REVIEW ON PHASE CALIBRATION OF 445MHz ATMOSPHERIC WIND PROFILING RADAR

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Abstract : Today antenna has become a necessity for many applications in recent wireless communication such as Radar, Microwave and space communication. The adaptability of the phased array antenna makes it attractive for a variety of multi-beam applications. Previously, its use was limited mostly to military applications due to the large expenses associated with this type of antenna. In recent years, reduced costs have made phased array antennas successful for a variety of commercial applications. As this technology acceptable on new markets, with it comes the need to learn how to properly calibrate phased array antennas. To date, there have been numerous measurement techniques and methodologies developed for calibrating phased array antennas. The calibration process for a phased array antenna requires adjusting the relative phase between individual radiating elements to form a collimated antenna beam. For an active phased array antenna, the amplitude for each element is also adjusted to achieve a desired beam shape. The fidelity of the adjustment is limited by the number of control bits available for the variable device. Values are controlled using a digital command sent through a beam steering interface. During calibration of antennas for phase adjusting a procedure is laid out for perfect beam forming. Calibration is a process in which phase and amplitude deviations are measured and errors are computed and nullified.

***Index Terms* – RADAR, Antennas, Phased Arrays, Calibration of Arrays etc.**

I. INTRODUCTION

Due to the extreme development in the field of satellite and wireless communication there has been great demand for low cost, minimal weight, compact low-profile antenna that can maintain high performance over a large spectrum of frequencies. The distance of communication may be got easier by wireless communication rather than wire communication and for maximum gain in a particular direction we may use concept of phase array antenna. By arranging group of antennas in linear or planar fashion and varying phase and amplitude of each antennas for maximum gain and desired shape of beam is known as Phase array antenna. Here expanding at a rapid pace with multi-dimensional activities such as climate research, weather forecast, etc. Atmospheric observations at single location are not sufficient to unravel scientific problems like weather forecasting. Wind profiler network is a potential system for multi-point observation and providing initial conditions for NWP simulations. Further, profilers can be installed in locations, which are prone for natural disasters, to enhance understanding on wind and precipitation structures in those systems. 400MHz class wind profilers are very popular and many networks employ them for research/operational meteorological applications, because these can be realized at lower cost and provide optimal performance with optimal size, in contrast to massive 50/200 MHz class radars, despite providing very good height coverage and 1 GHz class radars, which probe atmosphere only up to 4-5 km in clear air and provide erroneous results during convection/precipitation. Keeping the above in view, as a first step, it has initiated the development of 445 MHz radar which can be used for wind profiling and also for multi-receiver applications like imaging. To make the radar cost effective spaced antenna configuration is chosen for wind profiling application, which does not require complex beam steering network. The proposed radar will have seven antenna sub-groups, each with 36 elements. Out of seven subgroups, four will be arranged for spaced antenna mode in such a way to get two different base line lengths. Each sub-group will be fed with one 2 kW Transmit Receive Module. Hence, the total transmit peak power is 8 kW. Remaining three groups can be located to get even longer base lines. There will be possibility for repositioning these three subgroups, to obtain various antenna configurations. The subsystems of the radar are developed through local industry.

While phased array antennas have been in existence for several decades, their use has been confined primarily to military applications due to their complexity and cost. Recent advances in the RF component industry have made this technology successful for a variety of commercial applications including medical, communication, and automotive. This evolution has taken place through the miniaturization, cost reduction, and improved manufacturing techniques of the various RF components required to construct phased array antennas. This technology has also given birth to a new generation of adaptive or "smart" antennas.

This paper is organized as section II describes Existing System and in section III discussed Proposed Method and Section IV describes in Simulation results and Section V concludes the paper followed by references.

II.EXISTING SYSTEM

Beam steering is a concept which changing the direction of main lobe to a desired direction. Bema steering is possible in several ways i.e. Mechanical steering is one of the techniques which exists from several decades. For example, dish antennas which we are using in our home appliances. The parabolic reflector or dish antenna is the form of antenna which finds many uses in domestic satellite television reception, terrestrial microwave data links, general satellite communications and many more. Its size means that it is generally limited to use above 1GHz, although larger antennas may be used for frequencies down to about 100MHz. The parabolic reflector antenna or dish antenna is known for its distinctive shape, its high gain, and narrow beam widths. It is the performance which can be achieved by using one is the reason it is so widely used at higher frequencies.

III.PROPOSED SYSTEM

A. Phased Array Principle

The block diagram of an N- element phase array is shown in figure. 1. "N" identical antennas are equally spaced by a distance "d" along the axis. Separate variable time delays are incorporate at each signal path to control the phases of the signal before combining all the signals together at the output. A plane wave beam is assumed to be incident upon the antenna array at an angle of θ to the normal direction. Because of the spacing between the antennas, the beam will experience a time delay equal to equation in researching successive antennas.

$$\Delta\tau = 2\Pi d \sin(\theta)\lambda \text{ ....(1)}$$

Here, λ is the wavelength of the signals. Hence, if the incident beam is a sinusoid at frequency with amplitude of A, the signals received by each of the antenna can be written as 2.

$$Si = Ae{-}j\tau\Delta n \text{ .... (2)}$$

The plane wave incident at an angle upon the phase array experience a linear delay progression at the successive antenna elements. Therefore, the variable delay circuits must set to a similar but with reverse delay progression compensate for the delay of the signal arrived at the antenna elements. In linear arrays, variable time delays are designed to provide uniform phase progression across the array. Therefore, the signal in each channel at the output of the variable delay block can be written as Eqn. 2.

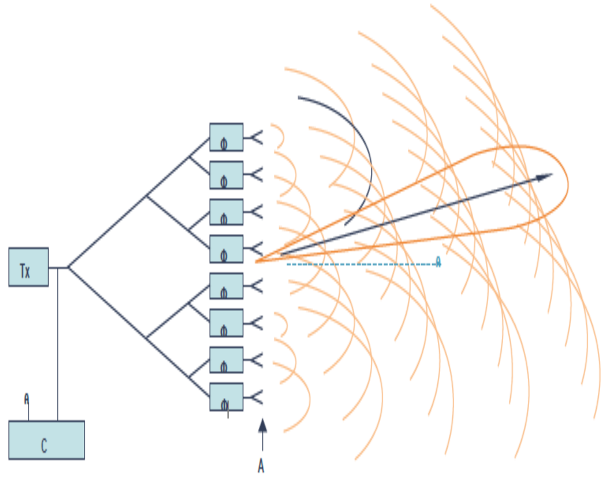

Figure 1. Block diagram of phased array antenna

B.CALIBRATION TEST

Calibration is process of measuring certain device or instrument, compute the error and rectify the error. Calibration is a comparison between a known measurement (the standard) and the measurement using your instrument. Typically, the accuracy of the standard should be ten times the accuracy of the measuring device being tested. Calibration of your measuring instruments has two objectives. It checks the accuracy of the instrument and it determines the traceability of the measurement. In practice, calibration also includes repair of the device if it is out of calibration. A report is provided by the calibration expert, which shows the error in measurements with the measuring device before and after the calibration.

C. Calibration of Antennas

Antenna theory defines a phased array as an array of antennas in which the relative phases of the respective signals feeding the antennas are set so that the effective radiation pattern of the array is reinforced in a desired direction and suppressed in undesired directions. These relative phases can be either fixed or adjustable, allowing the direction of the antenna beam to be electronically steered. This type of phased array is typically referred to as an Electronically Scanned Array (ESA), and employs phase shifters or time delay devices to control the relative phase between radiating elements. The addition of adjustable amplifiers and/or attenuators, provide amplitude control of the radiating power distribution for altering the antenna beam directivity. The ability to also control amplitude adds another layer of complexity as these devices must also be adjusted during the calibration process. To further complicate the issue, these devices may also be frequency and temperature dependent, requiring the calibration to be performed for varying operating parameters and conditions. The calibration process for a phased array antenna requires adjusting the relative phase between individual radiating elements to form a collimated antenna beam. For an active phased array antenna, the amplitude for each element is also adjusted to achieve a desired aperture taper, or beam shape.

The phase should be same as well as amplitude for desired directivity and antenna pattern. To calculate the required adjustments, the amplitude and phase of each individual element channel must first be determined. This can be accomplished using a variety of measurement and processing techniques. Choosing the optimal approach will depend on both the measurement system configuration and the antenna design. For example, in some applications the array control interface provides the availability to activate and deactivate the RF through individual channels, thus making it possible to deactivate all elements except the one being measured. In this way, a single element can be easily isolated. Basically, in 445Mhz wind profiling radar consisting of 5 TR modules and 144 microstrip antennas. For calibrating we need to calibrate both TX and Rx phases by taking reference phase as exciter.

IV. CONCLUSION

Antenna beam forming allows an antenna system consisting of a number of individual antennas to have the direction of the beam to be changed by altering the phase and amplitude of the signals applied to the individual antenna elements in the array. The main purpose of Phase array antenna is that it is an electronically scanned array, a computer- controlled array of antennas which creates beam of radio waves that can be electronically steered to point in different directions without moving the antenna. By using phase array concept, we design desired radar for our convenience. When we are radiating a array of antennas there may deflection of radiation pattern occurs. So, to reduce the error of phase of all individual elements the phase should be same. So, for the adjustment of each phase of individual antenna the calibration test is required. So, for efficient radiation and perfect beam forming calibration technique is needed. This technique provides necessary and proper forming of beam and the phase is done by computer which is fastly change beam direction (in range of microseconds). Calibration is understood and done in 445MHz Wind profiling Radar which is developed

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