Search And Find Emergency Drone

"SAFE Drone"

Team 4

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Team Members

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Review of Project

- Autonomous drone to search a predefined remote area for lost, missing, or injured people carrying cell phones.
- Detection of signal emitted by a powered-on cell phone searching for service/cellular tower.
- For use in remote areas with no reception.
- Download of GPS way points with associated signal strength to make a “heat map” of signal strength over the area in question.

Requirements

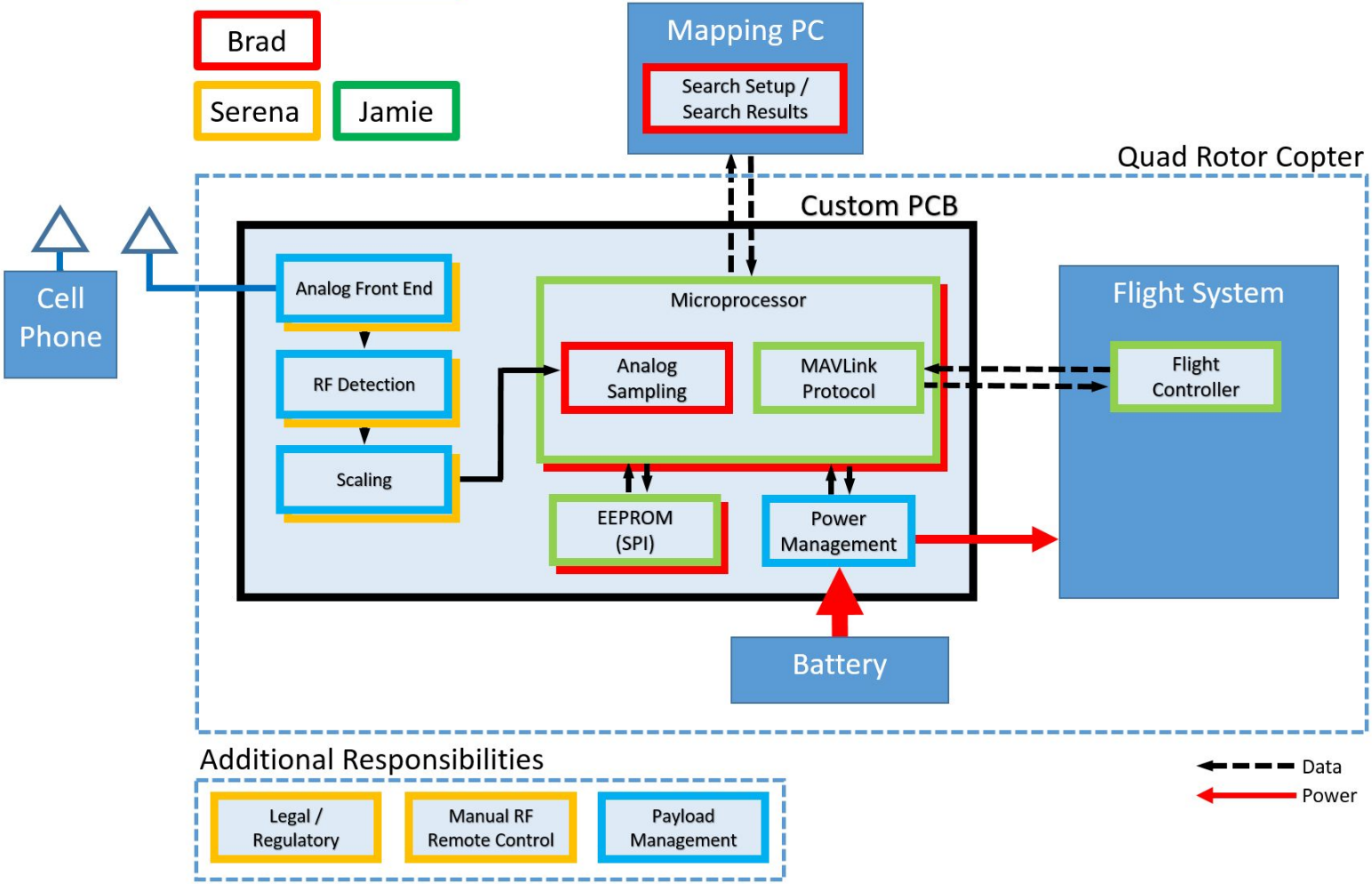
- ✓ UAV (Unmanned Aerial Vehicle) capable of autonomously scanning a pre-defined tree covered area.
- ✓ Ability to measure signal strength of 835-915MHz signals within 100’.
- ✓ Ability to record signal strength/GPS coordinates.
- ✓ Ability to return to home on completion.
- ✓ Present data to search teams by overlaying signal strengths onto map of mission.

What were the proposed FPR deliverables?

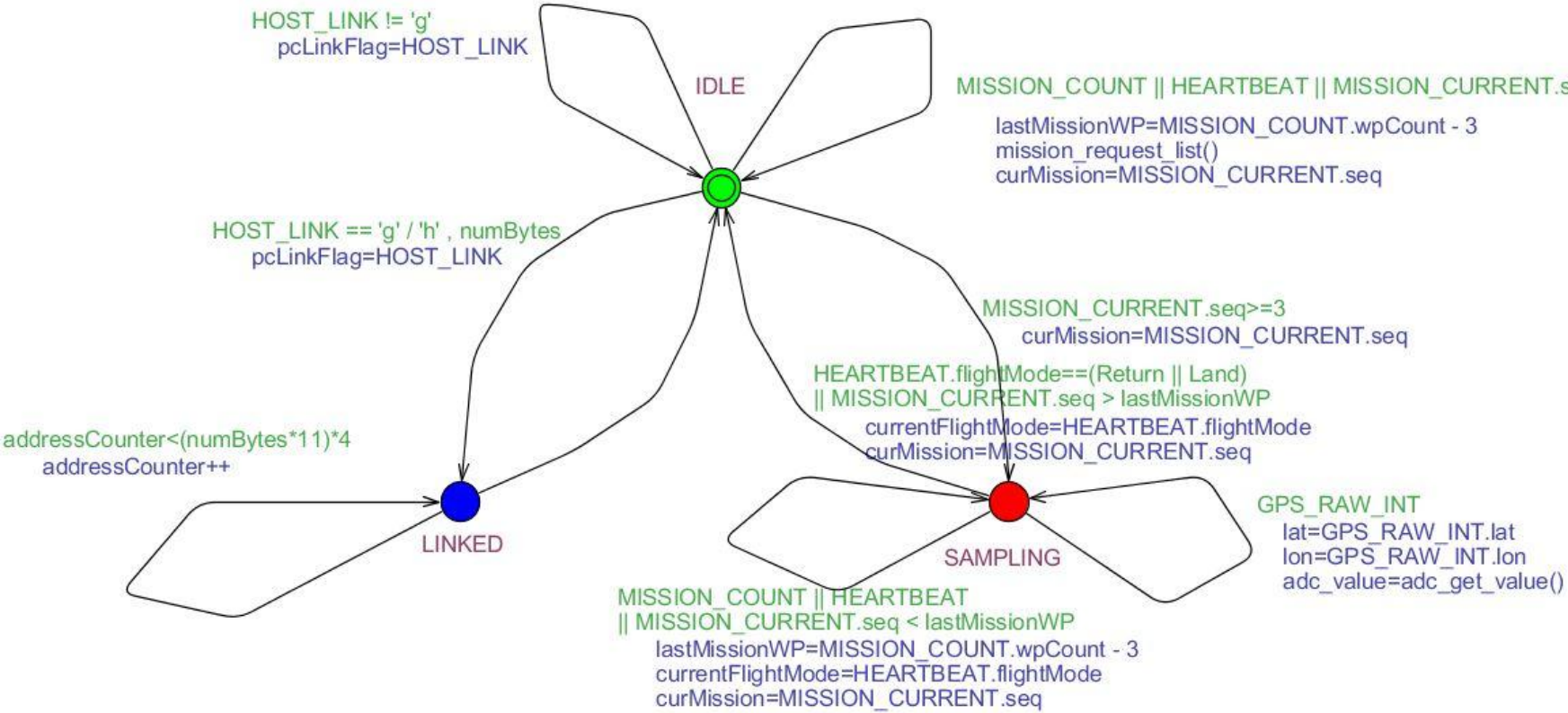
✓ 1. Efficient search algorithm study (not necessarily implementation, but proof of concept to go hand in hand with possible antenna choices)
✓ 2. Band-pass filter and semi-directional antenna tests (less noise interference)

1. Develop / integrate interrupt-based EEPROM write routines
✓ 2. Refinements (usability, features) to host PC link software

✓ 1. Develop / integrate interrupt-based serial buffer routines.
2. Final mechanicals prep: tidying wiring, “prep/paint/polish”
✓ 3. Complete next PCB revision documents, update website


Brad
Serena
Jamie
Mapping PC
Search Setup / Search Results
Quad Rotor Copter
Custom PCB
Cell Phone
Analog Front End
RF Detection
Scaling
Microprocessor
Analog Sampling
MAVLink Protocol
EEPROM (SPI)
Power Management
Flight System
Flight Controller
Battery
Additional Responsibilities
Legal / Regulatory
Manual RF Remote Control
Payload Management
Data
Power

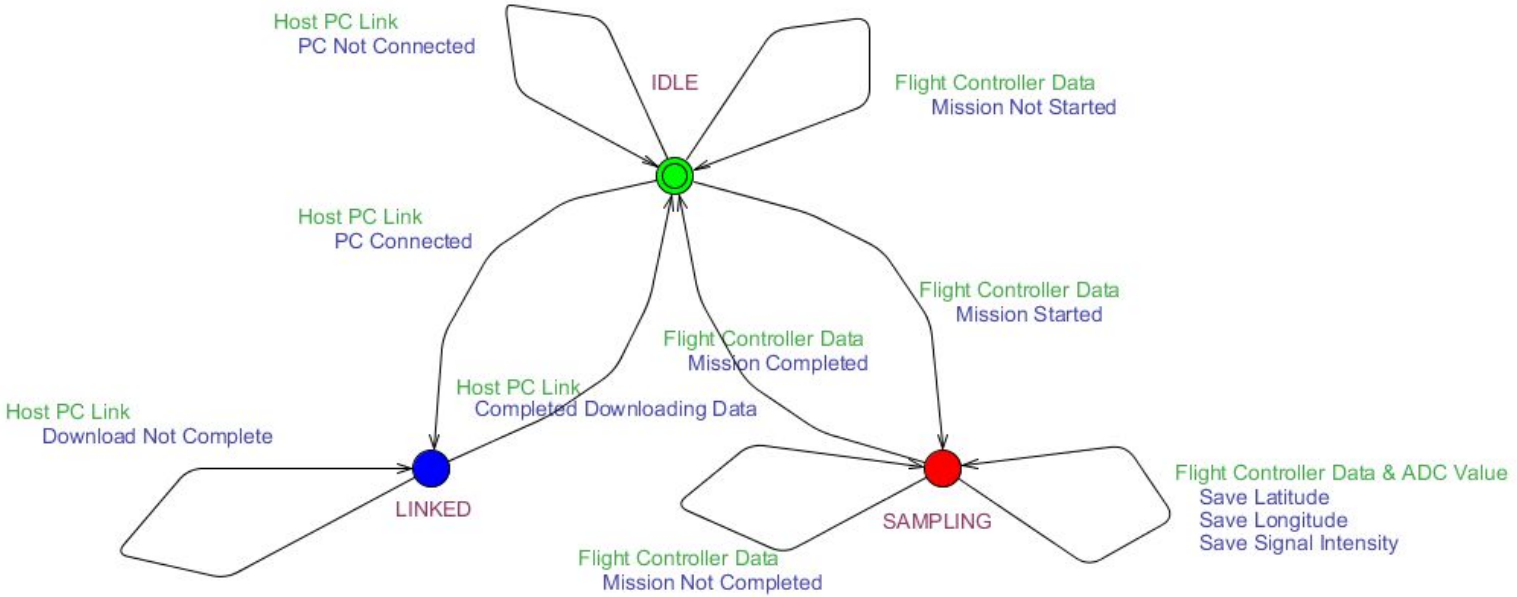
State Machine



State Machine

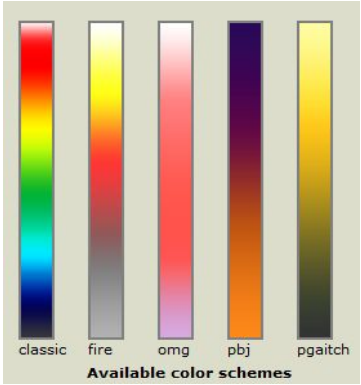
Atmel At32UC3B1256 QFN-48

- 16 MHz
- 256KB internal
- 10-bit ADC
- 3 USART
- SPI
- TWI
- 3.3V Input
- 200mA



Results

```
Please enter dot dize:
>> 100
Please enter color scheme:
>> classic
Please enter deviation factor:
>> 2
Sample Mean = 195.246648794

Variance = 131.18093632

Standard Deviation = 11.4534246547

Minimum Outlier = 219

Maximum Outlier = 235

[(219.0, -72.5348257, 42.3823457), (231.0, -72.5349662, 42.38238), (224.0, -72.5
341448, 42.382332), (220.0, -72.5342046, 42.3821852), (220.0, -72.5346714, 42.38
21947), (221.0, -72.5346139, 42.382196), (235.0, -72.5349708, 42.3823734), (221.
0, -72.5345951, 42.3821957)]
Heat map saved as 04_17_1537.kml
Please select an option
```



$$s_x = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

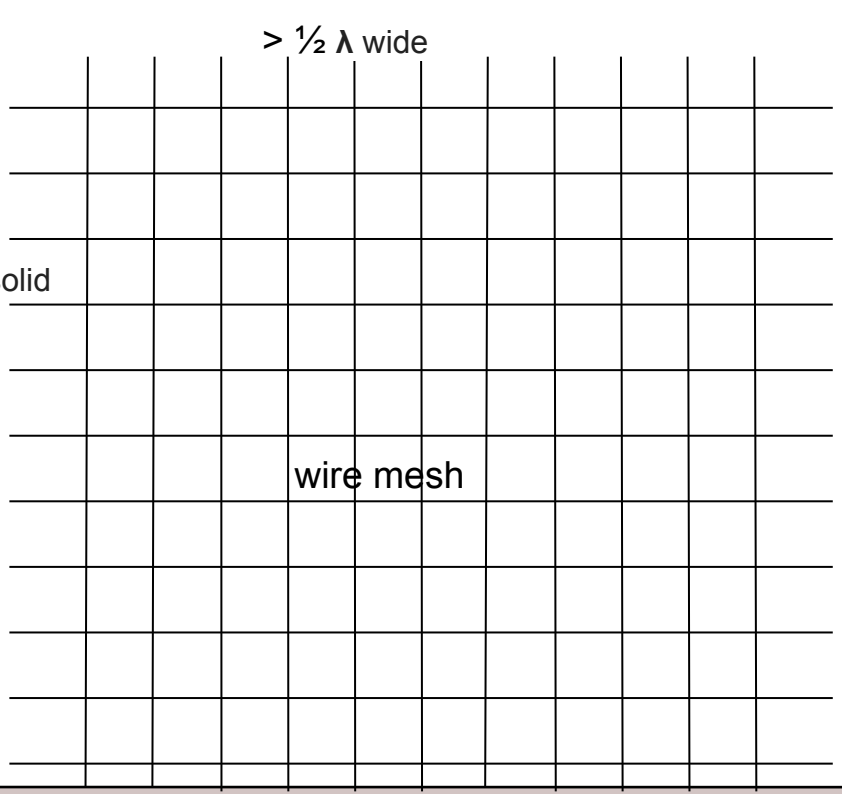
n = The number of data points

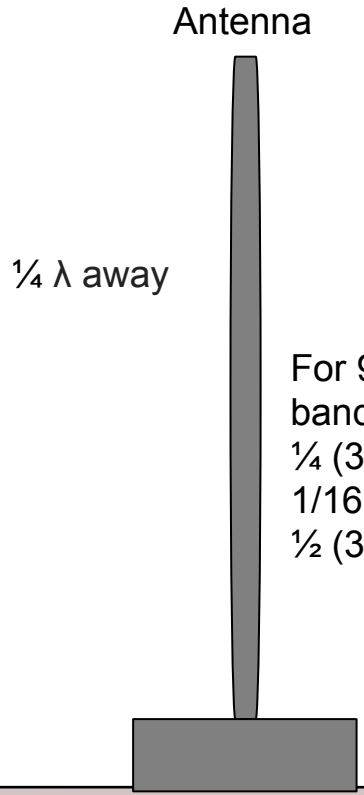
$\bar{x}$ = The mean of the x_i

x_i = Each of the values of the data

Outliers > $\bar{x} + (DF * s_x)$

Omni-directional to Semi-directional

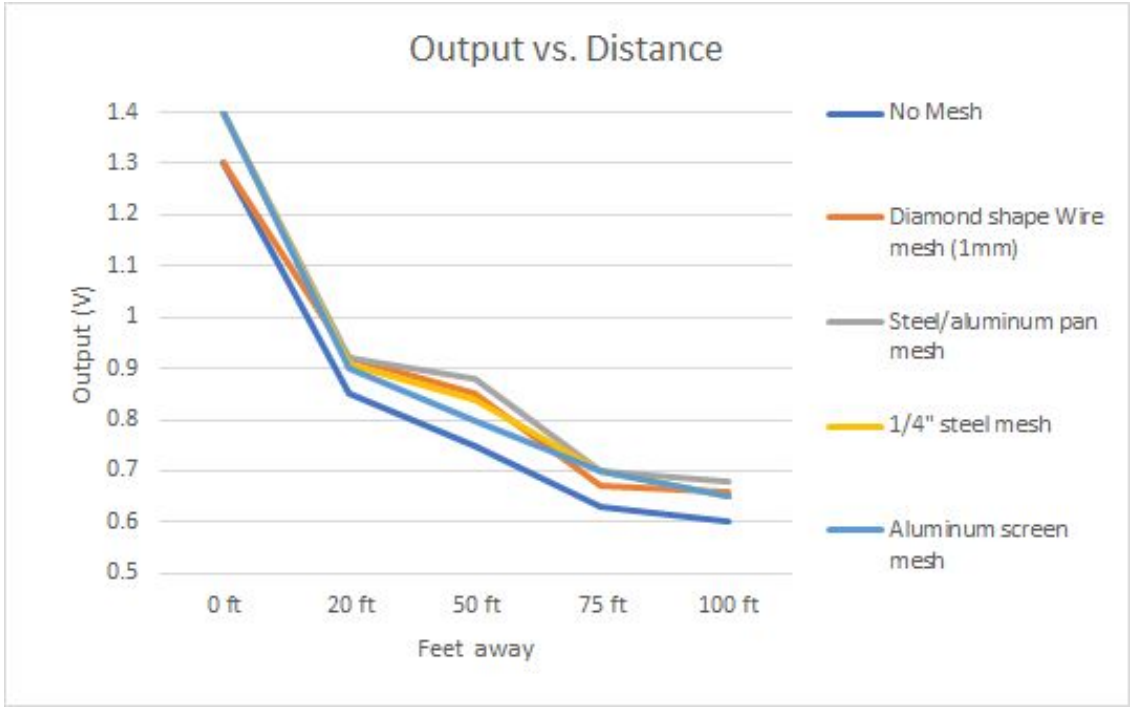




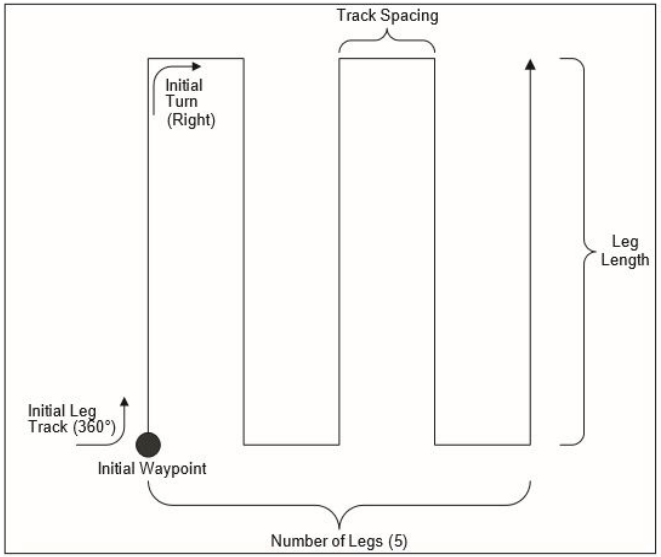
For 900mhz = 33cm band:
¼ (33cm) = 8.33cm
1/16 (33cm) = 2.08cm
½ (33cm) = 16.65cm

Signal Strength Testing

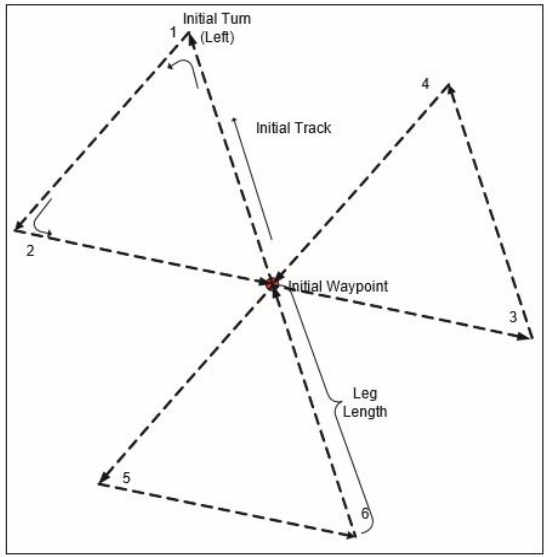
- Ambient level = 0.54V
- Output going directly into ADC, whose output is saved to EEPROM



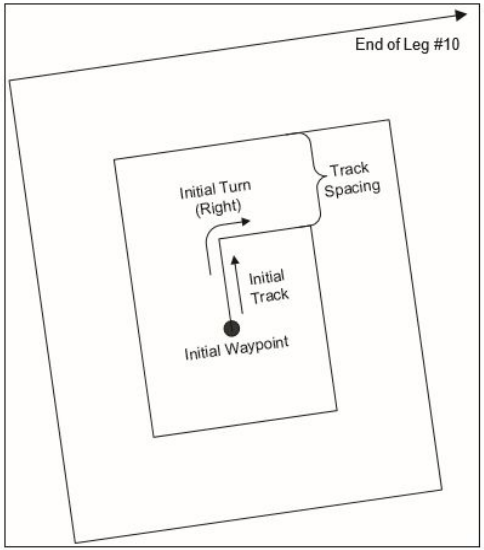
Most Efficient Search Algorithm



Parallel Track Search Pattern



Sector Search Pattern



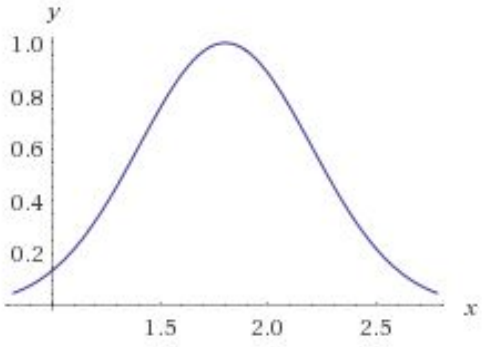
Expanding Square Search Pattern

Figure 1 Search and Rescue Flight Patterns

https://www.capmembers.com/media/cms/G1000SAR_Pilots_Guide_36A7F9D9CD4D5.pdf
http://www.aiai.ed.ac.uk/project/ix/project/wollan/2004-msc-wollan-sar-patterns.pdf

Probability Calculation

- the probability that a phone is at a point chosen (by SAR team member) on the resulting “heat” map
- assume a normal distribution of points of power levels
- higher power level = higher probability a person is at that point
- When graphing all the power levels, they will be at one point in the normal distribution graph
- The probability (out of 1.0) is given on the y-axis, with the voltage/power level given on the x-axis



(x from 0.8 to 2.8)

Equation of graph:

$$f(x) = \frac{1}{\sigma}\sqrt{2\pi}\,\exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$

where f(x) is the probability, $\sigma = 1/\sqrt{2\pi}$, and μ is the highest output voltage when directly over a cellphone, assumed here to be 1.8V

- when given a power level as x, the probability that a person is at those coordinates is f(x)

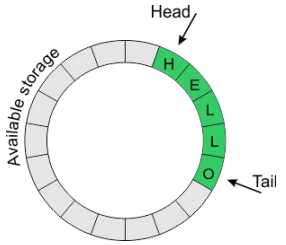
Interrupt-Driven Serial

Interrupt Benefits:

- No longer have to poll serial port: more efficient
- Other operations can be carried out while receiving: faster

Buffer Benefits:

- Prevents single-byte buffer overrun: more reliable



(256 Byte ring buffer)

Validation:

- Intentional delays added to stress system
- System can tolerate 400uS delay in proc.

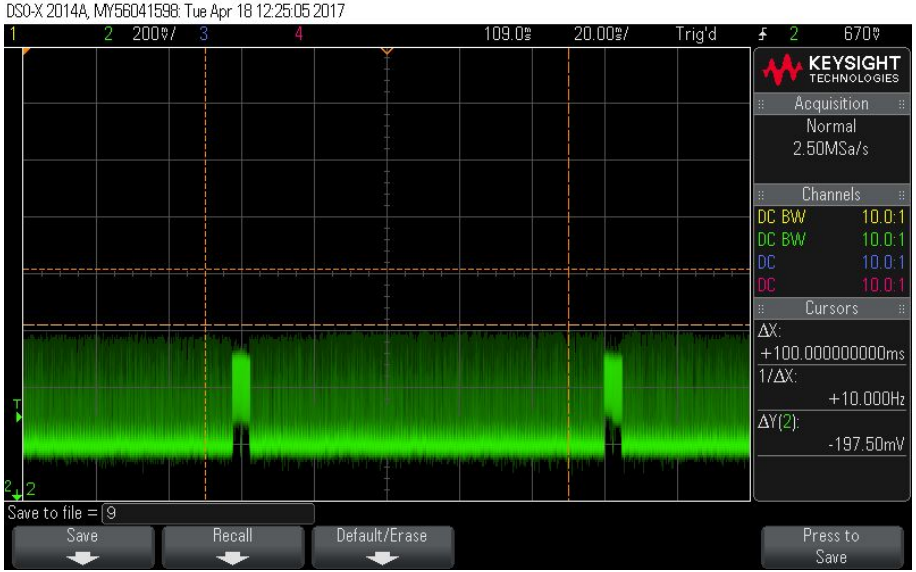
Logic (2uS) and ADC (20uS) well within

GPS Packet →

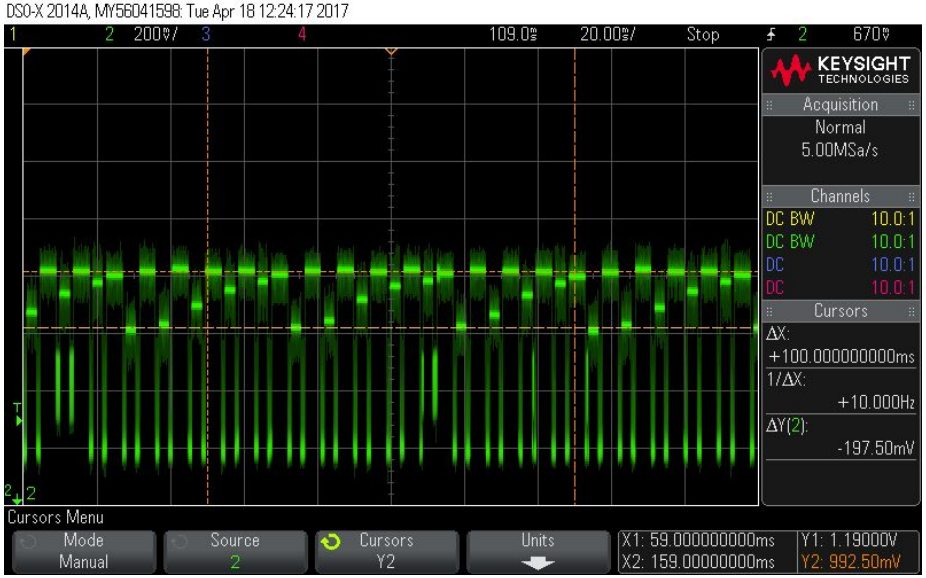
Buffer full Ind. →

Transmitter Interference

RSSI Analog Outputs:



Remote Control: OFF



Remote Control: ON

Demo - what to expect and why

1) Mission/scan area setup and download to craft (here): *necessary*

1) Person in scan area toggling airplane mode: *simulates searching for tower with high power.*

1) Flight: *demonstrates proper mechanical integration of subsystems with craft*

1) Retrieval of collected data: *demonstrates PC subsystem communication*

2) Analysis of data (here): *demonstrates (indirectly) majority of subsystem integration: clean power supply, proper routing, analog front-end sensitivity, digital sampling, data storage, communication to flight controller, etc.*

Meeting the Specs

Specifications	Value	Actual	
Max Flight Time:	10 Minutes	12 Minutes	✓
Max Speed:	30 MPH	33 MPH	✓
Max Sample Speed:	200 KSPS	128 KSPS	
Max Samples:	5,300	11,915	✓
Coordinate Accuracy:	< 12 inches	4 inches	✓
Sensing Sensitivity Range:	-70 dBm to 5 dBm	-70 dBm to 5 dBm	✓
Sensing Frequency Range:	835 MHz - 915 MHz	~300-900 MHz	✓
Sensing Distance Range (to Src.):	15-100ft	15-100ft	✓

Demo

Demonstrations!

Thank You

Questions?