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RHEA

RHEA Newsletter

Robot fleets for highly effective agriculture and forestry management

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Inside this issue:

The RHEA puzzle: all pieces are getting in place

For an outsider, the RHEA system may look like a puzzle: a complex set of ground and air units, equipped with different types of tools, guidance and control systems, managed by a series of programs that make decissions regarding unit movement and actions, controlled remotely from a central base station, etc, etc.

During the first two years of the project all these components have been developped and constructed by different research teams all over Europe. Now, during the scientific and technical meeting held in May at Zedelgem (Belgium), these individual components have been placed together in the factory of CNH, assessing the integration of all the pieces. As expected, everything fitted nicely. It was very satisfying to see, for the first time, how the RHEA fleet may look like at the end of the project.

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Base Station

The base station can be considered as the core of the fleet system. Within a portable cabin, a computing system, software packages and communication systems provide the interaction point between the whole system and the operator. It is based on a friendly Graphic User Interface (GUI) for system operation, monitoring, information record-keeping and operation optimization. The GUI system will be connected in real time with the real system and will display in 3D the current state of operations, i.e., position, orientations, speed, and status of every robot. It will allow the user to send instructions to the fleet of robots and will include a simulation system to allow the user to test rapidly new operations before the instructions are actually sent to the real system or to test the result in simulation of an emergency procedure started from the current real situation. This will help to manage emergency situations where the user has to define rapidly new operations in case of problem (e.g., the failure of one robot). During the meeting at Zedelgem, RHEA participants from **CSIC-CAR**, **FTW, SAP, UPM** and **Cyberbotics** presented the current status of development of the Mission Planner, the Communication and Location System Equipment, the Aerial Unit Controller and the Graphic user Interface.

Aerial Units

In order to provide aerial images for weed patch detection, a group of aerial robots based on small commercial quadrotors and equipped with vision systems are being developed. Quadrotors are cheap, lightweight aircrafts that do not need certification for flying. This fact simplifies the legal consideration for accomplishing real missions. In Zedelgem, **AirRobot** presented the Aerial Mobile Unit (AMU) prototype developed in the project. This AMU (AR-200) is a drone equipped with 6-rotors, with 2.20 m of diameter and with a flying time of 30


Demo with the drone AR-200

minutes with a load of 1.5 kg. The demonstration conducted with the AMU showed the reliability and the capabilities of this equipment. The participants from **IRSTEA** made a real time demonstration of the use of the remote perception system developed by this group and installed on the AMU.


Ground Mobile Unit

Ground units

The Ground Mobile Units are based on a small tractor (CNH Boomer T3050 CVT) built by **Case New Holland (CNH)**. This tractor has a wheelbase of 1.7 m, weights 1.5 tons and 51 CV (ca 38 kW) horsepower. The relatively small size of these units, their high reliability and their good fulfillment of all the project requirements makes them ideal for their mission. **CNH** and **BlueBotics** have adapted these vehicles for their autonomous operation, including the steering and braking systems. Installation of different pieces of equipment was conducted by participants from **CSIC-CAR** (High Level Decision Making System)**, CogVis** (Row and Obstacle Detection System)**, Polytechnic University of Madrid** (Laser system)**, Universidad Complutense de Madrid** (Ground Detection System), Communication **(FTW)** and Location **(SAP)** Systems**.** Every component was attached to its related structure, assessing their integration and the actions to follow. Changes in the engine speed and in the three point hitch were also introduced by **CNH** to improve the adaptation to its mission. The unit carries an additional fuel cell power system and a solar panel developed by **Tropical** to be used for electronic equipment on board. This autonomous tractor is expected to follow a defined track within a field with minimum deviations, recognize crop rows and obstacles and control mounted implements at predefined action points.


Antennas and camera


Integration assessment meeting

Implements

Three different types of implements have been designed and constructed to be used in combination with the ground units to perform different crop protection operations.


User Portable Device

The **University of Pisa** has constructed a device designed specifically to perform mechanical weed hoeing in the inter-row of the crop and precision application of crossed flaming (thermal weed control) in the row of the crop. This machine is 4.5 m wide, covering 6 crop rows spaced 75 cm. A detection system mounted on the ground unit will discriminate the crop and the weeds in a strip of 0.25 cm. This information will be processed by the high level decision making system that will manage the different LPG working pressure according with the perceived level of weed cover. This will allow a precise flaming application. The correct position of the tools (mechanical and thermal) will be guaranteed by a precision guidance system driven by a hydraulic piston connected with the hydraulic system of the ground unit and managed by a row detection system. Two steering wheels mounted on the frame of the machines will maintain the correct position of the tools following the real alignment of the crop row. **BlueBotics** is in charge of the coordination of every subsystem.


Implement for thermal treatment

Soluciones Agricolas de Precisión (SAP), a Spanish company specialized in precision agriculture machinery, has designed a sprayer prototype to be attached to the ground units for herbicide application. Twelve high-speed solenoid valves are mounted on a stainless steel sprayer boom with an equidistant spacing of 0.5 m. The boom sprayer is divided into twelve sections, each containing one-solenoid valve. Each one of these valves is powered by a 12 V source that allows the spray from each section to be controlled independently. A central direct injection system is equipped with a water tank (200 L) and a separate container for the herbicide (15 L) to be injected according to the prescription information from the


Spraying system

High Level Decision Making System (HLDMS). An intermediate connection box between the sprayer and HLDMS was created and installed to accommodate the signal sensors, hosting the injection system controller and the automation (PLC) device provided by **BlueBotics**.

Implement for pesticide application in olive trees

The **University of Florence** has designed and constructed an air assisted sprayer with spray distribution based on the geometry of intensive and super-intensive olive trees. The semi-mounted sprayer, attached to a small autonomous tractor, is equipped with different typologies of sensors and is able to recognize the presence, shape and thickness of the various horizontal bands of the canopy, adjusting the activation, the amount and the type of spraying. Moreover, it is possible to control on each band the direction of air diffusors and the airblast flow rate in relation to the presence or thickness of the canopy. An innovative device system to control dose application proportionally to the canopy band thickness has been applied by a high frequency solenoid valve driven by variable duty cycle controller. Again, **BlueBotics** provides the PLC for automating the implement.

Testing remote perception systems

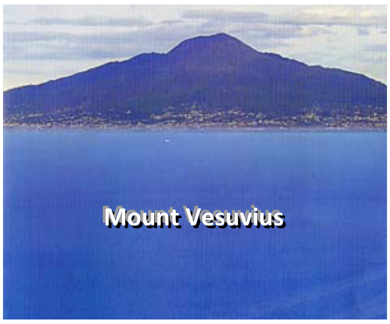

Testing the remote perception system


Watching the drone ….

A few days before the Zedelgem meeting, researchers from four RHEA groups (**CSIC-IAS, CSIC-ICA, CSIC-CAR** and **IRSTEA**) met at the **CSIC-ICA** facilities (La Poveda Research Station, Arganda del Rey, Madrid) to assess the aerial perception procedures thar are currently under development by **CSIC-IAS** and **IRSTEA**. The tests were conducted on the same maize field where the final Project Demo will be conducted in 2014. Two different types of AMU and two camera systems were used in the assessment. Images obtained at different heights (30 and 100 m) were ground truthed using quadrats located in a grid covering the whole field. Currently, images are being processed for mosaicking and weed detection and quantification. The procedures developped will be used to automatically scout weed patches present in crop fields prior to control practices.

Social life

Project workshops are an excellent opportunity to strengthen personal relationships among project participants. At the end of the day, once the daily objectives have been accomplished, it is time to enjoy social life.


Mount Vesuvius

In February, at Sorrento, workshop participants were able to enjoy local food, wine and good company in a typical trattoria. Outstanding views of the Vesuvius from the hotel rooms were another important bonus of this meeting.


Participants in hard competition …


… one more meeting …

In May, after the meeting held at the **CNH** factory (Zedelgem), workshop participants enjoyed a walk through the streets of Bruges before visiting the old brewery "Maes". In that historic place, the tour guide told us of many details not only about the manufacturing process but also on culture and importance of beer in Belgium. Afterwards, participants had the opportunity to enjoy a fantastic dinner, accompanying each dish with a different beer with increasing alcohol degree (simple, double, triple and… quadruple!). After tasting beers so delicious, it was no surprising that some of the participants dared to "throw" beer almost precisely in the sense of "brewers". There was an "unofficial" competition of beer waiters. The prize for the winner was, of course, a big bottle of beer!