User Presence Detection Based on Tracking Network Activity in SmartRoom

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SmartRoom: Assistance for Collaborative Work

- Many services (composition, personalization)
- Participation of many users (user can be indoor and outdoor)
- Participants come with own devices and use personal clients
- Based on the Smart-M3 platform
## Presence Detection: Scenarios for SmartRoom

Each scenarios group supports a set of services:

<table>
<thead>
<tr>
<th>Scenarios group</th>
<th>Description</th>
<th>Examples of services</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$ (before)</td>
<td>user arrival to the room before starting the main activity</td>
<td>– personalized welcome service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– runtime initialization service</td>
</tr>
<tr>
<td>$S_2$ (during)</td>
<td>user joins and leaves during the main activity</td>
<td>– realtime status for agenda service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– planning speeches service</td>
</tr>
<tr>
<td>$S_3$ (after)</td>
<td>activity statistics</td>
<td>– activity analysis service</td>
</tr>
</tbody>
</table>
Presence Detection: Technology

- End-users have personal computers and mobile devices
- Radio Detection using **Received Signal Strength Indication**
- Innorange Footfall Technology
- Correspondence of users and MAC – registration service
Ontology of user presence is part of the SmartRoom ontology
User presence is based on the context of the user profile
All relationships here are of type “has”
The presence sensor sends its measurements: MAC, RSSI and timestamp
Backend processor is HTTP endpoint to processing presence data from sensor
Presence detector KP detects presence information change
Activity analysis service processes of accumulated data from content service
User Presence: Device Detection + Other Context

R: the user is registered in the system
D: the presence sensor is detected user’s device
L: the user accessed the system

user-1 ↔ +R +D +L
user-2 ↔ +R −D +L
user-3 ↔ +R +D −L
user-4 ↔ +R −D −L
user-5 ↔ −R +D +L
Model: User Presence State and Transitions
Visualization: Agenda-service of SmartRoom

Smart-M3 Applications

User status

11:00 - 11:10  Full  Andrey Vdovenko
Mobile Multi-Service Smart Room Client: Initial Study for Multi-Platform Development

11:10 - 11:20  Virtual  Ivan Galov
The SmartRoom Infrastructure

11:20 - 11:30  Physical  Dmitry Korzun
Proactive Personalized Mobile Multi-Blogging Service on Smart-M3

11:30 - 11:40  Absent  Pavel Kovyrshin
Programming Android Client for M3 Smart Spaces

11:40 - 11:50  Welcome to Ivan Galov  Aleksandr Lomov
Ontology-based KP development for Smart-M3 applications
### Evaluation: Performance of State Transitions

<table>
<thead>
<tr>
<th>Use case</th>
<th>( S_1 ): User arrival to the room</th>
<th>( S_2 ): User joins and leaves during the main activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>User arrival is detected before starting main activity</td>
<td>(+R -D -L \rightarrow +R +D -L)</td>
<td>-</td>
</tr>
<tr>
<td>User is detected after the first arrival</td>
<td>_</td>
<td>(+R -D +L \leftrightarrow +R +D +L) (+R -D -L \leftrightarrow +R +D -L)</td>
</tr>
</tbody>
</table>

- \( S_1 \) and \( S_2 \) are based on detecting the transitions between states
- Evaluate the time required to detect transitions of \( S_1 \) and \( S_2 \)
- Scenario \( S_3 \) aggregates history of presence detection
Evaluation: Conducted Experiments

Scenario $S_1$ (steps):

1. The presence sensor determines close device and sends the device presence data
2. The backend processor publishes presence data in ontological form
3. The presence detector updates the properties and publishes the presence level property
4. Any service that uses information on user presence subscribes to updates of the presence level property

Steps 1–4 requires Detection time

Scenario $S_2$:

1. Leave threshold
2. Re-joining the main activity (similarly as in $S_1$)

Scenario $S_3$:

1. Memory occupied by the statistics files on the content service
2. Processing time activity analysis service of the network activity metrics
Evaluation: Detection Time in $S_1$

- Sample size is 100
- Average detection time is 677 ms
- Detection time does not depend on the number of devices
For the **iPhone 5** device the distribution delta arrival time of probe request frames was in the range \([40, 50]\)

The values of high probability are **45 s**
For the **Lumia 920** device the distribution delta arrival time of probe request frames was in the range $[31, 37]$.

The values of high probability are **35 s**.
For the **Galaxy S3** device the distribution delta arrival time of probe request frames was in the range \([27, 34]\) s.

The values of high probability are **30 s**.
Evaluation: Network Activity Metrics in $S_2$ and $S_3$

- Content service is used for accumulation of statistics
- It generates on the text file for each user

Metrics:

- Level of network activity:
  \[ L_k = n_k \]

- Activity rate:
  \[ f_k = \frac{j-i}{t(s_{kj})-t(s_{ki})}, \]
  \[ 1 \leq i < j \leq n_k \]

- Average value of RSSI
Evaluation: Processing Time and Memory in $S_3$

- Activity includes 10 speakers
- Every speech is lasted 15 minutes
- Participants use their mobile devices
- At the end of the activity, the activity analysis service runs on a separate machine: CPU 2.30GHz, RAM 4Gb, Windows 7

Performance evaluation:

- The average data processing time is $0.72\,\text{s}$
- The average size of a user statistics file is $346\,\text{KB}$
- $3500\,\text{KB}$ of free space is needed on average to store the statistics files on the content service for 10 participants
Conclusion

- Ontological model for collecting and representing the presence information about the dynamic SmartRoom users
- The architecture for the integration the information source on user presence for use in SmartRoom
- Coarse-grained model of user presence state for determining the presence levels
- Experimental evaluation the proposed solutions
- Open source code: http://sourceforge.net/projects/smartroom/services/presence-service

Thank you for attention