Multimodal Plant Image Registration (mPIR) v.0.1 – Quick guide

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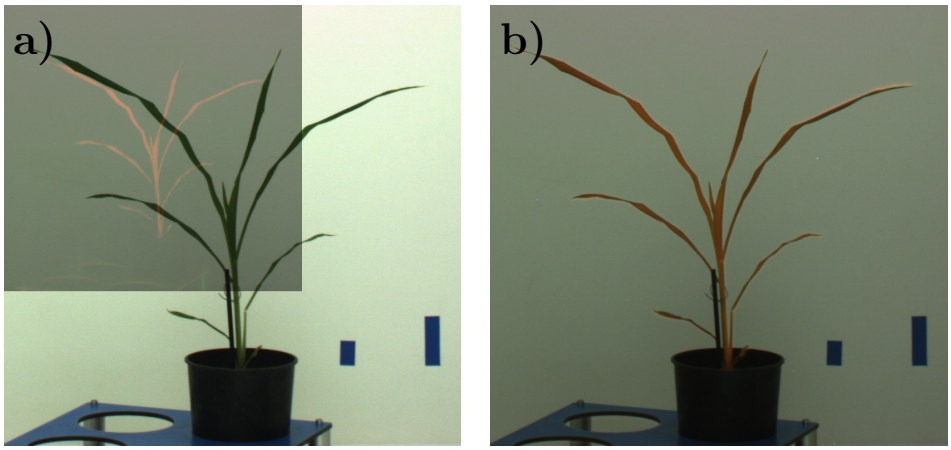


Example of affine registration of fluorescent (FLU) and visible light (VIS) images of a maize shoot: blended overlay of (a) original and (b) registered FLU/VIS images.

Contents

1 Introduction

mPIR tool is developed within the scope of a research study [1] aiming to investigate the parameter-dependent performance of three different methods for multimodal alignment of plant images including feature point matching (FP), phase correlation (PC), and intensity information (INT) based registration techniques.

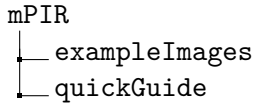
1.1 Key Features

The tool performs affine registration of each two selected images (for example, FLU and VIS images of the same plant shoot) using three registration techniques (i.e. FP, PC, INT) and shows the result as a blended overlay. The user can adjust diverse algorithmic parameters and study their effects on the result of image registration.

2 Quick Start

2.1 How to install?

After unpacking the zip archive following three folders will be generated:



The mPIR folder contains the pre-compiled executable of the computer program, a readme- and a license file. Please, read both text files carefully before starting the program. The *exampleImages* folder contains a set of example images, see Sec. 3, and the *quickGuide* folder contains a copy of this file.

2.2 How to run?

The mPIR tool comes compiled in two versions, one for Linux- and one for Windows-based operation systems, respectively. To run the program the user has to install the MATLAB Runtime Environment. Since the mPIR tool was developed, tested and compiled under MATLAB 2018a, we recommend to install exactly the same version, i.e. MCR 2018a, which can be downloaded from the official MATLAB side Install and Configure the MATLAB Runtime.

2.2.1 Linux

Under Linux-based operation systems one has to open a terminal and switch to the folder which contains the mPIR tool . Then type

```
./run_mPIR.sh /path/to/your/MATLAB/Runtime/v94
```

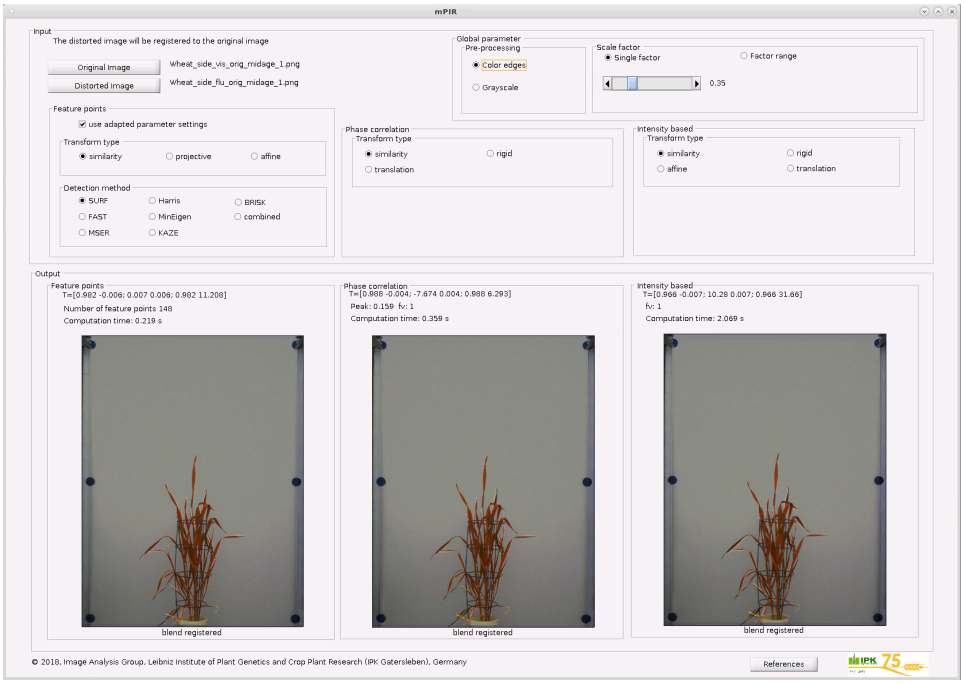
where */path/to/your/MATLAB/Runtime/v94* specifies the path to the locally installed MATLAB Runtime Environment (version 2018a - v94).

2.2.2 Windows

To run the program under Windows double-click on the icon of the provided executable in the Windows file explorer or start it with its name from the command line.

2.3 The Interface Layout

The major elements of the software interface include an **Input-area** at the upper part and an **Output-area** at the lower part of the GUI as shown below.



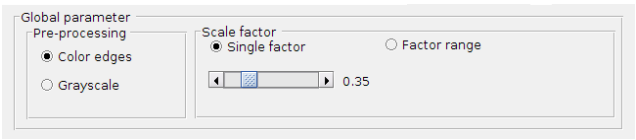
2.4 First Steps

To run the program, select the original and distorted image files in the input area. We suggest to select the visible light image as the ”original” image and the fluorescent image as the ”distorted” image. Once both images are found and successfully imported into the program, registration immediately starts. Image registration is always performed using the actual set of algorthmic parameters that can be adjusted by the user. The registration result is automatically re-calculated after every change of parameters and shown in the output area of the software interface.

By clicking on each image, one can switch between

Original →*Distorted* →*blend(Original, Distorted)* →*blend(Original, registered)*

image.
The user can try to change ether the global settings (image mode and scaling setup)



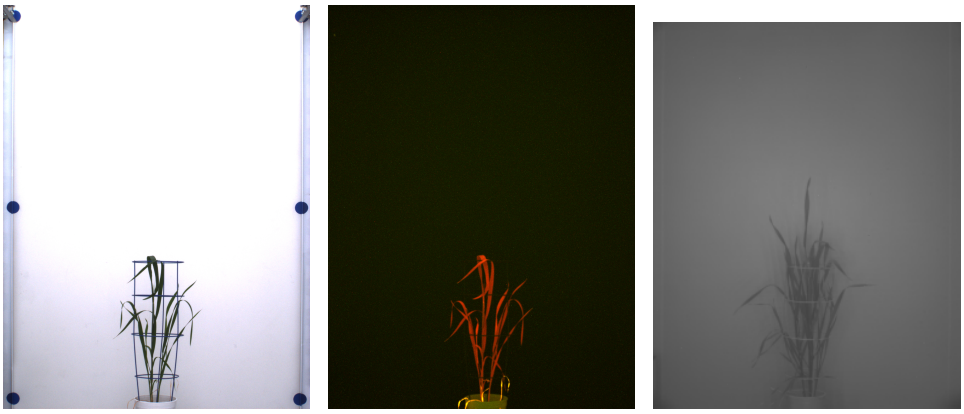
or the individual settings for every method.

After the global settings are changed the registration will be performed for all three methods automatically. When a local parameter of a single method has been changed only the corresponding method will be recalculated using the new set of parameters.
For all three registration methods the following types of geometrical transformations can be defined: similarity, projective, affine, rigid, translation. For the feature point matching the particular method of feature point detection can be selected (e.g., SURF, Harris, BRISK, FAST, MinEigen, MSER, KAZE, or combination of all). For feature point based registration, one can switch between the default settings of the MATLAB routines and a so-called ”adaptive” mode, in which the parameters for *detect<Methode>Features*, *matchFeatures*, and *estimateGeometricTransformation* have been optimized for the better performance with FLU/VIS plant images.
For studying the dependency of image registration on scaling, one can select between the single scaling factor or a range of scaling factors. If a range of scaling factors is chosen, an additional button pops up which has to be pushed in order to run the registration.

The scaling range requires three input values. To prevent recalculation at each action this button was introduced so that the user can decide when all changes are done and the registration can start. One should keep in mind that the calculation of the series of registrations over different scaling factor takes significantly longer than for a single image. As result of the registration via a ”factor range” the best performing registration is returned.

3 Provided example data

The mPIR tool comes with a small set of example images consisting or young and mid-age arabidopsis, wheat and maize images, for visual light and fluorescence in top and side view. For arabidopsis and wheat examples of near-infrared images are also provided. In addition to original images, the user can select manually segmented images to study effects of background-filtering.



VIS: 1234x1624 FLU: 1234x1624 NIR: 254x320

Example of a shoot image of a mid-age wheat plant.

The images can be found at the *exampleImages* folder (see Sec. 2.1. The naming of the files follows this convention:

$$\left\{\begin{array}{c} Arabidopsis \\ Wheat \\ Maize \end{array}\right\}\_\left\{\begin{array}{c} side \\ top \end{array}\right\}\_\left\{\begin{array}{c} vis \\ flu \\ nir \end{array}\right\}\_\left\{\begin{array}{c} orig \\ seg \end{array}\right\}\_\left\{\begin{array}{c} young \\ midage \\ old \end{array}\right\}\_<number>.png$$

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B Acknowledgments

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C Links

For details on implementation of FP, PC and INT registration we refer to the description of the MATLAB's Image Processing Toolbox™ (https://de.mathworks.com/products/image.html).

D References

[1] Henke, M., Junker, A., Neumann, K., Altmann, T., Gladilin, A., Comparison and extension of three methods for registration of multi-modal plant images, *in preparation*

E Terms of use

1. The mPIR tool is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY under the terms described in the EULA license. See the included *EULA.txt* file for details.

2. The user manual is intellectual property of the Image Analysis Group of the IPK Gatersleben. The user may download and use the tool and information available on our web site.

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