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IMPROVING THE QUALITY OF AN IMAGE/VIDEO USING SIMULINK

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Abstract - *In this paper we bring out an objective method of improving the quality of the image by improving the resolution of the image which helps in overcoming the common problems faced with handling an image like storing, transmission etc without having to compromise on the quality of the image. This method has also been successfully extended for videos using SIMULINK as the platform.*
Keywords - *Digital image, Bilinear Interpolation, Pixel, Resolution, Scaling of image, Video.*

I. INTRODUCTION

There always exists a tradeoff between size of the image, its resolution and its quality whenever we are working with images. A very high resolution picture is desirable but owing to the hardware, processor and memory constraints is often not feasible in many of the situations and applications for example, transmission of an image usually requires a larger bandwidth which is a limited resource which leads towards slowing down of other functionalities being done using the same network, two possible solutions to this are either to increase the bandwidth of the network which usually costs more, the second solution is to decrease the occupying of the bandwidth by the image. In this work we are specifically aiming at providing a solution to the problem using the second approach. This work helps in increasing the quality of a low resolution image by objective method of operation. By using this method a sender can transmit a low resolution image which usually occupies a lesser bandwidth which can then be received by the user and using this method can enhance it to the desired quality to appease his requirement which actually speeds up the process of transmission and reception with only a minor or no increase in the cost. This method can further be used in various other fields like surveillance where videos from a CCTV cameras are obtained which usually are of lower resolution and also for storage of an image where a very high quality image requires a large amount of storage can be scaled down to a lower resolution while storing but the image of the same quality can be obtained back by restoring it when desired.

II. DIGITAL IMAGE AND VIDEO

The two dimensional representation of an image is called a digital image. An image obtained using any instrument is in an analogous form which is to be sampled and quantized to bring it to the form of a digital image which is usually done by default in a digital camera. Sampling the image reduces it to manageable number of data whereas quantizing it helps it representing each image as a 1 or a 0 for a digital image or by the convention used.

Most of the images used for processing is in a digital format as it is supported by a large user base. A digital video is a set of images that is displayed by repeating the same frame of the image over and over for a fixed number of times. The rate at which it is displayed is called frame rate. The figure Fig.2.1 represents a typical representation of a video frame and a digital image.
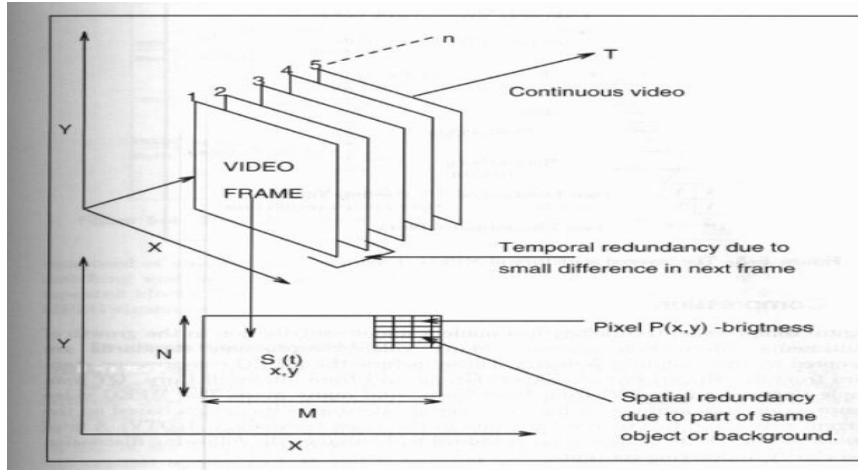
Figure.2.1 Representation of a digital video frame

2.1. Image quality

The quality of an image refers to an assessment or subjective measure of how accurately or fully an image of a subject represents that subject. A low quality image poorly represents the subject where as a high quality image accurately represents the image.

2.2. Types of Digital image processing

The types of image processing can be broadly classified in to two groups they are,

      i.   Subjective image processing
     ii.   Objective image processing

Subjective processing refers to evaluation techniques that are based on the user or the observer. Hence it may vary from person to person based on their evaluation. But this is very important as most of the processing is done to meet the end user's requirement.

Objective processing refers to evaluation techniques that are mathematical models which approximate results of subjective quality assessment, but are based on criteria and metrics that can be measured objectively and automatically evaluated by a computer program. Objective methods are classified based on the availability of the original video signal, which is considered to be of high quality (generally not compressed).

2.3. Simulink

Simulink, developed by MathWorks, is a data flow graphical programming language tool for modeling, simulating and analyzing multi-domain dynamic systems. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries. It offers tight integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it. Simulink is widely used in control theory and digital signal processing for multi-domain simulation and Model-Based Design, design and analysis, signal processing and communications, code generation, rapid prototyping and HIL simulation, verification, validation, and test, simulation graphics and reporting.

2.3.1. Capabilities of Simulink

- Building the Model — Model hierarchical subsystems with predefined library blocks.

- Simulating the Model — Simulate the dynamic behavior of your system and view results as the simulation runs.

- Analyzing Simulation Results — View simulation results and debug the simulation.

- Managing Projects — Easily manage files, components, and large amounts of data for your project.

- Connecting to Hardware — Connect your model to hardware for real-time testing and embedded system deployment.

III. IMAGE RESIZE

In computer graphics, image scaling is the process of resizing a digital image. Scaling is a non-trivial process that involves a trade-off between efficiency, smoothness and sharpness. With bitmap graphics, as the size of an image is reduced or enlarged, the pixels which comprise the image become increasingly visible, making the image appear "soft" if pixels are averaged, or jagged if not. With vector graphics the trade-off may be in processing power for re-rendering the image, which may be noticeable as slow re-rendering with still graphics, or slower frame rate and frame skipping in computer animation.

The Resize block of simulink enlarges or shrinks an image by resizing the image along one dimension (row or column). Then, it resizes the image along the other dimension (column or row).

This can be done in three ways

i. Nearest neighborhood Interpolation
ii. Bilinear interpolation
iii. Bi cubic interpolation

Nearest neighborhood interpolation refers to assigning of the intensity to a newly created pixel as a result of extending the original image to the required size, from the pixel of the original image that is most close to it.

Bilinear interpolation refers to assigning of the intensity to a newly created pixel by taking in to account the pixel values of four neighboring pixels. For bilinear interpolation, pixel values are obtained by using the equation (1) given below. This gives a better approximation compared to the previous method.

Bi cubic interpolation refers to assigning of the intensity to a newly created pixel by taking in to account the pixel values of sixteen nearest neighboring pixels. For bilinear interpolation, pixel values are obtained by using the equation (2) given below. This gives a better approximation compared to the previous two methods but at the cost of added burden of complex computations.

$$v(x,y) = ax + by + cxy + d \qquad\qquad v(x,y) = \sum_{i=0}^{n} \sum_{j=0}^{n} a_{ij} x^{i} y^{i}$$

Equation 1   Equation 2

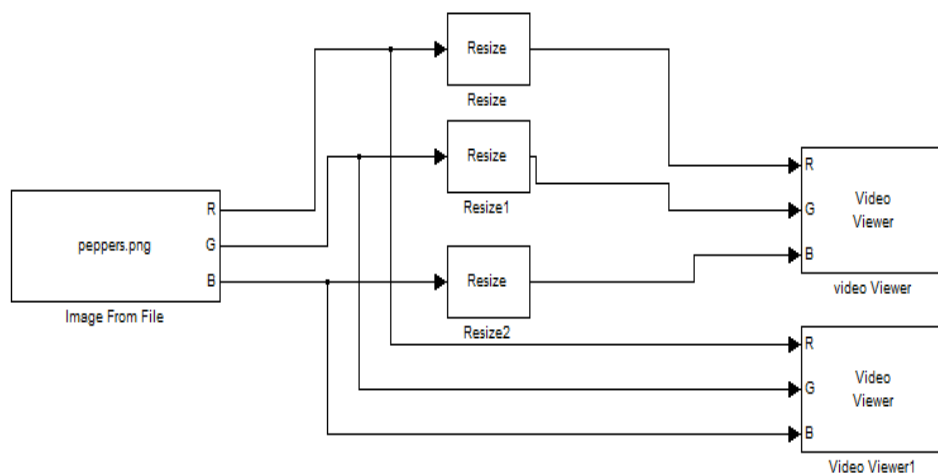### 3.1. Realization of the model for obtaining the resized image using simulink

Figure.3.1 Simulink model for obtaining resized model

3.2. Description of the blocks used in the model

The blocks used in the above block diagram are image from file, resize and video viewer. The image is taken from file which is diversified in to 3 basic colors R(red),G(green) and B(blue). Individually RGB components of input image are given to RESIZE blocks respectively. After the intermediate stage the output is compared with the initial input image using VIDEO VIEWER.

3.2.1. Image from File block

This block is used to input an image in to the model. It offers various options like selecting a stored image or obtaining the image from a camera linked to the system for real time operations. The input image is diversified in to 3 colors R G B to the next block.

Each RGB scalar, vector, or matrix value represents one plane of the input RGB video stream. Outputs from the R, G, or B ports have the same dimensions as the inputs but are only differentiated in to the respective vectors.

3.2.2. Resize block

To resize a particular region of each image, select the Enable ROI processing check box. This option is available under these conditions:

Specify = Number of output rows and columns.

Interpolation method = Nearest neighbor approximation, Bilinear, Bicubic, Lanczos2 and Lanczos3 are available. We utilize Lanczos3 method here as it gives the best approximation compared to the other supported methods.

Check the "Perform antialiasing when resize factor is between 0 and 100 "check box as this prevents any aliasing of the samples.

If you select the Enable ROI processing check box, the ROI port appears on the block. Use this port to define a region of interest (ROI) in the input matrix, I, that you want to resize. The input to this port must be a four-element vector, [row column height width]. The first two elements define the upper-left corner of the ROI, and the second two elements define the height and width of the ROI.
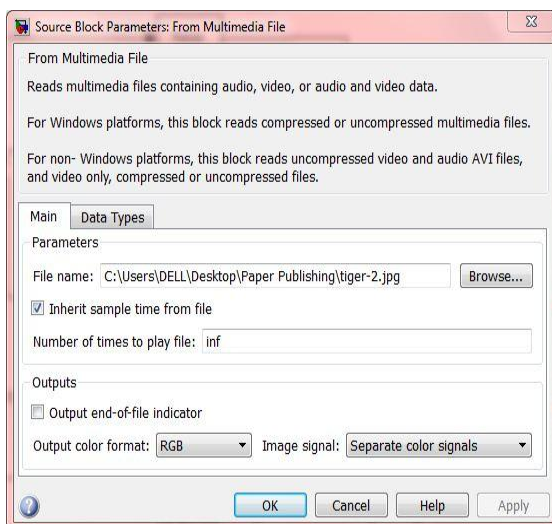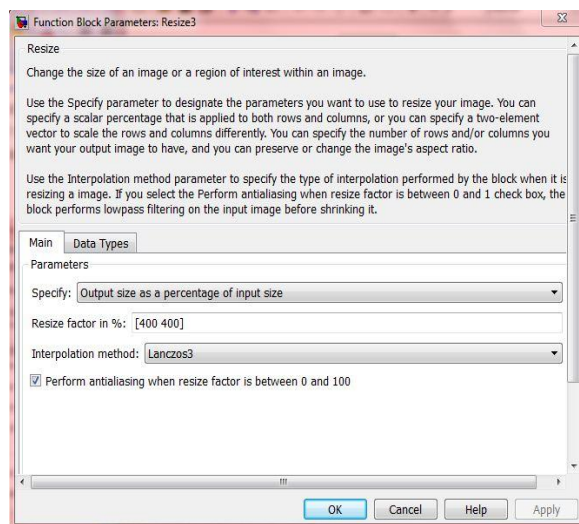
Figure.3.2.1 Snapshot of "Image from file" block   Figure.3.2.2 Snapshot of "Resize" block

IV. RESULTS

Here the original image in the Fig.4.1acts as the input image which is enhanced using the above block shown in the Fig.3.1. The end result after processing is as shown in the Fig.4.2 whose quality has quiet visibly been increased using the aforementioned method. The latter image shows a higher resolution of about 750 x 1000 as compared to the former image which is only of the resolution 75 x 100. Thereby we can conclude that using this method we can objectively enhance the quality of the image theoretically to any resolution as required; the only limitation is that of the graphical memory of the system that is being used for the process.
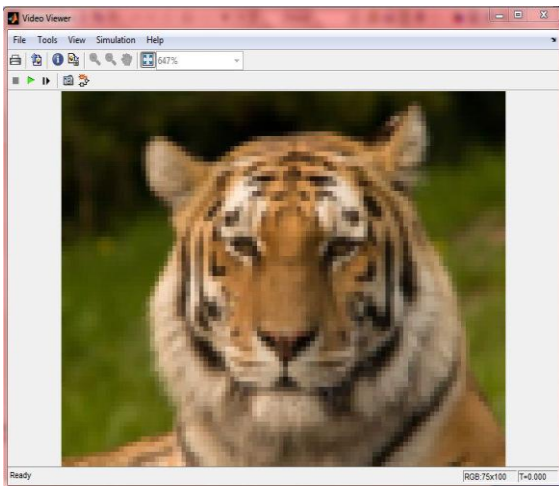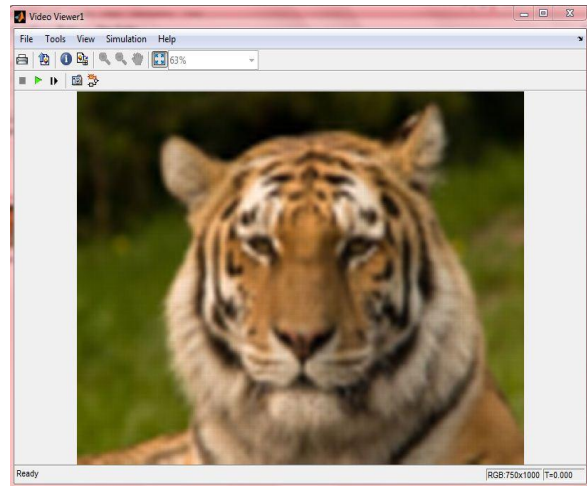

Figure.4.1 Input Image of lower resolution

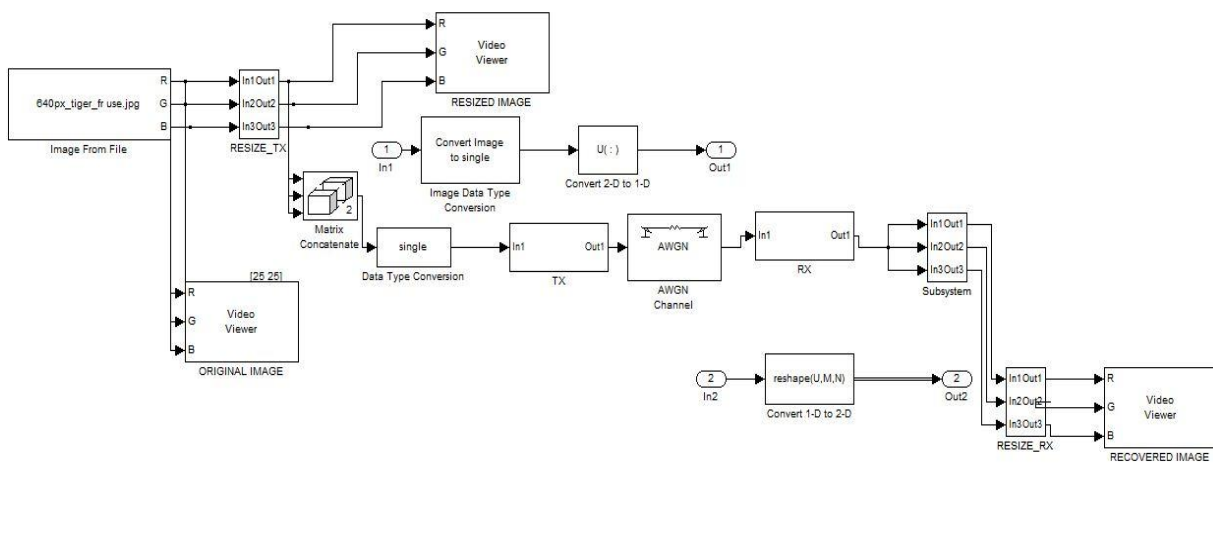Figure.4.2 Enhanced Image

4.1. Proof of concept

Figure.4.1.1.A communication model for transmission of image using AWGN channel

Fig.4.1.1 Shows the simulink model where as a proof of concept we have applied our method to a communication system wherein before transmitting an image or a video over a channel we first down sample it i.e. reduce its resolution thereby reducing the number of bits that is to be transmitted over the channel, Here we are utilizing an AWGN channel for transmission of the image which is later received at the receiver and is then up-sampled to recover the original image from the received low resolution image to get back an equally higher quality image as the original image that had to be transmitted. The result of this procedure is as seen in the Fig.4.1.
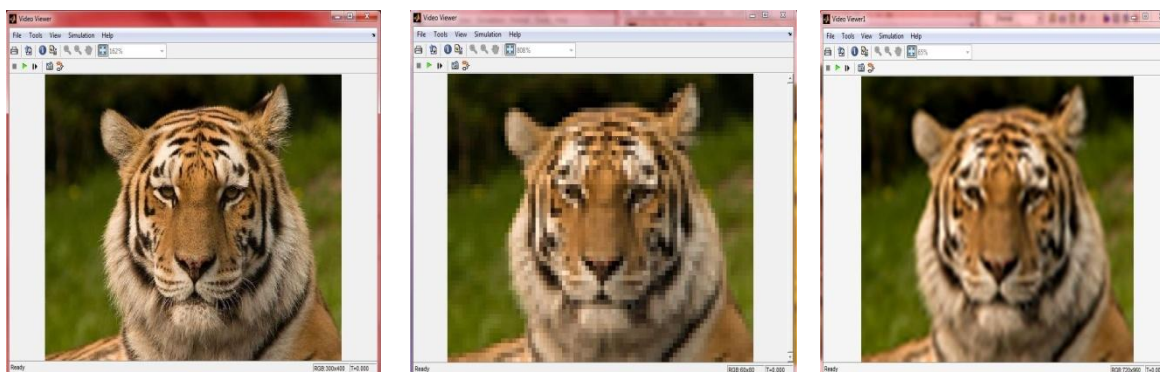
Figure.4.1.2 Original Image   Figure.4.1.3 Transmitted Compressed Image   Figure.4.1.4 Received & Recovered Image

V. CONCLUSION AND FUTURE WORK

In this work, we have developed an efficient method of enhancing the quality of an image by objective method and we were further able to apply it to a simple communication channel employing an AWGN channel to demonstrate its effectiveness in the real world. This method can easily be adapted in to the present day communication system as this system is network independent hence it only requires the end users to update their system to include this method which proves to be very economical and faster which is the need of the day. This can further be used while one is archiving the photos this method is bound to save lots of memory compared to conventional storage methods. The following points summarize the end results that can be achieved by utilizing this method

i)   Decrease the actual time required for transmission of the image or the video there by speeding up the entire process of transmission.

ii)   As there is lesser number of bits for transmission the utilization of the available bandwidth is decreased which again speeds up the use of network owing to the amount of free bandwidth space available.

iii) As we are downloading or uploading lesser amount of data the cost of usage also is decreased by utilizing this method.

iv)   Decrease the amount of memory space required to store photos and videos, which is very economical compared to the conventional methods.

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