Using Intel® Edison to Fuse Embedded Linux with Existing Drone Flight Controllers

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Motivation

• Build an extensible drone platform on top of an existing Low Level Flight Controller
What is Edison?

- Compute Module
- Atom Silvermont
- Dual Core 32-bit 500MHz
- 1GB RAM, 4GB eMMC
- Wi-Fi (802.11a/b/g/n), BT 4.0
- 70-pin Hirose Connector
- Quark 32-bit 100MHz Processor
Why Edison?

• Integrated Wireless Connectivity
• Small Form Factor (35.5 x 25 x 3.9 mm)
• Low Power Design
• Processing Power
• Stackable Design
Multirotor Drone
Multirotor Drone
Software Stack High Level Flight Controller

- Yocto Project Based Distribution
- Runs on Edison
- Reads waypoint mission data and commands from web server
- Reads sensor data from sensor hub
- Computes bearing to target
- Generates output to control desired throttle, pitch, roll and yaw
- Transmits output to LLFC via MUX
- Logs data to file system + transmits telemetry via radio
Sensor Hub

- Atmel ATMega 328P
- ADAFruit 10-DOF IMU
  - 3 axis Accelerometer
  - 3 axis Gyroscope
  - 3 axis Magnetometer
  - Barometer
- uBlox GPS
- Retrieves sensor data via I²C
- Transmits serial packet to Edison
GPS Serial to I\textsuperscript{2}C Converter

- Atmel ATMega 328P
- uBlox 6M
- Initialize GPS module 5Hz at 57600 Baud
- Format GPS serial data to single packet
- Convert to I\textsuperscript{2}C for Sensor Hub
• Propeller P8X32A
• Multiplexes:
  • Serial Commands from Edison
  • R/C RX inputs
    • MUX selector
    • Manual stick inputs (flight controls & bailout)
• Outputs PWM to Flight Controller
Navigation Planner

- Webserver on Edison
- node.js
- Express
- Socket I/O
- Arduino
- Google Maps v3 API
- Telemetry
- Waypoint Support
Navigation Planner Software Layout

Tablet/Laptop

Browser
  Google Maps v3
  Socket I/O

Internet

Edison

Server
  Express
  Socket I/O
  Domain Socket

HLFC
  Auto Pilot
  Domain Socket

MUX
Telemetry Visualization
Results (Highlights)

- Altitude Testing
- Yaw Testing
- Waypoint Navigation
- GEO Fencing
- Telemetry Data Visualization
- Bailout/Safety Switch
- GPS accuracy
- Short Development Time
Results (Pitfalls)

• Sensor Problems
  • Magnetometer
  • Barometer
  • Signal Noise

• Software Problems
  • Node.js error handling
  • Arduino IDE issues
  • Toolchain
  • File Syncing
  • Boot time
Results (Pitfalls Continued)

- Board Level Problems
- Lack of Power Domain Control
- Power Supply Noise
- I/O Voltage Level Conversion
What is Next?

• Board Level Optimizations
• Navigation Tightening
  • Better Heading Estimation
  • Improved Flight Speed
  • Flight Simulation
• Object Detection, Avoidance, Following
  • Vision System
  • Terrain Avoidance
What is Next? (Continued)

• Drone Code protocol support
• Leverage Quark/RTOS
• Cellular Modem (Internet Connection)
• Weather Database Query En Route
Project Websites

- Project Page: (GitHub) http://goo.gl/hTVcDY
- YouTube Videos
  - Test Flight To Waypoint
    - https://www.youtube.com/watch?v=zwC07qLmMzQ
  - Test Flight Over Controlled Yaw
    - https://www.youtube.com/watch?v=OTQT48VxALY
- Edison Product Page
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Questions?