Deliverable for experiment GAROTICS

D 3.1: Field experiment report (first season)

Green asparagus harvesting robotic system

STRAUSS
UNIHB

Version 1
Submission date: **30.10.2015**

1 Introduction

During proposal writing and project negotiation it has been the plan that the consortium would have a couple of month for testing at least some technological solutions implemented before the harvesting season. However it turned out that the project only started in Month May exacly with the start of a harvesting season. In order to progess with the implementation and testing of new technological ideas the 'season' was extended on artificial dams, which were built outside the facilities of STRAUSS. The reported results below have been achieved exclusively on these artificial dams.

2 Asparagus detecton

In the first two month of the project the parterns specified the technologies which will be used for the optimization of the harvesting machine. For the detection of asparagus stalks it was decided to use a camera type 'Microsoft Kinect V2'. For detection tests an artificial pallet based dam was created on which real asparagus stalk were fitted to a palett and which was then covered with soil. Seeral of these palett based dam-sections were put one behind another to creat a long enough dam for sufficient testing.

The developments and tests for the development of the asparagus detection carried out can be described as follows:

a) **Taking images** of real green asparagus under outdoor light condition with Kinect camera

The Kincet camera is offering several advantages compared to the previously used 'stereo camera' as e.g. (i) more precise acquisition of asparagus shape and position, (ii) faster processing of image information and thus (iii) less distance between camera and asparagus position, as well as tracking of apsragus stalks, which consequently will improve the harvesting precission.

Figure 1 Images taken with Kinect camera

Esential insiths:

- The images taken during tests (see also figure 1 above) were looking promessing for their potential towards high quality processing;
- The camera is more prone to changes of light conditions, which has an impact on the complexity of the images processing.

b) Development of a mathematical logarithm for **processing the images** into position data

The images taken were used to develop a new image processing program (IPP) suitable for the use with the Kinict camera. The main focus for the program developemt during the first season laid on the determination of a pricise harvesting position. The programming was done in four steps as shown in the figure below:

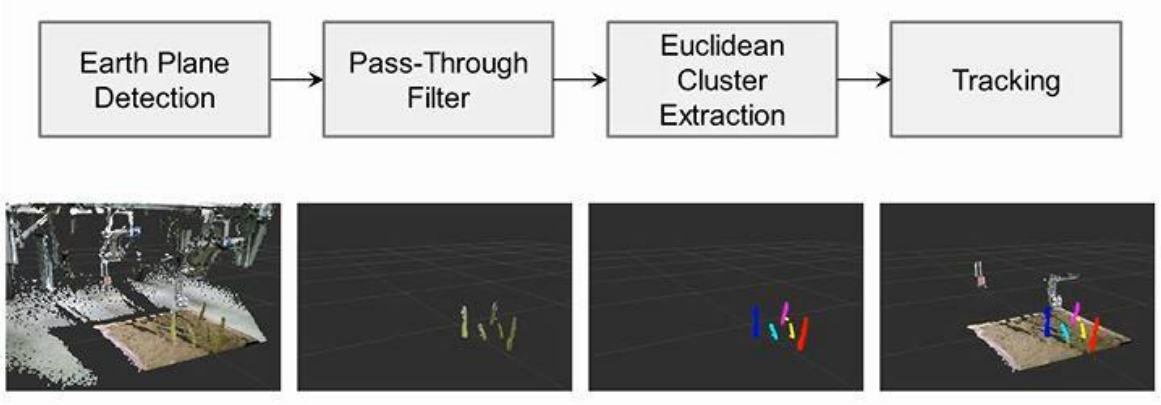

Figure 2 Detection and tracking of asparagus

In total three cycles of programming, testing and optimization were needed before the tracking was eventually functional, however, the protocol for the tracking still needs improvements for an icrease of the precision. A video of realtime detection and tracking can be watched under the following link:
https://www.youtube.com/watch?v=6ZYUINj_GfM

c) **Translation** of IPP information into PLC position data

For the communication between IPP and PLC a 'translation' program is required. With the use of a new camera the original (AmLight) translation program was not functional any longer and a new program was developed, implemented and tested.

Esential insiths:

- Communication protocol between IPP and PLC established

3 Asparagus harvesting tool

Harvesting tool related field experiments took place on the same artificial dam as used for the detection system using the latest versionof the AmLIght harvesting tool. Tests have revealed the following problems:

- Tool opening too wide for small asparagus stalks but too narrow for big stalks;
- Cutting blade in good position for small stalks but too far back for medium and big stalks (they get broken off);
- Grip on the asparagus stalk not quite enough for always secure lifting of stalks.

Once these difficulties had been identified STRAUSS, UNIHB and together with the former researcher of AmLight were reviewing AmLight results and had a brain storm with respect to potential modifications. From that a test plan was developed in order determine parameter for the gripping cutting tool such as material for the gripper, required contact area, opening angles of gripper and cutting blades, relativ positions of blades and gripping area. The opportunity of having an active harvesting tool (adjustable and/or movable) blades and grippers was discussed however; this only appears as a plan B if tests with the passive system don't lead to any good solutions.

Test with the harvesting tool only stated in September. **Esential insiths:**

- Test plan for harvesting tool parameter established

4 Conclusions

The main results achived during the first (extended) season for field experiments are:

- The images taken during tests (see also figure 1 above) were looking promessing for their potential towards high quality processing;
- The camera is more prone to changes of light conditions, which has an impact on the complexity of the images processing;
- Communication protocol between IPP and PLC established;
- Test plan for harvesting tool parameter established;

These results were discussed were discussed in October 2015 with the experts from RIF in Pisa, who agreed to the GARotics approaches.