An FPSLIC-based UAV Control Platform

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This paper will present an unmanned aerial vehicle (UAV) control system based on the Atmel FPSLIC (Field Programmable System Level Integrated Circuit) device. The FPSLIC provides a unique hardware/software platform that allows system functions to be implemented in either hardware or software as requirements dictate and provides for easy and fast communication between the two during system operation. Furthermore, the level of integration of the FPSLIC device makes for a low-power, compact system solution that fits well within the requirements for a UAV.

The ATMEL FPSLIC device combines an 8-bit AVR microcontroller with 32K bytes of SRAM and a 40K gate equivalent FPGA device on a single chip. Atmel supplies an FPSLIC development board, ATSTK94, which contains a single AT94K40AL FPSLIC device. The ATSTK94 development board provides access to all of the AT94K device's I/O pins via headers, two RS-232 drivers and connectors, a programming interface and connectors, and several LEDs, switches, and 15-segment displays for interfacing to the AK94K device. Atmel also provides the System Designer software for developing applications based on the FPSLIC. System Designer includes a comprehensive FPGA tool suite based on the Exemplar HDL Synthesis tool and Figaro Place and Route tools for developing hardware to be implemented in the on-chip FPGA. For software development, System Designer includes an AVR Instruction Set Simulator and the AVR Studio development and debugging environment. In addition, several third-party C and C++ compilers are supported for seamless integration into System Designer. Finally, System Designer includes a unique interactive co-simulation environment for the FPSLIC device based on the ModelTech HDL simulator and the Mentor Graphics Seamless co-simulation tool.

A complete UAV control system based on the above architecture has been developed and installed in a surplus FQM-117B "MIG-27" Army target drone and is currently undergoing testing. The system is designed for both manual and autonomous operation using GPS for navigation. The architecture of the control system makes effective use of the FPSLIC device by mapping some functions to dedicated hardware in the FPGA portion of the FPSLIC, and other functions to software executing on the AVR microcontroller inside the FPSLIC. Repetitious or long time-scale functions such as the measurement of command pulses being received from the ground pilot via the standard RC transmitter/receiver, and the generation of the outgoing command pulses for the aircraft servos, are implemented in hardware, while more complex functions such as the Proportional, Integral, Derivative (PID) controllers for altitude and heading control are implemented in software. Future use of the hardware resources on the FPSLIC could include interfacing, collecting, storing, and transmitting sensor data from on-board sensors placed on the UAV. The control system also includes an off-the-shelf GPS unit

that communicates with the AVR on the FPSLIC device, and a 900MHz two-way radio modem that allows the software running on the AVR to communicate with ground station software running an a laptop computer. This link provides feedback to the pilot and researchers on the state of the aircraft and the control system itself.

The paper will provide a detailed description of the system architecture based on the FPSLIC, experiences with using the FPSLIC and the System Designer tool, and results of the test flights of the UAV system.