dxRadar: using a PC for TA DX

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Introduction

Inspired by an article [1] in MW News, I have made a computer program for unattended DXing. The idea is to have the computer searching the mediumwave band for TA carriers and, to record audio from the stronger signals in the night while you sleep. One can then listen to the recordings at a comfortable time of day. The main advantage is that this way one can monitor the mediumwave band every night, which very few, if any, people can do in person.   Furthermore one can specify under which conditions the program will record audio on a TA channel, which is an improvement over unattended recordings made on a fixed channel.

The program, called dxRadar, grew out of a program which was intended to identify non-directional beacons on longwave. It consists of about 8000 lines of C++ code having accumulated in the last two years plus some simple Perl scripts for off-line data analysis. dxRadar brings together three approaches: unattended recording on TA channels, monitoring TA channels for carriers [1], and measuring the frequency of TA carriers with high precision. This means that one can resolve different stations on one TA channel in which the carrier frequency differs by as little as 2 Hz. According to Nick Hall-Patch, using exact frequency of carriers to identify stations was first pioneered in the 70s and 80s in America [2].

Description of Setup

Figure 1 shows the setup I am using. It consists of a large indoor tuned loop antenna and an AOR AR7030 receiver.   The computer controls the receiver via the serial port and reads the audio signal using a sound card. It also tunes the loop antenna by means of a computer controlled stepper motor (using a parallel port to I2C bus adaptor and two standard IC's talking to the stepper motor) driving the loop antenna's variable capacitor. Using a 200 step stepper motor with a one and a half turn variable capacitor gives 300 steps to cover the mediumwave band. The program is also capable of 'calibrating' the loop antenna by finding the position with maximal signal strength for some (European) channels throughout the mediumwave band. Of course, this is done best under daylight conditions.

Mode of operation

The program continuously goes through the mediumwave band searching for carriers. In one sweep, the dxRadar software performs the following tasks:

1. tunes the receiver and loop antenna in LSB (USB) mode 400Hz above (under) the given TA channel
2. records about two seconds of audio
3. performs a spectral analysis on the recorded sound samples (8000Hz sampling rate,   8*1024 point FFT, and 1Hz resolution)
4. searches for peaks in the spectrum (i.e. a peak at 410Hz corresponds to a carrier 10 Hz off-channel) and writes the data to a file.

5.   then it goes back to item 1, until all TA channels have been worked.

This takes about two minutes. Hence one is able to sample the status of all TA channels with two minutes temporal resolution. I would like to add that there is a trade-off between frequency and temporal resolution since one has to sample at least one full period of an audio signal one wants to measure. Doubling frequency resolution, for example, means that one sweep lasts four minutes.

In general, the program will detect lots of peaks, most of which are not real carriers but are caused by splatter or by other noise. Since these signals are very short-lived, a very effective way to reject them is to require a given peak to appear in four consecutive sweeps. The signals that are then left are either TA carriers or carriers of navigational beacons. If the program finds more than 10 'real' carriers, it tunes the receiver and antenna to the channel with the strongest signal and launches the RealAudio recorder to record two minutes of audio on this channel.

Data analysis

The program has been running almost every night since February 2002, and I have logged several stations by listening 'offline' to the RealAudio files made in the night. Figure 3 displays the seasonal variation of reception times, showing local sunrise, time of peak reception and fadeout, while Figure 4 shows maximum number of carriers by date along with the variation of the A-index.
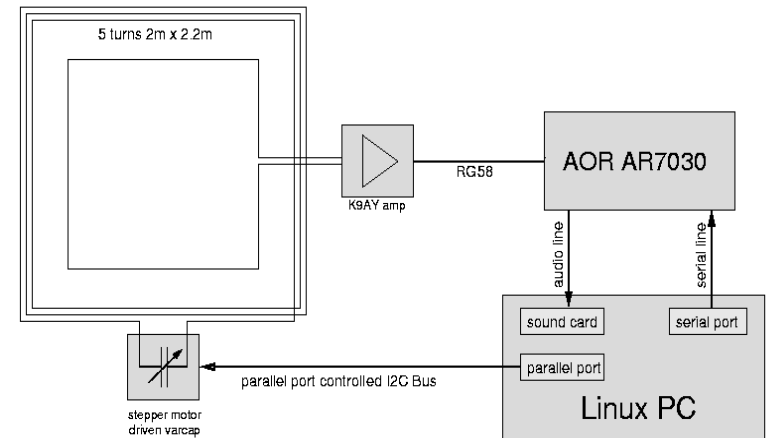

One can see that the peak of TA reception occurs close to local sunrise in winter and up to one hour before local sunrise in summer.

Figure 1: The Setup

A word of caution with Figure 3 is in order. The bottom figure shows data obtained with different versions of the program. For example I have improved the frequency resolution from 5Hz down to 1Hz recently and also the stepper motor is a recent improvement. Both changes increase the number of carriers seen by the program.

The waterfall plots (Figure 2) display the activity on two TA channels from a number of nights. More precisely, they show the superposition of data from several nights. Each point is a peak found by the program in the audio spectrum. One can clearly distinguish several carriers on each channel. It should be noted that most signals on the plots were too weak to yield an intelligible audio signal.

Moreover, one can see in Figure 2 that the receiver's frequency stability is sufficient for this
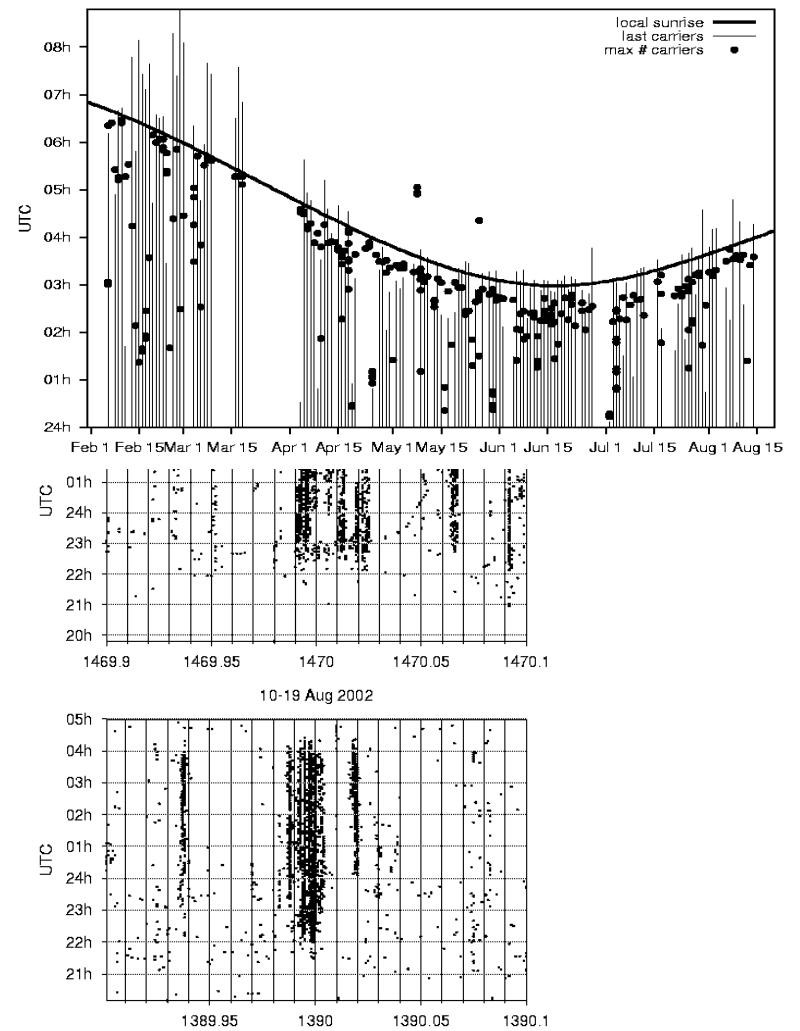
purpose, even when one compares signals from different nights. For similar plots see [3]. Once one has identified a station 'by ear' on a particular frequency one can recognize it in the data later on, e.g. WWZN is on 1510.017 kHz, VOCM on 590.005 kHz, CPN Radio on 1469.994 kHz, CKEC on 1320.01 kHz, WEGP on 1390.02 kHz etc . . .

For more plots and data see [4]. Any comments and suggestions are welcome. Also, I am willing to share the code with other people, of course only for non-profit uses. Just contact me by email. It would be nice if other members used this method. For instance, one could then in detail compare TA reception between different locations in Europe.

Figure 2: Waterfall plots

Figure 3: seasonal variation of peak reception time
Figure 4: maximum number of carriers compared with A-index
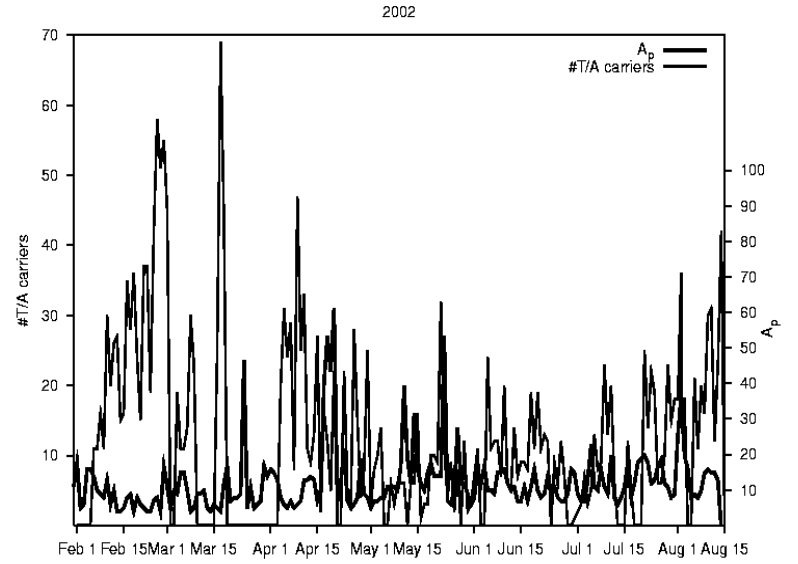
References

[1] Nick Hall-Patch in MWN 45/06, 45/07 (also DXM Vol.37 #5 and 6 .)
[2] Nick Hall-Patch on the [mwc] mailing list.
[3] http://www.dxradio.co.uk/mwoffsets
[4] http://www.tpi.uni-jena.de/_chm/main.html

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