APPLICATION OF MODIFIED FAST CHIRP FOURIER TRANSFORM FOR ISAR IMAGING WITH WIDEBAND RADAR

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Abstract: In this research, a new approach called as Modified Fast Chirp Fourier Transform is used to demonstrate ISAR imaging across a broad frequency range (MFCFT). Radar imaging is often carried out at frequencies ranging from 1 to 8 GHz in the L, S, and C bands, respectively. When imaging a target in the 1-40GHz range, it is important to scan the object at a wideband frequency, which is occasionally required. It is shown in this study that ISAR imaging can be performed for broad (1- 40GHz) frequencies. In this range of frequencies, conventional imaging techniques such as RD and RID fail to reproduce pictures with sufficient resolution, but the suggested approach reproduces images with excellent resolution throughout a broad range of frequencies.

Keywords: ISAR, Radar System, MFCFT.

I. INTRODUCTION

Infrared scanning radar (ISAR) is a high-resolution Radar imaging technique that creates pictures of excellent quality in a two-dimensional plane [1]. The RD approach is the fundamental way of ISAR imaging. It is employed for targets that are rotating smoothly and where the phase of the return echo is assumed to be constant. When dealing with moving targets, the RID approach is used, in which the phase of the echo signal is supposed to be quadratic [2]. When dealing with targets that have very complicated movements like as pitch, roll, and yaw, the Range Instataneous Chirp (RIC) approach is utilised, in which the phase is regarded to be cubic chirp. The existence of the RIC approach is owing to the failure of the previously mentioned methods in the presence of cubic phase terms. In the RD technique, the fast Fourier transform is employed to process the echo signal in order to recreate a 2D picture, but in the RID method, time frequency transforms[4], such as the Short Time Fourier Transform (STFT) [5] and the Gabor transform [6], are utilised to process the signal. The Modified Wigner Ville distribution [8, the Product High-Order Matched-Phase Transform [9], the Product Generalized Cubic Phase Function [10], the TC Dechirp technique [11], the Discrete Chirp Fourier Transform and the Modified Discrete Chirp Fourier Transform [12] are all examples of algorithms that have been developed. When using the RIC technique, a new approach known as MFCFT is utilised to analyse the echo signal and generate a 2D picture, which is called the RIC method.

II. WIDEBAND RADAR

Radar imaging is often performed at microwave frequencies (L, S, C, X, Ku, K, and Ka), which are typically in the 1- 40GHz frequency range. Previously, ISAR imaging was accomplished by selecting just one frequency from this range for all of the techniques mentioned above. In this study, the ISAR imaging for cubic chirp signals utilising the suggested approach is accomplished for wideband frequencies in the 1- 40GHz range, and the superiority of this algorithm over STFT and Gabor transform is shown by comparison with these other algorithms. Specifically, in the case of Range Instantaneous Doppler (RID), in which the received echo includes quadratic phase terms, the imaging is done solely at the frequencies of the L, S, and C bands. When done in this frequency range (1-8 GHz), all of the pictures created using the Gabor transform and STFT are found to be of high quality. The RD and RID approaches fail to replicate high-resolution pictures when the frequency range is expanded to higher ranges such as (X, Ku, K, Ka), and the images become fuzzy. In the case of MFCFT, on the other hand, high-resolution pictures are replicated over the whole frequency

range (1- 40GHz). The findings are addressed in further detail in the next section.

III. SIMULATION RESULTS

Utilizing MATLAB software, the simulation is carried out for a ship target that has been designed with 13 scattering sites, as seen in Figure 2. The amplitudes of all of the scatters are the same (assumed). Using the suggested method, MFCFT, for a variety of frequencies, we may achieve the following results: (1-40GHz). In addition, a comparison is made between the STFT, the Gabor transform, and the MFCFT, such that the superiority of the MFCFT over the STFT and the Gabor transform can be clearly seen in the acquired data.

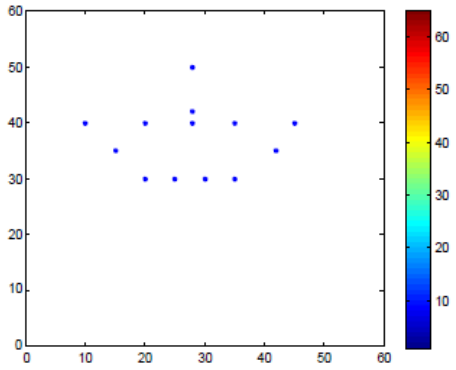

Fig.2. Simulated ship with 13 scatters

Fig.3, represents ISAR imaging using STFT, Gabor and MFCFT respectively for a frequency of 3GHz. In Fig.3, the hot spots are identified but the image is not having high resolution. In case of Fig.3, all the hot spots are clearly identified and in Fig.3, all scatters are identified and image is having a high resolution.

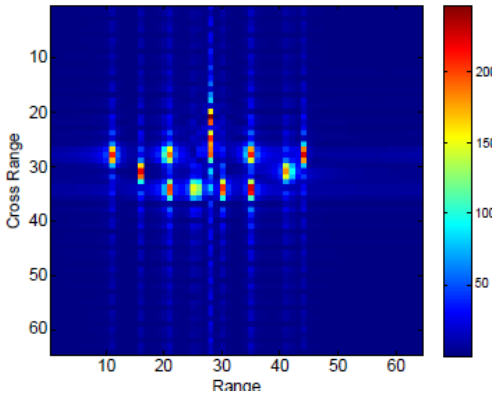

Fig.3. ISAR image using STFT for F=3GHz

IV. CONCLUSIONS

In this paper, ISAR imaging for cubic chirp signals is done for wideband radar frequencies ranging from 1-40GHz using proposed method. The simulation is carried out for a ship target using STFT, Gabor and MFCFT. From the obtained results, ISAR imaging using proposed method is found to be far better compared to STFT and Gabor transform.

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