Object Recognation with Surveillance Radar Systems

Gun Sergiy

Abstract - **In this thesis have written description and principle of radar systems and them classification. As well as radar systems are used where and for what. The most optimal signal transmission and principles of systems in general**

Keywords - **radar system, Doppler, EM Wave, signal, transmission.**

I. INTRODUCTION

The radar system is designed for radar surveillance of the perimeter and area, detection of moving targets, measuring their coordinates and speed of recognition class and auto-tracking of detected objects. Intensive research began in the 1930s with the aim of using radar techniques for military applications.

II. MAIN PRINCIPLE OF RADAR SYSTEMS

In principle a radar system emits an electromagnetic *(EM)* wave into free space and "listens" for its echo. If an object is within the radar system's beam, a current is induced, generating an EM-field itself. From this EM-field, called scattering field, an EM-wave is reradiated in all directions.

A small segment of the scattering field is directed back to the radar system. The measured time delay between the transmitted and received wave (T_R). based on two-way propagation, can be used to calculate the range to the object *(R)* to

$$R = \frac{c \cdot T_R}{2} \tag{1}$$

The detection range of a radar system depends on many different factors which are related to each other by the radar equation. A simple form of the radar equation can be derived to

$$R = \left(\frac{P_{T\mathrm{x}} \cdot A_e^2 \cdot \sigma}{4 \cdot \pi \cdot \gamma^2 \cdot S_{\min}} \right)^{1/4} \tag{2}$$

List of symbols and the corresponding frequency range and scope of their use was officially standardized by the Institute of Electrical and Electronic Engineering *(IEEE)* in IEEE Std 521-2002.

Radar systems have been developed for many different applications. So they can be classified based on their functionality. According to Skolnik (2001) one of the ways of classifying radar systems is based on the signals they utilize.

Continuous Wave *(CW)* radar systems continuously emit an EM-wave and use separate transmit and receive antennas. Their main applications are velocity measurement (e.g., police radar speed gun) and object tracking.

Pulsed Radar *(PR)* systems transmit then signals in form of trains of pulses. A single pulse is of the width t_P and the time between two following pulses is T_P , which is often also referred to as the Pulse Repetition Interval *(PRI)*. If the PRF is too high, an echo from a long-range object might arrive after the transmission of and be mistakenly associated with the next pulse. These multiple-time-around echoes can result in an ambiguous range measurement.

If the PRF is too low, range ambiguities can be avoided, but therefore ambiguous Doppler (velocity) measurements occur.

After a brief introduction to pattern recognition systems four different classifiers have been introduced. While all introduced classifiers are suitable for classification of radar range profiles in general, they show very different results in performance and accuracy. Only SVMs, which have poor performance but achieve good accuracy, were discussed and the DWT was presented as a possibility to further improve performance and accuracy in classification of radar range profiles.

There have been many studies of radar surveillance systems and only the combination of linear frequency intrapulse modulation and Costas-ordered stepped-frequency interpulse modulation not only achieved the desired range resolution but brings with it the advantages of being easy to implement, introducing a random-like signal component, and achieving good time sidelobe levels.

III. CONCLUSION

So in the assumed surveillance radar system an object classification capability can be enabled by coordinating the radar band local oscillator, as source for the Costas-ordered stepped-frequency interpulse modulation, with the direct digital synthesizer, as source for the linear frequency intrapulse modulation, via the radar processor without additional costs. The way ahead will have to focus on the receive channel, on the pattern recognition system in particular. Independent of its implementation additional memory will be needed. Today memory for digital systems is available in many different forms as cost-efficient mass product. For that memory can be assumed to raise the costs for a classification capability only moderately.

As for the pattern recognition system itself, the way of how recorded high-resolution radar range profiles will be stored within and based on what classification algorithm algorithms will be used will have great influence on the overall performance of object classification. It would also be interesting to see if it would be beneficiary to the signal-to-noise ration to process the effective bandwidth of two burst of the proposed radar signal and then use an additional decompression level in the support vector machine of the pattern classification system.

REFERENCES

[1] Costas. John P.: *A Study of a Class of Detection Waveforms Having Nearly Idea! Range-Doppler Ambiguity Properties.* Proc. of the IEEE, Vol. 72. No. 8, pp. 996-1009. August 1984. H

[2] Skohiik, Merrill I.: *Introduction to Radar Systems.* 3rd ed.. New York; Chicago: McGraw Hill, 2001.

Gun Sergiy - National Technical University of Ukraine "KPI" ,
Peremogy Av., 37, Kyiv, 03148, Ukraine,
E-mail: molotovgun@ukr.net