Submission Title: Two-Step Angle-of-Arrival Estimation for Terahertz Communications

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Re: 15-17-0588-00-thz-multifrequency-measurements

Abstract: This contribution presents an AoA estimation algorithm in two steps based on the correlation of power angular spectra (PAS) in different frequencies. A low frequency radio frequency (RF) frontend is applied for a rough and fast AoA estimation in the first step and the THz RF frontend estimates the precise AoA within the angular range confined in the first step to reduce the time consumption of AoA estimation. The correlation of PAS in different frequencies is the premise of the algorithm and is validated with a broadband channel sounder in a typical application scenario of indoor THz communication. Finally, the algorithm efficiency is analyzed with two exemplar scanning resolutions.

Purpose: Information of the IG THz

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Two-Step Angle-of-Arrival Estimation for Terahertz Communications

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The contribution is an extension to [1] and based on [2].
Outline

• Motivation
• Measurement Campaign
• Two-Step Angle-of-Arrival Estimation
• Demonstration
• Conclusions
Motivation

• The alignment of high gain antennas used for 300 GHz links is challenging especially in the device discovery phase during the set-up of the connection.

• Brute-force scanning of the angle-of-arrival at the receiver and of the angle-of-departure at the transmitter is too time-consuming.

• Therefore, a two-step process can be applied, where rough estimations of the angles are derived at lower frequencies with antennas having lower gains in the first step [3].

• A pre-requisite to apply such a method are similarities of the channel at the higher and lower frequencies.

• In [1,2] a comparison of measured spatial channel characteristics at carrier frequencies of 9 GHz, 64 GHz and 304 GHz using an ultra-wideband channel sounder [4] has been provided already. A short summary of these results will be given also in this presentation.
Summary of Results from 15-17-0588-00-thz-multifrequency-measurements [1]
TUBS‘ Time-Domain Channel Sounder

Source [1]
Technical Parameters of the Channel Sounder

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock Frequency</td>
<td>9.22 GHz</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>~ 8 GHz</td>
</tr>
<tr>
<td>Chip duration</td>
<td>108.5 ps</td>
</tr>
<tr>
<td>M-sequence order</td>
<td>12</td>
</tr>
<tr>
<td>Sequence length</td>
<td>4095</td>
</tr>
<tr>
<td>Sequence duration</td>
<td>444.14 ns</td>
</tr>
<tr>
<td>Subsampling factor</td>
<td>128</td>
</tr>
<tr>
<td>Acquisition time for one CIR</td>
<td>56.9 µs</td>
</tr>
<tr>
<td>Measurement Rate</td>
<td>17,590 CIR/s</td>
</tr>
<tr>
<td>Center Frequencies</td>
<td>9.2 / 64.3 / 304.2 GHz</td>
</tr>
<tr>
<td>SISO/MIMO</td>
<td>up to 4x4</td>
</tr>
</tbody>
</table>

Source [1]
Measurement Scenario (Lecture Room)

Source [1]
Measured Power Angular Spectra

Source [1]

Submission

Thomas Kürner, TU Braunschweig
Two-Step Angle-of-Arrival Estimation
Algorithm

Pre-defined searching directions (different resolutions)

Full scan with 5° resolution would require 3,515,625 scans => Speed up by a factor of up to 2,521
Demonstration
Using the Channel Sounder for a Demonstration of the two-step Beam Searching Concept

- Demonstration in a large lecture hall
- Mechanical steerable Rx
- Rx is following received power
  - Step 1: 30° increment at lower frequency
  - Step 2: 5° increment at 300 GHz
Beam Searching „in Action“

Step 2. Beam is found. Estimation accomplished.
Conclusion

- A two-step AoA estimation algorithm, which aims to achieve a balance between precision and estimation time for device discovery at THz communication systems.
- In the first step of the algorithm, rough estimates of AoD and AoA are searched individually at a low frequency band.
- Based on the results, the optimal AoD and AoA combination is estimated with high precision and within the rough region that is found in the first step.
- The algorithm has been demonstrated in a larger lecture room scenario.
References


