

Claims

What is claimed is:

1. A radar device comprising:
 - a transmitter configured to transmit a first transmit signal and, after the first transmit signal, a second transmit signal, wherein the first transmit signal comprises at least a part of a preamble of a communication packet,
 - a receiver; and
 - a radar processor configured to
 - convolve a first receive signal received by the receiver with the first transmit signal and to generate a first delay-Doppler map, comprising, for each delay-Doppler bin of a set of delay-Doppler bins, a radar response value, from the result of the convolution of the first receive signal with the first transmit signal;
 - convolve a second receive signal received by the receiver with the second transmit signal and to generate a second delay-Doppler map, comprising, for each delay-Doppler bin of the set of delay-Doppler bins, a radar response value, from the result of the convolution of the second receive signal with the second transmit signal;
 - combine the first delay-Doppler map with the second delay-Doppler map by taking, for each delay-Doppler map bin of the set of delay-Doppler bins, the minimum of the value of the first delay-Doppler map for the delay-Doppler map bin and the value of the second delay-Doppler map for the delay-Doppler map bin; and
 - determine a range and a velocity of one or more objects from the result of the combination.
2. The radar device of claim 1, wherein the communication packet is a physical layer radio transmission frame.

3. The radar device of claim 1 or 2, wherein the at least a part of the preamble is a first part of the preamble and wherein the second transmit signal comprises a second part of the preamble or wherein the second transmit signal comprises at least a part of the payload data of the communication packet.
4. The radar device of any one of claims 1 to 3, wherein the first transmit signal and the second transmit signal comprise a complementary pair of a Golay complementary code.
5. The radar device of any one of claims 1 to 4, wherein the transmitter is configured to transmit the first transmit signal by single-carrier transmission and to transmit the second transmit signal by multi-carrier transmission, in particular by Orthogonal Frequency Division Multiplexing, wherein the at least a part of the preamble is a first part of the preamble and wherein the second transmit signal comprises a second part of the preamble.
6. The radar device of any one of claims 1 to 4, wherein the transmitter is configured to transmit the first transmit signal by single-carrier transmission and to transmit the second transmit signal by single-carrier transmission, wherein the second transmit signal comprises at least a part of the payload data of the communication packet.
7. The radar device of any one of claims 1 to 6, wherein the transmitter is configured to transmit a plurality of first transmit signals and the radar processor is configured to convolve, for each first transmit signal, a respective first receive signal of a plurality of first receive signals with the first transmit signal and to generate the first delay-Doppler map by combining, per delay-Doppler bin, the results of the convolutions of the first receive signals with the first transmit signals.

8. The radar device of any one of claims 1 to 7, wherein the transmitter is configured to transmit a plurality of second transmit signals and the radar processor is configured to convolve, for each second transmit signal, a respective second receive signal of a plurality of second receive signals with the second transmit signal and to generate the second delay-Doppler map by combining, per delay-Doppler bin, the results of the convolutions of the second receive signals with the second transmit signals.
9. The radar device of any one of claims 1 to 8, wherein the combination of the first delay-Doppler map with the second delay-Doppler map gives a combined delay-Doppler map, wherein the transmitter is configured to transmit, after the second transmit signal, a third transmit signal and wherein the radar processor is configured to
 - convolve a third receive signal received by the receiver with the third transmit signal and to generate a third delay-Doppler map, comprising, for each delay-Doppler bin of the set of delay-Doppler bins, a radar response value, from the result of the convolution of the third receive signal with the third transmit signal;
 - combine the combined delay-Doppler map with the third delay-Doppler map by taking, for each delay-Doppler map bin of the set of delay-Doppler bins, the minimum of the value of the combined delay-Doppler map for the delay-Doppler map bin and the minimum of the value of the third delay-Doppler map for the delay-Doppler map bin and
 - determine a range and a velocity of one or more objects from the result of the combination of the combined delay-Doppler map with the third delay-Doppler map.
10. The radar device of claim 9, wherein the first transmit signal is at least a part of a preamble of a physical layer radio transmission frame, the second transmit signal is at least a part of the preamble of a physical layer radio transmission frame and

the third transmit signal is at least a part of the payload data of the physical layer radio transmission frame.

11. The radar device of any one of claims 1 to 10,
wherein the combination of the first delay-Doppler map with the second delay-Doppler map gives a combined delay-Doppler map, wherein the transmitter is configured to transmit, after the second transmit signal, a sequence of third transmit signals and wherein the radar processor is configured to generate, starting from the combined delay-Doppler map and until a final delay Doppler map, a sequence of delay-Doppler maps by,
 - for each third transmit signal,
 - convolving the third receive signal received by the receiver with the third transmit signal and generating a respective third delay-Doppler map,
 - comprising, for each delay-Doppler bin of the set of delay-Doppler bins, a radar response value, from the result of the convolution of the third receive signal with the third transmit signal and generating a respective delay-Doppler map for the sequence by combining the delay-Doppler map which is currently the last delay-Doppler map of the sequence with the third delay-Doppler map by taking, for each delay-Doppler map bin of the set of delay-Doppler bins, the minimum of the value of the combined delay-Doppler map for the delay-Doppler map bin and the minimum of the value of the third delay-Doppler map for the delay-Doppler map bin;
 - andto determine the range and velocity of one or more objects from the final delay-Doppler map of the sequence .
12. The radar device of claim 11, wherein the first transmit signal is at least a part of a preamble of a physical layer radio transmission frame, the second transmit signal is at least a part of the preamble of the physical layer radio transmission frame and the third transmit signals are consecutive segments of the payload data of the physical layer radio transmission frame.

13. A method for performing radar detection comprising:
 - transmitting a first transmit signal, wherein the first transmit signal comprises at least a part of a preamble of a communication packet;
 - transmitting a second transmit signal after the first transmit signal;
 - receiving a first receive signal;
 - receiving a second receive signal;
 - convolving the first receive signal with the first transmit signal and generating a first delay-Doppler map, comprising, for each delay-Doppler bin of a set of delay-Doppler bins, a radar response value, from the result of the convolution of the first receive signal with the first transmit signal;
 - convolving the second receive signal with the second transmit signal and generating a second delay-Doppler map, comprising, for each delay-Doppler bin of the set of delay-Doppler bins, a radar response value, from the result of the convolution of the second receive signal with the second transmit signal;
 - combining the first delay-Doppler map with the second delay-Doppler map by taking, for each delay-Doppler map bin of the set of delay-Doppler bins, the minimum of the value of the first delay-Doppler map for the delay-Doppler map bin and the value of the second delay-Doppler map for the delay-Doppler map bin; and
 - determining a range and a velocity of one or more objects from the result of the combination.
14. The method of claim 13, wherein the combination of the first delay-Doppler map with the second delay-Doppler map gives a combined delay-Doppler map, and the method comprises:
 - transmitting a third transmit signal after the second transmit signal;
 - receiving a third receive signal;
 - convolving the third receive signal with the third transmit signal and generating a third delay-Doppler map, comprising, for each delay-Doppler bin of the set of

delay-Doppler bins, a radar response value, from the result of the convolution of the third receive signal with the third transmit signal;
combining the combined delay-Doppler map with the third delay-Doppler map by taking, for each delay-Doppler map bin of the set of delay-Doppler bins, the minimum of the value of the combined delay-Doppler map for the delay-Doppler map bin and the minimum of the value of the third delay-Doppler map for the delay-Doppler map bin; and
determining a range and a velocity of one or more objects from the result of the combination of the combined delay-Doppler map with the third delay-Doppler map.

15. The method of claim 14, wherein the first transmit signal is at least a part of a preamble of a physical layer radio transmission frame, the second transmit signal is at least a part of the preamble of a physical layer radio transmission frame and the third transmit signal is at least a part of the payload data of the physical layer radio transmission frame.
16. A computer program element comprising program instructions, which, when executed by one or more processors, cause the one or more processors to perform the method of any one of claims 13 to 15.