Data Recording in Unmanned Vehicles
Application Note 102

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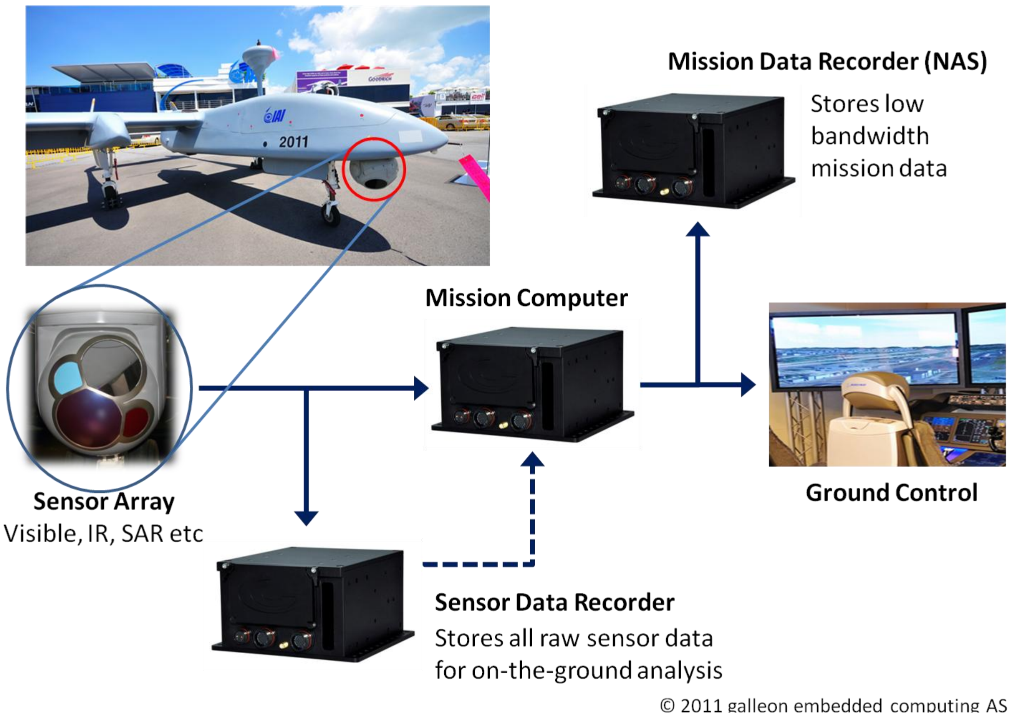
As the number of UAVs in operation around the world has snowballed, so their complexity has increased enormously. They are now used in many civil and military applications, each with its own set of specific requirements. In the case of a border patrol, the priority may be on long endurance flying, spotting movements on the ground amongst a barren landscape. However, a military UAV may be focused on integrating data from multiple sensors and sending it to a ground control station for targeting purposes. The design study described below uses Mission Computers and Rugged Recorders from Galleon Embedded Computing to handle the control and storage elements within a modern UAV application.

System Architecture

All but the simplest Unmanned Vehicle works by linking together a set of complex sub-systems (navigation, sensor collection, sensor processing, flight control, data recording, etc) which must work together seamlessly for a successful mission. The capability (and usually the complexity) of each subsystem is continually being increased, which in turn drives improvements in the related subsystems. This Application Note describes a proposal to upgrade a counter-terror UAV platform for use by military and civil customers. Compared with the previous generation vehicle, the onboard cameras have an increased frame-rate and resolution (spectral and pixel), driving a corresponding increase in the bandwidth of the link to the ground station. Additional sensors have also been installed whose output is fused with the existing cameras to improve the operator's ability to pick out objects which would otherwise be invisible. These performance enhancements increase the UAV capability enormously, but also dictate a massive increase in the capacity of the on-board storage.



Of course, drive capacity is continually increasing as technology improves, but still imposes a limit on the capability of the vehicle. One way to reduce Size, Weight and Power (SWAP) while increasing capacity, is by combining several recording functions into a single multi-drive storage unit. Packing more drives into each recorder eliminates extra metalwork, PSU and controller hardware, but the unit must still be capable of receiving multiple high speed streams of data and recording them independently. In this application, the Galleon XSR rugged recorder (qualified to MIL-STD-810) was selected to capture the following data streams:-

- 2 x sFPDP sensor streams
- 1 x video data stream via IP
- GPS data for timestamp and location
- Other legacy interfaces including ARINC429 plus GPIO status lines

The internal bandwidth of each Galleon XSR recorder is around 800Mbytes (more than enough for this application), but multiple recorder units can be ganged together to increase performance if required. Each recorder holds 4 solid-state drives which provide a maximum of 4TB of storage. A Galleon XSR-NAS (Network Attached Storage) unit was included to store the low bandwidth mission data. It is accessible by the other UAV subsystems, irrespective of which processor-type and OS they use.

In some circumstances the sensor recorder must be started and stopped remotely by the UAV operator – at other times particular combinations of sensor data will start the recorder automatically. In either case, the vehicle's Mission Computer (a Galleon XSR-MC unit) sends the recorder start/stop commands for each channel via GbE. Other low bandwidth streams (GPIO status, ARINC, etc) are recorded alongside the raw sensor data streams, and all data is time stamped via the GPS. This recorder was chosen because it can easily be updated to support additional data streams (such as Firewire, analog video, etc) using plug-in modules, if new sensors have to be added during future upgrades.

Another important consideration for unmanned vehicle recorders is the time needed to offload the data from the recorder between missions. This application needed a fast turnaround, so draining the data via an Ethernet or SATA-type link was not an option. Instead, the data is recorded on a removable cartridge which can be swapped with an empty cartridge when the mission is complete. Different grades of storage (including encrypted drives) can be used for different applications by choosing an appropriate cartridge specification. Files are recorded using a non-proprietary file format, to simplify the transfer of data into a workstation for analysis on the ground.

For military vehicles, Urgent Operational Requirements (UOR) mean reduced development timescales for many subsystems. This upgrade project could only meet its aggressive timescales by using generic COTS equipment designed for use in many different environments (fixed/rotary wing, land or sea applications, conduction/air-cooled, etc). In addition, engineers' learning time is reduced by reusing hardware that they are already familiar with (the same goes for software tools) and which is already proven in other projects within the same company.

Conclusion

Increased use of unmanned vehicles (land, air and sea) in military and commercial applications is driving development towards 'bigger, better and faster' in many areas of on-board technology. This trend means that data recorders must evolve in parallel to keep up with increased demand for capacity, ruggedness and bandwidth. However, by using modular COTS products which need only be tailored for each new application, it is possible to build a fully qualified solution with the minimum engineering effort and cost.

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