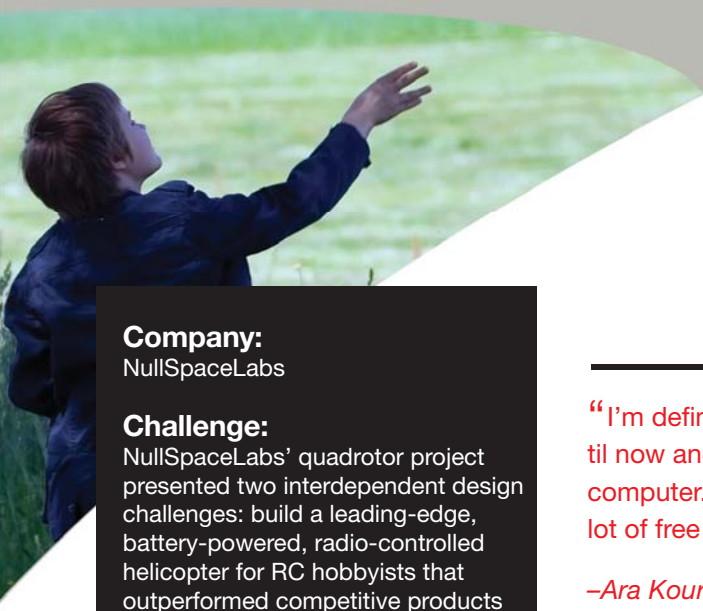
Stellaris® Cortex™-M microcontrollers improve flight range for hobbyist aircraft



Company:
NullSpaceLabs

Challenge:
NullSpaceLabs' quadrotor project presented two interdependent design challenges: build a leading-edge, battery-powered, radio-controlled helicopter for RC hobbyists that outperformed competitive products in every aspect of flight performance; and because quadrotor pushes the limits of robotics functionality, create an open-source, general-purpose robotics development board for future projects.

Solution:
Balancing the thrust created by the four rotors and other flight control software required real-time processing of information from the craft's gyroscopes, GPS and sensors. The ability to crunch complex algorithms in real-time was essential. NullSpaceLabs picked TI's Stellaris® microcontrollers for their processing power, on-chip memory and rich I/O options.

Customer benefit:
The 32-bit, 80-MHz ARM® Cortex™-M3-based Stellaris microcontroller ecosystem provided NullSpaceLabs with a powerful computing platform with extensive math libraries and development tools. The 100KB of on-chip memory contributed to the blazing speed for algorithm execution and the integrated USB port made configuring the ZigBee® wireless network a snap.

"I'm definitely sticking with this chip. I've worked mostly with 8-bit MCUs until now and Stellaris® MCUs are overwhelming. It's almost like programming a computer. The flight control software uses just 5% of memory which leaves a lot of free space for people to add code for new functions."

–Ara Kourchians, NullSpaceLabs

The challenge

Early entries in the quadrotor segment of the RC hobbyist market were often based on 8-bit MCUs, which placed severe restrictions on virtually every aspect of system performance. NullSpaceLabs wanted to push the performance bar higher by designing a craft that had greater range, was more maneuverable and most important, offered an extensible, open-source platform for adding sensors, cameras and navigation peripherals that would make the quadrotor semi-autonomous. These requirements demanded not only an MCU with plenty of performance headroom but one that could accommodate future innovations in terms of I/O, communications ports and general expandability.

The application

NullSpaceLabs is using TI's ARM Cortex-M3-based Stellaris LM3S9B96 microcontrollers, libraries and development tools to conceive a highly integrated, lightweight design that includes a TI CC2520 ZigBee-based wireless mesh network. The 200 Dhrystone MIPS of the MCU easily handle real-time execution of all flight control and inertial guidance algorithms as well as multiple inputs from sensors, which allows individual quadrotors to go to a location, avoiding obstacles, using only GPS coordinates. ZigBee's built-in mesh

"My goal is to eliminate the computer," says designer Ara Kourchians, "and Stellaris MCUs can handle communication among a swarm."

networking will ultimately allow quadrotor squadrons to fly in formation and – because of the nature of mesh networking – have a range limited only by the on-board batteries.

The solution

The blazing performance of the Stellaris LM3S9B96 microcontroller made an impossible design task possible. Software development was a monumental task that the extensive Stellaris MCU ecosystem made easier on many fronts: sophisticated ADC filtering averages multiple samples automatically without bogging down the processor. Prescalers for the timers shorten development time. Library algorithms execute the six-point math necessary for rotor control. ARM's Thumb®-2 instruction set delivers the best balance of code density and performance. An ultra-efficient compiler kept code size tiny considering its functionality. From a board layout perspective, well thought-out pin placements make hardware design easier.

OEM customer benefits

As an open-source design house, NullSpaceLabs is determined to go beyond designing leading-edge products. Just as important is providing highly extensible platforms for other engineers to leverage. In the quadrotor design, TI's Stellaris MCU and ZigBee's transceiver opened new vistas for innovation. The CC2520 ZigBee transceiver will replace an Xbee® module that occupied 25 percent of the board, freeing up space for additional functionality. Stellaris MCUs' ultra-high performance at reduced clock rates compared to other chips will benefit the energy consumption budget of spin-off designs. Its extensive, easy-to-use math, driver and peripheral libraries will speed up the design cycle. In most quadrotor designs, flight control information is not processed on the quadrotor itself but by a computer on the ground. The performance headroom of Stellaris MCUs will change that paradigm.

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