APPLICATION OF DIGITAL SIGNAL PROCESSING IN RADAR: A STUDY

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ABSTRACT
Nowadays, most of the electronic devices used Digital Signal Processing (DSP). This paper discussed the block diagram, radar detection, implementation of a convolution, Doppler processing, scanning, compression and filtering that been used in the applications of DSP in Radar purposes.

Keywords–*Digital Signal Processing (DSP), Filter, Pulse, Radar, System*

I. INTRODUCTION

Radar is a system for detecting an object in which radio waves are used to determine the range, altitude, direction, or speed of the object. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather and terrain. Radar dish or antenna sends pulses of radio waves that bounce or microwaves any object in their path. In some countries before and during World War II, radar was developed secretly. In 1940, the United States Navy, created the term RADAR as an acronym for Radio Detection and Ranging.

Flexibility and diversity of digital techniques developed in the signal processing front and with the integrated digital circuits, high-speed signal processing has been developed and realized. Radar continued to grow in recent years to take care of future expansion in mind and with a better digital capability. Contribute significantly to the DSP in radar signal processing has to be in, automatic detection and extraction of signal, image reconstruction, and others. In this paper, an attempt was made to identify the contribution of DSP in progress Radar. [1]

Radar has been used in air traffic control, radar astronomy, air defense systems, antimissile systems; marine radar to detect landmarks and other ships; aircraft anti-collision system; ocean surveillance systems, surveillance systems and meeting space; monitoring of meteorological precipitation; altimetry and flight control systems; guided missile targets across the system; and ground-penetrating radar for geological observations. From high noise levels of high-tech radar systems are associated with digital signal processing it is capable of extracting useful information.

Other radar systems that used portions of the electromagnetic spectrum is "LiDAR", which is uses a visible light from lasers of radio waves..

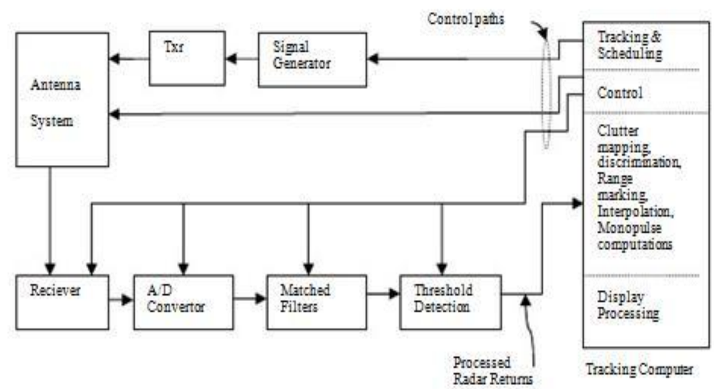

Fig. 1 Block diagram of Radar [2]

Figure 1 above shows the block diagram of radar. The main components of radar are antenna, computer and signals scanning. The functions of computer are to scan the performance of all function. [2].

II. RADAR SYSTEM

Detection is the process in which the presence of the target is detected in front of competing signs arising from the background echoes (clutter), atmospheric noise, or noise generated in the radar receiver. Noise power present at the output of the radar receiver can be reduced by using filters, the frequency response function maximizes output peak-signal-to-noise means (power) is called the matched filter. This paper discusses application of digital filters for matched filtering.

Convolution implementation:

Dual pipeline FFT Filter matched with these convolution systems, FFTs is channel signal and both origin-r FFTs forward and backward is implemented in hardware. Early recordings were used to input buffer (IB) memory and it took 'N / R' n clock pulses to read the data points and rails input 'r'. Total time 'N / R' is called an epoch. It takes three days for the first data really is filtered and sent through a period thereafter. FFT system dual arbitrary data is filtered sequentially by reference function arbitrarily selected from reference memory. The weakness in many applications the same set of data is filtered with a different filter, in this case only one change made to the front followed by some inverse transform, it is possible to eliminate one pipeline FFTs. This is desirable because it will save a large amount of hardware.

Doppler processing:

Doppler processing is used to filter out the clutter and thereby exposing the moving targets quickly. As implemented in digital filters, FFT, or a set of horizontal filters. Cancellers and some optimized method is part of the clutter rejection technique:

1) Canceller

Clutter rejection filters of FIR digital filter design with pass bands to reject creasing frequency components. Simple filter is Chancellor of two pulses. [3]

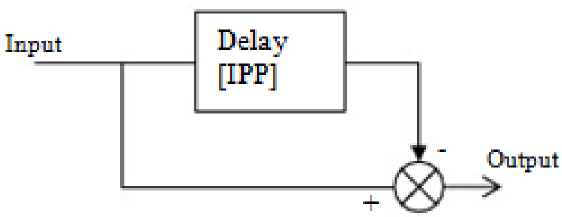

Fig. 2 Canceller filter

Practically, the clutter power spectrum includes frequencies above DC. Two pulse barriers will weaken the low-frequency components but not altogether reject clutter. A three-pulse barrier with equivalent functions change with FIR filter attenuates the components near DC.

Scanning Application:

The processor optimized for pulsed, forming waves on non-coherent n pulses are square law detectors followed by pulse non-coherent integrator using the same weighting each pulse is detected. Integrators must not only be realized in a practical sense but also:

(i) provides a possible small loss detection
(ii) provides a way to reduce the losses associated with the sample window integration and straddle beam scanning of the target

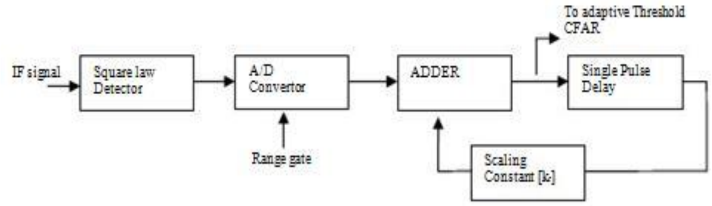

Fig. 3 Square law detector

Figure 3 above shows that the square law implementation. Integrators which are commonly used are sliding windows and require data storage for an inter-pulse period. Single-loop processor data storage required for a single inter-pulse period. Of course, if the data memory somehow limited and if acceptable performance feedback approach is preferred and a single feedback loop is shown above. [3].

Radar equation:

The power P_r returning to the receiving antenna is given by the equation: [4]

$$P_r = \frac{P_t G_t A_r \sigma F^4}{(4\pi)^2 R_t^2 R_r^2} \qquad [1]$$

Where

- P_t = transmitter power
- G_t = gain of the transmitting antenna
- A_r = effective aperture (area) of the receiving antenna
- σ = radar cross section, or scattering coefficient, of the target
- F = pattern propagation factor
- R_t = distance from the transmitter to the target
- R_r = distance from the target to the receiver.

In the common case where the transmitter and the receiver are at the same location, $R_t = R_r$ and the term $R_t^2 R_r^2$ can be replaced by R^4, where R is the range. These yields:

$$P_r = \frac{P_t G_t A_r \sigma F^4}{(4\pi)^2 R^4}. \qquad [2]$$

This shows that the received power declines as the fourth power of the range, which means that power is seen from distant targets is very small. Additional filtering and integration pulse radar slightly modify the equation for the performance of pulse-Doppler radar, which can be used to increase the detection range and reduce the sender power. The above equation with F = 1 is a simplification for vacuum without interference delivery. Factors contributing spread multipath and shadowing effects and depend on environmental information. In a real world situation, path loss effects should also be considered. [4]

Digital compression:

Pulse compression is a signal processing that is mostly done digitally in the radar system. However, many systems still exist with analog-delay line pulse compressor. In this system, the analog pulse compression is done at IF, followed by ADC in the processing chain. Digital pulse compression system, ADC preceded pulse compressor and only need to accommodate a variety of dynamic pre-compression signal, which can be much lower requirements. Digital signal is converted to baseband and passed to a digital pulse compressor. Increase dynamic range for pulse compression gain adjusted to improve the number of bits in the digital computation

Digital filter:

Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filter. Figure 4 shows a block diagram drawn from direct form FIR digital filter types. Sample input feeds a shift register, where each block is labeled t indicates a slow one sample shift register. Sample input and output each stage of the transition data aggregated by unique coefficient, and output is the sum added to create a filtered output. software tools exist to generate these coefficients and the amount needed when the user gives the desired characteristics of the filter, such as filter type (amplitude, Caesura, band pass, and so on. sample rate, cut and stop band frequency, pass band ripple is desired, and stop band attenuation.

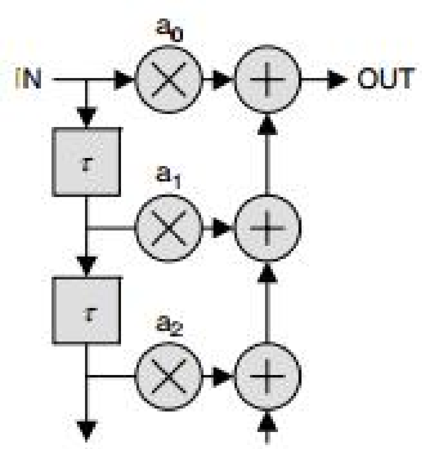

Fig. 4Block diagram of FIR filter

III. DISCUSSION

Radar system is so many relationships with digital signal processing (DSP). There are some improvements that can be translated to the system in order to create better results. First, the detection range must be increased; the input signal should not restrict the value of a lot more to achieve accurate results. In order to detect smaller velocity and a higher range, adequate sampling rate that to be used is essential. Algorithm seeks to optimize the search for the velocity analysis to provide a more accurate performance. Finally, a system that is designed to send a signal to the RADAR one, and also simulated signal back to an object some distance or moving at a certain velocity has been successfully studied. Many objects that are relatively close and far managed to be seen and the velocity of a moving object can be quickly calculated properly.

IV. CONCLUSION

In this paper, the digital signal processing applications in radar briefly overview is presented. Implementation of matched filter, echo cancellers and automatic detection and detection are discussed in separate sections. In most models, the Fast Fourier transform is a technique commonly used to analyze and filter the digital signal. The case study conducted on synthetic Radar System Aircraft Landing Vision bad weather. Different techniques target detection in foliage discussed for radar. Currently progress in digital signal processing the information signal that is summed with many other algorithms to present latest perspective dates and can be implemented in Digital Signal Processing as they flexibility and the ability to achieve high precisions.

V. ACKNOWLEGMENT

We are grateful to Centre for Telecommunication Research and Innovation (CeTRI) and UniversitiTeknikal Malaysia Melaka (UTeM) through PJP/2013/FKEKK (29C)/S01215 for their kind and help for supporting financially and supplying the electronic components and giving their laboratory facility to complete this study.

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