Test and Evaluation of Localization and Tracking Systems: A New Project (NP) Proposal to ISO/IEC JTC 1

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Introduction

• Lack of standardized Test and Evaluation (T&E) procedures has been an impediment to market growth for Localization and Tracking Systems (LTSs), particularly in “mission-critical” applications, because
  – T&E using different criteria and procedures is wasteful and may lead to inconsistent results,
  – users are unable to verify whether a system meets their requirements, and
  – use of disparate minimum performance requirements by various buyers / jurisdictions forces manufacturers to develop jurisdiction-specific products, thereby raising product costs.

• Many stakeholders and user communities have demanded T&E standards for LTSs be developed.
LTS Taxonomies

- There are different types of LTS:
  - Operating Environment
    - indoor / outdoor / both
    - above ground / underwater
  - Networking / Sensor Infrastructure
    - available / unavailable
  - Site-Specific Training
    - allowed / not allowed
  - Platform Capabilities (computation / storage / radio communications)
    - RFID tags / smart phones / devices with higher capabilities
  - Person / Object Speed
    - stationary / pedestrian speeds / ground vehicular speeds / higher speeds
- T&E procedures may have to be specialized to the type of LTS under consideration.
Sensors for Localization

- In contrast with purely RF-based localization, there is a trend towards development of LTSs that use a variety of sensors and data fusion. This is particularly true in LTSs for mission-critical applications.
- Representative list of localization sensors:

<table>
<thead>
<tr>
<th>WiFi/RF Receivers</th>
<th>Clock</th>
<th>Azimuth Rate Sensor</th>
<th>Temperature Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-/2-/3-Axis AOA/LOB/TDOA Sensors</td>
<td>Accelerometer</td>
<td>Pedometer</td>
<td>Star Tracker</td>
</tr>
<tr>
<td>Range/Pseudo-Range Range Finder</td>
<td>Gyroscope</td>
<td>Inclinometer</td>
<td>2D/3D Imager</td>
</tr>
<tr>
<td>GPS</td>
<td>GyroCompass</td>
<td>Barometer</td>
<td>LiDAR</td>
</tr>
<tr>
<td>MMWR and Other Radars</td>
<td>Magnetometer</td>
<td>Acoustic Sensor</td>
<td>Infrared Sensor</td>
</tr>
</tbody>
</table>
Scope of Proposed NP (I)

- Develop performance metrics for LTSs.
  - Accuracy
  - Consistency
  - Latency
  - Availability
  - Coverage
  - Susceptibility
  - Robustness
Scope of Proposed NP (II)

- Take a **black-box system testing** approach and develop T&E scenarios that include
  - testing in different types of buildings / structures,
  - stressing “potential” system components – need to know what degrades performance of each component – , and
  - various modes of mobility (stationary, walking, running, crawling, walking backward/sideways).
Scope of Proposed NP (III-a)

- Propose best practices for presenting and visualizing T&E results.

Spatial distribution of horizontal error with color-coding to show evolution with test time.

\[ CE95 = R = 4.043 \text{ m} \]

\[ \text{Mean} = 2.545 \text{ m} \]

\[ \sigma = 1.129 \text{ m} \]
Scope of Proposed NP (III-b)

Vertical error vs. test time

VE95 = V = 2.386 m
Mean = 1.309 m
σ = 0.789 m
Scope of Proposed NP (III-c)
Other Considerations

• Additional factors that need to be considered:
  – availability of in-building networking / localization infrastructure
  – whether off-line site-specific system training is allowed
  – availability of building floor plans
  – availability of precise WGS-84 building boundary coordinates

• LTS T&E needs careful planning, but a well-designed standard will foster market growth for localization and tracking products.
How to get involved?

• This will be an international standard developed by ISO/IEC JTC 1/SC 31/WG 5 (Real Time Locating Systems).
• You need to be a member of the US TAG (Technical Advisory Group) to ISO/IEC JTC 1/SC 31 in order to participate in WG 5 meetings.
• You need to join the Association for Automatic Identification and Mobility (AIM) in order to be part of the US TAG to SC 31.
• WG 5 meets roughly twice a year. The meetings alternate between North America, Europe, and Far East Asia.
• There will also be domestic (US National Body) meetings, held via teleconferencing.
• For further information, please contact me at moayeri@nist.gov.