Systems Research for Practical Autonomy in Unmanned Air Vehicles

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There exists a general expectation that advanced unmanned vehicles will require autonomous functionality, over and above a straightforward increase in level of automation. Much work is currently in hand in the research and development of algorithms and software approaches to achieve autonomy, but it is perceived that less attention is being given to hardware optimized to execute the algorithms. This paper will discuss practical approaches in achieving autonomy, what tools might be required to provide it, and what the implementation might be in a systems engineering context. The areas concerning systems testing and flight certification will also be touched upon. Work at Blue Bear Systems Research (BBSR), has concentrated on use of the Soar Artificial Intelligence language. This is not the only approach that can be used for the purpose, but has the attractive properties of reasoning, problem solving, planning and learning. Intelligent systems of this type are often referred to as 'agents'. It is often the case that these agents can become very large very quickly, and BBSR have been pursuing a more modular approach. To achieve the complexity likely to be implicit in a future autonomous system it is probable that the end system will need to be a multi-agent structure with communicating sub-agents having specialization in a specific task such as situational awareness, combat tactics, team-working or optimal route planning. Note that by their very nature these processes may be asynchronous, and indeed something like planning may be a 'batch-mode' job, where the agent is given a task and it then informs the other agents when it has completed, and presents its results. Note also that these different functions are likely to be expressed using differing techniques and software embodiment. Thus a multi-agent system could, for example, use Bayesian belief approaches for reasoning, Soar methods for problem solving and learning, and a direct mathematical algorithm implemented in C to carry out the route planning. Considerable effort at BBSR has been expended in investigating hardware solutions suitable for the implementation of distributed agents in smaller UAV's and Micro Air Vehicles. This requirement focuses on size weight and power requirements in order to provide sufficient the required computing resource, whilst providing a direct route to larger, more capable systems that could equip a larger J-UCAS class UCAV. The paper will present techniques from computer science in the employment of clustering techniques using low-cost X-scale and PC based processors, and the relative merits of Floating Point Gate Array (FPGA) solutions. This will be illustrated in the context of a complex multi-agent system designed to search a network of roads.

I. Introduction

With considerable work under way in the area of unmanned vehicles in the air, land and sea environments, it is not surprising that the concept of Autonomy arises. Autonomous systems are expected to have properties

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