Distributed expectation aware implicit context processing
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Motivation

Phase 4:
Feedback is broadcast to the network

Phase 3:
Receiver estimates the phase synchronisation level of the received sum signal

Phase 2:
Source nodes transmit to the destination as a distributed beamformer

Phase 1:
Source nodes adjust their carrier phase offset and frequency randomly
This talk ...

- A sensor seldom considered in Pervasive Computing
  - Available in every WSN device
  - Virtually no energy cost for context acquisition

- A Representation of aggregated context data
  - Compact
  - Tolerant for changing network topology
Case study

- 3 USRP software radios
  - 2.4GHz and 900MHz transceiver boards
  - Network connection between devices

- 3 Situations
  - Person in a room
  - Door opened/closed
  - Phone call
Situation classification

- Features
  - RSSi(t)
  - Mean(RSSi, window size)
  - Count(noise peaks, window size)
  - EnergyIncrease(relevant frequencies)

- k-nearest neighbour
  - Distance between reference vector and current sample

- Experiment
  - After training, situations measured 10 times
Results

## Results:

<table>
<thead>
<tr>
<th>Situation</th>
<th>mean</th>
<th>median</th>
<th>Standard-deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door (opened /closed)</td>
<td>0.952</td>
<td>0.9513</td>
<td>0.0099</td>
</tr>
<tr>
<td>Presence of individual</td>
<td>0.817</td>
<td>0.8238</td>
<td>0.0455</td>
</tr>
<tr>
<td>Phone call (gsm)</td>
<td>0.900</td>
<td>1.0</td>
<td>0.32</td>
</tr>
<tr>
<td>Door opened (cond.: Empty room)</td>
<td>1.0</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Door closed (cond.: Empty room)</td>
<td>1.0</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Door closed (room occupied)</td>
<td>0.832</td>
<td>0.83</td>
<td>0.041</td>
</tr>
<tr>
<td>Door opened (room occupied)</td>
<td>0.976</td>
<td>0.98</td>
<td>0.0184</td>
</tr>
</tbody>
</table>
In-network context processing

- Distributed context processing - assumptions
  - No central node for context aggregation
  - Computational load equally distributed among nodes
  - Minimum overall communication load
  - Robust towards topology changes
In-network context processing

\[ |0\rangle \]
(Initial state)
No modification applied

\[ R_x(5\theta) |0\rangle \]
(Rotation on the x–Axis)
Environmental measurement

\[ R_y(3\theta) |0\rangle \]
(Rotation on the x–Axis)
Environmental measurement

\[ R_z(5\theta) |0\rangle \]
(Rotation on the x–Axis)
Environmental measurement

Context representation

Environmental stimuli
In-network context processing

- Neighbourhood:
  - Not euclidean distance
  - Neighbourhood defined by rotations of participating nodes
  - Standard classification approaches feasible
Discussion

Benefits

- Context processing unambiguous
- Robust to network-topology changes
- Cheap aggregation of contexts via rotation
- Neighbourhood of correlated points straightforward
- Rotation represented by two angles

Issues

- Inverse operation practically impossible
  - Extraction of sensor readings from aggregated rotation expensive
- Higher precision requires more precise angles
Questions?

Thank you.
Context representation for public spaces

- Context processing in public spaces
  - Multiple sensors installed in the environment
  - Sensor measurements utilised by several individuals

- Assumptions
  - No central processing entity
  - Processing load fairly distributed
  - Frequent topology changes
  - Distinct expectations
Situation awareness from a communication channel

- Situations and environmental changes impact channel quality
  - Movement
  - Presence of people
  - Wireless access
  - Movement
  - Opened/closed doors or windows
  - Network size

- Impacts on the channel
  - Noise
  - Interference
  - Signal strength
Bloch sphere representation

- Sensor measurement represented by vector in a bloch sphere
  - Rotations are no multiple of 360°
  - Unique rotation for each sensor
  - No multiple of other sensor’s rotation
  - Sensor measurements encoded in multiples of these rotations

- Context aggregation
  - Context = aggregated rotation
  - Nodes successively apply rotations
  - Resulting vector unique
  - Neighbourhood:
    - Neighbouring rotations