Drone 'System on Chip' Demonstration Platform Proposal
PSU ECE Department Capstone Project Program

8/15/2016

Background and Problem:

Currently, consumer drones use several microcontrollers and sometimes even high-end application processors to control various elements of the system such as motor control, RF communication, inertial-measurement units, LEDs, etc. The problem with this solution is that using multiple microcontrollers increases the BOM (bill of materials) cost and power of the drone. It also makes ease of development more difficult since microcontrollers need to communicate with each other for inter-dependent tasks.

Portland-based Lattice Semiconductor is a smart connectivity company with a variety of FPGA devices targeted for the consumer, communications and industrial markets. We believe a better system solution for drones and other control applications with multiple motors may be to use one FPGA instead of multiple microcontrollers. FPGAs typically have a higher I/O count and can process multiple independent operations in parallel within a single device. This resolves the need for multiple devices and ultimately lowers BOM cost and power. It also increases ease of development by having a single FPGA as the central device controlling all functions.

Lattice would like to showcase multiple sensor and control functions in a drone demonstration platform. Additionally, Lattice would like to provide a motor control reference solution with their FPGAs. Since motor control and monitoring are such an important part of drones, a platform that handles this as well as other peripheral and control functions through a single FPGA would be a strong demonstration.

We know you have innovative ideas and as a student design project, we're interested in seeing the unique approach you'd have to solve this problem, while at the same time getting hands-on experience designing with our FPGAs. You'll have access to a Lattice FPGA expert who will be there to provide guidance along the way.

…We need your help! Are you in?!?!

Project Requirements:

The resulting project is to build a basic drone using a single Lattice FPGA as the compute engine. The drone will be used as a demonstration platform for trade shows and customer visits as well as a reference point for performing motor control and other peripheral functions with Lattice FPGAs.

Basic Outlined Requirements:

1. Build a drone that flies via remote control or smartphone
    a. Drone must appear as a clean, finished product (no visible wires, tape, easy to assemble)
    b. Drone must be able to perform the most basic features (hover, fly, turn, etc.). Advanced features like ultrasonic sensors, cameras, etc., are not necessary.
2. All compute intelligence must be handled by a Lattice FPGA
    a. Lattice MachXO2 or MachXO3L FPGAs will likely provide the best fit for this application
    b. Discrete components such as mosfets, battery charger ICs, etc., can be used in the system
3. Mechanical elements of the drone can be recycled/repurposed from a low cost drone (like on eBay)
    a. We're not trying to develop the mechanical design for this project (although this may be a good follow-on for a Mechanical Engineering Capstone project).
    b. The purchase of few drones to see which one is best for this design may be required. We don't want it ultra-low cost, but not the most expensive platform either.
4. Final FPGA RTL design must be clean, user friendly and commented
    a. Ideally written in Verilog
    b. Bonus – Verilog and VHDL versions of the design
5. Final block diagram, schematics, BOM and user guide
6. Bonus – Technote specifically on the motor control solution developed for the drone demonstration

Resources:

- Lattice to provide FPGA breakout boards and FPGA device samples
- Lattice to purchase a few drones to be used to recycle mechanical elements and motors
    - Will work with the team to find best options
- Lattice to provide funding for miscellaneous extras as needed (wire, RF modules, ICs, etc).
    - Will review team's system architecture proposal then fund appropriately to maximize success
- Lattice to provide FPGA SW for project
- Lattice will provide an engineer to monitor the project and answer questions as needed

Deliverables:

1. Drone
2. Remote (if applicable)
3. RTL source
4. Any associated apps or software for controlling the drone
5. User Guide (Bonus - put documentation in Lattice documentation format)
6. Schematics (if applicable)
7. BOM

Skills required (4/5 team members):

- Verilog coding experience
- Robotics experience (Motor control skill highly desired)
- Previous experience integrating complex embedded systems highly desired
- Software skills based on the Drone platform chosen

Timeline:

- Drone platform deliverable – 3 months (Winter 2017 Quarter, most of the development work)
- Code clean up/improvements – 1 month (Spring 2017 Quarter)
- Documentation – 1 month (Spring 2017 Quarter)