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Intelligent control interfaces developed on Versatile Portable Intelligent Platform in order to improving autonomous navigation robots performances

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ABSTRACT

The paper presents Intelligent Control Interfaces (ICIs) for real-time control for terrestrial mobile robots or unmanned aerial robots in order to improve the navigation performances. Intelligent control interfaces using advanced control strategies adapted to robot environment are presented, implemented through IT & C techniques with fast processing and real-time communications in order to develop a versatile, intelligent and portable VIPRO Platform with behavior of e-learning platform, which allows achievement inter-academic research networks and building new intelligent vectors robots. Implementation of ICIs laws in the intelligent real time control interfaces depends on the particular circumstances of the characteristics 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).

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1. INTRODUCTION

The field of robotics studies the interaction between perception and action, and robots are devices capable of performing similar activities to people. Robots have high mobility in the work environment, increased autonomy and the ability to perceive the environment by reacting to it. Mobile robot applications are found in many areas where people's work is relieved or completely replaced due to working conditions (medical services, transport, rescue missions, firefighting monitoring and surveillance, etc. (Barz et al., 2014, 2015; 2015b, Martínez et al., 2018).

2. IMAGE PROCESSING FOR AUTONOMOUS NAVIGATION ROBOTS

A starting point in developing an autonomous navigation robots imaging interface that should be considered is the images we normally take with our cameras. The images we are familiar with represent only a small part of the spectrum of images we can get at different wavelengths and in different ways. A post-quantification concept is relevant for virtually all of these ways - sampling and quantization - that will always be necessary (Wu et al., 2018; Burkhard, 2005).

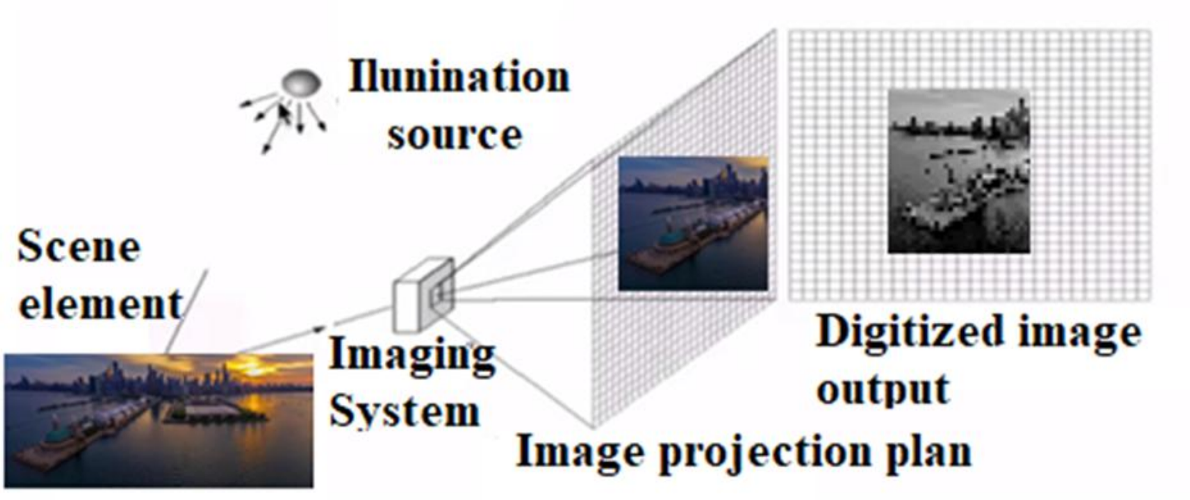

Figure. 1. Digitizing the image acquired by the sensor system

What the normal human eye sees is light reflected by objects, and this light reflected by objects enters into a type of sensor, which can be the human eye or the room. In our eyes, the sensor grid is represented by the retina, the individual components of which are cones and rods acting as sensors. Normally, a regular camera is a two-dimensional array composed of these sensors, which is the sensor grid arrange in a square or rectangle, as shown in Figure 1, followed by sampling, spatial meshing and amplitude meshing by quantifying the gray values. In the case of color images, the representation is in three colors, one for blue - blue there are scenes, green and red, are abbreviated in images in the form of R, G and B.

The next step is interpolation. There are three discrete images, made up of red, green and blue channels. If a pixel has the red value, it will be necessary to generate a green and blue way, what is done from the neighbor pixels. If the green value is available, it will be necessary to generate the red and blue values, resulting in three discrete images made up of the red, green and blue channels.

Figure. 2. Image processing

One of the problems developed using the IOSQ ICI interface is saturation, if a very dark region and a very open region are present at the same time, when an area is saturated, it will look white because all its values are equal to 255.
Another common occurrence when capturing images is the appearance of what is called a very strong reflection or reflection that is displayed as the white area, caused by the saturation of the sensors by the excessive brightness generated by the additional reflections. This brings the problem back to two meshing, one in the sampling space and the other in gray (Figure 2).
An optimum must be found between the spatial quantization and the quantization of gray values that affect the final image. A coarse less dense discretizing which has fewer pixels uses only a few values, but can affect the image quality and the results obtained after processing. A significant comparison is shown in Fig.3 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 3a), 16 gray levels (Figure 3.b), respectively 2 levels of gray (Figure 3c).

a) b) c)

Figure. 3. Optimizing spatial quantification vs. quantification of gray values

The more samples are available, the image quality increases and allows for more variations in color variations. In terms of gray, the more memory the computer has, the higher the image quality, followed by data compression.

3. IOSQ ICI INTERFACES FOR VIPRO PLATFORM

Intelligent control interfaces apply advanced control strategies adapted regarding space imagine modeling represented in the computer, colour imagine modeling represented in the computer, and the very important concepts of sampling, representation, and quantization..

IOSQ interface is based on 2-dimensional arrays of pixels which can be subjected to various types of operations, that are very simple but extremely useful and will illustrate how images can actually be manipulated through imaging techniques using simple or complicated operations to get clearer images or highlight fundamental details. Once a 2-dimensional array is available, one of the things that can start being explored is neighborhoods. The image is stored as a 2-dimensional array of pixels. There are two types of standard neighborhoods that are taken in image processing. One is called a four neighborhood, in which only the cardinal four are considered. That means only the pixels located directly North, South, East, or West of the central pixel, giving us a four neighborhood. There is another very popular type that is an eight neighborhood, which takes into account all the pixels surrounding the center one.

The eight-neighborhood is the most common neighborhood used today in most modern image processing. However it's important to be aware of the other type of neighborhood as well, especially when doing segmentation. Another area where neighborhoods are important is in 3D images. For now, as we have 2-dimensional arrays, we can do simple operations between 2-dimensional arrays. For example, we can add them. Every point has a value. Thus, a second image can be added to the first image. Image 1 below can be added to image 2. This example uses 3 x 3 image. The values in the upper left corners of the two images are added. If the value in the top-left corner of the first image is 7 and the value in the top-left corner of the second image is 10, the resulting value is 17. This is repeated for the next pixel and so on. This is a simple addition of images, however an extremely important operation by itself.

a) b)

Figure. 4 IOSQ interface on intervention missions with terrestrial and aerial vectors robots.

One application of this consists of rescue missions in case of calamities. Following the devastating earthquakes in Japan (Hanshi-Awaji earthquake - Figure 4a), an international project has been developed that brings together world-renowned research teams in search and rescue robots as the RoboCup-Rescue Project. Another application may be to perform robot, terrestrial and aerial mission interventions in areas of disaster, terrorist action or incidents (Figure 4b).The images are very noisy, but all the images are aligned. The camera is kept immobile, and nothing is moving. Images are captured one after the other, and then added, as more and more images are added, they become more and more clear.

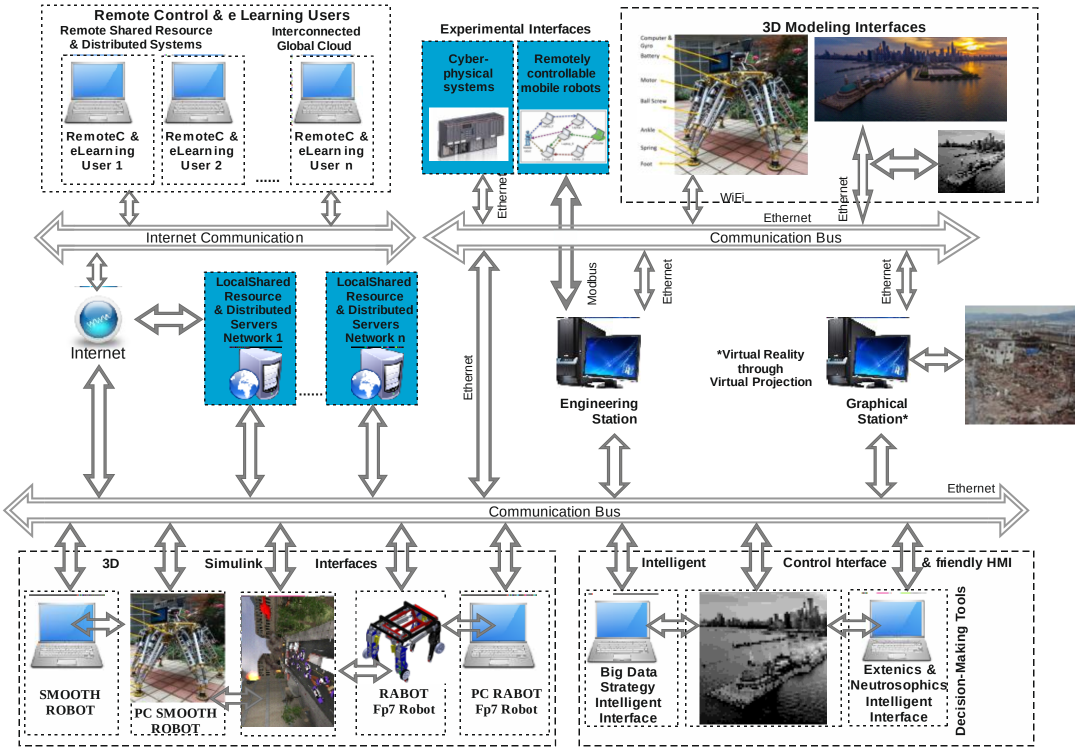

Figure. 4. IOSQ interface integrated in the VIPRO Platform

For this more sophisticated operations have been implemented. 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 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. 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. Finally, the result is overlapped. Using the right camera and settings which are proven for autonomous navigation robots using robot vectors, the IOSQ ICI interface allow to avoid distorted photos such as chromatic aberration and barrel distortion.

The Versatile Intelligent Portable Robot Platform VIPRO (Vladareanu V. et al., 2015a. 2015b), with open system integrated in the cognitive IoT (Pureswaran, et al. 2015; Zhang et al., 2017), (fig. 4) was developed to improve the walking anthropomorphic robots performances, provide unlimited power for design, test, experiment the real time control methods by integrating the intelligent control interfaces (ICIs) in robot modeling and simulation for all types of humanoid robots, rescue robots, firefighting robots, aerial robots and robot vectors (Feng et al., 2016, 2017;Wang H.B. et al., 2015, 2017).

4. RESULTS AND CONCLUSIONS

The Intelligent Control Interfaces (ICIs) for real-time control for terrestrial mobile robots or unmanned aerial robots developed by image formation, images operation sampling & quantization can lead to improvement the navigation performances using applying image processing techniques.

Intelligent control interfaces, exemplified by the IOSQ ICI interface, using advanced control strategies adapted to robot environment, implemented through IT & C techniques with fast processing and real-time communications can be integrated into versatile, intelligent and VIPRO portable platform to provide them behavior of the e-learning Platform, for the achievement inter-academic research networks and building new intelligent vectors robots.

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