MFIF – Fuzzy image fusion

Ver.: 1.1

User manual

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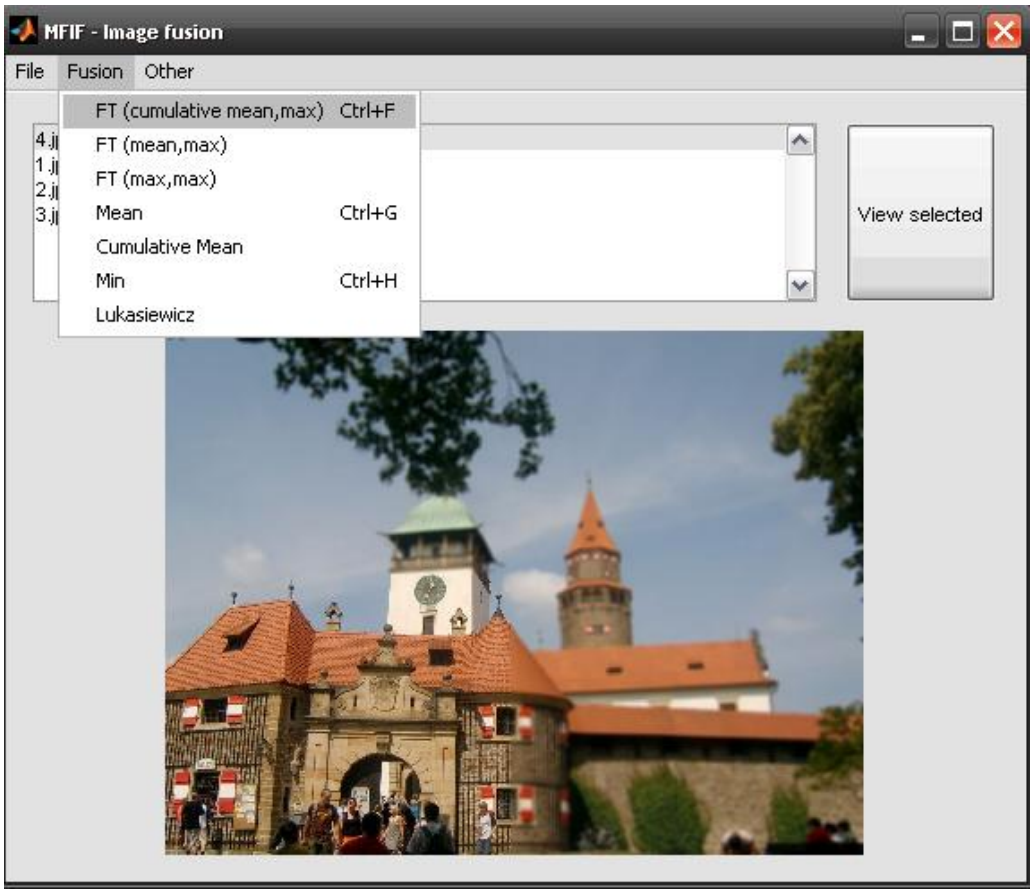
http://irafm.osu.cz



1 MFIF – Fuzzy image fusion

MFED is Matlab implementation of fuzzy detection algorithms, with extension of the behavior of the classical algorithms. Moreover, edge detection algorithms supported by the discrete fuzzy transformation are added. The approaches are formally described mainly in [http://irafm.osu.cz/en/c94_image-processing/]. It is based on properties of fuzzy transform in the locations where the source image changes and the behavior of created components for those locations. A more detailed explanation about the image fusion process and examples can be found on [http://irafm.osu.cz/en/c120_image-fusion/ and http://irafm.osu.cz/en/c95_image-fusion-tool-fuz/] page and its references.

The application takes the set of selected images and settings as an input and generates resulting image containing best parts of each image fused together.

2 Instalation

The application is developed and tested only for Windows OS family. Tested and verified versions/editions are Windows XP Home/Professional and Windows 7 Professional.

To run the application the product called MATLAB Compiler Runtime (MCR). This package can be downloaded from the internet or can be provided on request by the IRAFM institute. More information can be found at http://www.mathworks.com/help/toolbox/compiler/f12-999353.html#bs5vv3i.

Second step is to install application. Distributed ZIP file needs to be extracted to some location. If MCR package is installed correctly, the extracted file ReadImages.exe must be executed to start the application.

3 Usage of the application

3.1 Step first – loading the file(s)

You can load or save the file using the menu *File* → *Open*. Application can accept common image file types, however, there have been reported some issues with PNG files. Unfortunately, this issue source is probably located in the original Matlab libraries and we have no way how to treat them. We suggest users to prefer .jpg or .bmp files.

Multiple files must be loaded to process the fusion. All files must have same size (same number of pixels on width/height).

Only one file is visible at the image screen at once, but all loaded files will be processed.

3.2 Step two – setting active file

You can select the *active file* from the list of the opened files. Select desired file in the list and push *View selected* button. The image will be displayed and become *active file*. **The selection of the *active file* have no effect on the order or the result achieved by the fusion process.**

There can be only one *active file* at the time.

You can clear of loaded files expected to be processed the list using *File* → *Clear list* menu item.

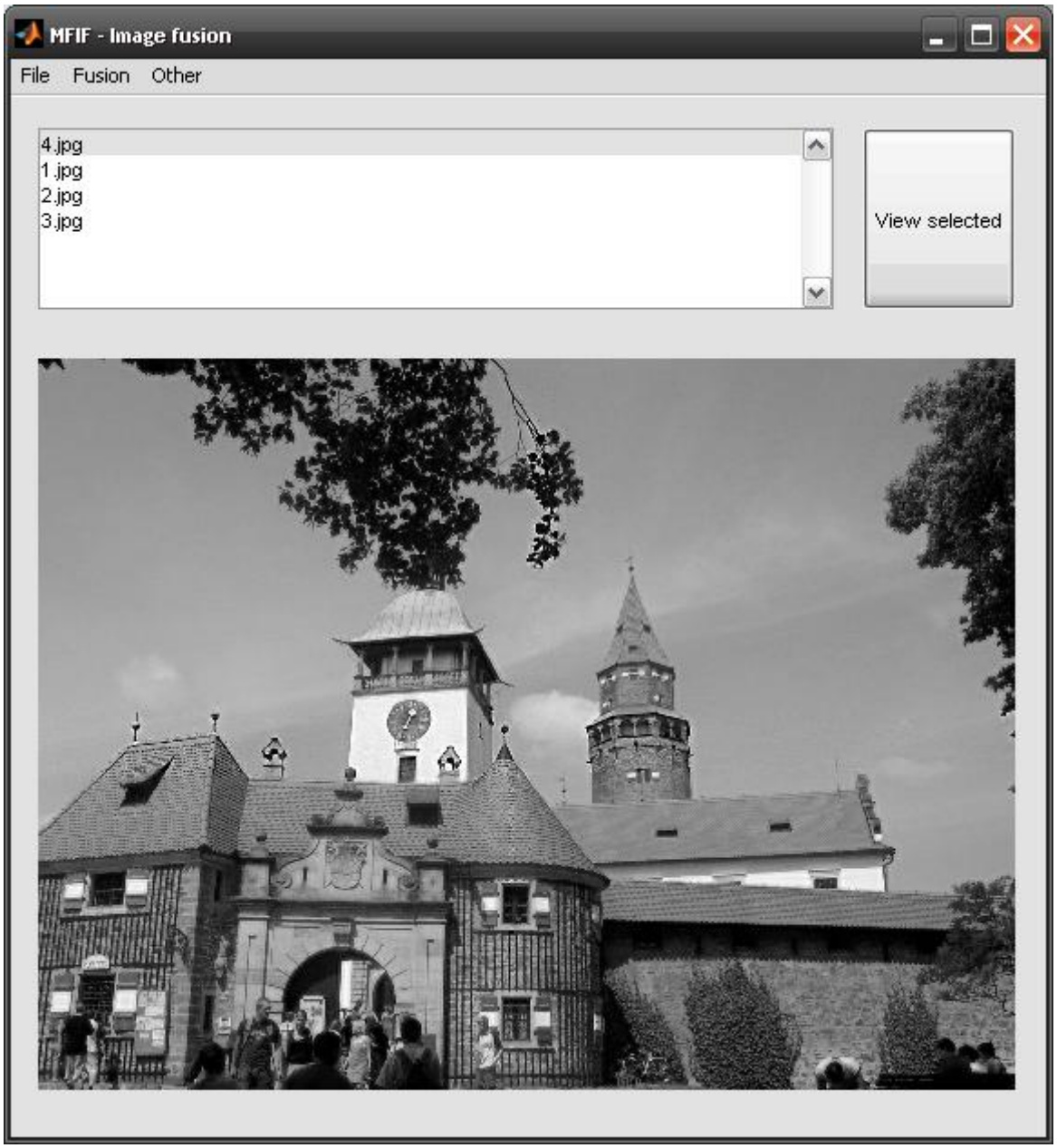
3.3 Step three - processing image

Nowadays, only grayscale images are expected as a result of the fusion process, even if color images are set as a source.

To process fusion, select one of the methods in the *Fusion* menu. There are multiple methods, the most interesting developed using fuzzy transformation or Lukasiewicz algebra are explained below.

3.3.1 FT – (xxx,yyy) – Fuzzy transform

Fuzzy transform this algorithm will process the input image using the two dimensional default fuzzy transformation with input image matrix as a source. Then, the result is combined with two one-dimensional fuzzy transformations, one by rows and the other by columns). More information about the principles of the edge detection using fuzzy transformation can be found at [http://irafm.osu.cz/en/c94_image-processing/].



The basic principle is that image is taken by and it is processed by the forward and then the inverse discrete ordinary fuzzy transformation. The main idea is that the result image, which was created by passing through the forward and inverse fuzzy transformation, differs from the source image at the edges. This approach can be used in situations where are multiple shots of the objects in various focus.

There were three slightly different approaches implemented in the environment:

- Cumulative mean – the combination of information from the source image are calculated as the cumulative mean. In this approach **the result depends on the input image order**.
- Mean – result after fuzzy transformation processing is cumulated as standard mean between all of the images.
- Max – result after fuzzy transformation processing is cumulated as the maximum value function over all the images.

Which method is used is described in the brackets in the menu item text.

The execution the method asks for *points-per-base*. This value defines the size of the basis function. The common value for most case are 3-5; higher value may improve results for noisy images, but produces more blurry edge detections.

3.3.2 Mean

Fusion of the images is calculated via the common mean function over all pixel values over all items.

3.3.3 Cumulative mean

Fusion of the images is calculated via the common cumulative mean function over all pixel values over all items. Again, in this case the result may differ base on the **order of the input files** included in the process.

3.3.4 Min

Fusion of the images is calculated via the common minimum function over all pixel values over all items.

3.3.5 Lukasiewicz

Another implemented approach uses fuzzy transform over the standard Lukasiewicz algebra. This only approach is internally built for source ranges < 0; 1 >, so the source images have to be transformed into this range. There can be multiple approaches based on this technique. Implemented solution starts from the definition of two operations, marked as * and →. Definition of those operations follows:

$a * b = \inf\{(a + b - 1),(1)\}$

$a \rightarrow b = \sup\{(1 - a + b),(2)\}$

Using this approach, basis for the forward and inverse fuzzy transform can be made. There are two typical approaches dependent on the way how the meaning of the functions is mapped by the fuzzy transformation over Lukasiewicz algebra. The one described above produces a lower approximation

of the input. There exists also the dual to this fuzzy transform that creates an upper approximation of the input. Since in the problem of image fusion, both approaches give nearly the same results, we have decided to implement only one of them. This approach can be used to extract sharp parts from the input set of images and provide them as a result.

The behavior of the fusion algorithm is basically the same like in the standard fusion function, only the values of the internal components calculated to detect the "best" part of the image differs.

3.4 Step four – Saving the result files

Result file can be saved, again using *File* → *Save* menu item. You must provide extension of the file, because via extension the file-type format of the saved file can be recognized. BMP, JPG and PNG files are supported. Again, result file after image fusion is always only in grayscale color model.

3.5 Other behavior

You can return to the previous image by menu *Other* → ← *previous image*.

4 Uninstallation

The program can be simply deleted from the computer.

The MCR have to be uninstalled via standard OS installation menu, that is *Control Panel* → *Add or remove programs*.

5 Other information

According to continuous research in this area, a newer version of this or similar software may be available. For any further information or comments contact IRAFM staff.

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