

## Application to PreciPoint – Technical Challenge

### 1 – Creating the Stack

The stack is generated by blurring the original image using a Gaussian mask with increasing sigma values. The position of the original image within this stack is random.

The whole stack is stored in a folder chosen by the user. This is done for visualisation purposes. I tried using an image list to store the images at runtime; however, the resolution of images in such a list is limited to  $256 \times 256$  (while the images provided are  $960 \times 960$ ).

### 2 – Measuring Sharpness

The measurement of sharpness was done using the method presented by Kanjar De and V. Masilamani [1]. The algorithm they propose is done in the frequency domain and follows these steps:

1. Given an image  $I$  of size  $M \times N$ , find its Fourier transform  $F$  shifting the origin to its centre
2. Calculate the magnitude of the Fourier transform  $F$
3. Find the maximum value  $M_v$  of the magnitude of the Fourier transform
4. Calculate the threshold  $thres$  as  $M_v$  divided by 1000
5. Find the total number of pixels  $T_H$  whose value is above this threshold  $thres$
6. The Image Quality Measure or Sharpness value is then calculated as:

$$Sharpness\ value = \frac{T_H}{M \cdot N}$$

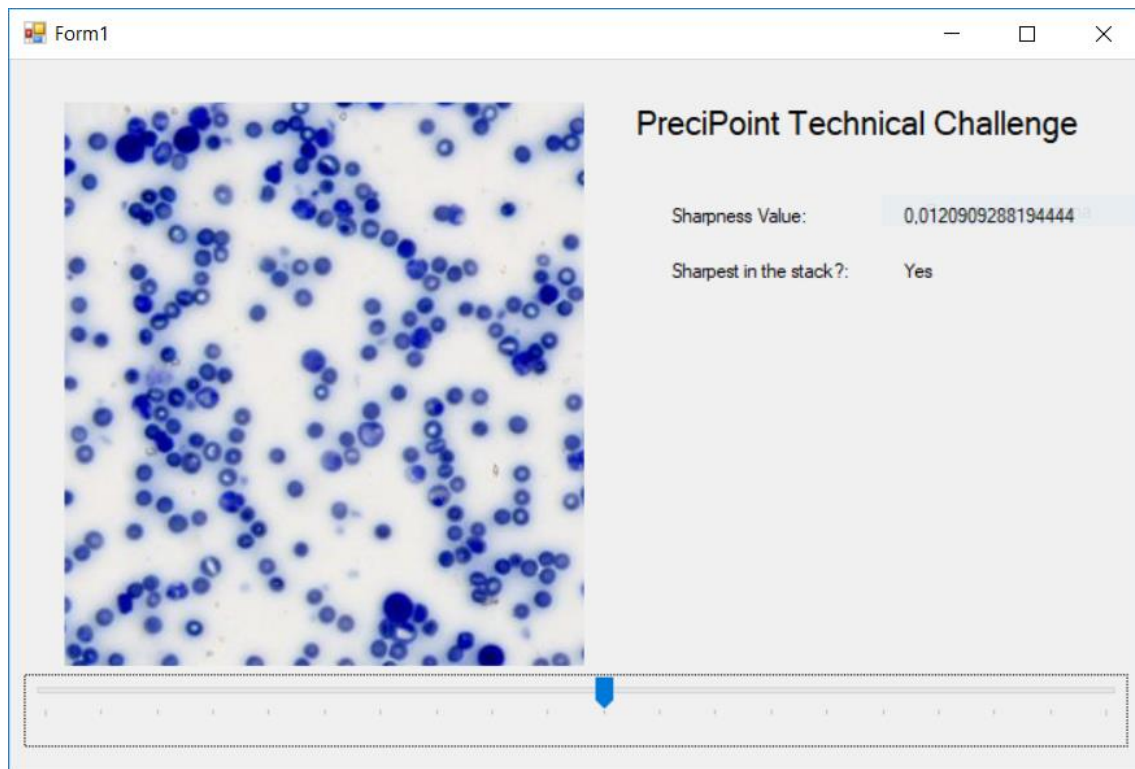
This Sharpness value was calculated for each image in the stack. The one with the largest value is the sharpest image.

### 3 – Putting Both Steps Together

Creating the Stack and Measuring Sharpness were done in two separate loops, so as to replicate a situation in which the image would be obtained first and then handed over for processing (two separate steps). Alternatively, both loops could have been merged into a single one, which would replicate a situation in which processing would take place as soon as an image is being acquired by the microscope. I decided to use the former approach so as to provide clearer code.

### 4 – Displaying Results

A simple UI was created to present the results. A slider at the bottom of this UI allows the user to move through the stack. For each image, the Sharpness value is reported and whether that image is the sharpest one or not.



## 5 – Notes

This was developed on C# using Visual Studio and the EMGU toolbox.

After selecting the original image, the program asks for a folder location. This dialog opens behind the window, so alt + tab has to be used to access it.

Ideally, the stack would start at a blurry image, then the images would become gradually clearer until the sharpest one is reached, and then the images would become blurrier and blurrier. Unfortunately, a simpler method was used, though not realistic.

## References

- [1] K. De y V. Masilamani, «Image Sharpness Measure for Blurred Images in Frequency Domain,» *Procedia Engineering*, vol. 64, pp. 149-58, 2013.