HORIZON 2020

The EU Framework Programme for Research and Innovation

SWEEPER

Sweet Pepper Harvesting Robot

GRANT AGREEMENT Number 644313

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References

Grant	EU Framework Programme for Research and Innovation Horizon 2020 Grant agreement no 644313 “Sweet Pepper Harvesting Robot” SWEEPER
DoA	Sweet Pepper Harvesting Robot GRANT AGREEMENT Number 644313 Annex 1 Description of Action
SWEEPER D1.1	Sweeper Data Management Plan, version 1.1-v2, M18

Definitions - Abbreviations

Definitions or Abbreviations which are needed for understanding this document are listed here.

Abbreviation	Description
none	

Data Management Plan

This project works according to the H2020 guidelines for Data Management, as set out in the Data Management Plan (D1.1). This deliverable also refers to the following data:

Data type	Description
Images	Images of sweet pepper, referred to as DB#2

Executive Summary

In May 2016, the first integrated gripper with sensor and illumination was produced and used for data collection in the greenhouse under conditions resembling best (thus far) the acquisition likely to happen by the Sweeper harvester. This includes the EFFILUX LED array surrounding the iDS camera and an acquisition process that triggers the LEDs during very short exposure times in order to overcome ambient illumination and sun light. While deliverable 5.3 is the dataset itself, this short report describes its design and content, and how to publically access it.

Contents

1. Introduction

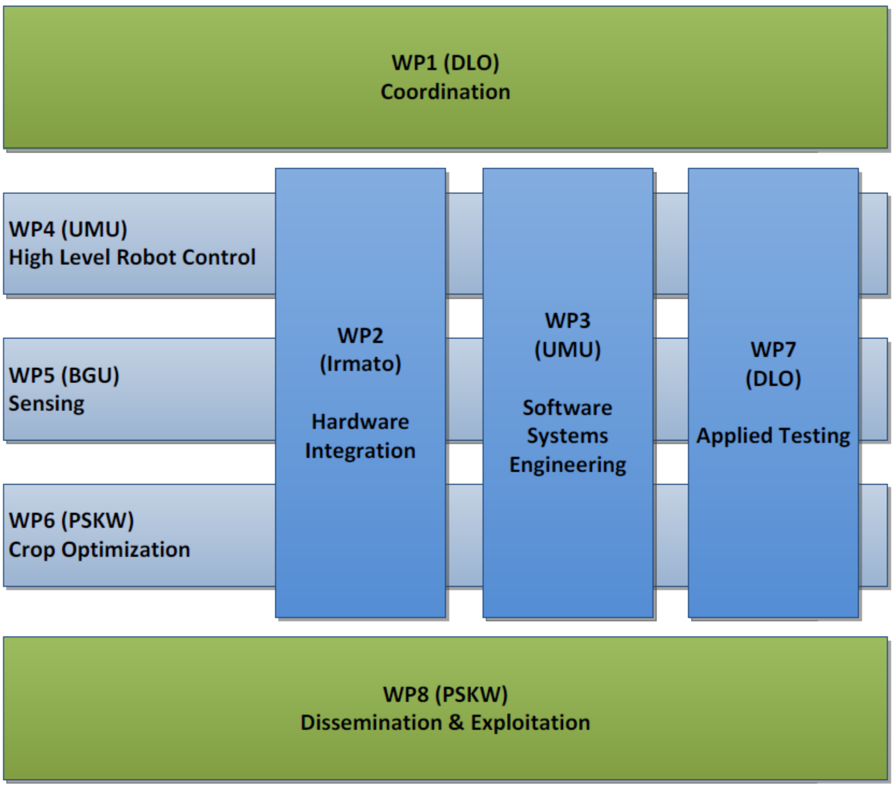
SWEEPER Project and Objectives

The Sweet Pepper Harvesting Robot (SWEEPER) research project is supported by the Horizon 2020 programme of European Union. The main objective of the SWEEPER project is to put the first generation greenhouse harvest robots onto the market [DoA-B; 1.1].

The project will achieve this by lifting up proven fundamental research results of a sweet pepper harvesting robot developed in the FP7 project CROPS, with a Technology Readiness to a market ready level (TRL = 9), which means the actual application of the technology is in its final form and under mission conditions, such as those encountered in operational test and evaluation environments.

The SWEEPER project is a partnership between Umea Universitet in Sweden (UMU), Ben Gurion University of Negev in Israel (BGU), Proefstation voor de Groenteteelt in Belgium (PSKW) and from the Netherlands Wageningen University & Research Centre (DLO), Irmato Industrial Solutions Veghel B.V. (IRMATO) and sweet pepper grower De Tuindershoek BV.

The SWEEPER project is organized into 8 work packages as shown in the figure below.



Work package WP5

The general objective of this work package WP5 is:

The sensing systems to be researched and developed in this work package are intended to provide SWEEPER the ability to detect the fruit, reach it and harvest it. The work to be carried out will start with formulation of methodologies for data collection and evaluation and datasets (T5.1). These datasets will serve for development of algorithms for fruit detection and localization (T5.2), obstacles detection and localization (T5.3) and fruit maturity (T5.4). Extensive benchmarking will complete the work of this work package (T5.5).

Purpose of this deliverable

Sweeper detection and localization algorithms are designed to be data-driven. To facilitate this approach, the Sweeper research plan includes no less than 4 data collection sessions to serve algorithm design for both the basic and advance system. In May 2016, a team from DLO deployed the recently developed gripper system by Irmato to obtain a new dataset of images in the grower's greenhouse in order to check the developed concept and collect data for algorithmic design. According to the research plan, this dataset, as well as the forthcoming ones, should be made public both for the Sweeper community and the research community in general. The rest of this short document describes the content of this dataset and how to access it.

2. Dataset design, protocol, and content

While the Sweeper robot is likely to observe the sweet pepper plant from various angles and distances, tests done by DLO (and also in the CROPS project) indicate that lower angles are preferable. With trigger-able and strong flash illumination, concerns regarding the position of the sun as well as ambient light in general, became less significant in DB#2 and thus imaging angle was limited to lower angles facing up. The acquisition protocol thus utilized the selected sensors and illumination, the selected sweeper manipulator, and custom-made software, to collect data in the following way:

- Sensors and illumination were mounted on the tip of the manipulator (Fanuc LR mate 200iD, 900mm 7L version) that was programmed to move between 15 predefined configurations that cover 5 viewpoints at each of 3 distances from the plant. Since on the ground it was found that the furthest and highest viewpoint pushes the limits of the arm, that viewpoint was discarded, leaving 14 viewpoints for each scene.

- The settings that were used: 5000mA 50μs strobe, 50μs exposure time, fully open diaphragm. Images were taken at 20 degrees upwards, from the left (-45deg), center and right (+45deg) of the plant and at distances of 50, 40, 30, 20 and 10cm between the fruit and the front of the camera lens.

- The best configuration of the EFFILUX lenses and diffusers and angles was similar to the conclusions of the lab tests: no diffuser, no angles and lenses placed right on top of the LEDs provided the best contrast.
- Upon completion of all viewpoints, the robot switched to a homing position, the platform was moved to a new place to face a new scene, and the entire sequence of operation restarted.

Figure 1 shows the gripper with the iDS camera, laser and suction cups.

Figure 1: the gripper with the iDS camera, laser and suction cups.

Since images were taken under strobed flash and short exposure time, we removed the custom-made automatic exposure control that served D5.1. Figure 2 shows several examples of resultant images. In total, DB#2 contains 750 images in 50 scenarios. For each of those scenes the DB contains 5 different distances, and 3 viewpoints for each.

Figure 2: Several sample images under the described protocol. Note that even under direct sun (example on the left), the image is not full saturated and the fruits are still observable.

3. Public web access and graphical user interface

All data of the second Sweeper image database (Sweeper DB#2) are available publically through a web interface at the following URL:

http://www.cs.bgu.ac.il/~icvl/lab_projects/agrovision/DB/Sweeper02/

A snapshot of the main screen and the intuitive user interface is shown in Fig. 3. This web interface allows interactive browsing through the dataset, and it provides downloading features of a single image, a single image set (from a given viewpoint), or the entire dataset in one click of a button.

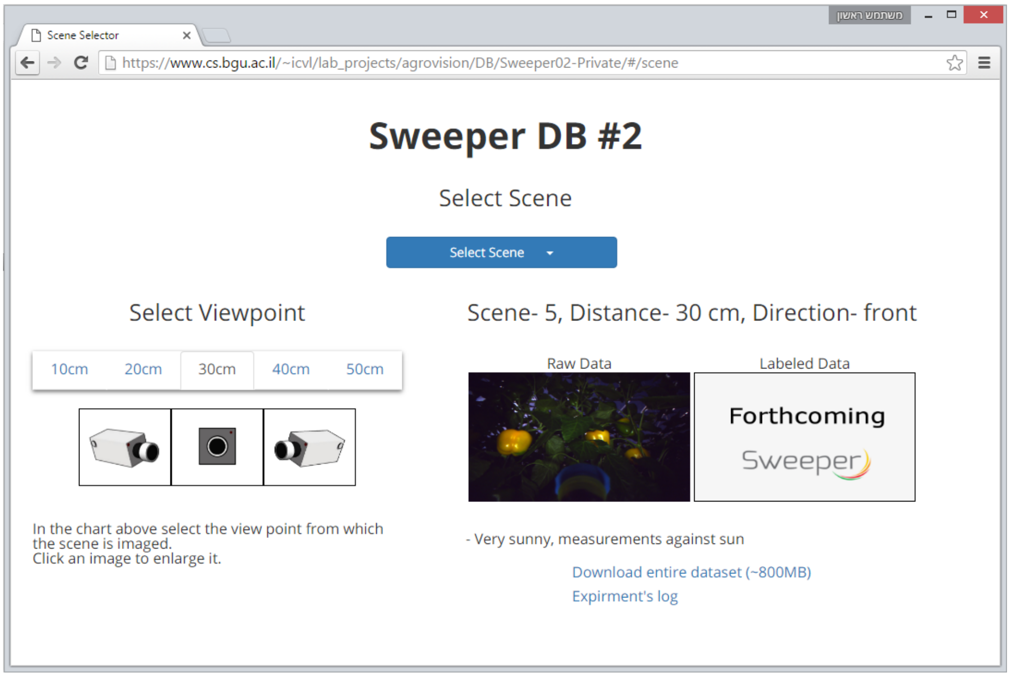


Figure 3: A snapshot of the interactive web interface to the 2nd Sweeper DB.

4. Conclusions

The first version of the integrated basic sensor system was used to collect a large collection of images for algorithm development. The system includes the camera and laser scanner, as well as integrated illumination that is strobed during short exposures. The images are dominated by the artificial illumination and show little sensitivity to ambient and sun light, and indicate that the strobe light approach is promising. Data is available on a public website for all project partners and the research community.