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Ground Station System Level Block Diagram
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On-Board System Level Block Diagram
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**Group Organization**

- **Alexander Adams - Aircraft Control & Power Manager**
  - Power Supplies
  - PWM Controllers
  - Inertial Reference Unit

- **Sebastian Siatkowski - Microprocessor Manager**
  - Microprocessor Hardware
  - Microprocessor Software Initialization and Configuration
  - Camera Module

- **Michael McKeown - Software Architect**
  - On-Board Code Structure
  - Ground Station GUI Structure
  - GPS Module

- **Ethan Preble - Wireless Communication Manager**
  - Wireless Transceiver Configuration
  - Wireless Protocol Definition
  - Joystick Interface
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Vehicle Interface

• Power from BEC
• PWMs control ESC and Servos
• Out of radio range behavior
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Orientation Sensor

- Sensors
  - 3 axis accelerometer
  - 3 axis gyro
  - 3 axis magnetometer
- Kalman filtering
- OEM module
- Heading has singularity at board pitch of +/- 90 degrees
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Microprocessor Hardware

PIC24FJ64GA106

• 32 MHz clock
  o 8 MHz External Crystal w/ 4x PLL

• 4 UARTs

• 16 kB Memory

• Timer interrupts

• 16-bit Architecture
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Camera Module

LinkSprite LS-Y201

• On-Chip JPEG Compression

• Configuration
  o Compression Ratio
  o Image Size
    ▪ 640x480, 320x240, 160x120

• Implemented Features
  o Capture Mode
    ▪ Continuous (0.1 - 1 FPS)
    ▪ On Request
  o Image Save to Disk Option

• Large On-Board State Machine
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Global Position System (GPS) Module

66 Channel LS20031 GPS Receiver

- Original GPS module was faulty
- Configured to output latitude, longitude, altitude, ground speed, and fix information at 2.5 Hz
- Position Accuracy: 2.5m-3m (at best)
  Altitude < 18,000 m, Velocity < 500 m/s
- Transmits data to ground station at 1Hz
- Ground station displays data on GUI
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Ground Station Software Components and Structure

• Qt (Open Source GUI Framework) with Microsoft Visual Studio 2010 C++
  o Main Window
  o Widgets/Objects
    ▪ Open Source Libraries
  o Signals and Slots
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Ground Station Software Components and Structure
• Microchip MPLab X IDE with C30 Compiler in C
  o All UART serial communication is interrupt driven
  o Serial data received from all components goes into software buffer from ISR
    ▪ Except data received from wireless transceiver
      • Preserves priority for aircraft control data
  o Main loop polls and parses software receive buffers
    ▪ Transmission of sensor data to ground station based on parsing or timer
Serial data transmitted goes into software buffer

- Interrupt when hardware transmit buffer has at least one spot in it, fill hardware buffer with data from software buffer

- UART hardware buffers never overflow!
Xbee 900 Pro

- Range >300m
- Throughput 156 Kbps
  - 640*480 JPEG = 50kB
- Delay 0.1 - 0.2 sec
- FCC Approved
- ISM 900 MHz
  - Little interference
## Wireless Packet Structure

<table>
<thead>
<tr>
<th>Flag</th>
<th>Payload Length</th>
<th>Packet Type</th>
<th>Payload</th>
<th>Checksum</th>
</tr>
</thead>
</table>

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Wireless Communication Protocol
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Wireless Communication Protocol

Image Chunk Retransmits
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Joystick Interface

- Four Axes
  - x - Roll
  - y - Pitch
  - z - Yaw
  - Throttle
- Interrupt driven
  - 25ms or 40Hz
- Deadzone
- Mappable buttons
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Completed and Populated PCB
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Camera/Aircraft Integration

Camera
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Ground Station
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First Flight

Flight 1: SBRCM Airstrip
5-27-2012
First Flight
What Went Wrong & How We Fixed It

- **Problem**
  - Ailerons engaged on takeoff

- **Cause**
  - Unintended X-Axis Movement
  - No Deadzone

- **Fix**
  - Added Joystick Deadzones and rescaled
AURCA Second Flight

AURCA Test Flight 2
SBRCM Airfield 5-28-2012
Conclusions

• What we felt we did right
  o Good organization and teamwork
  o Designing for robustness and reliability
  o Picked an exciting project idea
  o Did not try to do TOO much, we wanted to add a lot more

• What we felt we did wrong
  o Left some important parts to the last minute
  o Overly complex components
  o Thoroughness of checking board layout

• Advice to future Senior Capstone Students
  o START EARLY!!!
  o Pay attention to all details, do not overlook ANYTHING
  o Pick a project that you think will be fun and will have exciting results. This makes the whole class easier.
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Thanks to Our Sponsors and Others!

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