Measuring electromagnetic signals in traffic using software-defined radio

Peter Miklavčič[1], Belma Šestan[1], Nikola Latković[1], Hana Lozej[2], Robert Magdič[2], Matevž Moljk[2], Miha Vardijan[2], Jakob Gajšek[3], Kristina Petelin[3], Tomaž Sindičič[3]

Matej Bažec[2], Marko Gombač[4], Peter Gajšek[5], Boštjan Batagelj[1], Franc Dimc[2]

[1]Fakulteta za elektrotehniko Univerze v Ljubljani, Tržaška 25, 1000 Ljubljana, Slovenija
[2]Fakulteta za pomorstvo in promet Univerze v Ljubljani, Pot pomorščakov 4, 6320 Portorož, Slovenija
[3]Medicinska fakulteta Univerze v Ljubljani, Vrazov trg 2, 1104 Ljubljana, Slovenija
[4]Result d.o.o., Celovška cesta 182, 1000 Ljubljana, Slovenija
[5]Inštitut za neionizirajoča sevanja (INIS), Pohorskega bataljona 215, 1000 Ljubljana, Slovenija
E-mail: franc.dimc@fpp.uni-lj.si

1 Introduction

The main purpose of our project was to develop an inexpensive proof-of-concept device for measuring RF signals using software-defined radio in transport, meaning mobile operation was also required. We also tested an experimental application to detect the GPS jammers and used four such devices on Slovenian roads.

2 Theory

As the Wikipedia firmly defines: *Software-defined radio (SDR) is a radio communication system where components that have been typically implemented in hardware (e.g. mixers, filters, amplifiers, modulators/demodulators, detectors, etc.) are instead implemented by means of software on a personal computer or embedded system.*[1]

SDR is therefore useful for DSP of RF signals, which allows for many practical applications everywhere, including in transport, where GPS signals are one of the most important ones. GPS signals are multiplexed with CDMA, which gives them typical wide (spread) spectrum. But the commercially available GPS jamming devices are mainly narrowband (FHSS-like) and thus easily detectable by software algorithms.

3 Hardware

The device consists of a Raspberry Pi board (any version and any edition), powered with a 5V (min. ~1,5A) source. Two power sources are applicable and were tested for usage in the transport; a car charger or a car battery. The latter also needed an additional electronic circuit for voltage stepping and stabilization, which also provided an interrupt signal to the Raspberry Pi when the battery level was critically low. An RTL-SDR (DVB-T dongle) and a GPS receiver were also connected to the USB ports provided by Raspberry Pi.

RTL-SDR was identified as a very interesting device needing additional exploration. For ~10€ a wideband SDR can be obtained by using the right DVB-T dongle with the right drivers. A few RTL-SDR dongles were then thoroughly tested and analysed, rendering similar results as previously published[2,3,4].

4 Software

Raspberry Pi was running a Raspbian (Debian) OS v2015-05-05 with the RTL-SDR driver package *rtl-sdr* v0.5.3 from the *keenerd*'s branch[5]. The detection logic and logging was implemented by using the customized Python script *freqwatch* and a few smaller shell scripts.

5 Results

The results of the different student groups within the project are presented on the accompanying poster.

Acknowledgement

Projekt delno financira Evropska unija iz Evropskega socialnega sklada. Projekt se izvaja v okviru Operativnega programa razvoja človeških virov za obdobje 2007-2013, 1. razvojne prioritete »Spodbujanje podjetništva in prilagodljivosti« ter prednostne usmeritve 1.3: »Štipendijske sheme«, v okviru potrjene operacije »Po kreativni poti do praktičnega znanja«.

References

[1]https://en.wikipedia.org/wiki/Software-defined_radio
[2]http://f6fvy.free.fr/rtl_sdr/Some_Measurements_on_E4000_and_R820_Tuners.pdf
[3]http://superkuh.com/rtlsdr.html
[4]http://sterrenwachtleeuwarden.nl/documenten/rtl_R820T2%281%29.pdf
[5]https://github.com/keenerd/rtl-sdr