6 Channel synchronous SDR-Platform

Daniel Froß*, Ahmad El Assaad†, Marko Rößler*, Ulrich Heinkel*
*Chair for Circuit and System Design
Faculty of Electrical Engineering and Information Technology
Chemnitz University of Technology, Germany
Email: {daniel.fross, marko.roessler, ulrich.heinkel}@etit.tu-chemnitz.de
†Novero GmbH, Research, Nuremberg, Germany
Email: ahmad.el-assaad@novero.com

Many modern applications depend on precise location information. For example vehicle self-localization is a key requirement for the development of advanced driver assistance systems (ADAS) [1]. Radio frequency (RF) based self-localization is one of different techniques used to determine the position in indoor and in outdoor environments [2]. Typically, geometrical algorithms based on the time of arrival (TOA) and the angle of arrival (AOA) of received RF signals are used to estimate the position of a device to a fixed base station or anchor [2]. Typically, uniform linear array (ULA) and uniform circular array (UCA) antennas are connected to a multi-channel receiver, where the AOA can be estimated with advanced digital signal processing in the baseband. Active antennas and transmit beamforming is another way to gain RF based localization information, i.e. applied for passive UHF RFID in [3].

We present a high performance multichannel software defined radio (SDR) platform based on FPGA that allows the quick development and prototyping of respective technology parts. Requirement was to sample allow phase and frequency synchronization across up to six high precision ADC/DAC and stream data from/to the FPGA fabric for parallel data processing. The 6x6 MIMO platform supports three RF-Frontends (AD-FMCOMM-S3) that contain the AD9361 chip from Analog Devices. The adapter PCB features dual FMC connectors (LPC/HPC), allowing for connectivity with the Xilinx ZC706 and KC705 boards.

For self-localization using mobile phone RF (LTE) a samling rate of 50 MSa/s at 12 bit resolution is required, which results in prosessing an initial data stream of 7.2 Gbit/s. Full flexibility is given to algorithmic development by connecting the SDR platform via PCIe 3.0 link at x8 lanes to a performant computing platform running Linux OS. This allows a step whise refinement of the HW/SW partitioning and rapid prototyping of the signal processing chain, i.e. by utilization of the GNU-Radio framework.

Our first use case is to deploy the platform as an on-board unit (OBU) within a vehicle in an infrastructure to vehicle (I2V) setup. The SDR represents the multi-channel receiver required for vehicle self-localization purposes. The presented

This work was supported by the German Federal Ministry of Education and Research within the project "Generalized Platform for Reliability and Verification" under contract number 03 IPT 505 X.

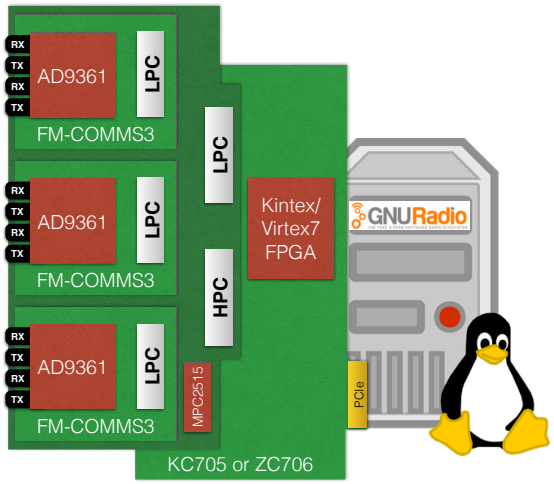

Fig. 1. Software Framework

SDR is connected to a UCA antenna mounted on the rooftop of a vehicle. When RF signals are received from a road side unit (RSU) over a multipath channel, an algorithm for line-of-sight (LOS) extraction is performed, if the LOS signal is available. The AOA of the LOS signal is estimated using the MUltiple SIgnal Classification (MUSIC) algorithm with advanced signal preprocessing[4]. The TOA of the LOS signal is estimated using a cross correlation based method. The vehicle position is estimated in the RSU coordinates system. The localization algorithm on the SDR will be extended in future work to handle non-line-of-sight (NLOS) propagations.

REFERENCES

[1] Bengler, K.; Dietmayer, K.; Farber, B.; Maurer, M.; Stiller, C.; Winner, H., "Three Decades of Driver Assistance Systems: Review and Future Perspectives," in Intelligent Transportation Systems Magazine, IEEE , vol.6, no.4, pp.6-22,

[2] Gustafsson, F.; Gunnarsson, F., "Mobile positioning using wireless networks: possibilities and fundamental limitations based on available wireless network measurements," in Signal Processing Magazine, IEEE , vol.22, no.4, pp.41-53, July 2005

[3] Cremer, M.; Pervez, A.; Dettmar, U.; Hudasch, C.; Kronberger, R.; Lerche, R., "Multichannel digital transmit beamforming experiments for RFID tag localization," in RFID Technology (EURFID), 2015 International EURASIP Workshop on , vol., no., pp.126-131, 22-23 Oct. 2015

[4] Schmidt, R.O., "Multiple emitter location and signal parameter estimation," in Antennas and Propagation, IEEE Transactions on , vol.34, no.3, pp.276-280, Mar 1986