Communications

Opened Parasitic Elements Nearby a Driven Dipole

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Abstract—**The characteristics of an antenna system consisting of opened parasitic elements and a nearby parallel driven dipole antenna are investigated. The aim is to show quantitatively the significance of the opened parasitic elements that affect the characteristics of the antenna system, and hence cannot be ignored as the radius of the elements becomes thick and the interelement spacing becomes small.**

The effect of a parallel shorted parasitic element upon a nearby dipole antenna has been reported by Adams and Warren [1]. On the other hand, the case where opened parasitic elements are used has not been treated numerically so far, as the opened elements have usually been considered to affect the characteristics of the antenna system very little. Harrington has pointed out in his paper [2] that an opened parasitic element would act as a scatterer. Systems including opened parasitic elements nearby a driven antenna element can often be seen in practice. A typical example is a switched diversity system, where elements are switched to either closed or opened status as they are made either active or inactive; this is often encountered, for instance, in mobile antenna systems. The purpose of this communication is to analyze the effect of the opened parasitic elements upon the antenna system and to discuss the significance of such opened parasitic elements. The variation of the current distribution on the antenna system and the radiation pattern due to the existence of the opened parasitic elements is calculated by using the method of moments [3].

Fig. 1 shows the antenna system consisting of a driven dipole 1 and a parallel opened parasitic element 2. The coordinate system is also shown in the figure. Both the driven and parasitic elements are considered as vertical half-wave dipoles of radius a and their interelement spacing is d. It is assumed that the driven element is excited by a 1 V source, and that the gap of both elements is infinitesimal and the gap capacitance of each element is neglected. In the calculation, the piecewise sinusoidal Galerkin method is used and each antenna element is divided into 17 subsections.

Since the opened half-wave parasitic element 2 can be considered, equivalently, as two quarter-wave shorted parasitic elements 2-a and 2-b, as shown in Fig. 1, the antenna system here can be treated as an array of a driven half-wave dipole and two shorted quarter-wave parasitic dipoles.

The current distribution on each element is calculated and shown in Fig. 2, where Fig. 2(a) shows the variation with the radius of the elements and Fig. 2(b) with the interelement spacing. The current distribution of the driven element 1 does not vary very much with the radius or the interelement spacing; however, the amplitude of the current on the parasitic elements, 2-a and 2-b, increases appreciably as either the radius increases or the interelement spacing decreases. When the elements become thicker, the reactive part of the self-impedance of both elements 2-a and 2-b decreases. When the interelement spacing is narrowed, the mutual coupling between the driven element and the parasitic element increases [4]. This is the principal reason for the variation in the parasitic current amplitude. Furthermore, the interelement spacing significantly affects the phase of the current on the parasitic element (Fig. 2(b)). When the interelement spacing is 0.2 λ (λ: wavelength) and the radius is 0.005 λ, the maximum amplitude of the current on the opened parasitic element is about 12 percent of that on the driven element.

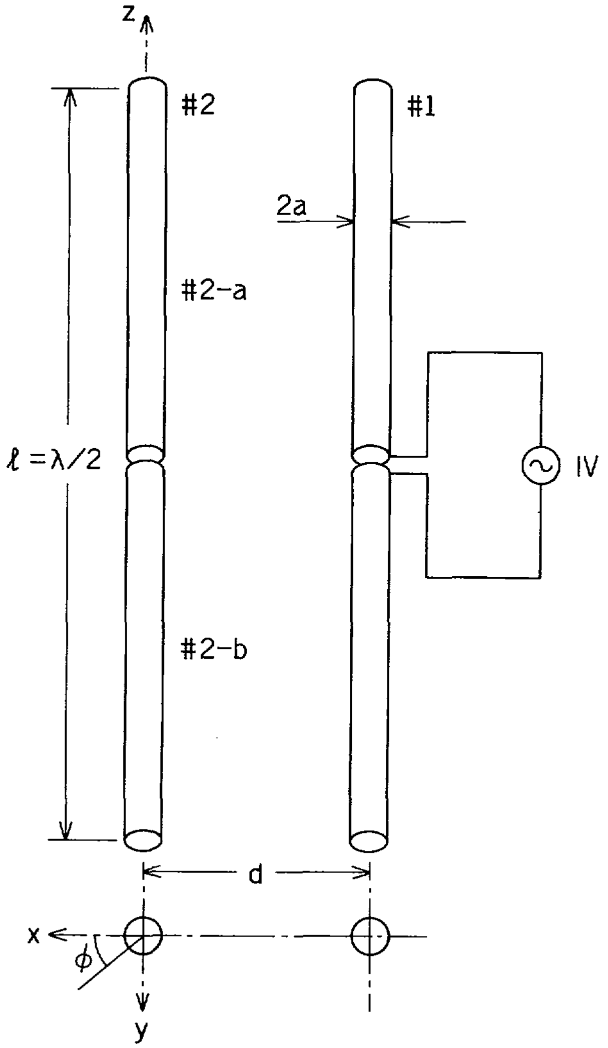

Fig. 1. Antenna configuration.

If the effect of the parasitic element is ignored, the radiation pattern in the horizontal plane is obviously omnidirectional. However, as the current on the parasitic element is not negligibly small, it contributes to the variations of the radiation pattern, as Fig. 3 shows, where the radiation field strength $|Ez|$ is normalized with respect to the maximum value. It is noticeable that increasing the radius a of the

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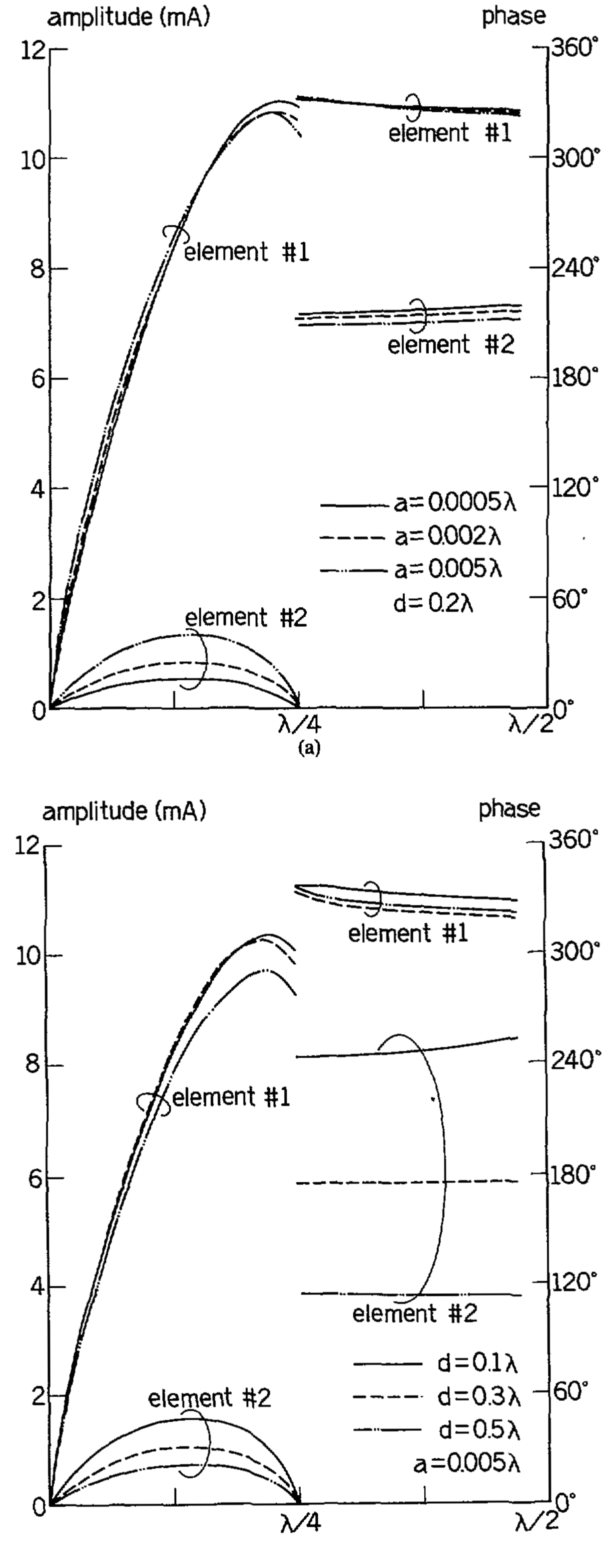
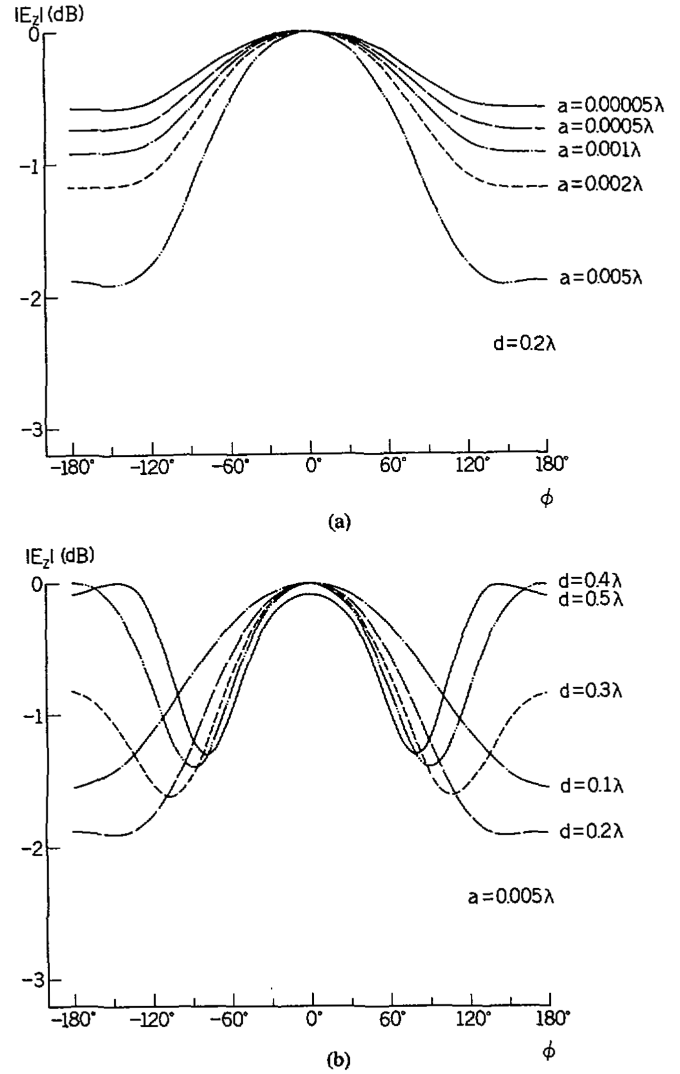


(a)

(b)

Fig. 2. Current distribution. (a) Variation with element radius. (b) Variation with interelement spacing.

elements decreases the minimum value of $|Ez|$ (Fig. 3(a)), while the interelement spacing d affects both the minimum value of $|Ez|$ and its direction (Fig. 3(b)). The reason for this is rather obvious since both the amplitude and the phase of the current on the parasitic element change very much when the interelement spacing changes, as seen in Fig. 2(b). For example, when $d = 0.2\ \lambda$, the $|Ez|$ minimum is about -1.9 dB in the direction of $\phi = 145°$, while for $d = 0.5\ \lambda$, the $|Ez|$ minimum and its direction become -1.3 dB and 75°, respectively, as can be seen in Fig. 3(b).



(a)

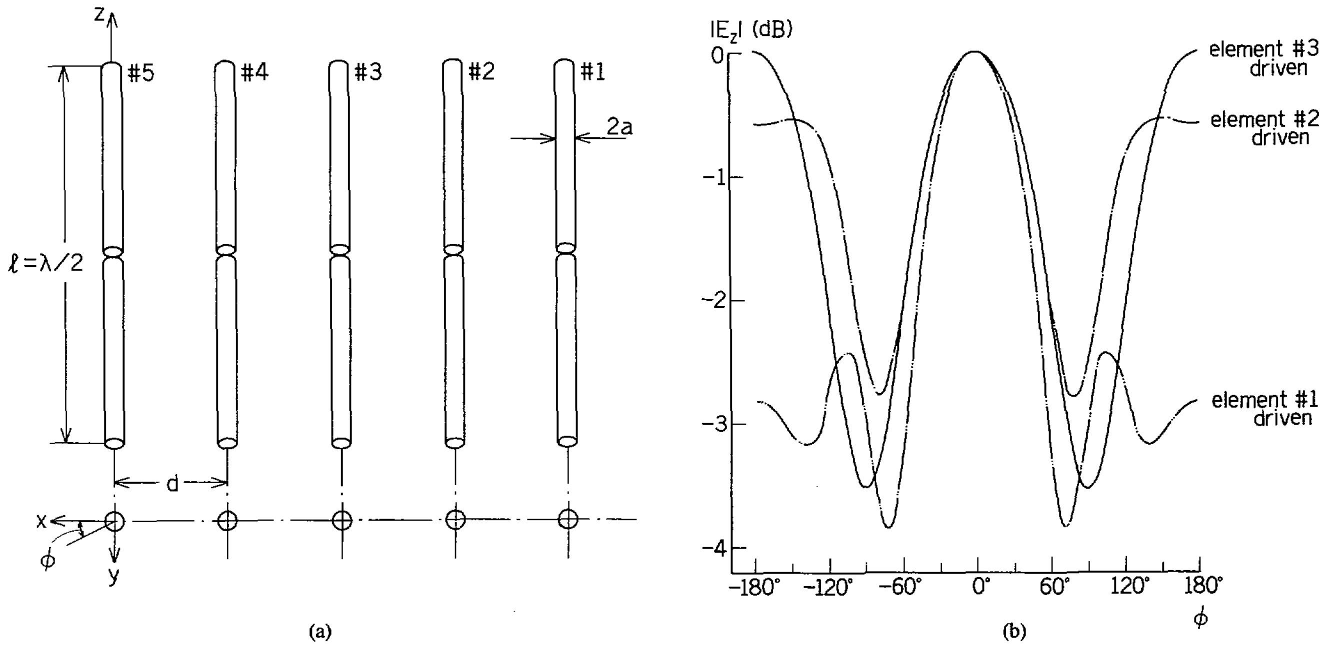
(b)

Fig. 3. Radiation pattern. (a) Variation with element radius. (b) Variation with interelement spacing.

When the number of the opened parasitic elements increases, the effect of them upon the radiation pattern increases as well. As an example, a five-element system consisting of one driven and four parasitic elements is taken into account. Fig. 4(a) shows the antenna configuration and Fig. 4(b) shows the variation of the radiation pattern on the horizontal plane with the position of the driven dipole. Here, the interelement spacing d is taken as $0.2\ \lambda$ and the radius a of the elements $0.005\ \lambda$. Again the field strength $|Ez|$ is normalized with respect to its maximum value. The minimum value is seen to be about -3.8 dB at most in Fig. 4(b), when the end element 1 is driven.

It is worth mentioning that the effect of opened parasitic elements cannot be ignored if the radius of the elements is thick and the interelement spacing is small. The variation in the radiation pattern becomes appreciably large and cannot be ignored for the antenna systems where the pattern is of prime importance.

It can be concluded that the effect of the opened parasitic elements must be taken into account depending upon the interelement spacing, the radius and the number of the elements. The results shown here may be useful in the design of antenna systems applied to switched diversity operations, adaptive arrays, and so forth.



(a) (b)

Fig. 4. A five-element system. (a) Antenna configuration. (b) Radiation pattern.

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Comparison of the Synthetic Storm Technique with a Conventional Rain Attenuation Prediction Model

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Abstract—**It is confirmed that the synthetic storm method is in some way related to one year's existing attenuation data in Greece, but that also one of the standard models (in particular Lin's empirical) works as well and even better. Since agreement between prediction and observation has not been clear for the synthetic storm technique, an extension of the present work is now planned to include a longer data sample.**

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INTRODUCTION

The possibility of predicting rain attenuation statistics on terrestrial paths from rainfall intensity data has been a subject of considerable interest during the past years and has stimulated an extensive series of theoretical and experimental results.

A number of prediction methods have been developed and are available today. Generally speaking, the prediction techniques based on rain gauge data can be classified into two main groups:

1) rainfall statistics techniques; and
2) the synthetic storm technique (SST).

The first group of methods makes use of the cumulative distribution of point rainfall rate. The problem of spatial inhomogeneity of rainfall intensity is taken into account by using either an effective path length [1], [2] or a more accurate statistical description of the rainfall medium [3], [4]. On the other hand, the second group generates attenuation statistics by using a storm translation velocity to convert time records of point rain rate to spatial distributions along the path [5]-[7].

The purpose of this communication is to perform a systematic comparison of representative modeling methods on the basis of attenuation and rainfall intensity measurements carried out in the area of Greece. Furthermore, some conclusions concerning the applicability of the synthetic storm technique in this particular region have been also deduced.

A REVIEW OF SOME REPRESENTATIVE MODELING TECHNIQUES

The empirical effective path length model proposed by Lin [1] has been selected as a representative of the first group methods for the following reasons:

1) because it is simple and gives quite good attenuation predictions for many parts of the world [8];
2) it requires meteorological data in the form of 5-min rainfall rate distributions which are available from the Hellenic Meteorological Agency for a long-term period. According to this formulation the cumulative attenuation distribution $A(p$ percent) can be