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RHEA Newsletter

Robot fleets for highly effective agriculture and forestry management

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By Cesar Fernandez-Quintanilla (CSI-ICA)

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Integration week

After almost three years of planning, design, development, construction and testing, at the end of April all the individual components of the RHEA project were finally ready. The initial plans had been followed without major deviations and now we had reached a critical step in the project development: the preliminary integration of the whole fleet.

During the first two weeks of May all these individual components were delivered at the Centre of Automation and Robotics (CSIC-CAR) in Arganda del Rey, Madrid. The test plans for the fleet assessment had been prepared in advance, including checking of each system independently and in combination with other systems. From May 9 to May 16 the various RHEA participants were gradually arriving at the CSIC-CAR facilities to perform all these tests. The aim of all this work was to assess the current integration of the system, identifying both finished and still pending issues in order to achieve the final project objectives.

Controlling the system from the Base Station

All modules related to the Base Station (BS) were integrated. Modules such as the Mission Manager (MM), which incorporates a Planner and a Supervisor for both aerial and ground units, the Weed Mapping System (WMS), integrated by two modules one for mosaicking pictures and another one to detect weed, and the Graphical User Interface (GUI), were installed and their functionality was tested. In addition, the communications among the modules in the BS as well as the communications between BS and external elements, such as the Ground Mobile Units (GMU), the Aerial Mobile Units (AMU) or the User Portable Device (UPD), were estabished and checked. Finally, the Mission Manager Dispatcher (MMD), a module that controls all the workflow and supervise the communications into de BS, was successfully integrated. Summarizing, at present, the Base Station is fully operational so an operator might, among others, generate and send sub-plans to the mobile units of the fleet, supervise both treatment and inspection missions, control the GMU directly from the GUI, etc.

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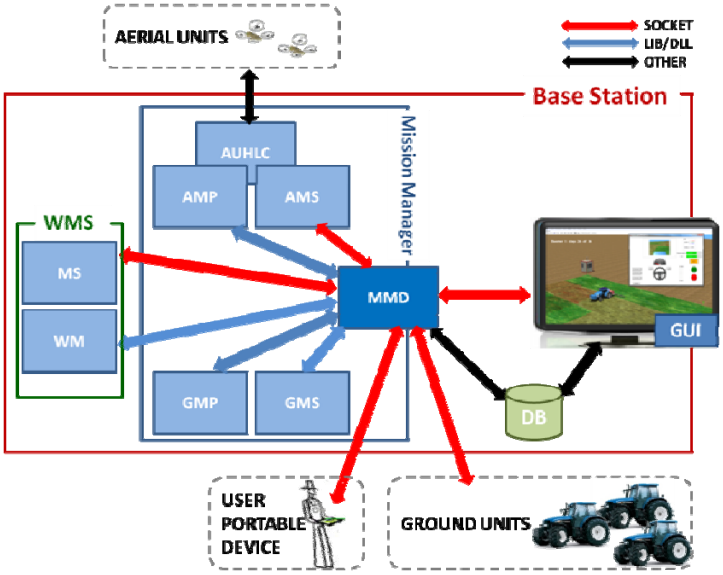


Integrating Aerial Mobile Units

Previous work on the Aerial Mobile Units (AMU) had concentrated on the improvement of the security of the rotors, the reliability of the engines and the efficiency of the smart battery system. The AMU-1 was updated to this technology level and a new drone (AMU-2) was built with the same features to reach the milestones for the final integration.

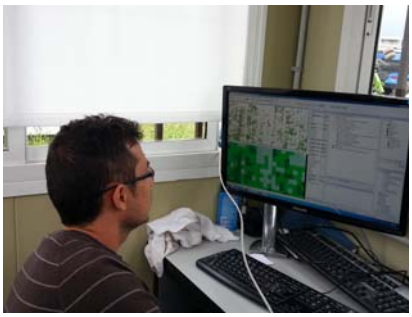
At the integration, the Aerial Mission Planner, the path followed by the AMU and the dual payload system were tested successfully and images were recorded for the post processing in the Remote Perception System. This was an excellent opportunity for testing, for the first time, the implementation of the cameras on the drones, as well as the automatic flight programming. Despite unfavorable weather conditions, several flights at various altitudes were made, allowing to collect visible and near infrared images of the wheat and maize fields. The automatic detection of ground reference targets in the images for georeferencing purposes was also tested successfully. The team in charge of weed patch detection began working on the collected aerial images. Other aspects, such as the software communication messages between the perception system and other modules, were also validated.

Integrating Ground Mobile Units

During the first days, the various partners had the opportunity to integrate their own subsystems (power supplies, fuel cell system, solar panel, localization system, communication system, camera, laser and all the different controllers) into de Ground Mobile Units located in the CAR workshop. The second part of the integration took place outside, under field conditions, and it was focused on path following tests leading to autonomous navigation and the integrations of the three different implements. The different actuations systems of those implements were successfully controlled by the actuation controller.

Crop row and weed detection

Before integration week, we had developed a single software module to run in the Compact-Rio (cRIO) main processor. This module was designed to capture the image, to process it according to our needs (crop row detection and weed



identification), to compress it and to send it to the base station. These four steps were integrated into a single module. During integration days, this module was split out into four independent sub-modules so that other partners could have access to either of them. The four sub-modules are the following: (a) image acquisition module, (b) image processing module, (c) image compression module and (d) image sending module, based on TCP/IP protocol. The main module is the image processing, where the extracted information is directly transferred to the HLDMS, also deployed on the cRIO. All these modules are currently operative on this unit after the integration tasks carried out during the last integration period.

Communication and localization

We built and tested a communication infrastructure between robots and the base station that enables other participants to transfer their data across the system. We also installed and configured a data logging system that collects communication parameters and application messages from routers mounted on robots and stores them in the base station. The purpose of the data logging system is to enable near real-time system monitoring. Furthermore, software that runs on the user portable device successfully managed to remotely control both, a ground mobile unit and an implement respectively. Localization tests were conducted on the user portable device. In addition, extensive localization tests were conducted regarding ground mobile units.

RHEA meetings

On April 15th and 16th the University of Florence organized a meeting attended by a large group of project participants. The meeting took place in the impressive Aula Magna of the Facoltà di Agraria. In the first session, the work carried out from August 2011 to January 2013 was assessed in the **RHEA Second Project Review Meeting**. The meeting was attended by Carmine Marzano (Project Officer) and by Gabriele Jansen (Project Technical Adviser) as well as by the beneficiary representatives. In the second session we had a scientific and technical meeting devoted to planning the integration activities that were going to take place in Madrid in May. The aim of this session was to coordinate the integration among different groups and to define the tests to be done and the criteria for subsystem evaluation. As social events we had a walking tour around the old city centre and a guided visit to the Uffizi Museum.

The twelve **Scientific and Technical Meeting** of the RHEA project took place in Madrid on May 17. It was hosted by the School of Agricultural Engineering of the Polytechnic University of Madrid. The aim of this meeting was to assess the integration process that had taken place in the previous days, identifying both finished and still pending issues in order to achieve the final project objectives.
A detailed list recalling the current progress in all the individual subsystems of the project and the corresponding comments and pending actions was prepared. Finally, a review was done of the project deliverables due at month 36 (July): twenty eight in total. At the end of the day, a walking tour through the Retiro Royal Park and the Serrano street and a gala dinner at the Pompeian style salon of the restaurant Pedro Larumbe concluded the meeting.