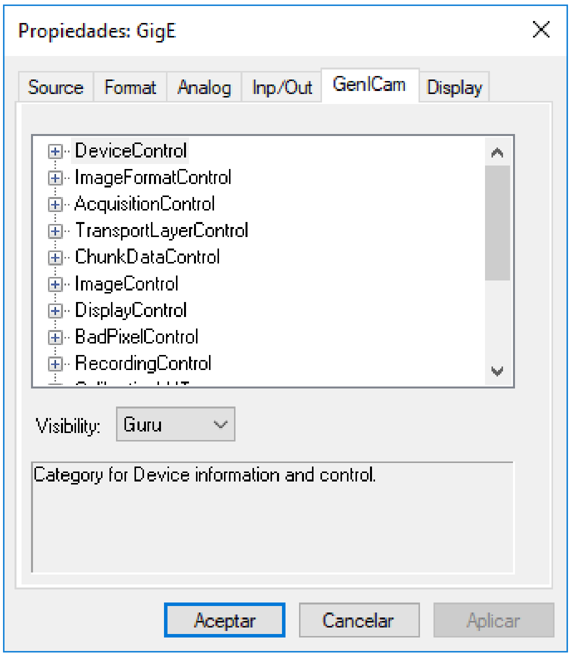

Figure 19 – Camera features per GenICam standard.

GenICam Tree

Shows all the camera features sorted by categories as reported by the camera's XML file. GigE Vision™ standard, which is a subset of the GenICam standard, uses XML files to expose all the commands and features available for a camera. To access a specific feature, browse through the categories and highlight the desired feature.

Feature Control

Depending on the type of the feature highlighted in the tree, the following options will become available:

Feature type	GUI control	Action
Integer	Text box + spin control	Adjust the feature value or enter the desired value in the text box
Float	Text box + spin control	Adjust the feature value or enter the desired value in the text box
Boolean	List box	Select "On" or "Off" value
Enumerated	List box	Select among available feature values
Command	Push button	Click the button to execute the command

Table 1 - Feature control options.

Feature Description

Shows the description of the currently selected feature. The availability of the feature description depends on the camera XML implementation.

5.6 Display

This property page is used to select the properties specifying the display settings of *ActiveGige*.

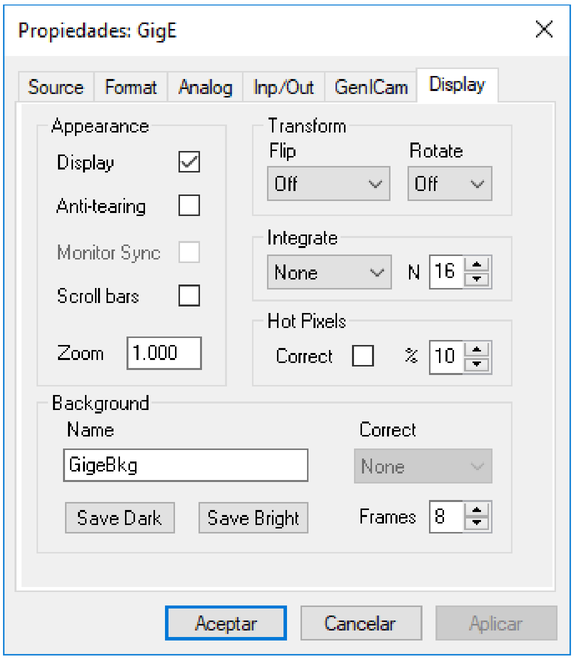

Figure 20 – Display settings of ActiveGige.

Display

Allows to enable or disable live display in the control window. You might want to disable the display option if you want to render captured frames by other means such as Picture box. When using DirectShow Video Capture Filter, setting this property to TRUE will activate the internal RGB24 conversion which is required by image data access and image analysis methods. Equivalent to the Display property.

Anti-tearing

Allows to enable or disable the anti-tearing feature. Anti-tearing removes horizontal tears in the live video caused by a difference between the camera frame rate and refresh rate of the monitor. Equivalent to the AntiTearing property.

Monitor Sync

Allows to enable or disable the monitor synchronization mode. If this box is checked, the camera frame rate will exactly match the refresh rate of the system monitor thus eliminating all the display artifacts related to the digital image transfer. Equivalent to the MonitorSync property.

Scroll bars

Allows to enable or disable the scroll bars in the control window. If this box is checked and the video width or/and height exceed the size of the control window, the scroll bar(s) will be displayed on the border of the control window allowing you to pan the live video. Equivalent to the ScrollBars property.

Digital zoom

Allows to adjust the magnification of the live video display. This option doesn't change the content of the image data, but only its appearance in the control window. If it is set to zero, the image will be fit to the size of the control window. In this case the display might not retain the original proportions of the video frame. Equivalent to the Magnification property. *Note - if the Display option is unchecked and Digital zoom is set to zero, ActiveGigE will enter a raw image transfer mode with the minimal CPU usage.*

Flip

Allows to select one of the flipping modes. Flipping affects the live video display as well as actual order of pixels in the frame buffer. Select among the following modes:

Off

No image flipping is performed.

Horizontal

The image is flipped horizontally.

Vertical

The image is flipped vertically.

Diagonal

The image is flipped horizontally and vertically.

This option is equivalent to the Flip property.

Rotate

Allows to rotate the image. Rotation affects the live video display as well as actual order of pixels in the frame buffer. Select one of the following modes:

Off

No image rotation is performed.

90°

The image is rotated counterclockwise.

180°

The image is rotated 180 degrees.

270°

The image is rotated clockwise.

This option is equivalent to the Rotate property.

Integrate Mode

Allows to select the frame integration operation mode. The frame integration allows you to average or add frames "on the fly" without sacrificing the frame rate. Equivalent to the Integrate property.

Select one of the following modes:

None

Frame integration is disabled.

Average

Running Average mode. Each output frame is the result of averaging a selected number of previously captured frames.

Add

Running Accumulation mode. Each output frame is the sum of a selected number of previously captured frames.

Integrate Window (N)

Sets the number of frames for the integration. Equivalent to the IntegrateWnd property.

Hot Pixel Correct

Allows to enable or disable the hot pixel correction mode. If this box is checked, unusually bright pixels will be effectively removed from the image. Hot pixels are assosiated with elements on a camera sensor that have higher than normal rates of charge leakage. For more details on hot pixel correction refer to HotPixelCorrect.

Hot Pixel Level (%)

Sets the hot pixel correction level, in percent. Equivalent to the HotPixelLevel property.

Background name

Allows to enter the name prefix under which the background files are stored. See BkgName for more details.

Save Dark

Click this button to store a dark field background image on the hard drive. Dark field should be saved when no light transmitted through the camera lens. The dark field will be calculated by averaging the number of consecutive frames specified by the **Frames** option. Equivalent to the SaveBkg method.

Save Bright

Click this button to store a bright field background image on the hard drive. Bright field should be saved with the maximum light transmitted and no objects in the filed of view. To achieve the best dynamic range, the light intensity should be adjusted so that it stays just below the saturation level of the camera. To control the saturation for monochrome cameras, use the **Saturated Palette**.

The bright field will be calculated by averaging the number of consecutive frames specified by the **Frames** option.

Correct

Allows to select a background correction mode. Select *None* if you do not want the background correction to be performed. Select *Dark/Offset* to apply the dark-field background correction to each frame captured. Select Flat/Gain to apply the flat-field background correction to each frame captured. Make sure to save the bright and dark fields before using this option, otherwise certain background correction modes will not be available. For more details on background correction refer to BkgCorrect.

6 References

[1] https://msdn.microsoft.com/en-us/library/60k1461a.aspx

[2] http://www.ab-soft.com/HLP/ActiveGige.pdf

[3] https://docs.microsoft.com/en-us/dotnet/csharp/programming-guide/

[4] https://msdn.microsoft.com/en-us/library/bk77x1wx.aspx