Orca

Orchestration and Reconfiguration Control Architecture

SHOWCASE 1

26 GHZ MM-WAVE COMMUNICATION FOR VIDEO STREAMING

GOALS

- Demonstrate the real-time beam tracking functionality for the 26 GHz mmWave antenna arrays of TUD.

- Demonstrate mmWave setup as an experimental support for the development of wireless communication systems in an industrial environment.

- Demonstrate the employment of TUD's multi-user system by allowing more than one sub 6 GHz link.

CHALLENGES

- Real-time beam tracking capability with mmWave frontend. It is necessary to perform the beam steering functionality on the FPGA, in order to guarantee fast beam tracking under the mobility scenario.

- The design of a control loop with low latency for beam tracking.

- The design of mmWave antenna that can be easily attached to any SDR platform.

- Design of a multi-user mechanism to coordinate the links with multiple users.

CONCEPT

We consider a remote-controlled robot moving around the factory hall with a camera attached to it for inspection purposes. The camera is constantly transmitting a live video stream to the AP through the mmWave link. Then, the base station forwards the video to a factory worker located remotely via a second mmWave link. Therefore, the mmWave solution is advantageous in two aspects:

- It uses a novel frequency band allowing more capacity of the network.

- The directivity feature of the electromagnetic waves makes it possible to use several links close to each other using the same time and frequency with very low interference level.

We take advantage of this aspect by employing a second mmWave link as backhaul, where the video is forwarded to the user who is not located in the base station.
In addition, the remote user can steer the robot using a sub 6 GHz link, which makes it possible to thoroughly inspect the production line remotely.

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DEMO SET-UP

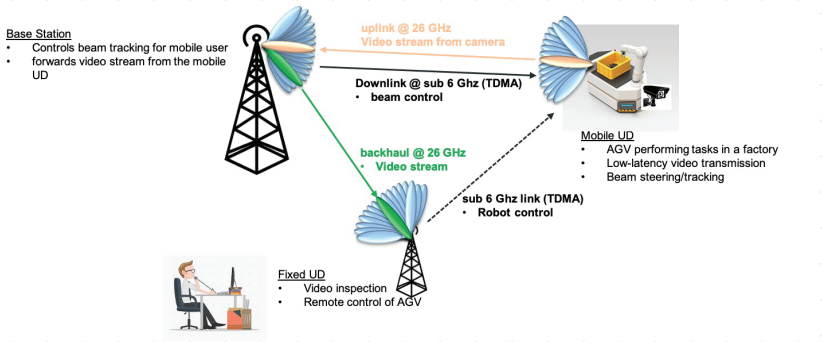
- The demo has three nodes:
1. Base Station (BS)
2. Mobile User Device (UD)
3. Fixed UD

- The mobile UD is an Automated Guided Vehicle (AGV) and sends a video stream to the BS through the mmWave uplink.

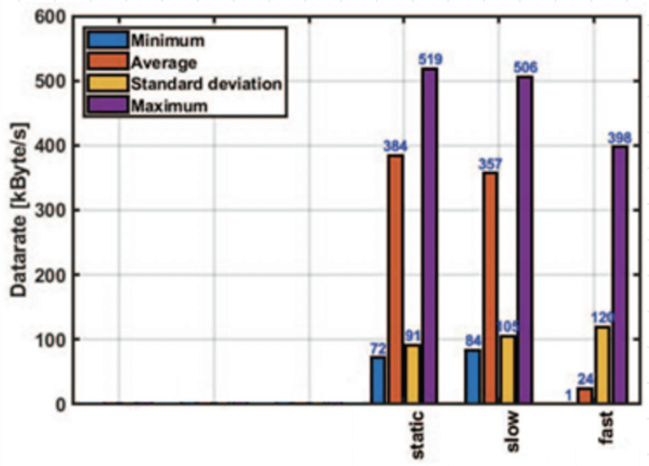
- The video is then forwarded to the Fixed UD using the backhaul mmWave link, for a video inspection application.

- The Fixed UD controls the AGV using a TDMA-based sub 6 GHz link.

- The BS performs the beam tracking algorithm and sends information to the Mobile UD via the TDMA-based sub 6 GHz link.



RESULTS



[1] Martin Danneberg, Roberto Bomfin, Ahmad Nimr, Zhongju Li, Gerhard Fettweis, "USRP-based platform for 26/28 GHz mmWave Experimentation". WCNC 2020 Smart Spectrum Workshop, April 2020, Seoul

This showcase demonstrates the fast beam steering algorithm of TUD. Under the mobility scenario, the system is able to successfully track the best beam pair with a maximum delay of 20ms and minimum delay of 2.5 ms when the best TX beam changes by one beam. In addition, the capacity of the mmWave frequency band is duplicated by reusing a second link with. Additionally, we demonstrate the employment of two sub 6 GHz links operating in TDMA mode.

The figure on the left depicts the measured end-to-end throughput of the mmWave uplink. For the mobility scenarios, we classified 3 cases. Namely, static, slow with 1.1km/hr, and fast with 2.2km/hr, where the beam tracking algorithm has been evaluated and published in [1]. For the low mobility scenario, the throughput loss is very low in comparison to the static case, demonstrating the feasibility of the beam tracking algorithm.
More information about the setup and the open source code are accessible in the TUD's testbed web page http://owl.ifn.et.tu-dresden.de/orca/mmwave26ghz/

INNOVATION

- The 26 GHz antenna arrays, easily integrated to the TUD's GFDM implementation for National Instruments' SDRs.

- A simple beam tracking algorithm can be employed for applications that do not require an ultra-reliable link, e.g., video streaming.

IMPACT

This showcase demonstrates the mmWave transmission for industrial communication using commercial SDR platforms, which opens a variety of possible extensions for future work, including the experimentation of implementations for the mmWave.