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|  | Firstly, a number of global variables is initialized. The list “array” contains the intensity of each pixel from the input image. The other variables are responsible for naming the image once it is saved.    The home screen includes the headline, the buttons for opening and saving the images, as well as the buttons for the different operations.  A brown rectangle with white text  Description automatically generated with low confidence  When clicking on the “Open Image” button another screen, that contains the images from the database is opened. |
|  | The screen “ImageDatabase” is scrollable and shows all the images. When clicking on one of the images, the user returns to “Screen1” and the chosen image is carried as a start value, as shown in the snippet below.  On the home screen the input image is now displayed in the top right corner. This is shown in the next screenshot of the user interface  Simultaneously, the intensity of each pixel is read from the original image, with the function “GetPixelColor” and written into the predefined variable “array” by proceeding through two for-loops. After this the input image is saved as “OriginalImageN.jpg”, where N represents an ongoing number. The logic of this can be seen in the block snippet below. |
|  | |
|  | Right now, a pretty dark image is chosen and therefore the goal is to make it brighter. When clicking on the intensity transform, a brighter output image is created by adding a constant value, in this case 64, to each pixel. Again, each pixel is sampled with two for loops, which proceed through the “array” and then 64 is added to each pixel, before the new intensity value is written into the output image. It is crucial to clip the intensity values to 255, in order to avoid errors. For example, if a pixel has the value 210 and 64 is added, resulting in 264, then the new intensity value would be wrong because the function “make color” interprets this as 264-255 = 9, which is very dark instead of white. The implementation of the clipping algorithm is achieved by a simple if-then-else condition. The name of the picture for later saving is set to “BrightImage”. The according block diagram is shown in the snippet below. |
| A screenshot of a computer program  Description automatically generated with low confidence | |
|  | The brightened output image is now displayed in the bottom right of the screen and the effects of the transformation are clearly visible. If wanted the image can be saved by clicking on the “Save Image” button. As shown in the snippet, the image is then saved as a .jpg with the previous defined name and the ongoing number.  By clicking on the “Open Image” image button, it is possible to chose another image to process. This is described next. Alternatively, the spatial filter can be applied to the already selected image. |
|  | Now, a MRI of the brain is selected, which is corrupted with gaussian noise. To get rid of this, an average filter is applied on the image. When clicking on the “Spatial Filtering” button the image will get smoothed with a 5x5 average filter. Notice that no padding is applied and therefore the two edge pixels will be ignored. Once again the array is sampled with two for-loops, but this time for each pixel the neighbors are also sampled by proceeding through two more for-loops from -2 to 2. Then the intensity value of all these pixels is added together and divided by 25 to receive the average intensity. Here the name of the image is set to “BlurredImage” for saving it later. The block sippet is shown below. |
| A screenshot of a computer program  Description automatically generated with low confidence | |
|  | The results of the spatial filtering is displayed in the bottom right of the screen. The effects of applying an average filter can be seen. If wanted the image can be saved or another image can be opened. |

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| Original Image | Intensity Transformation | Spatial Filtering |
|  | A close-up of a brain scan  Description automatically generated with medium confidence | A close-up of a brain scan  Description automatically generated with medium confidence |
|  |  |  |
|  |  | A picture containing mold, black and white, monochrome  Description automatically generated |
|  |  |  |
|  | A hand holding a star  Description automatically generated with low confidence | A picture containing text, monochrome photography, black and white, monochrome  Description automatically generated |
|  |  |  |
| A blurry image of a person walking  Description automatically generated with medium confidence | A blurry image of a person walking  Description automatically generated with medium confidence | Blur a blurry image of a person walking  Description automatically generated with low confidence |
|  |  |  |
|  |  | A picture containing screenshot  Description automatically generated |
|  |  |  |
| A person wearing a hat  Description automatically generated with low confidence | A person wearing a hat  Description automatically generated with low confidence | A close-up of a person's face  Description automatically generated |
|  |  |  |
| A close-up of a black and white background  Description automatically generated with low confidence | A picture containing clothing, fabric, pattern, screenshot  Description automatically generated | A picture containing clothing, screenshot, fabric, pattern  Description automatically generated |
|  |  |  |
| A close-up of a black sand  Description automatically generated with low confidence | A picture containing nature, black and white, beach, sand  Description automatically generated | A picture containing nature, black, screenshot, crater  Description automatically generated |
|  |  |  |
| A picture containing sky, cloud, black and white, nature  Description automatically generated | A picture containing cloud, nature, clouds, black and white  Description automatically generated | A picture containing sky, nature, black, black and white  Description automatically generated |
|  |  |  |
| A close-up of a wave  Description automatically generated with medium confidence | Close-up of a wave  Description automatically generated with medium confidence | Close-up of a wave  Description automatically generated with medium confidence |
|  |  |  |
| A picture containing black, text, monochrome, black and white  Description automatically generated | A long shot of a tunnel  Description automatically generated with medium confidence | A blurry image of a tunnel  Description automatically generated with low confidence |
|  |  |  |
| A close-up of a cat  Description automatically generated |  | A close-up of a cat  Description automatically generated |
|  |  |  |
| A picture containing black and white, landscape, outdoor, nature  Description automatically generated | A picture containing black and white, nature, landscape, outdoor  Description automatically generated | A picture containing landscape, black and white, sky, outdoor  Description automatically generated |
|  |  |  |
| A close-up of a black and white background  Description automatically generated with low confidence | A picture containing pattern, black and white, monochrome, honeycomb  Description automatically generated | A close-up of a black and white background  Description automatically generated with low confidence |
|  |  |  |
| A person walking on a road with trees in the background  Description automatically generated with low confidence | A person walking on a road with trees in the background  Description automatically generated with low confidence | A person walking on a path with trees in the background  Description automatically generated with low confidence |
|  |  |  |
| A person running under a bridge  Description automatically generated with low confidence | A person running under a bridge  Description automatically generated with low confidence | A person running under a bridge  Description automatically generated with low confidence |
|  |  |  |
| A picture containing landscape, sky, monochrome, outdoor  Description automatically generated | A picture containing screenshot, black and white, black, sky  Description automatically generated | A picture containing sky, black, screenshot, landscape  Description automatically generated |
|  |  |  |
| A close-up of a wave  Description automatically generated | A close-up of a wave  Description automatically generated | A close-up of a wave  Description automatically generated |
|  |  |  |
| A picture containing sketch, drawing, tree, black and white  Description automatically generated | A picture containing sketch, drawing, line art, art  Description automatically generated | A picture containing sketch, drawing, black and white, branch  Description automatically generated |
|  |  |  |
| A close-up of a mountain peak  Description automatically generated with medium confidence | A close-up of a mountain  Description automatically generated with medium confidence | A close-up of a mountain  Description automatically generated with medium confidence |
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