Positional accuracy of six portable GPS receivers

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Satellite-based navigation system

Can be used to monitor location over multiple days

Often combined with accelerometer

Increasingly portable and cheap standalone units
Tested accuracy of Garmin Foretrex 201

Static tests placed GPS units on geodetic points

Mean distance from units to geodetic point was 3.02 m (SD 2.51)

81.1% of observations within 5 m and 99.4% within 15 m
Expand on previous work

- More GPS units
- More geodetic points
- Variety of environmental conditions

- Eight GPS models initially selected
  - Three units for each model

- Tested for battery life and signal acquisition times

- Units placed on geodetic points for 60 min, collecting data in 1 sec epochs
StarsNav BTS-110 (Taiwan)

- Price: US$65
- Size: 76 x 46 x 20 mm
- Connection: USB
- Advertised accuracy: 7 m (90%)
- Recording intervals: 1 s to 30 min
- Data storage: 4-16 MB (optional)
- Advertised battery life: 22 h
- Advertised acquisition time: Hot = 3-6 s, warm = 38 s, cold = 42 s
- Key features: Voice feedback, auto on/off function
FRWD B100 (Finland)

- Price: US$200
- Size: 95 x 55 x 15 mm
- Connection: Bluetooth (to computer or mobile phone)
- Advertised accuracy: 3 m
- Recording intervals: 1-6 s
- Data storage: 16 MB
- Advertised battery life: 12 h
- Advertised acquisition time: Information not available
- Key features: Shockproof and splash waterproof, armband and back satchel available
Garmin eTrex (USA)

- Price: US$100
- Size: 51 x 112 x 30 mm
- Connection: Serial
- Advertised accuracy: <15 m (95%)
- Recording intervals: 1 s, continuous
- Data storage: 10,000 points, 10 tracks
- Advertised battery life: 22 h
- Advertised acquisition time: Warm = 15 s, cold = 45 s
- Key features: DGPS (WAAS/EGNOS) capable (<3 m accuracy), waterproof
Garmin Foretrex 201 (USA)

- Price: US$182
- Size: 84 x 43 x 18 mm
- Connection: Serial
- Advertised accuracy: <15 m (95%)
- Recording intervals: 1 s, continuous
- Data storage: 10,000 points, 10 tracks
- Advertised battery life: 15 h
- Advertised acquisition time: Warm = 15 s, cold = 45 s
- Key features: DGPS (WAAS) capable (<3 m accuracy), waterproof
Garmin Forerunner 205 (USA)

- Price: US$150
- Size: 53 x 69 x 18 mm
- Connection: USB
- Advertised accuracy: < 10 m (50%)
- Recording interval: 1 s
- Data storage: 50 tracks, 100 waypoints
- Advertised battery life: 10 h
- Advertised acquisition time: Hot < 1 s, warm = 38 s, cold < 45 s
- Key features: Waterproof
GlobalSat TR-203 (Taiwan)

- **Price:** US$200
- **Size:** 79 x 42 x 18 mm
- **Connection:** Cellular network, USB
- **Advertised accuracy:** 10 m (3 m DGPS)
- **Recording intervals:** 1 s to 18 h
- **Data storage:** 150,000 points
- **Advertised battery life:** 12-290 h (depending on interval)
- **Advertised acquisition time:** Hot = 1 s, warm = 33 s, cold = 36 s
- **Key features:** Voice monitoring, cellular transmission, waterproof, DGPS (WAAS, EGNOS)
QStarz BT-Q1000X (Taiwan)

- **Price:** US$100
- **Size:** 72 x 47 x 20 mm
- **Connection:** USB, bluetooth
- **Advertised accuracy:** 3 m (50%)
- **Recording intervals:** 1 s
- **Data storage:** 200,000 points
- **Advertised battery life:** 42 h
- **Advertised acquisition time:** Hot = 1 s, warm = 33 s, cold = 35 s
- **Key features:** Auto on/off function, DGPS (WAAS, EGNOS)
Telespial Trackstick II (USA)

- Price: US$149
- Size: 114 x 32 x 19 mm
- Connection: USB
- Location accuracy: 2.5 m
- Recording intervals: 5 s, 1-15 min
- Data storage: 1 MB
- Battery life: Power save mode = 1 week, full mode = 36 h
- Acquisition time: Hot = 9 s, warm = 37 s, cold = 52 s
- Key features: Weatherproof case, detachable belt clip, direct integration with Google Earth
<table>
<thead>
<tr>
<th>Model</th>
<th>Advertised Battery Life</th>
<th>Observed Battery Life</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garmin Forerunner 205</td>
<td>10 h</td>
<td>15.2 h</td>
<td>↑ 52%</td>
</tr>
<tr>
<td>Garmin eTrex</td>
<td>22 h</td>
<td>26.8 h</td>
<td>↑ 22%</td>
</tr>
<tr>
<td>GlobalSat TR-203</td>
<td>84 h</td>
<td>87.5 h</td>
<td>↑ 4%</td>
</tr>
<tr>
<td>Garmin Foretrex 201</td>
<td>15 h</td>
<td>14.2 h</td>
<td>↓ 5%</td>
</tr>
<tr>
<td>QStarz BT-Q1000X</td>
<td>42 h</td>
<td>39.8 h</td>
<td>↓ 5%</td>
</tr>
<tr>
<td>FRWD B100</td>
<td>12 h</td>
<td>10.6 h</td>
<td>↓ 12%</td>
</tr>
<tr>
<td>Telespial Trackstick II</td>
<td>36 h</td>
<td>23.2 h</td>
<td>↓ 36%</td>
</tr>
</tbody>
</table>

And the winner is...
<table>
<thead>
<tr>
<th>Model</th>
<th>Advertised Acquisition Time</th>
<th>Observed Acquisition Time</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q Starz BT-Q 1000X</td>
<td>35 s</td>
<td>34.0 s</td>
<td>↓ 3%</td>
</tr>
<tr>
<td>Garmin Forerunner 205</td>
<td>45 s</td>
<td>51.5 s</td>
<td>↑ 14%</td>
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<tr>
<td>Garmin Foretrex 201</td>
<td>45 s</td>
<td>57.4 s</td>
<td>↑ 28%</td>
</tr>
<tr>
<td>GlobalSat TR-203</td>
<td>36 s</td>
<td>59.4 s</td>
<td>↑ 65%</td>
</tr>
<tr>
<td>Telespial Trackstick II</td>
<td>52 s</td>
<td>136.3 s</td>
<td>↑ 162%</td>
</tr>
<tr>
<td>FRWD B100</td>
<td>-</td>
<td>41.7 s</td>
<td>-</td>
</tr>
<tr>
<td>Garmin eTrex</td>
<td>-</td>
<td>43.1 s</td>
<td>-</td>
</tr>
</tbody>
</table>

And the winner is...
Geodetic Point 1: Summit of volcano (unobstructed)
Geodetic Point 1: Summit of volcano (unobstructed)
Geodetic Point 2: Summit of volcano (under beacon)
Geodetic Point 2: Summit of volcano (under beacon)
Geodetic Point 3: Residential
Geodetic Point 3: Residential
Geodetic Point 4: Mixed use
Geodetic Point 4: Mixed use
Geodetic Point 5: Under canopy
Geodetic Point 6: Urban canyon
Geodetic Point 6: Urban canyon
<table>
<thead>
<tr>
<th>GPS Model</th>
<th>N Obs</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garmin eTrex</td>
<td>21977</td>
<td>17 m</td>
<td>27 m</td>
<td>&lt;1 m</td>
<td>256 m</td>
</tr>
<tr>
<td>Garmin Foretrex 201</td>
<td>17975</td>
<td>10 m</td>
<td>20 m</td>
<td>&lt;1 m</td>
<td>452 m</td>
</tr>
<tr>
<td>Garmin Forerunner 205</td>
<td>31614</td>
<td>13 m</td>
<td>18 m</td>
<td>0 m</td>
<td>121 m</td>
</tr>
<tr>
<td>GlobalSat TR-203</td>
<td>25215</td>
<td>18 m</td>
<td>20 m</td>
<td>&lt;1 m</td>
<td>175 m</td>
</tr>
<tr>
<td>QStarz BT-Q 1000X</td>
<td>21600</td>
<td>9 m</td>
<td>11 m</td>
<td>&lt;1 m</td>
<td>67 m</td>
</tr>
<tr>
<td>Telespial Trackstick</td>
<td>19</td>
<td>34 m</td>
<td>40 m</td>
<td>2 m</td>
<td>139 m</td>
</tr>
</tbody>
</table>
Mean distance by unit and geodetic point.
Mean distance for individual units

High Rise
Mixed Use
Open Sky
Residential
Under Beacon
Under Canopy
<table>
<thead>
<tr>
<th>GPS Model</th>
<th>ICC</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garmin eTrex</td>
<td>0.540</td>
<td>0.164</td>
<td>0.935</td>
</tr>
<tr>
<td>Garmin Foretrex 201</td>
<td>0.476</td>
<td>0.121</td>
<td>0.895</td>
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<tr>
<td>Garmin Forerunner 205</td>
<td>0.415</td>
<td>0.074</td>
<td>0.943</td>
</tr>
<tr>
<td>GlobalSat TR-203</td>
<td>0.502</td>
<td>0.024</td>
<td>0.996</td>
</tr>
<tr>
<td>QStarz BT-Q 1000X</td>
<td>0.644</td>
<td>0.398</td>
<td>0.954</td>
</tr>
</tbody>
</table>
Take home points

1. Advertised battery life and acquisition time of current GPS units is usually inaccurate

2. Most GPS units are accurate to within metres in unobstructed conditions and within 100s of metres in urban canyons and under canopies

3. Interunit reliability is high when unobstructed but low in obstructed conditions

4. Accuracy under dynamic conditions may be different
Welcome to the GPS-HRN

The Global Positioning Systems in Health Research Network is an international collaboration of academics and health professionals interested in GPS technology. This website is an online meeting place for members to share ideas and experiences relating to their work with GPS. GPS-HRN membership is by application only. To apply, please follow the link at the top right of this page.

Background to the GPS-HRN

Who are we?
The Global Positioning Systems in Health Research Network was launched at the 2009 International Society for Behavioural Nutrition and Physical Activity Conference in Cascais.

The aim of the GPS-HRN is to establish a communication forum that will allow GPS researchers to share ideas and experience.

The GPS-HRN administration team is based out of AUT University in New Zealand, UCL in the UK, and the University of Lausanne in Switzerland.

Lead Coordinator: Dr Scott Duncan (AUT University)
Asst Coordinator: Dr Hannah Badland (University College London)
Asst Coordinator: Dr Melody Oliver (AUT University)
Chair: Prof Yves Shutz (University of Lausanne)

The GPS-HRN is currently sponsored by AUT University; however, we will be pursuing further funding for the ongoing maintenance of the network.
Nau mai haere mai

We are pleased to invite you to join us for the
2011 ISBNPA Post Conference Satellite Meeting in Queenstown, New Zealand
Rydges Lakeland Resort Hotel Queenstown, 38 - 54 Lake Esplanade, Queenstown. 21-23 June 2011
Ko te pae tawhiti whaia kia tata, ko te pae tata whakamaua kia tīna!