AWARE Year 1 Newsletter

Platform for Autonomous self-deploying and operation of Wireless sensor-actuator networks cooperating with AeRial objEcts

Introduction

The AWARE project is committed to the development of a platform that will enable the co-operation of autonomous aerial vehicles with ground wireless sensor-actuator networks comprising static and mobile nodes. The platform will offer self-deployment, self-configuration and self-repairing features by means of co-operating autonomous helicopters. These features are highly relevant in natural and urban environments without pre-existing infrastructure or in situations where the infrastructure has been damaged or destroyed. Two validation scenarios are being considered: Disaster Management/Civil Security and Filming applications.

Disaster management and Civil Security Scenario

Objectives

The general objective of the project is the design of, development of, and experimentation with a platform providing a middleware and functionalities required for the co-operation of aerial flying objects (i.e. autonomous helicopters) with a ground sensor-actuator wireless network, including ground mobile nodes carried by persons and vehicles. The platform will permit operation in sites with difficult access and without a communication infrastructure. Additionally, the project also considers the self-deployment of the network using autonomous helicopters that have the ability to transport and deploy loads (communication equipment and nodes of the ground network).

Filming Scenario

Partners and Their Roles

The consortium, coordinated by AICIA, consists of seven partners, with four institutions that are currently playing an important role in several EU initiatives in the field and three companies with significant industrial capabilities that will exploit the results in different sectors, such as Disaster Management-Civil Security and Filming.

The company SELEX Sensors and Airborne Systems will lead the specifications. AICIA, Technische Universität Berlin and Flying-Cam will collaborate in the co-operation of autonomous systems and UAVs. Universität Stuttgart and Universität Bonn are in charge of the middleware. The University of Twente is responsible for the ground wireless sensor networks. Iturri is in charge of the preparation of the experiments. SELEX and Iturri will evaluate the system for Civil Security/Disaster Management applications, while Flying-Cam will be in charge of the evaluation for Filming.

The AWARE First Year

The AWARE first year has been very exciting. All the objectives scheduled in the workprogramme have been achieved. In the first semester the specification of the AWARE Platform has been the most important activity. In the second, the simulation environment was produced, the middleware and the functionalities have been designed and the UAVs were updated and tested in the experiments.

The workprogramme includes in the first year preliminary general field experiments to collect information to complete the design. These experiments were carried out in the factory of the company Protec Fire of the Iturri Group in Utrera, near Seville (Spain) in March 26-31, 2007. All the partners attended the experiments, that were a success and provided very valuable information to complete the designs and to test preliminary implementation of functionalities. End users also attended the experiments and provided very valuable inputs for exploitation activities.

AWARE experiments layout

AWARE Utrera 2007 experiments

AWARE Architecture and Middleware

The objective is to develop the architecture and middleware required for the co-operation of the heterogeneous objects. The middleware provides transparent communication among heterogeneous nodes, even in the case of topology changes. The architecture has been designed to enable the co-operation between aerial vehicles, static sensor-actuator nodes, and mobile nodes carried by ground vehicles and persons.

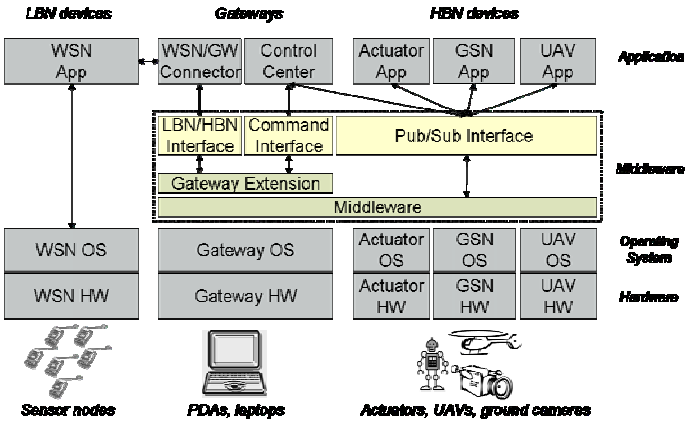
The work in the first year was:

Specification: Analysis of the functionality of the middleware regarding communication as well as the quality of service and generation of the system architecture specification.

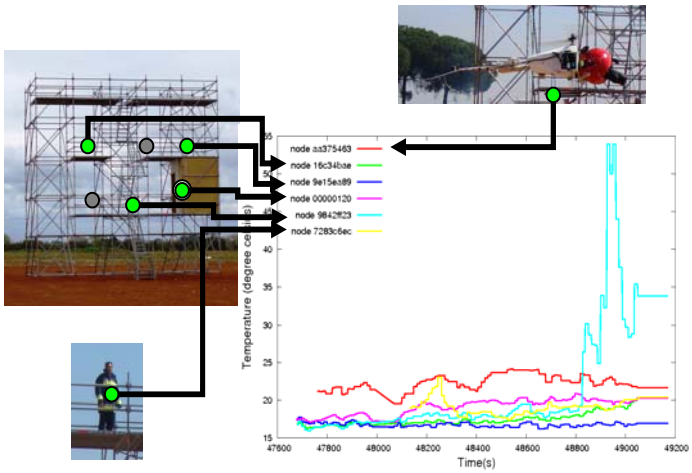
The AWARE first year experiments

Distributed Autonomous UAV co-operation: Development of algorithms for the distributed solution of multi-UAV task allocation using a market-based approach, and research on UAV collision avoidance.

Middleware for the Integrated UAV-WSN System: Preliminary integration of the middleware with the WSN and the UAVs. All partners were able to send data through the middleware using the mechanism provided in the design document (publish/subscribe paradigm) during the Utrera experiments very successfully.



AWARE System overview and middleware



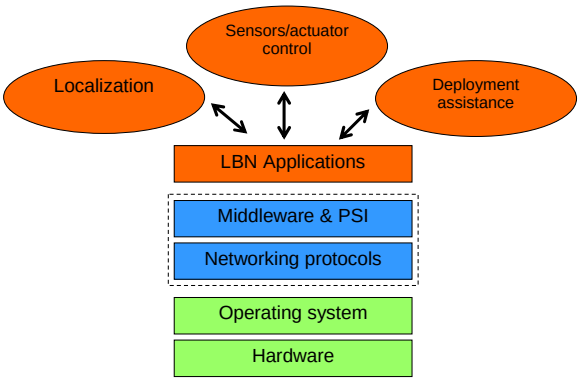
Readings of temperature sensor on the building structure, carried by fire fighters and on board UAV

Integration and Validation of the Software Platform: Changes in the interfaces (with respect to the connection of the HBN and the LBN), as well as the control center.

Ground Wireless Sensor Network

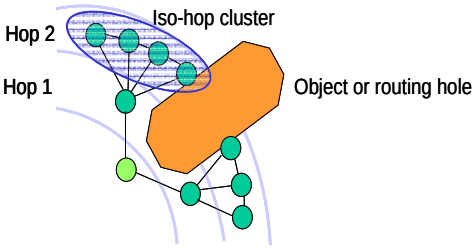
These networks typically consist of resource-constrained, embedded sensors, which communicate wirelessly and collaborate in establishing a representative description of their environment.

Network Architecture and Protocols: Specification of the node platform with a special focus on the AWARE functional specifications and general communication structure within the ground WSN with bridge nodes, router nodes (static or mobile) and tags (cheap wireless sensors not capable of routing). Ongoing work on the integration of mobile sensors (e.g. attached to firemen, UAVs and vehicles) together with static (pre-) deployed nodes.



Ground Sensor Network Architecture

Dynamic Self-organization and Repair: Translation of the AWARE application requirements to WSN specifications; analysis of message routing protocols to deal with mobile nodes and mobile sinks; research on gossiping for moving sinks, e.g. UAV's subscribing to sensor information in the wireless sensor network; channel power measurements and interference effects; validation of MAC protocol self-organisation; and research of network connectivity for autonomous deployment.



Analysis for the autonomous deployment

Co-operation Between Static & Mobile Sensor Node, Event Detection: Use of business rules for sensor nodes to express simple logic in a compact and efficient way, and integration in the AWARE middleware. Ongoing work on a distributed fuzzy-logic inference engine capable of fusing multi-sensor, multi-node unreliable information, in order to produce a more reliable result.

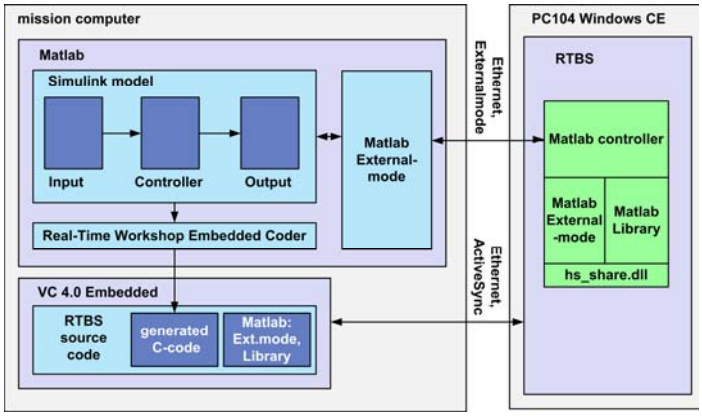
Implementation and Evaluation: Integration of the WSN with the middleware and networking protocols to support static and mobile nodes; and investigation of smoke sensors and node enclosures for self-deployment from helicopters.

Self-Deployment with Co-operative UAVs

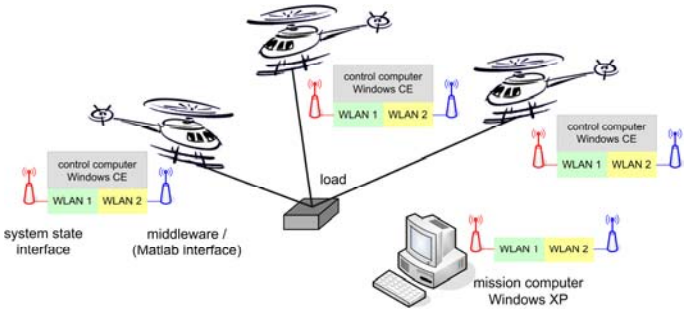
The objective is to develop an embedded system for the control and coordination of several autonomous helicopters for self-deploying, self-configuration and self-repairing of the sensor network as well as for using autonomous helicopters equipped with sensors as intelligent sensor nodes. This software should be connected to the middleware.

Simulation Environment: Programming the real-time base system and the Matlab/Simulink framework for controller design, simulation and automatic code generation; development of the helicopter model and verification of this model in flight experiments; and implementation for a laboratory setup as well as for the outdoor helicopters.

Design of the Control System: Development of a robust control algorithm for a helicopter capable to compensate the influence from the load and/or the other helicopters coupled to the load, testing of this algorithm in simulation environment and on the helicopter.



Simulation environment for distributed control systems



Implementation for outdoor helicopters

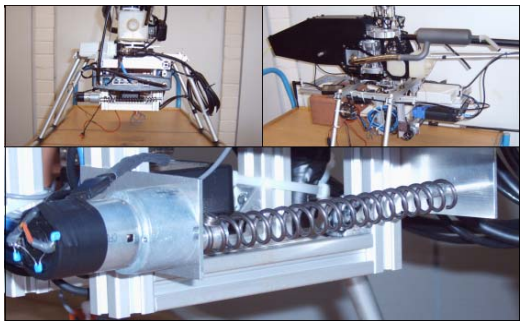
Functionalities for the Operation

Development of network-centric functionalities for the operation: Perception for the self-deployment and operation, including surveillance, localisation and tracking; and Reliable co-operation strategies.

UAV Updating and Integration: Updating the Flying-cam helicopter with a new interface and software for image capture, synchronization, and processing.

FlyingCam helicopter monitoring in Utrera 07

Updating the Marvin TUB helicopter with new hardware and software; and development of a device for the automatic deployment of nodes that was used in the Utrera 07 experiments.



Marvin and device for the autonomous deploying

Marvin deploying a node in Utrera 07 experiments

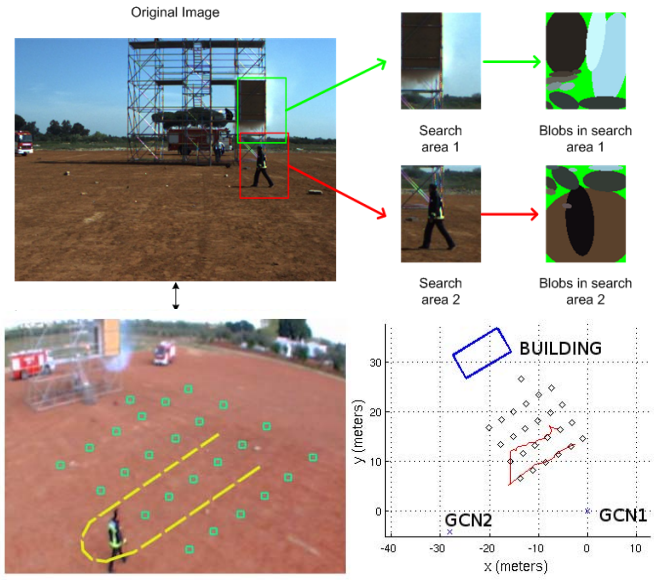
Tools for Co-operative Surveillance and Tracking: New strategies for co-operative perception with multiple robots including perception/decisional systems; design of a distributed architecture; research on the integration of the WSN and the UAV fleet to exploit the benefits of having WSN nodes mounted on mobile robots, e.g. estimate the position of the ground nodes, by means of Kalman and Particle Filters to project the known position of the UAV into the ground nodes; development and integration in the network of ground camera nodes; development of a visual image smoke detector and a tool for detection and tracking of persons using visual images; and testing with the data and images from the two ground camera nodes and the camera mounted on the Flying-Cam helicopter in the Utrera 07 experiments.

AWARE User Group

The User Group (UG) includes End Users (Agencies for Disaster Management/Civil Security, filming companies), ICT companies and researchers interested in AWARE technologies. New members of the UG are welcome.

Interested individuals can register in the Web site and/or contact the person below.

The Seville Fire Fighting Service in Utrera 07



Detection and tracking of firemen using ground camera nodes,UAV and WSN nodes

CONTRACT NUMBER: IST-2006-33579

TYPE: Specific Targeted Research Project

PROJECT PARTICIPANTS

AICIA (Spain)
Technische Universität Berlin (Germany)
Flying-Cam (Belgium)
University of Twente (Netherlands)
Universität Stuttgart (Germany)
SELEX sensors and airborne systems (UK)
ITURRI (Spain)
Universität Bonn (Germany)

CONTACT PERSON

Prof. Dr.-Ing. Anibal Ollero
AICIA. Robotics, Vision and Control Group
Edif. Escuela Superior de Ingenieros
Camino de los Descubrimientos, s/n
41092 Seville (Spain)
Phone: +34 954 487349 Fax: +34 954 487340
e-mail: aollero@cartuja.us.es

PROJECT WEBSITE

http://www.aware-project.net