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.
UMassAmherst
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
HOST_LINK != 'g'
  pcLinkFlag=HOST_LINK

HOST_LINK == 'g' / 'h', numBytes
  pcLinkFlag=HOST_LINK

addressCounter<(numBytes*11)*4
addressCounter++

MISSION_COUNT || HEARTBEAT || MISSION_CURRENT.seq < 3
  lastMissionWP=MISSION_COUNT.wpCount - 3
  mission_request_list()
  curMission=MISSION_CURRENT.seq

MISSION_CURRENT.seq>=3
  curMission=MISSION_CURRENT.seq

HEARTBEAT.flightMode==(Return || Land)
|| MISSION_CURRENT.seq > lastMissionWP
  currentFlightMode=HEARTBEAT.flightMode
  curMission=MISSION_CURRENT.seq

GPS_RAW_INT
  lat=GPS_RAW_INT.lat
  lon=GPS_RAW_INT.lon
  adc_value=adc_get_value()
State Machine

Atmel At32UC3B1256 QFN-48

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

Deviation Factor=0

Deviation Factor=1

Deviation Factor=2

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

- \( n \) = 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:
\( \frac{1}{4} (33\text{cm}) = 8.33\text{cm} \)
\( \frac{1}{16} (33\text{cm}) = 2.08\text{cm} \)
\( \frac{1}{2} (33\text{cm}) = 16.65\text{cm} \)

1/16 \( \lambda \) apart to appear solid (horizontal lines)

> \( \frac{1}{2} \lambda \) wide

\( \frac{1}{4} \lambda \) away

wire mesh
- 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

• 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

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 \( \mu \) 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 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

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

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

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Value</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Flight Time:</td>
<td>10 Minutes</td>
<td>12 Minutes</td>
</tr>
<tr>
<td>Max Speed:</td>
<td>30 MPH</td>
<td>33 MPH</td>
</tr>
<tr>
<td>Max Sample Speed:</td>
<td>200 KSPS</td>
<td>128 KSPS</td>
</tr>
<tr>
<td>Max Samples:</td>
<td>5,300</td>
<td>11,915</td>
</tr>
<tr>
<td>Coordinate Accuracy:</td>
<td>&lt; 12 inches</td>
<td>4 inches</td>
</tr>
<tr>
<td>Sensing Sensitivity Range:</td>
<td>-70 dBm to 5 dBm</td>
<td>-70 dBm to 5 dBm</td>
</tr>
<tr>
<td>Sensing Frequency Range:</td>
<td>835 MHz - 915 MHz</td>
<td>~300-900 MHz</td>
</tr>
<tr>
<td>Sensing Distance Range (to Src.):</td>
<td>15-100ft</td>
<td>15-100ft</td>
</tr>
</tbody>
</table>
Demonstrations!
Questions?