GARTEUR GROUP FOR AERONAUTICAL RESEARCH AND TECHNOLOGY IN EUROPE

FRANCE GERMANY ITALY THE NETHERLANDS SPAIN SWEDEN UNITED KINGDOM

FM/AG-18: Towards greater Autonomy in Multiple Unmanned Air Vehicles

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Background

The wider use of UAVs for Military, Civil and Commercial applications is dependent on obtaining the optimum partnership between the human supervisor and the system. Communications between the supervisor and the system should be reduced as far as possible and be at high levels of abstraction with the majority of activity carried out with a minimum of human intervention. Given adequate autonomy, communications between the human supervisor and the vehicle can be minimised being necessary only where critical decisions are required. Moreover, it is clear that the more challenging applications with only a small number of human supervisors available to operate more than one UAV will create a distributed control problem.

Work carried out by the GARTEUR nations has led to the conclusion that unprecedented autonomy levels will be required and world-wide research in the area is very active examining a range of methods for achieving autonomy. It is very difficult to judge the effectiveness of innovative methods for achieving UAV autonomy due to:

- Scarcity of adequate models and simulation environments.
- Dispersion of techniques (not well-known or unknown)
- Lack of common benchmark for comparison
- Lack of awareness about autonomy gap and its implications.

Consequently, it is difficult to identify where investment is needed to rapidly mature the most promising contenders. This action group is designed to aid this process and the aim of the work is the:

Collection, implementation and systematic categorisation of machine based reasoning and artificial cognition approaches applicable to facilitate co-operation between UAVs and other assets with reduced human intervention. Those other assets will include other UAVs, manned assets and human operators performing supervisory control. The environment is highly uncertain, the goals may change and the problem may have no unique solution.

Programme/Objectives

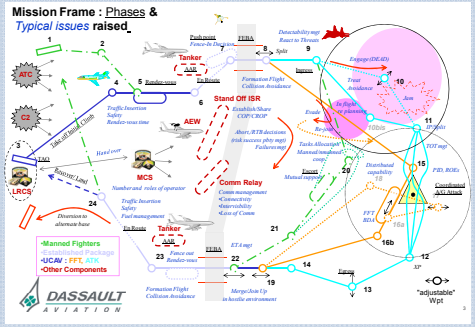
Within the aviation industry human supervisory control of complex systems has long been a requirement driven by the need to reduce air vehicle crew levels and workload, compensate for human frailty and latterly, the demands of UAVs deployed in many diverse tasks. The development of autonomous planning and decision making techniques will increase vehicle autonomy potentially enabling a reduction in the number of operators required, a reduction in operator workload, as well as compensating for human frailty and thus preserving system effectiveness in a more cost-effective manner.

The objectives of the FM/AG-18 are:

- The definition and selection of a suitable overarching framework comprising relevant aspects of anticipated future autonomous UAV missions.
- The application of various methods within the framework.
- A better understanding of autonomous systems and levels of autonomy.
- An indication of spin-off applications and critical technology research areas for the future.
- To inform the generation of a toolset and metrics to support the work.
- Better understanding of human operator requirements for different levels of autonomy.
- To acquaint the wider UAV community of the current state of the art and to inform the development of a technology roadmap to greater autonomous capability.

It is expected that the machine reasoning and artificial cognition methods to be developed in this AG will have broader application in a wider range of domains than FM/AG-14 given the greater coverage of the work framework.

A three-year project is in progress (having commenced in Sep 2009) and composed of a number of Work Packages (WP). Problem areas are derived (WP2) from an overarching framework (WP1) and then appropriate methods (WP3) are mapped to these areas. Applicable methods are applied to the problem areas in WP4 and the experimental approach and gathering of results is contained within WP5. WP6 looks after exploitation of the knowledge gained within the study.



Typical mission framework showing mission phases

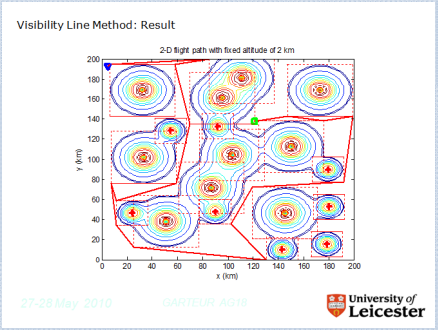
WP1 has concluded, producing an operational framework into which all of the methods addressed will be contextualised. An example framework is shown above. WP2 has developed a matrix methodology that allocates the framework functions to six broad categories of technology. These are: Automated Flight; Vehicle Health Management; Data Management; Reasoning/Planning/Decision-making; Communication and Collaboration. These categories, in the broadest terms, reflect the nature of the technology being addressed in WP4 of the AG. Within each of these broad categories are further sub-categories of problem which are cross referred to the original framework function. Using this matrix it has been possible to map the chosen technological approaches investigated within the AG to be assessed as to their fitness to solve a range of problems within the context of the over-arching framework. WP3 is carrying out an ongoing assessment via questionnaire of each of the candidate technologies being investigated across the AG. The questionnaire will elicit a general description of all methods, their maturity, applicability as well as implementation considerations.

Results

Organisations taking part in the FM/AG-18 are: Cassidian, CIRA, Dassault Aviation, DLR, INTA, NLR, ONERA, QinetiQ, Selex-Galileo, Thales NL, and the Universities of Complutense, German Armed Forces, Leicester and Loughborough. This impressive team aspires to gather evidence as to where particular technologies can be applied across the entire UAS design space, the relative strengths and weaknesses of each approach in solving these problems, and finally, where particular approaches have not been addressed within FM/AG-18 but which might offer some value. Such evidence will help to identify where investment is needed to rapidly mature the most promising technological approaches. The AG is confident that the exploitation of the results can improve the understanding of research and industrial bodies of the key domain issues, helping to further develop strategies and methodologies for increasing Autonomy in UAVs.

The candidate methods are being further applied to the problem to produce the results, on the basis of which indications will be given of spin-off applications and critical technology research areas for the future. How the candidate approaches can be applied to both military and civil systems with few or minor modifications will be articulated.

The AG hopes to exploit its results by a dedicated session in the Bristol UAV conference in May 2013. Therefore, the AG has been extended to the end of June 2013



Screenshot of Path Planning work