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A ROBUST RECTANGULAR ULTRA WIDE BAND ANTENNA FADING STRUCTURE FOR MICROWAVE FREQUENCY AND WIRELESS COMMUNICATION

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ABSTRACT: In the world of modern wireless communication, engineer who wants to specialize in the communication field needs to have a basic understanding of the roles of electromagnetic radiation, antennas, and related propagation phenomena. These papers discuss on the performance, characteristic, testing, measurement and application of antennas in modern wireless communication systems. Antenna is an important part of any wireless communication system as it converts the electronic signals (propagating in the RF Transreceiver) into Electromagnetic Waves (Propagating in the free space) efficiently with minimum loss. We use antennas when nothing else is possible, as in communication with a missile or over rugged mountain terrain where cables are expensive and take a long time to install. The performance characteristics of the parent system are heavily influenced by the selection,. To overcome these limitations, we developed a new rectangular waveguide antenna feeding structure that can establish an aperture field distribution very similar to that of the fundamental waveguide mode with a relatively short waveguide section and over two octaves of bandwidth. The overall antenna size is $0.55\lambda\times0.27\lambda\times0.18\lambda$ where λ is wavelength at the minimum operating frequency. Due to the planar aperture of the antenna, a polarizer could be added to the antenna to ensure good cross-polarization performance with fabrication tolerances. The proposed feed requires a balun structure, and thus an integrated balun design is presented. It is found that a standard balun would interact with the antenna structure and thus a modified design was implemented. The antenna was fabricated and measured. The antenna had VSWR < 2.5 from 1.08 to 4.9 GHz and the measured gain showed almost constant aperture gain

I. INTRODUCTION:

ULTRA-WIDEBAND (UWB) systems with multi-octave bandwidths offer many advantages over conventional narrowband systems. For example, they can provide very high resolutions in radar and imaging applications thus making them very attractive for UWB radar applications such as ground penetrating radars (GPR) as well as medical imaging [3]. They can also provide very high data rates for short range and MIMO communication applications. One of the important components in all UWB radar and communication systems are the antenna elements, which are required to be compact, lightweight and to have good radiation characteristics. The most commonly used directional UWB antennas

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are Vivaldiantennas and ridged horn antennas. Vivaldi antennas are typically required to be a few wavelengths long for them to have good matching and a reasonable gain which limits their use in low frequency portable UWB radars and communication systems where the size of antenna becomes a limiting factor. Ridged horns offer significantly higher gain at a smaller size but they are still relatively bulky and do not provide as good aperture efficiency as rectangular and circular waveguide horn antennas.

II. LITURARE SURVEY:

1. Refocusing through building walls using synthetic aperture radar

Author: M. Dehmollaian and K. Sarabandi

Through-wall imaging/sensing using a synthetic aperture array technique is studied by employing ultra wideband antennas and for wide incidence angles. The propagation through building walls, such as brick and poured concrete in response to point sources near the walls, is simulated by using high-frequency methods. Reciprocity is used to find the responses of point targets behind walls, which are then used to simulate the synthetic aperture radar (SAR) imaging through the walls. The effect of building walls on the target-image distortions is investigated by simulations and measurements. It is shown that by using the idea of match filtering, the effect of the wall can be compensated for, and the point target response can be reconstructed, provided that the wall parameters are known. An optimization method based on minimization of squared error in the SAR image domain within an area confined within the expected point-spread function is used to estimate the wall parameters and sharpen the image simultaneously. A controlled experiment within the laboratory environment is performed to verify the methods presented. It is shown that for an ultra wideband system operating over a frequency band of 1-3 GHz, highly distorted images of two point targets in close proximity of each other behind a wall can be resolved after refocusing. A dual-frequency synthetic method is also presented that can improve the cross-range resolution of the refocused image.

2. "UWB antipodal vivaldi antennas with protruded di-electric rods for higher gain, symmetric patterns and minimal phase center variations

AUTHOR: . Elsherbini, C. Zhang, S. Lin, M. Kuhn, A. Kamel, A. E. Fathy, and H. Elhennawy,

A technique to improve the gain, narrow the H-plane beam width, and minimize the phase center variations with frequency by utilizing Vivaldi antenna with a protruded dielectric rod. A sample antenna was fabricated and measured, and preliminary measured. Vivaldi antennas belong to the class of tapered slot antennas (TSA), and have several advantages such as light weight, easy fabrication and end fire radiation. They are used for many applications such as: satellite communications systems and multi-beam arrays . Recently, they were found very useful in UWB pulse transmission, as well, since they cause slight distortion to the transmitted UWB pulses . However, to obtain symmetric patterns, it is required to significantly reduce the H-plane beam width by using an H-plane array. Additionally, Vivaldi antennas have an unacceptable phase center variation in the H-plane , which may not have significant effects in pulse transmission, but do cause a noticeable error in the high precision localization applications (as indicated in). In this work, we are proposing a technique to improve the gain, narrow the H-plane beam width, and minimize the phase center variations with frequency by utilizing Vivaldi antenna with a protruded dielectric rod. A sample antenna was fabricated and measured, and preliminary measured results are very promising, and in good agreement with our simulation results.

3. UWB high-isolation directive coupled-sectorial-loops antenna pair

Author: A. Elsherbini and K. Sarabandi

The analysis of a capacitive fed wideband planar patch antenna array mounted on a cylindrical surface is presented. The antenna element used is in the shape of an octagon in which slots are placed on three of its sides. The elements are each fed by a small rectangular patch connected to a coaxial probe. On a cylinder of radius 100 mm, the single element is able to achieve an impedance bandwidth from 0.55 to 2.65 GHz, which is 131% of center frequency. When placed in an array environment, the bandwidth reduces slightly to 0.572.6 GHz, i.e., 128%. Simulation results, via two software packages, including S parameters, radiation patterns, and gain of the single element as well as those of the array are provided. A single- and a double-element antenna fabricated are tested, and results are compared with those of simulations. This antenna structure provides stable radiation patterns across the entire pass-band.

4. Broadband design of coaxial line/rectangular waveguide probe transition

Author: R. B. Keam and A. G. Williamson

A theoretical model is presented for a coaxial-line probe to rectangular-waveguide transition for the case where the probe is dielectrically sheathed and extends part of the way into the waveguide. Comparison of theoretical with experimental results demonstrates that the model is very accurate. The model is used to perform a bandwidth investigation of both sheathed and unsheathed probe transitions to gain insight into the effects of various junction parameters. It is found that the electrical size of the coaxial-line aperture in the waveguide plays a significant role in the overall bandwidth performance of the transition, and in many cases the bandwidth performance may be enhanced by offsetting the location of the junction from the centre of the waveguide or by dielectrically sheathing the probe in the waveguide.

III.EXISTI NG SYSTEM

cavity backed rectangular aperture antennas (CB-RAA): The directive antennas are presented in the literature that address different aspects of the drawbacks of Vivaldi and ridge horn antennas for low

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frequency applications. However, some of these antennas are open structures [which limits their use in array configurations since the cross-coupling between such open structure elements is usually relatively high and placing absorbing foams to improve the isolation results in low radiation efficiency. Others are based on cylindrical cavities and waveguides]. Circular apertures have good aperture efficiency (ideally 83.6%) but they suffer from relatively poor cross-polarization performance away from the principal planes. Also, when used in array con-figurations they require more space compared to rectangular apertures for the same overall active aperture area. To overcome these limitations, we investigated the use of cavity backed rectangular aperture antennas (CB-RAA) to achieve very good radiation characteristics and excite the fundamental mode (TE_{10}) over very wide bandwidth. The ideal radiation efficiency is very close to circular apertures (81% vs. 83.6%) but the electric field lines are parallel thus providing significantly better cross-polarization performance off the bore sight. In addition, because they have approximately the same effective aperture independent of the operating frequency (as long as only TE_{10} mode is excited) their gain increases with frequency which helps achieving a relatively constant received power over the operating band in communication applications. Also, their beam width decreases at higher frequencies and this can be used to suppress the array pattern grating lobes when they are used in UWB arrays or synthetic aperture configurations.

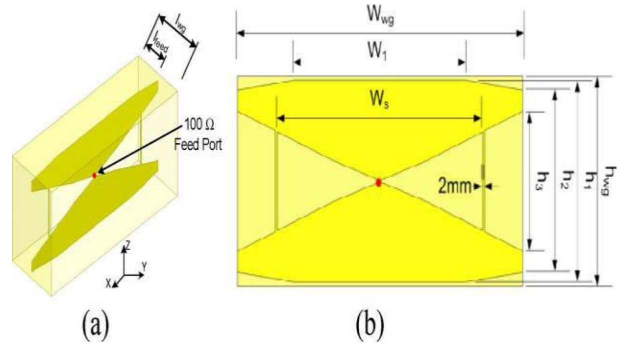
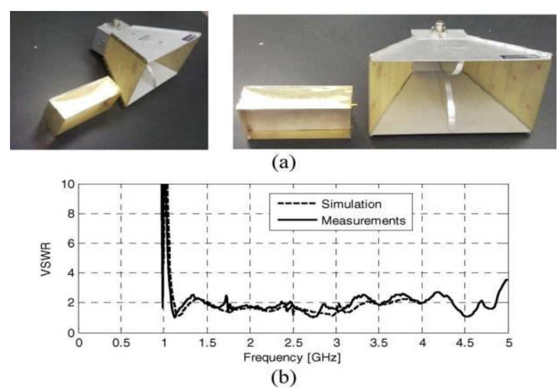


Fig.. Antenna structure: (a) isometric view; (b) front view.

to a standard ridged horn having the same minimum operating frequency where we can see the significant size reduction. The measured and simulated input VSWR of the antenna is low are shown in Fig



Antenna structure and operation

As discussed before, the major limitation of CB-RAAs is their relatively narrowband long resonant coaxial probe feeds. To obtain UWB performance, we replaced the conventional coaxial probe feed with a bowtie structure as shown in Fig. 1(a) and (b). To reach the final structure shown, we started from bowtie dipole as it provides wide impedance bandwidth compared to the conventional monopole/probe feeds. Also, a

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dipole bowtie is used instead of a monopole bowtie to avoid the resulting squinted radiation patterns due to asymmetric ex-citation around the E-plane of the waveguide. It was found that the bowtie provides optimum matching when its top and bottom corners are connected to the sidewalls of the waveguide while its wings are separated from the top and bottom walls of the waveguide. This top/bottom slots are required so that standing wave currents can be established on the bowtie wings. How-ever, a drawback of these slots is that they create an unwanted resonance in the middle of the operating band. This resonance is related to the third resonance of these slots and it was sup-pressed using the shorting lines between the wings as shown in Fig. 1(b) thus reaching the final structure. The operation of these shorting lines will be discussed in the following section The feeding structure is placed at a distance l_{fd} from the wave-guide shorting back and the overall waveguide length is l . The antenna dimensions are summarized in Table I

Dimension	*Value*	*Dimension*	*Value*
W_{wg}	15 cm	h_{wg}	7.5 cm
W_1	9cm	h_1	7.2 cm
W_s	10.8cm	h_2	06.5 cm
l_{wg}	5cm	h_3	5 cm
l_{feed}	2.5 cm		

Table i : antenna dimensions

In this section a parametric study is presented to demonstrate the effect of different physical parameters of the proposed antenna on its input impedance and radiation characteristics. Unless otherwise stated, the antenna dimensions are as summarized in Table I. Due to the large number of parameters for the proposed structure, only some of the most influential parameters will be discussed in this sectionThe first parameter to consider is the bowtie height, h_1 , which controls the capacitive coupling between the bowtie and the waveguide through the top/bottom slot widths. As shown in the simulation results in Fig. 3, reducing h_1 (increasing the slot width) helps in improving the matching but it also increases the minimum operating frequency which increases the antenna size for a given frequency band of operation and limits the resulting bandwidth. When, h_1 is equal to the waveguide width (no top or bottom slots), the standing wave currents on the

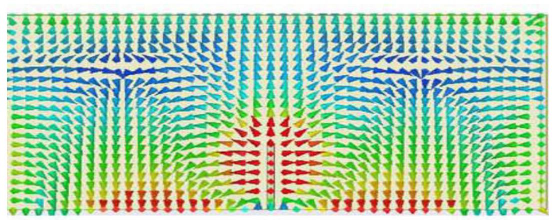
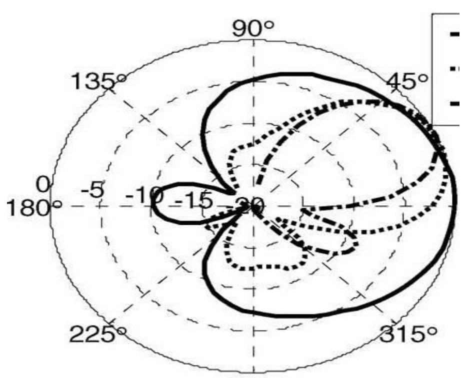


Fig:Aperture field distribution for the monopole feed



Draw backs

1UHF frequency transmission is not possible

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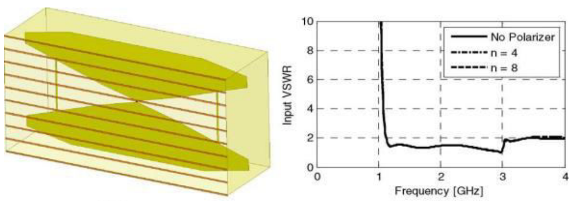
2.Cross correlation is high

3. Feed point configuration is more

4. vswr is more

IV.PROPOSED SYSTEM: In many radar applications, the polarization purity of the antenna is extremely important especially in fully polar metric radars. The proposed structure is symmetric around both the E- and the H-planes and thus ideally does not have any cross pole in either plane. However, due to fabrication tolerances and feed non-idealities, it can suffer from slightly higher cross- polarization than desired in such applications. For example, if the feeding bowtie is slightly tilted, cross polarization can appear along the bore-sight. Furthermore, away from the principal planes, the antenna.



(a) (b)

Fig. (a) The antenna with the near field

polarizer with n parallel strips that are 2 mm wide and (b) the input VSWR without and with the polarizer showing that the polarizer does not affect the input matchingIs not symmetric and thus the cross pole electric field components do not cancel out which becomes even more evident at higher frequencies. To overcome these issues, we made use of the fact that for an ideal rectangular TE_{10} aperture, placing a wire grid polarizer that is perpendicular to the electric field direction as shown in Fig. (a) does not result in significant degradation on the matching performance. The wire grid consists of n traces that are 2 mm wide. It should be noted that placing the polarizer that close to the antenna is achievable only because of the choice of the rectangular aperture and cannot be used in other aperture shapes such as the circular apertures in . Since the proposed feed excites the TE_{10} with very good efficiency over the band, the resulting input matching was not affected as shown in Fig. Placing the polarizer does not cause a significant improvement in the cross pole performance at low frequency (e.g., at 1 ghz in Fig. (a)) since the bowtie size is electrically small and the other waveguide modes are in deep cutoff. However, at higher frequencies (e.g., at 3.5 ghz), higher order modes can get excited and the bowtie size is relatively large which results in a noticeable increase in the cross pole level away from the principal planes as shown in Fig. The cross - pole can be improved by more than 10 db using the polarizer. The cross -polarization simulations are in accordance with Ludwig's third definition. It should be noted that in this figure, only

V.SIMULATION RESULTS:

The waveguide section of the antenna was realized using copper sheets and the feed bowtie and the feed balun were fabricated on a thin (32 mil) Rogers RO4003 substrate in order to keep the radiation efficiency of the antenna relatively high. The fabricated antenna is next to a standard ridged horn

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having the same minimum operating frequency where we can see the significant size reduction. The measured and simulated input VSWR of the antenna are shown in where good agreement between the measurements. And the simulations is observed. The measured VSWR was less than 2.5 over 1.08–4.9 ghz (1:4.5 impedance bandwidth).The antenna gain vs. Frequency was measured using the reference ridged horn antenna and was found to increase from 5 dbi at low frequencies to about 11 dbi at the high frequency end. It is interesting to note that the proposed antenna has com-parable gain to the ridged horn (within 2 db) while having only 1/4th of the aperture size. This is due to the fact that TE_{10} mode has significantly better radiation efficiency since it has a more uniform field distribution across the aperture compared to the fundamental ridged waveguide mode where the field is confined between the two waveguide ridges.So far, the antenna performance in the frequency domain was analyzed since it is more straightforward to analyze waveguide antennas in the frequency domain. However, in most UWB radar and communication systems, the time domain performance is also very important. To investigate the time domain performance of the proposed antenna, a time domain Hamming pulse over 1.1–4.8 ghz was synthesized using a vector network analyzer. A wideband ridged horn antenna was used to transmit the pulse which is then received using the proposed antenna. The results are shown in Figure, where the two antennas are compared. We can see that the peak magnitude differs by only about 1.4 db when replacing one of the two ridged horns with the proposed antenna. The antenna time domain response also does not show significant dispersion or ringing which is very important for UWB applications. The delayed 16 db peaks are due to nearby objects since the time domain measurements were not performed in the anechoic chamber.The antenna pattern was also measured over the operating band. The measured and simulated patterns are plotted in for different frequencies where we can see very good agreement between the simulated and measured results. The antenna has relatively low side lobe levels up to around 3.5 ghz

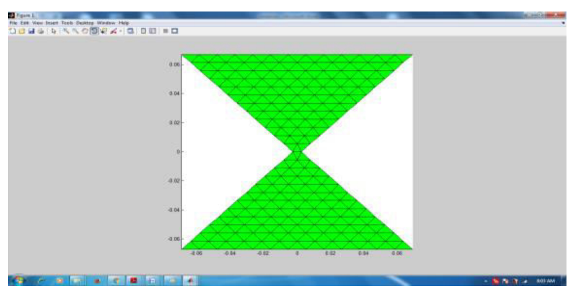

Fig:bowtie antena

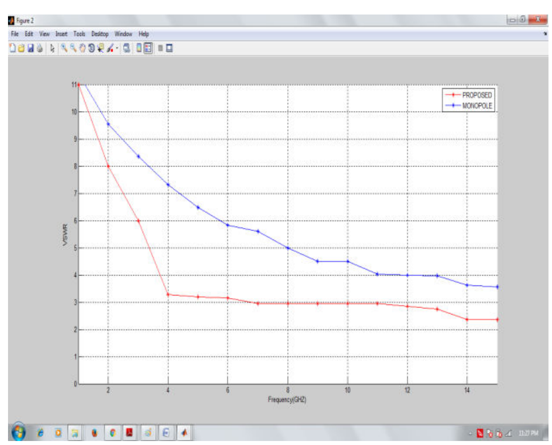

fig:comparsion of monopole and proposed in vswr

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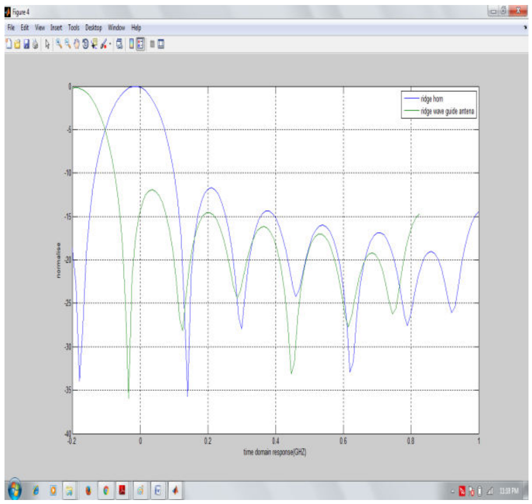

FIG: Normalized time domain response of the antenna compared to the ideal pulse

CONCLUSION:

This paper presents a compact antenna based on open ended rectangular waveguide structure. The new feeding structure allows the excitation of TE_{10} like aperture field distribution for very short waveguide sections (0.18λ) with good matching over more than two octaves of bandwidth. The effects of the antenna and feed dimensions on the performance are discussed in a parametric study. It is shown that the proposed bowtie feed efficiently excites the fundamental mode of the rectangular wave guide which allows the use of near-field wire grid polarizer to further improve the cross polarization performance away from the principal planes and maintain good cross polarization performance independent on the fabrication tolerances or the feeding structure. Then the design of the integrated feeding balun is presented. The antenna performance is validated through measurements of its input impedance, gain, time domain impulse response and radiation pattern of a fabricated prototype. The proposed antenna can be used in many radar and communication application requiring compact lightweight antennas with directive patterns and good polarization purity

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