Project Background
Project Overview

GPSight is a product which tracks and follows a remote object using GPS coordinates. Wireless communication, a digital compass, microcontrollers, and a pan and tilt unit all makeup the GPSight project.
Project Overview

Base

Module

GPSight
Aerial View in Action

Module

Base
GPSight in Action
GPS-18
MC9S12 microC
uart_rx
uart_tx
XBee-PRO
Module

Base
Servo Pan / Tilt
CMPS03 compass
pulse
i2c
XBee-PRO
XBee-PRO
uart_rx
uart_rx
Garmin GPS-18

- Global Positioning System
- Satellite based using time stamps to find position
- 24 satellites in use 4 typically locked
- RS-232 serial output @ 1Hz
GPS Output Data

- **NMEA Message**

  $GP{GGA,092204.999,4250.5589,S,14718.5084,E,1,04,24.4,19.7,M,,0000*1F}$

- **Comma delimited**

- **Latitude and longitude in degrees, minutes and decimal minutes**

- **Altitude in meters**

- **Other detailed information including time**
Freescale MC9S12C32

- 16-bit microcontroller
- C programmable
- UART (SCI)
- Modular design
- Prior experience
Atmel Mega64

- 8-bit microcontroller
- AVR-GCC programmable
- ISP programming
- JTAG debugging
- Hardware I2C
- 2 hardware UARTs
Devantech CMPS03

- 2 Axes compass
- Determine base orientation
- Features 2 Philips magnetic flux sensors
- PIC microcontroller interpolates sensors into compass bearing
I2C Synchronous Serial

- I2C is 2 wire synchronous serial interface
  SCA is clock and SDA is data

- Master [AVR] issues commands to slave [CMPS03] then reads data from slave

- CMPS03 register 1 is 8 bit compass reading

- 8 bits = 360 degrees (0-255)

- Calibration also executed using I2C
MaxStream XBee-PRO

- Advertised line-of-sight range: 1.6km
- Transmit current: 215mA @ 3.3V
- Idle current: 55mA @ 3.3V
Pan / Tilt Unit

- Horizontal motion: Pan
- Vertical motion: Tilt
- Hobby servo actuators
- Pulse width controlled
GPSight Module

MC9S12C32 uProcessor
- GPS IN
- XBee OUT
- status LEDs

GPS-18
Transmits GPS Data
- GPS OUT

XBee-PRO
Wireless Link to Base
- XBee IN
Module Algorithm

- Wait for ‘$’ from GPS
- Count commas
- Save degrees, minutes, hemisphere, fix code, altitude
- Convert minutes into degrees, convert degrees into radians
- Transmit position in radians, altitude
Base Algorithm

Base direction

Bearing to Module

Maximum Travel

Difference = bearing - direction
Great Circle Aviation

- A “great circle” is any circle on a sphere with the same diameter of the overall sphere.

- The shortest path (or line of sight) to any point on a sphere resides on a great circle.

- Used to derive distance and bearing.
Schematic Layout

- EAGLE Package
- Design parts
- Layout and name nets
PCB Layout

- EAGLE package
- Minimize Vias
- Use SMD components
- Route leaded components on bottom
PCB Layout
## Parts Budget

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
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<tbody>
<tr>
<td>Garmin GPS-18</td>
<td>N/A ($100 x 2)</td>
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<tr>
<td>Freescale MC9S12C32</td>
<td>N/A ($25)</td>
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<td>MaxStream XBee-PRO</td>
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<td>Atmel ATMega64</td>
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<td>Hobby servo brackets</td>
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<td>Enclosures</td>
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<tr>
<td>Miscellaneous</td>
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Parts Total Per Base & Module $145
Project Budget

Parts total: $145

Hours invested: 600

Hourly rate: $60

Research and development cost: $36,000

Total cost: $36,145
Project Shortcomings

- Module is bulky
- Radios have limited range (~100 m)
- GPS accuracy is 10s of meters, updates at 1Hz
- Pan / tilt unit lacks precision, torque
- AVR 8 bit ALU is slow computing 32 bit floats
Solutions

- The future of GPSight lies in your pocket: Cellular telephones meet all requirements

- Proper pan and tilt camera system using servos or stepper motors

- Garmin GPS-18-5
  5Hz GPS update

- FPGA or ARM7 32 bit CPU for complex math
We look forward to demonstrating GPSight on Friday, December 8th from 2-3PM.

For more information please visit: http://gpsight.sdsu.edu/

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