Feasibility Study of Mobile Phone WiFi Detection in Aerial Search and Rescue Operations

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Search and Rescue

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ORIGINAL RESEARCH

Dead Men Walking: Search and Rescue in US National Parks

Travis W. Heggie, PhD; Michael E. Amundson, BS

Results.—From 1992 to 2007 there were 78,488 individual incidents ended with 2,659 fatalities, 24,288 ill or injured. There were 11.2 SAR incidents each day at an average cost of $895 per operation. Total SAR costs from 1992 to 2007 were $58,572,164. In 2005, 50% of the 2,430 SAR operations occurred in just 5 NPS units. Grand Canyon National Park (307) and Gateway National Recreation Area (293) reported the most SAR operations. Yosemite National Park accounted for 25% of the total NPS SAR costs ($1.2 million); Wrangell-St. Elias National Park and Preserve ($29.310) and Denali National Park and Preserve ($18.345) had the highest average SAR costs. Hiking (48%) and boating (21%) were the most common activities requiring SAR assistance. Hiking (22.8%), suicides (12.1%), swimming (10.1%), and boating (10.1%) activities were the most common activities resulting in fatalities.

Conclusions.—Without the presence of NPS personnel responding to SAR incidents, 1 in 5 (20%) of those requesting SAR assistance would be a fatality. Future research and the development of any prevention efforts should focus on the 5 NPS units where 50% of all SAR incidents are occurring.

Key words: search, rescue, national park, fatality, injury, illness
# Highest incidents - Hiking

<table>
<thead>
<tr>
<th>Activity</th>
<th>No. of incidents</th>
<th>% of SAR</th>
<th>Fatalities</th>
<th>Illness/injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hiking</td>
<td>1167</td>
<td>48%</td>
<td>34</td>
<td>730</td>
</tr>
<tr>
<td>Day hiking (870)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overnight hiking (297)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boating</td>
<td>506</td>
<td>21%</td>
<td>15</td>
<td>116</td>
</tr>
<tr>
<td>Motorized (338)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonmotor (168)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swimming</td>
<td>153</td>
<td>6%</td>
<td>15</td>
<td>29</td>
</tr>
<tr>
<td>Climbing</td>
<td>127</td>
<td>5%</td>
<td>13</td>
<td>84</td>
</tr>
<tr>
<td>Scrambling (39)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical roped (76)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical unroped (12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle/driving</td>
<td>73</td>
<td>3%</td>
<td>9</td>
<td>35</td>
</tr>
<tr>
<td>Canyoneering</td>
<td>57</td>
<td>2%</td>
<td>3</td>
<td>39</td>
</tr>
<tr>
<td>Mountaineering</td>
<td>52</td>
<td>2%</td>
<td>14</td>
<td>37</td>
</tr>
<tr>
<td>Roped (39)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Current Methods

Limitations
• Terrain
• Manpower
Aerial Based

EXPENSIVE
Hobbyist UAV

- Affordable
- Easy to fly
  - iPad or Android
  - Autopilot
- Easy to deploy
Current Aerial Approach

P. Rudol and P. Doherty. Human body detection and geolocalization for UAV search and rescue missions using color and thermal imagery.
Drawbacks

- Requires Line-of-Sight
- Requires daylight
- Heavy payload
  - Optics
  - On-board CPU
Key Idea
Is it Feasible?

Signals from a phone?

Battery life?

Range of detection?
WiFi Scan/Probe

Probe Request Frame
WiFi Scan

802.11 Channel

Different Scenarios
Different Devices

Scan interval

WiFi Scan

Different Intervals
Different Scenarios

- **Scan Frequency**
  - High
  - Moderate
  - Low

- **Settings Screen**
  - High
  - Moderate
  - Low

- **Home Screen**
  - High
  - Moderate
  - Low

- **Display Off**
  - High
  - Moderate
  - Low
## Different Devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Settings Screen</th>
<th>Home Screen</th>
<th>Display Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTC Desire</td>
<td>Every 6 s</td>
<td>Every 15 s</td>
<td>Does not scan</td>
</tr>
</tbody>
</table>

More results in the paper (Table 1)
Battery Life

- Settings Screen
  - High: Short
  - Low: Long

- Display Off
  - Low: Long

Custom Android App

- Android WiFiManager API
- Increase scan frequency with display off
Monsoon Power Monitor
Sample Result of Battery Life

- **Motorola Electrify**

  - WiFi Setting Screen
  - Default Scanning Freq
  - 11 X Default

  - Our Custom App

  - 11 hours
  - 51 hours
  - 21 hours

More results in the paper (Table 2)
Passive Detection

- 4 to 5 Probe Request Frames
Active Probing

Clear To Send

Request To Send
Is it Feasible?

- Signals from a phone?
  - Yes
- Battery life?
  - Yes
- Range of detection?
DIY Quadrotor
Detection Range

Distance 250 m
Effective Range

≈200 m range
Effect of Phone Orientation

RSSI of CTS from phone (dB)

Distance from phone (m)

Flat orientation
Vertical orientation
Conclusion

Phone WiFi signal

Battery life: 2 days

Range: 200 to 230 m
RSSI Threshold

Good signal strength
Effect of Altitude

30 m

90 m

150 m

110 m
Effect of Altitude

No improvement