IMPLEMENTING ADVANCED CONTROL TECHNIQUES OF THE MOBILE RESCUE ROBOTS IN VIRTUAL REALITY USING VIPRO PLATFORM

Mihai RADULESCU[1], Victor VLĂDĂREANU[1], Ionel-Alexandru GAL[1], Doina MARIN[1], Alexandra CIOCÎRLAN[1]

[1]Robotics and Mechatronics Department, Institute of Solid Mechanics of the Romanian Academy

The paper presents Intelligent Control Interfaces (ICIs) for real-time control of terrestrial mobile robots or unmanned aerial robots in order to improve the navigation performances. Intelligent control interfaces are implemented through IT & C techniques with fast processing and real-time communications to develop VIPRO Platform. E-learning platform allows achievement inter-academic research networks and building new intelligent vectors robots.
Keywords: Intelligent Control Interfaces, navigation performances, VIPRO Platform.

1. INTRODUCTION

Active robotic sensors are rapidly gaining viability in environmental, defense, and commercial applications . As a result, developing information-driven sensor strategies has been the focus of intense and growing research in artificial intelligence, control theory, and signal processing. Generally, the authors focused on stereoscopic camera rigs, that is, two rigidly connected cameras in a pair. Specifically, the main problem is the determination of the trajectory of a mobile robotic sensor equipped with a stereo camera rig so that it localizes a collection of possibly mobile targets as accurately as possible under image quantization noise [1-4].

The advantage of binocular vision - compared to the use of monocular camera systems, is that it provides both depth and bearing measurements of a target from a pair of simultaneous images. Assuming that noise is dominated by quantization of pixel coordinates, it uses the Jacobian measurement to propagate the error from the pixel coordinates to the target coordinates relative to the stereo rig. In particular, it approximates the pixel error as Gaussian and propagate the noise to the target locations, giving rise to fully correlated second order error statistics, or measurement error covariance matrices, which capture target location uncertainty.

The resulting second order statistic is an accurate representation of not only the eigenvalues but also the eigenvectors of the measurement error covariance matrices, which play a critical role in active sensing as they determine viewing directions from where localization uncertainty can be further decreased.

In order to become suitable for digital processing, an image function f(x,y) must be digitized both spatially and in amplitude. Typically, a frame grabber or digitizer is used to sample and quantize the analogue video signal. Hence, in order to create an image which is digital, it is necessary to convert continuous data into digital form. There are two steps in which it is done:

- Sampling
- Quantization

The sampling rate determines the spatial resolution of the digitized image, while the quantization level determines the number of grey levels in the digitized image. A magnitude of the sampled image is expressed as a digital value in image processing. *The transition between continuous values of the image function and its digital equivalent is called quantization.*

The number of quantization levels should be high enough for human perception of fine shading details in the image. The occurrence of false contours is the main problem in image which has been quantized with insufficient brightness levels. In digital image processing, it shall talk about two key stages**: s**ampling and quantization that will be defined properly. Spatial and grey-level resolutions will be introduced and examples will be provided further, too.

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which the input is an image and output may be image or characteristics/ features associated with that image. Nowadays, image processing is among rapidly growing technologies.

The ability to obtain the accurate three-dimensional position information in the presence of limited sensor resolution is a crucial task in computer vision and other triangulation systems. Sensors for computer processing applications produce sampled quantized data, whose spatial resolution is determined by limits in device technology and bandwidth. In computer vision and photogrammetry, normally stereo camera setups are used for obtaining 3-D data [5, 6, 7].

In order to become suitable for digital processing, an image function f(x,y) must be digitized both spatially and in amplitude. Typically, a frame grabber or digitizer is used to sample and quantize the analogue video signal. Hence in order to create an image which is digital, we need to covert continuous data into digital form. There are two steps in which it is done: sampling and quantization. Image resizing is necessary when you need to increase or decrease the total number of pixels, whereas remapping can occur when you are correcting for lens distortion or rotating an image. Signals at frequencies above half the sampling rate must be filtered out to avoid the creation of signals at frequencies not present in the original sound.

Implementation of ICIs laws in the intelligent real time control interfaces depends on:

- ✓ the characteristics of the model used and
- ✓ the exact definition of optimization problem.

The results led to the development of the ICI interfaces through image analysis using Images Operation Sampling & Quantization (IOSQ).

The field of robotics studies the interaction between perception and action.

The main advantages of robots are:

- ✓ a high mobility in the work environment,
- ✓ an increased autonomy and
- ✓ the ability to perceive the environment by reacting to it.

The mobile robot applications are found in many areas medical services, transport, rescue missions, firefighting monitoring and surveillance, etc.

Referring to the images represented in the computer, it is important:

- ✓ how an image [8] is represented in the computer;
- ✓ how a color image is represented in the computer [9];
- ✓ the main concepts of sampling, representation, and quantization;
- ✓ operations we can apply that are very simple but extremely useful and
- ✓ how images can actually be manipulated to have clearer images or to highlight fundamental details.

What the normal human eye sees is light reflecting off an objects, and the light that is reflected from the objects goes into a type of sensor, which can be the human eye or a camera.

The light represented in the image is reflected from the object and enters in the sensing device. The image below from Fig.1 shows a magnified image of what is typically present inside on a camera.

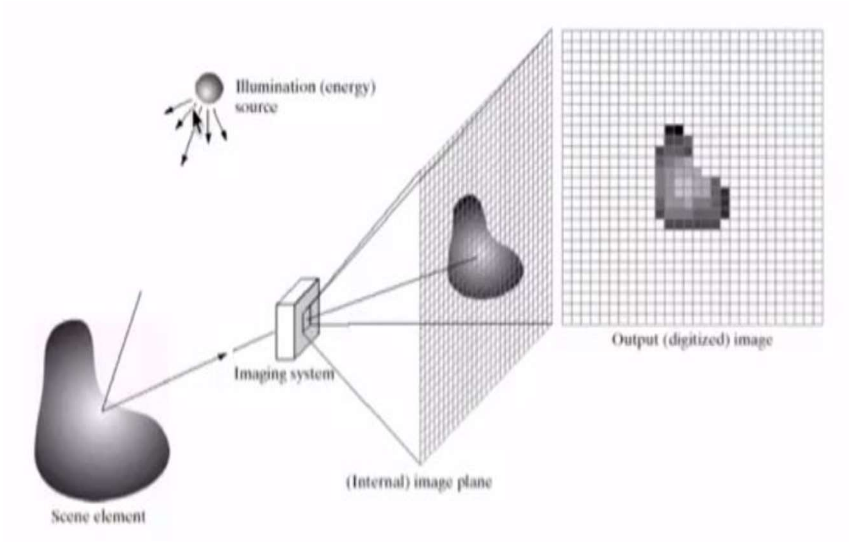

Figure 1 - Magnified image inside of a camera

In the cameras there are color images. Color images are represented by three images that the cameras taked:

- ✓ the blue colors in the scene
- ✓ the green color and
- ✓ the red color

This represents a RGB image.

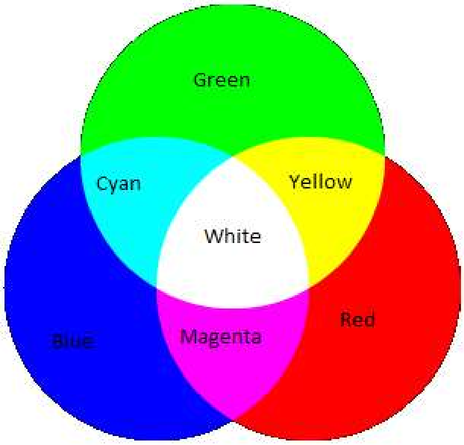

Figure 2 - RGB spectrum

2. IMAGE PROCESSING

Once a 2-dimensional array is available, one of the things that can start being explored is neighborhoods.

There are three types of standard neighborhoods that are taken in image processing:

- a four neighborhood in which only the cardinal four are considered;
- eight neighborhood which takes into account all the pixels surrounding the center one
- 6-connected neighborhood in the case of hexagonal sampling.

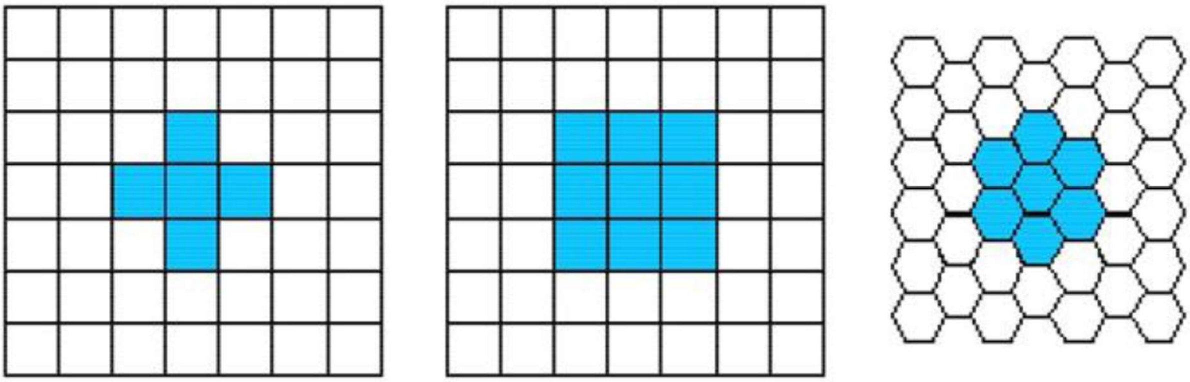

Figure 3 - Types of standard neighborhoods

Another area where neighborhoods are important is in 3D images.

For now, as we have a 2-dimensional array, we can do simple operations with them. There are many operations [11] that we can apply to images because each point has a value.

Below there are some examples:

- Image Addition
- Image Averaging
- Image Subtraction
- Background Subtraction
- Multiplication
- Single Image Point Operations
- Digital Subtraction Angiography (using X-ray)

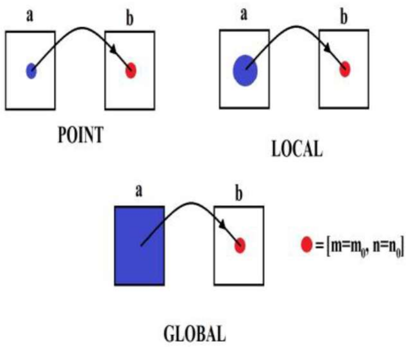

Figure 4 - Operations applied to images

One of the problems developed using the IOSQ ICI interface is saturation [10]. Because there are only 256 different levels that can be used, the image may be too bright and it might not be possible to represent all of the small variations in brightness.

Figure 5 - Image saturation

A significant comparison is presented in Fig.6 between the image processed through image analysis using image formation, images operation, sampling & quantization with high quantification resolution and 256 gray level color resolution.

Figure 6 - Image operations using different shades of grey

To improve the IOSQ ICI, logic operations can also be applied to images. Image operations can be introduced into the virtual space for testing and improving the quality and performance of rescue rebounds.
In the figures below 7a, 7b, 7c, images are presented with the working space of a mobile robot and the perception of obstacles as well as avoiding them using operations with the images taken.

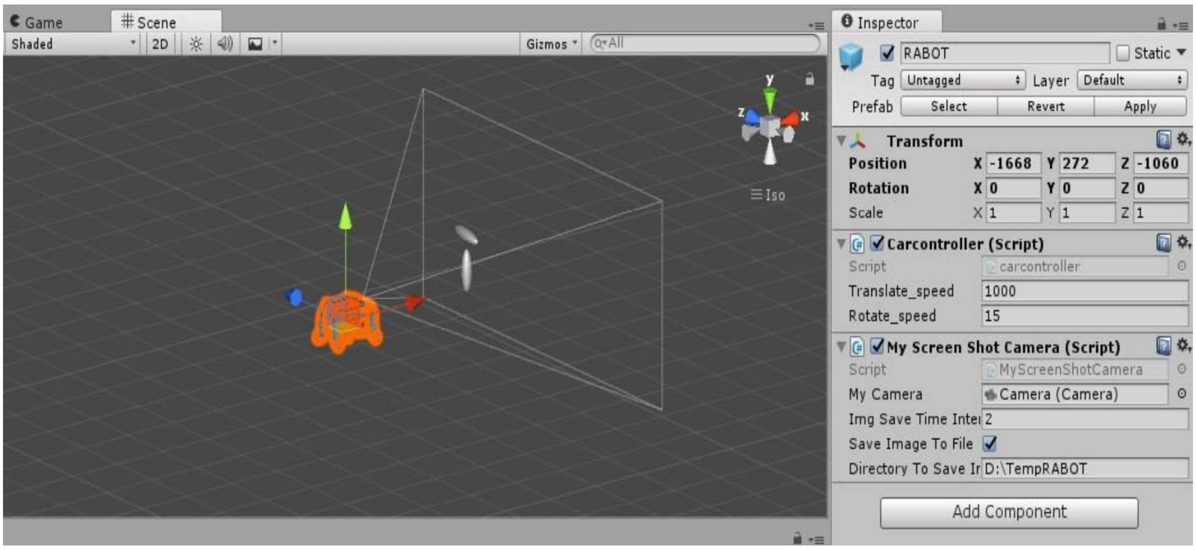

Figure 7a - Image capture mode

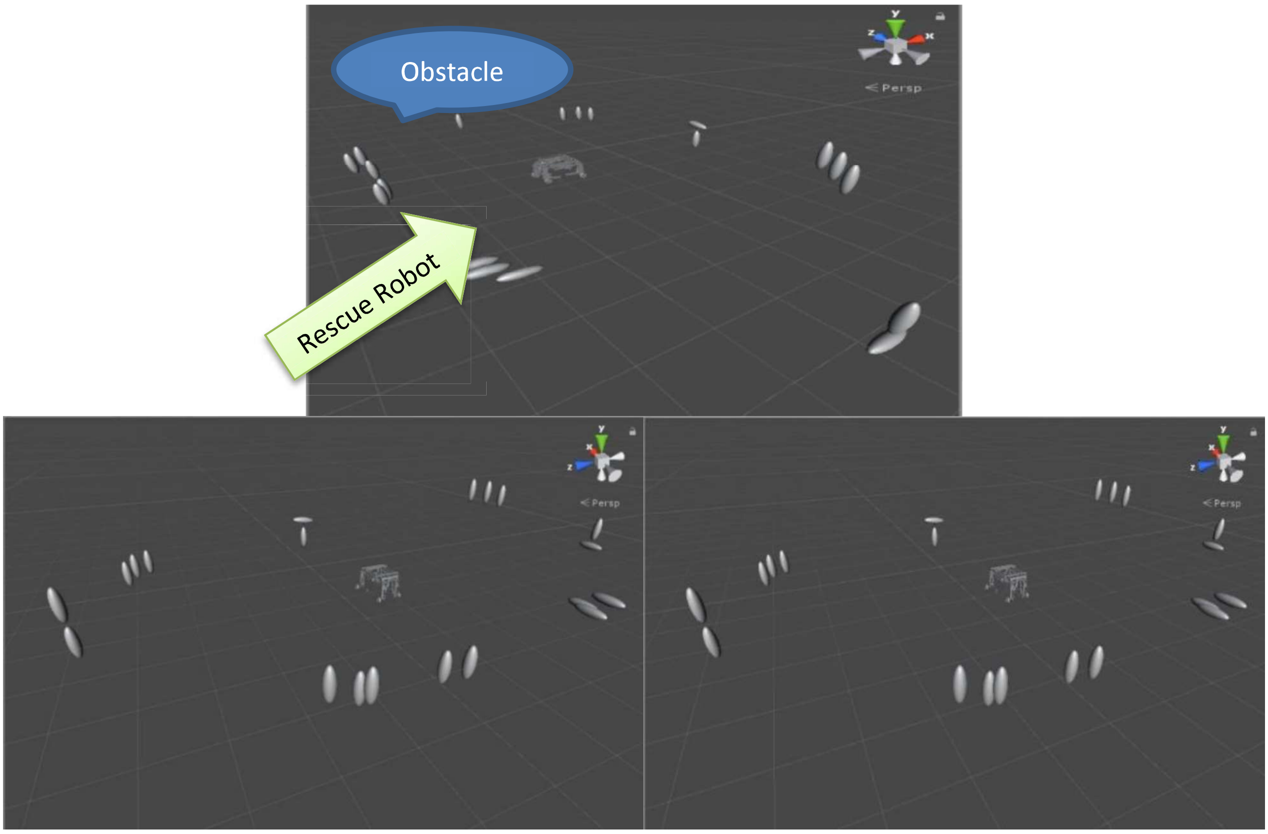

Figure 7b - Robot workspace

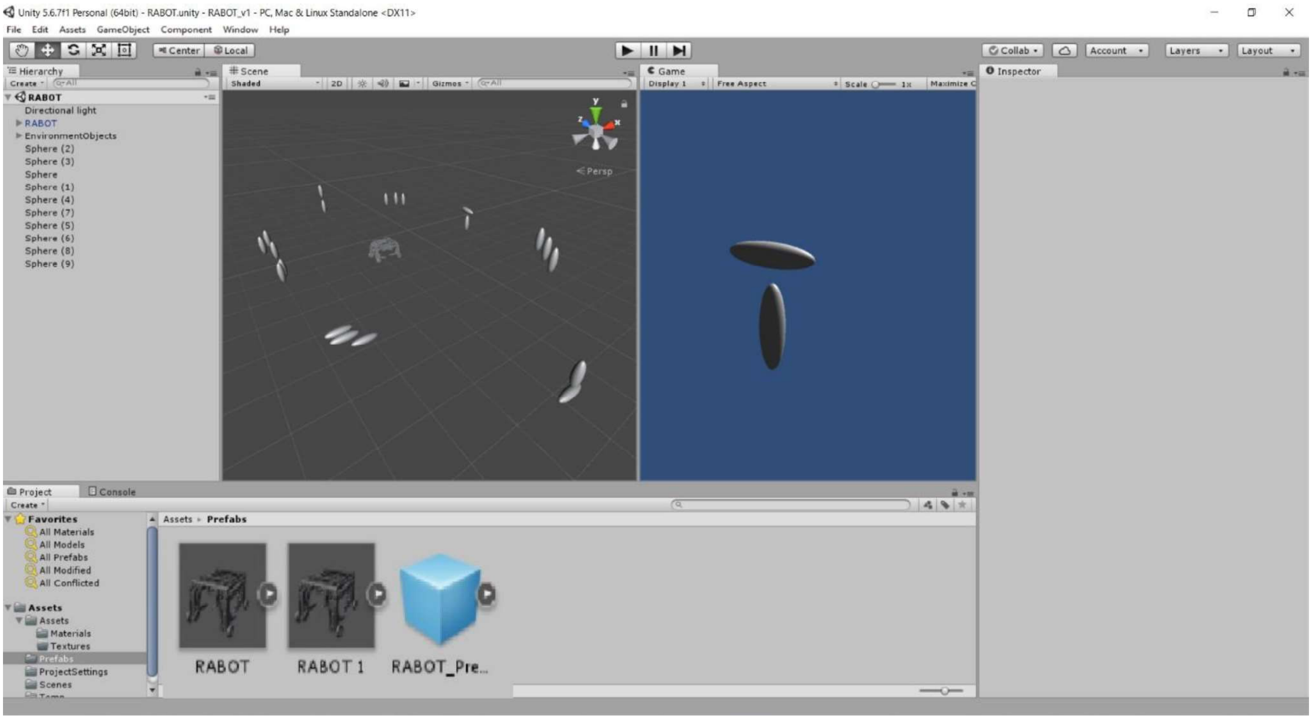

Figure 7c - Image capture mode and robot workspace

A pixel can be replaced by the average of all of its neighbors, including itself. This is done by summing up all the pixel values, dividing by nine and replacing that pixel by that result. To average the entire image, this operation is performed for every single one of the pixels.

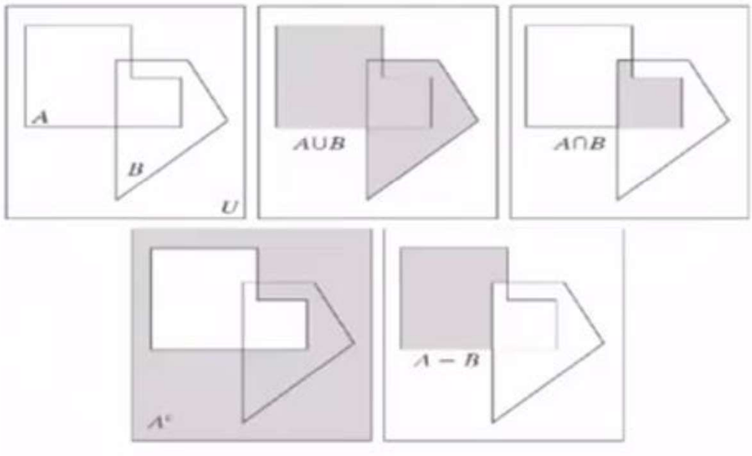

Figure 8 - Image Operations

3. IMPLEMENTING IMAGE COMBINING TO IMPROVE THE QUALITY OF ROBOT WORK ENVIRONMENT RECOGNITION

More sophisticated operations are also possible. We can actually take a pixel in the image, and replace it by the average of its neighbors. As before, we consider an eight neighborhood.

A pixel can be replaced by the average of all of its neighbors, including it. This is done by summing up all the pixel values, dividing by nine and replacing that pixel by that result. To average the entire image, this operation is performed for every single one of the pixels. The eight neighborhood of a pixel is averaged, and the value of the pixel is replaced by the average of the pixels around it. This is repeated for the next pixel, and so on. After that, the result is overlapped.

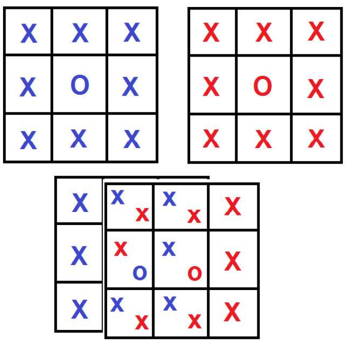

Figure 9 - Replacing pixels by the average of all of its neighbors

4.CONCLUSIONS

✓ The IOSQ ICI interface allows avoiding distorted photos such as chromatic aberration and barrel distortion.

✓ In aerial photography performed with the help of the drones, it is advisable to use a recommended camera, which, based on the tests performed on it, proved to be able to get the best photographs.

✓ In order to obtain professional aerial photographs using drones, it is necessary to use basic camera settings such as ISO, shutter speed, aperture, focus and measurement together with stabilization of the thorn.

✓ In this context, some of the most important camera settings used in aerial photography were presented in this paper in view of obtaining an image function f(x,y) digitized both spatially and in amplitude.

✓ The Versatile Intelligent Portable Robot Platform VIPRO was developed:

- to improve the walking anthropomorphic robots performances;
- to provide unlimited power for design;
- to test and
- to experiment the real time control methods by integrating the intelligent control interfaces (ICIs) in robot modeling.

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