Project

"UNMANNED GROUND TACTICAL VEHICLE (UGTV)"

under

Contract B-0068-GEM3-GC

Executive Summary

Period covered:	04.08.09 – 31.05.10	*Issue Date:*	30.06.2010
Start date of project:	04.08.09	*Duration:*	9 months
Project coordinator name:	Mario Ciavatta		
Project coordinator Organization name:	CIO / Iveco DV		
Revision:	1.0		

Revision chart and history log

Version	Date	Reason
1.0	30.06.10	First issue

1. Introduction

The unmanned technology, already established in the aircraft field, has a huge potential even in the ground applications, when it is necessary to carry out military missions without direct exposure of personnel or it is important to reduce the number of people involved: for example important military tasks are the surveillance, patrol and reconnaissance of a dangerous or contaminated area (potentially mined or NBC zone) for tactical support for the forces on the ground, or the logistic transport of goods on a repeated route or in a convoy.

A Main Project has been set with the main objective to test on a real demonstrator the potentialities of a system for automatic control of a ground vehicle, based on a production tactical vehicle platform. An additional objective is to achieve a modular system architecture of a kit for the improvement of different vehicles to UGTV. This Unmanned Ground Vehicle should be able to operate in different environments and road conditions, and allow the support of a remote operator who can supervise the mission and take control when needed.

1.1. Main Project objectives

The overall objective of the UGTV Main Project is:

- To demonstrate the potentialities of a system for automatic control of a ground vehicle, based on a production platform, providing a comprehensive analysis of performances, risks and benefits;
- To achieve a modular system architecture of a kit for the improvement of different vehicles to unmanned ground vehicles;
- To exploit technologies that are already in use at commercial or prototype level in modern defence systems.

1.2. First Phase Project objectives

The objective of this Project as first phase of the Main Project is:

- To provide an analysis of missions and requirements, as well as a benchmark of current technology, including a specification of the vehicle and its sub-systems and a definition of a detailed workplan aiming to develop and evaluate the demonstrator vehicle inside following capabilities:
- Surveillance / reconnaissance
- Patrolling / rescuing
- Mine sweeping operations
- Engineering operations
- Transport of goods and personnel /MEDEVAC

1.3. Industrial Group

The following countries and industries, organized within a Consortium, are involved in the First Phase Project:

Finland: **Patria Land & Armament Oy,** Hämeenlinna, Finland

France: **THALES Optronique S.A**, Elancourt , France
Germany: **DIEHL BGT Defence GmbH & Co. KG**, Ueberlingen, Germany
Greece: **Hellenic Aerospace Industry S.A.**, Athens, Greece
Italy: **CIO Iveco - Oto Melara Società Consortile a r.l.**, Rome , Italy
Poland: **PIAP**, Warsaw, Poland
Portugal: **EDISOFT**, Monte Caparica , Portugal

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Events

A compilation of past major events is listed beneath.

Date	Event	Location
2008-11	Project Agreement signature	
2009-02-09	Proposal	
2009-07	Consortium Agreement signature	
2009-08-03	Contract signature	
2009-09-23/24	Kick – off Meeting	Rome, Italy
2010-01-14	Progress Meeting	Bruxelles, Belgium
2010-07-01	Final Meeting	Bruxelles, Belgium

2. Project results

Work Package 1.1. Mission definition and system architecture

Work Element 1.1.1. Mission definition

Contacts by each partner with potential users of his participating nation (PMS) with the aim to identify a number of military missions which could be supported by a UGTV.

Missions review, considering in particular the expected value of the support from an unmanned vehicle, based on partners' experience.

Selection of some representing missions from this general scenario as application cases for the Project study.

Definition of basic requirements for these applications, both at system level for the overall platform and at subsystem level for e.g. sensing, navigation, communication, vehicle control, etc.

Choice of the most suitable types of vehicle platform for these applications, possibly grouping the missions, in order to reduce the number of required vehicle systems and simplify the technical support.

Work Element 1.1.2. System architecture

Design of a possible architecture of the UGTV taking into account modular and incremental configurations. The UGTV platform is mainly based on a perception subsystem, a decision subsystem and an actuation subsystem: this composition could reflect a possible differentiation of future system architecture with respect to different vehicle types and classes.

Work Element 1.1.3. System simulation Model architecture

To develop simulation hardware and software architecture, including models of UGTV and onboard systems. Definition of simulator applications in supporting UGV design, application and operator training.

Work Element 1.1.4. Diagnostic System architecture

The Diagnostic System architecture based on system architecture (task 1.1.2), concept of selected UGV platform operation parameters data acquisition. ; algorithms of selected alarm states. The whole system based on CAN network with central PLC controller.

Work Package 1.2. Technology benchmarking

Work Element 1.2.1. Driving & environmental sensors–data fusion

Assessment of radar, vision and laser techniques with a focus on the performance for difficult situations. The perception system must be able to identify positive obstacles (vehicles, rocks, walls,…) and negative obstacles such as a ditch. The recognition of road edges is a key issue. Additional requirements are related to the level of illumination, visibility and weather conditions.

Work Element 1.2.2. Positioning and navigation Systems

Analysis of all different subparts of a navigation systems, in particular Inertial Navigation Systems (INS), Global Positioning Systems (GPS), gyroscopes and accelerometers. Benchmarking of the operational performance of alternative solutions, aiming to achieve the greatest possible autonomy.

Identification of key parameters Tests, with a focus on the capability for the UGTV to survive in difficult terrains.

Investigation on SLAM-algorithms (simultaneous navigation and localization) and enhanced video navigation (combining data from video images, laser scanners, and infra-red cameras to support situation awareness for navigation purposes and obstacle avoidance features)

Work Element 1.2.3. Path planning and trajectory decision System

Path planning and trajectory decision system must generate a motion trajectory from a specified starting position to a final position in order to achieve the mission goals. This trajectory must take into account environment conditions (obstacles, threats, road conditions, etc.) and vehicle performances.

Analysis of the state of the art for path planning and trajectory decision technologies, considering also tools for Ground Vehicles.

Comparative assessment of path planning technologies and tools in term of main issues, like: - integration with other vehicle modules, - required input and output, - level of automatic control, - adaptation to a changing environment.

Evaluation at system level of the relationships of navigation, path planning, perception, and communication.

Analysis of the gap of these technologies or tools and the future trends.

Recommendation for the short term of the more suitable technology.

Work Element 1.2.4. Communication and remote control

List and evaluation of potential communication systems on the market, considering both, command & control and sensor data links, and especially evolving military grade systems.

Survey of the actual state of satellite communications and of its future one, considering potentiality of UAV assisted communications.

List of available teleoperation stations and analysis of their applicability based on the mission definitions.

Survey of suitable software architectures for teleoperation and supervisory commanding. Instructions to the Partners to make related national surveys in respective countries.

Work Element 1.2.5. Vehicle management and by-wire systems

The vehicle management subsystem has to integrate engine/driveline control, brake control and steering control. Investigation about, solutions for actuators supporting computer control for these subsystems .

Identification of the set of vehicle sensors providing dynamics information: these sensors will enable to maintain the vehicle motion within safety limits.

Work Element 1.2.6. HMI SW applications, graphics and HW

Operator interface must generate multiple control signals from the operator to the vehicle, to assure the UGTV motion on assumed trajectory with established speed, and be able to control the surroundings recognition system.

Evaluation of existing human-machine interfaces for unmanned ground vehicles.

Assessment of the different solutions for the HMI and different system configurations

Definition of the most suitable technologies for development .

Work Package 1.3. **Specifications**

Work Element 1.3.1. Driving & environmental sensors–data fusion

Definition of a set of environmental sensors to be used for the UGTV prototype, considering functionalities such as object detection and classification, road detection, obstacle positioning. Different zones (ranges) are considered, as a function of vehicle speed, in relationship to different perception tasks from ambient recognition, to manoeuvre identification and actuation.

Delivery of guidelines for the data fusion methods, including other sensors regarding vehicle status and navigation subsystem.

Work Element 1.3.2. Positioning and navigation Systems

Identification of the optimum performance of the localisation and navigation system as outlined in WP1.2, in order to accomplish the assigned mission.

Definition of key specifications of major components and finalisation of all the data necessary for system development.

The following main parts are considered: GPS module, IMU module, Fluxgate magnetometer. For these components basic characteristics are considered such as: data structure, accuracies, RFI immunity, form factors, environmental operating range, power and installation requirements.

Analysis of possibility to add a ranging receiver to identify the balance against its overheads, like cost, weight and power consumption.

Definition of final characteristics of the localisation and navigation system, including the contents of a user manual and manufacturing data package.

Work Element 1.3.3 : Path planning and trajectory decision System

Taking into account mission requirements assigned to the UGTV and environment conditions (obstacles, threats, road conditions, vehicle performance, etc.), the automatic path planning system must define the proper path in order to achieve mission objectives. For a completely known environment, path planning can be performed only once before the mission start. However, the environment is often only partially known, and as obstacles and threats are discovered they must be entered into the system and the path must be replanned automatically.

Specifications for the automatic path planning and trajectory decision system are defined. A top level design of the system is proposed and the relation (interface) of this system with other systems of the UGTV (communication system, vehicle control system, perception system, etc.) is specified. The input to the path-planning system will be stated; these data will be analysed by the trajectory decision subsystem. In order to define the most suitable path, the trajectory decision subsystem will sort the obstacles and threats and establish the minimum risk route, depending on the UGTV performance and situation. The output of the path-planning system will be a set of waypoints that specify the trajectory to be followed by the vehicle.

Work Element 1.3.4 : Communication and remote Control

Requirements are specified in detail – based on WP 1.1 - and circulated among partners. Communication requirements of the payloads of the missions are also analysed and included. Survey of national standards on communication and teleoperation systems and related system providers.

A few teleoperation stations alternatives are designed and evaluated. The human sense based situation awareness and cost-efficiency are specially considered.

Suitable software architectures for teleoperation and supervisory commanding are analysed and then best selected and software specified in task level. The aim is to enable commanding from various levels of hierarchy and to enable commanding in different level of autonomy. Interface specifications are made in detail to enable concurrent development.

Work Element 1.3.5 : Vehicle management and by-wire systems

Specifications are defined for the vehicle control architecture and the vehicle control software.

Approaches for a real time integrated control will be investigated, considering the issue of adaptation to the environmental conditions.

Logics for the interaction between the automated actuation system and the interventions of the remote operator will be considered.

Work Element 1.3.6 : HMI, SW applications graphics and HW

This task identifies the optimum performance of the human – vehicle interface system as outlined in WP1.2, in order to accomplish the assigned mission. It allows also to produce the optimum scenarios for compromising control commands given by human and the ones computed by the on-board control centre. Key specifications of major components is defined, and all the data necessary for system development is finalised.

The knowledge of interface standards and conventions is considered, as well as human capabilities and limitations.

Elaborated interface must grab the operator's attention when its need, and must allow the steering to be natural and intuitive .

The final characteristics of the human – vehicle interface system is defined, including the contents of a user manual and manufacturing data package.

Work Package 1.4. Final analysis and development plan

Work Element 1.4.1. Technological and functional roadmap for UGTV

A road map is defined starting from the previous analysis of user requirements, expected performance of current technologies and major gaps identified. Essential for this road map is the identification of the technical issues that need to be solved, the future actions by the partners and interrelations with other technical areas.

Work Element 1.4.2. Test and validation draft plan

A draft of the test and validation plan for the UGTV platform is defined, as an additional reference for the next phases of development. The plan, with a level of detail according to the concept study, will include test scenarios, parameters to be evaluated, key indicators and the experimental methods to be applied.

Work Element 1.4.3. Development plan

A detailed Project plan for the coming phases of the Main Project is prepared, consolidating the present ideas. The plan especially addresses the roles and responsibilities of the partners, based on their strategies and indications form the respective National Authorities .