ZOOMING METHODS

In this tutorial we are going to formally introduce three methods of zooming that were introduced in the tutorial of Introduction to zooming.

Methods

- Pixel replication or *Nearestneighborinterpolation*
- Zero order hold method
- Zooming K times

Each of the methods have their own advantages and disadvantages. We will start by discussing pixel replication.

Method 1: Pixel replication:

Introduction:

It is also known as Nearest neighbor interpolation. As its name suggest, in this method, we just replicate the neighboring pixels. As we have already discussed in the tutorial of Sampling, that zooming is nothing but increase amount of sample or pixels. This algorithm works on the same principle.

Working:

In this method we create new pixels form the already given pixels. Each pixel is replicated in this method n times row wise and column wise and you got a zoomed image. Its as simple as that.

For example:

if you have an image of 2 rows and 2 columns and you want to zoom it twice or 2 times using pixel replication, here how it can be done.

For a better understanding, the image has been taken in the form of matrix with the pixel values of the image.

1 2

3 4

The above image has two rows and two columns, we will first zoom it row wise.

Row wise zooming:

When we zoom it row wise, we will just simple copy the rows pixels to its adjacent new cell.

Here how it would be done.

1 1 2 2

3 3 4 4

As you can that in the above matrix, each pixel is replicated twice in the rows.

Column size zooming:

The next step is to replicate each of the pixel column wise, that we will simply copy the column pixel to its adjacent new column or simply below it.

Here how it would be done.

1 1 2 2

1 1 2 2

3 3 4 4

3 3 4 4

New image size:

As it can be seen from the above example, that an original image of 2 rows and 2 columns has been converted into 4 rows and 4 columns after zooming. That means the new image has a dimensions of

$$Originalimagerows * zoomingfactor, OriginalImagecols * zoomingfactor$$

Advantage and disadvantage:

One of the advantage of this zooming technique is, it is very simple. You just have to copy the pixels and nothing else.

The disadvantage of this technique is that image got zoomed but the output is very blurry. And as the zooming factor increased, the image got more and more blurred. That would eventually result in fully blurred image.

Method 2: Zero order hold

Introduction

Zero order hold method is another method of zooming. It is also known as zoom twice. Because it can only zoom twice. We will see in the below example that why it does that.

Working

In zero order hold method, we pick two adjacent elements from the rows respectively and then we add them and divide the result by two, and place their result in between those two elements. We first do this row wise and then we do this column wise.

For example

Lets take an image of the dimensions of 2 rows and 2 columns and zoom it twice using zero order hold.

1 2

3 4

First we will zoom it row wise and then column wise.

Row wise zooming

1 1 2

3 3 4

As we take the first two numbers : $2+1$ = 3 and then we divide it by 2, we get 1.5 which is approximated to 1. The same method is applied in the row 2.

Column wise zooming

1 1 2

2 2 3

3 3 4

We take two adjacent column pixel values which are 1 and 3. We add them and got 4. 4 is then divided by 2 and we get 2 which is placed in between them. The same method is applied in all the columns.

New image size

As you can see that the dimensions of the new image are 3 x 3 where the original image dimensions are 2 x 2. So it means that the dimensions of the new image are based on the following formula

$2(numberofrows$ minus 1) X $2(numberofcolumns$ minus 1)

Advantages and disadvantage.

One of the advantage of this zooming technique , that it does not create as blurry picture as compare to the nearest neighbor interpolation method. But it also has a disadvantage that it can only run on the power of 2. It can be demonstrated here.

Reason behind twice zooming:

Consider the above image of 2 rows and 2 columns. If we have to zoom it 6 times, using zero order hold method , we can not do it. As the formula shows us this.

It could only zoom in the power of 2 2,4,8,16,32 and so on.

Even if you try to zoom it, you can not. Because at first when you will zoom it two times, and the result would be same as shown in the column wise zooming with dimensions equal to 3x3. Then you will zoom it again and you will get dimensions equal to 5 x 5. Now if you will do it again, you will get dimensions equal to 9 x 9.

Whereas according to the formula of yours the answer should be 11x11. As $6(2$ minus 1) X $6(2$ minus 1) gives 11 x 11.

Method 3: K-Times zooming

Introduction:

K times is the third zooming method we are going to discuss. It is one of the most perfect zooming algorithm discussed so far. It caters the challenges of both twice zooming and pixel replication. K in this zooming algorithm stands for zooming factor.

Working:

It works like this way.

First of all, you have to take two adjacent pixels as you did in the zooming twice. Then you have to subtract the smaller from the greater one. We call this output OP.

Divide the outputOP with the zooming factor$K$. Now you have to add the result to the smaller value and put the result in between those two values.

Add the value OP again to the value you just put and place it again next to the previous putted value. You have to do it till you place k-1 values in it.

Repeat the same step for all the rows and the columns , and you get a zoomed images.

For example:

Suppose you have an image of 2 rows and 3 columns, which is given below. And you have to zoom it thrice or three times.

15 30 15

30 15 30

K in this case is 3. K = 3.

The number of values that should be inserted is k-1 = 3-1 = 2.

Row wise zooming

Take the first two adjacent pixels. Which are 15 and 30.

Subtract 15 from 30. 30-15 = 15.

Divide 15 by k. 15/k = 15/3 = 5. We call it OP.*whereopisjustaname*

Add OP to lower number. 15 + OP = 15 + 5 = 20.

Add OP to 20 again. 20 + OP = 20 + 5 = 25.

We do that 2 times because we have to insert k-1 values.

Now repeat this step for the next two adjacent pixels. It is shown in the first table.

After inserting the values, you have to sort the inserted values in ascending order, so there remains a symmetry between them.

It is shown in the second table

Table 1.

15 20 25 30 20 25 15

30 20 25 15 20 25 30

Table 2.

15	20	25	30	25	20	15
30	25	20	15	20	25	30

Column wise zooming

The same procedure has to be performed column wise. The procedure include taking the two

adjacent pixel values, and then subtracting the smaller from the bigger one. Then after that, you have to divide it by k. Store the result as OP. Add OP to smaller one, and then again add OP to the value that comes in first addition of OP. Insert the new values.

Here what you got after all that.

15	20	25	30	25	20	15
20	21	21	25	21	21	20
25	22	22	20	22	22	25
30	25	20	15	20	25	30

New image size

The best way to calculate the formula for the dimensions of a new image is to compare the dimensions of the original image and the final image. The dimensions of the original image were 2 X 3. And the dimensions of the new image are 4 x 7.

The formula thus is:

$K(numberofrowsminus1 + 1)$ X $K(numberofcolsminus1 + 1)$

Advantages and disadvantages

The one of the clear advantage that k time zooming algorithm has that it is able to compute zoom of any factor which was the power of pixel replication algorithm , also it gives improved result *lessblurry* which was the power of zero order hold method. So hence It comprises the power of the two algorithms.

The only difficulty this algorithm has that it has to be sort in the end, which is an additional step, and thus increases the cost of computation.