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Abstracts booklet

CROPS Equipment use workshop

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How to connect CROpS platforms to existing equipment

Benoit Debilde

R&D engineer

CNH Industrial Belgium N.V.

Abstract

The goal of this workshop on equipment use is to provide hands-on-training for manufacturers and employees in CROpS industries on all the equipment developed in CROpS.

This presentation focuses on the different CROpS subsystems and the requirements for their installation on agricultural vehicles.

How to calibrate the sensors on the sensory rig system

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Abstract

The goal of this work is to propose a procedure for the calibration and registration of the AVT Prosilica and the SwissRanger ToF cameras for the Crops Projects applications. In order to increase the accuracy of the image acquisition for the calibration and subsequently, the selection of the correspondences for the image registration, this procedure needs to be carried out with the help of the manipulator provided by TUM or the CSIC robotic platform.

The scenario provides certain constraints. One of these limitations is the low resolution of the ToF camera, which requires an extra effort to increase the accuracy in the pattern grid detection. Another constraint is the reduced size of manipulator's end effector and its load capacity are reduced. In consequence, the pattern board should be as smaller as possible, without any sacrifice in the goodness of the calibration results. Regarding these restrictions the CSIC decided to use the Matlab Calibration Toolbox [1] as a base of this procedure. This tool provides open and friendly user features. Concerning the restriction of the size of the board (to be the small as possible), it does not require any specific white outer border on the chessboard, which always increases the size of the board. Another pro, is the possibility to evaluate the quality of the selection of the grid points while the process is running.

The results have been evaluated according to the accuracy evaluation methods proposed in [2] and [3]. During the experimentation period the CSIC has tested different grid boards, and detected that small boards decrease the quality of the results. Normally a good number of training points is over hundreds of points, so if the effective pattern grid is 3x4 squares as it was the previous proposal, only 20 points (corners) per image can be acquired and at least 60 good images are needed to generate 1200 points. For that reason, the CSIC partners propose to use a pattern board of 6x7 squares size, with 4x5 effective squares grid. That means each of the acquired image will provide 30 points, and to take none less than 40 good images to run the calibration procedure.

The calibration procedure requires a large collection of training points to compute robust intrinsic parameters and to stabilize the errors, as well as to cover the entire field of view of the image. This can be done by positioning the pattern grid in front of the cameras at different poses. The orientation of the poses should not be extreme, because they can cause the loss of the intersection points for the corners detection methods. For the experimentation the CSIC has used the CSIC platform to simulate some of the movements of the manipulator. The sensory rig system setup was placed in front of the platform at 650 [mm], and the chessboard was attached to the top of pan-tilt unit on the platform. Then the platform was used to move the pattern grid at 45 poses of a 6x7 pattern board (with 4x5 effective grid) of 50 mm each square.

The evaluation of the calibration results was focused on two methods. The first one is the error between the re-projection of the known 3D data into the 2D images x_{pi} and the real data computed from image segmentation $\hat{x}_{pi}$, denoted *"Accuracy of the distorted image coordinates"* [2] [3]. The second is the 3D measurements errors of the pattern grid [2]. Normally, this method is oriented to use the 3D positions obtained from the stereo triangulation to compare the calculated 3D measures from the calibration results. However, since this particular case is based on the image registration, the CSIC partners propose to compare two groups of data with the poses of the chessboard in front of the camera. These two groups consist on, the calibration results of the ToF camera, and the results of the Prosilica camera obtained via the calibration and the registration procedure.

The computation and evaluation of the registration procedure requires a significant collection of truth data of the corresponding points (at least 300 of these corresponding points). This step is one of the most important on the registration procedure, because the goodness of the registration results is strongly linked to the errors in the corresponding points, so it must not be taken lightly. The evaluation of the registration error corresponds to the discrepancy between the registered data and the truth data. This error needs to be computed for both images, the one acquired from the ToF and the other from the RGB camera.

The proposed calibration and registration procedures have been evaluated and validated in laboratory conditions. Experimental results of the calibration method demonstrate its efficiency since the obtained errors are significantly lower than other present in the current literature [2, 3]. On the other hand, the goodness of the proposed procedures, it has been shown by means of the computation of arbitrary scenes.

The guidelines presented in this work allow the Crops partners to accomplish a proper image acquisition for computing the calibration and the registration procedure. These procedures should be carried out by the CSIC partners. Then, the CSIC will provide to the Crops partners two XML files containing the calibration cameras parameters and the transformation Matrix H. These files are arranged to be used for the CSIC ROS nodes.

References

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Adaption to new growing conditions

BGU , computer vision group

Abstract

This presentation summarizes the parameters adjustment required for developing the fruit detection modules. Proper values for these parameters will result in a more accurate and faster detection.

Fruit detection and localization modules using ROS code includes sweet peppers, apples and grapes from both platform sensors and gripper sensors.

Learning in sensing and grasping

Thomas Hellstrom, Sigal Berman, Danny Eizicovits, Efi Vitzrabin, Yael Edan

Abstract

This presentation summarizes the stages and algorithms developed for detection and grasping focusing on the learning aspects. Each algorithm consists of several parameters, which can either be determined manually or learned (trained). Detection algorithms were developed to detect humans, trees and objects in a forest, sweet peppers and apples, ripeness of apples and grapes, and diseases. For the learning in grasping, a module supporting grasp selection for harvesting new fruits is presented.

Learning to harvest new fruits

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Abstract

This presentation summarizes the stages required for developing a module supporting grasp selection for harvesting new fruits. There are seven development staged where the first stage is learning grasping and harvesting task requirement from human demonstration and based on developed gripper capabilities. The final stage requires coding the developed grasp selection module using ROS code and integrating it within the developed system. Intermediate stages include gripper and fruit modeling, adaptation of grasp quality measures, development of graspability maps, and evaluation and validation in simulation and in hardware.

The orchard and vineyard equipment (I) – Hardware integration

Benoit Debilde

R&D engineer

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Abstract

The goal of this workshop on equipment use is to provide hands-on-training for manufacturers and employees in CROpS industries on all the equipment developed in CROpS.

This presentation focuses on the integration of the CROpS subsystems onto a grape harvester for the apple harvesting and grape harvesting applications of the CROpS project.

Equipment use workshop
How to use the sweet-pepper harvester

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Abstract

This presentation gives an overview of how to use the final demonstrator for sweet-pepper harvesting that was developed during the Crops project. After reviewing the target working environment in the greenhouse and the working principle of the machine a short explanation of the single system components is given. Then a closer look is taken at the task sequence operated by a state-machine which was implemented with the Robot Operating System (ROS) installed on Ubuntu Linux. The network configuration of the different sensor and computers is explained. To place the robot on the rail system between the crop rows in the greenhouse it is recommended to use the support of a forklift. For carrying out experiments with the robot in the greenhouse a minimum of two operators is needed: one at the front side to operate the graphical user interface and a second one at the back side to monitor the robot actions and to perform ground truth measurements. The start-up procedure beginning with plugging the cable into a power outlet up to the state where all robot components are up and running and ready to harvest is described in detail. Finally the presentation discusses solutions to solve possible problems with the controller of the robot and the different camera systems.