# DIGITAL WATERMARKING FOR MAMMOGRAM AUTHENTICATION

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# Digital Watermarking For Mammogram Authentication

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*Abstract-* **The advances in multimedia and communication technology nowadays have provided new ways to store, access and distribute medical data in a digital format. Hence, by identifying best location on the mammogram to embed the patient's information without affecting the quality of the image will be studied. The development of authentication techniques for mammogram watermarking can be as one of the alternatives to overcome the weaknesses of losing and mishandling of medical images that will risk the patients. By embedding watermarking in medical image will be easier to identify the medical image by authenticating the patient identity. The paper aim for this research is to identify the best location on the mammogram to embed the patient's information without affecting the quality of the image and to develop an authentication technique of watermarking mammogram using the least significant bits LSB technique.**

## I. INTRODUCTION

As the technology drastically change especially in the medical environment, the medical imaging technology such as mammogram, Magnetic Resonance Imaging (MRI) and others are widely used in the medical domain for clinical purpose such as medical procedure to diagnosis the patients' internal problem without having the surgery operation. For example, mammogram is used to identify the breast cancer and it helps to detect the breast abnormality.

Since there are many advantages of medical images are discovered and it is frequently used in the medical domain, most hospitals are facing with issues to manage large amount of data storage such as administrative document, patient's information and medical images. Therefore, it is important to handle those data accurately to avoid problem of lost, tampering and mishandling record at the hospital [1].

There are few ways to manage the patient's information and the medical images and one of them is using the watermarking technique in medical images. The purpose of watermarking is to hide a message into the host of document or multimedia format. As one to many communications technique, when sending the watermarking image, only authorized user can read the hidden message. Thus, by inserting watermarking in the medical image, it will help to authenticate the owner of medical image. This is to ensure the medical image is issued from the right source and to solve the missing medical document problem [2]. The objectives of the paper are to develop an authentication technique of watermarking mammogram using the least significant bits LSB technique, And also to identify the best location on the mammogram to embed the patient's information without affecting the quality of the image.

## II. DIGITAL WATERMARKING

Watermarking is defined as a practice of unnoticeably altering a piece of data in order to embed information about the data. Watermarking can be categorized in two types such as invisible watermark and visible watermark, invisible is unable to be seen, either by nature or by concealed and the definition of visible is able to be seen or noticed. Additionally, invisible watermark can be divided into three types which are semi-fragile, fragile and robust. Mainly watermarking basic process consists of embedding and extracting processes. The measurement of quality image will be done after the extracting process by using Mean Squared Error (MSE) and Peak Signal-To-Noise Ratio (PSNR) [3].

Thus, watermarking is preferred as a favourite technique in hiding information by the researches to enhance the security and privacy in the hospitals and also to manage the patients' data since it still poses some issues regarding the image efficiency when designing such system. There are many advantages that have been recognized and many areas have implemented watermarking techniques. The following applications have been listed by [4]: Copyright protection, Unauthorized modification, Fingerprinting, Annotation and indexing, Copy control, Medical

applications, Broadcast monitoring, and Covert communications.

Furthermore, there are many types of watermarking such as Spatial Domain (i.e: Modification Least Significant Bit), and Transform Domain (i.e: Wavelet Transform (DWT) and Cosine Transform (DCT) Fractal transform) each of these techniques have their own advantages.

## III. WATERMARKING FOR MEDICAL IMAGES

Study on the medical image watermarking has been done for copyright protection, authentication and patient management system. Moreover, in future medical applications, it will be predicted to have the integration access with the generalized databases that contain the personal medical information of each patient [5] [6].

Many studies have done on watermarking for medical images. In Ref. [7], medical image security using digital envelope has been developed. Ref. [8] determined if the watermarked image has been tampered with or modified. Ref. [9] developed an algorithm for embedding multi-signatures using a multiple watermarked scheme to preserve the history of the genuine image. Ref. [10] used LSB technique in their paper to develop information hiding techniques for protection of medical information and copyright.

Encrypted patient's data can be embedded in an annotation while the tampering can be detected using fragile watermark. The embedded patient's data not only saves storage space, it also offers privacy and security. Furthermore the medical images in digital form must be stored in a secured environment to preserve the patient privacy [11]. Three experiments on the X-ray image of the chest, MR image of the skull and CT image of the brain have done, however the disadvantages can be found where there are possible to destroy the annotation watermark on purpose using malicious attack technology. To solve it, annotation watermark in textured regions of the image can be used as watermark instead of image borders.

Ref. [12] develops a framework for combating security issues in PACS for mammograms that involve the watermarking method to hide the patient's information into the mammogram without changing her important details and the watermark can also extract, this scheme is compatible with the mammogram transmission and storage on the Picture Archiving And Communication Systems (PACS). Based on the experimental that has done the evaluation of capacity, embedding distortion and content masking have been evaluated. Ref. [2] develops a watermarking for authenticity of DICOM Image identifiers codes (UID) and Patient identifiers (Id) were reviewed. The purpose of this paper is to combine an anonymized pivot number identifier with national patient identifiers to guarantee the privacy and interoperability of data. Ref. [10] develops the information hiding technique using LSB to protect medical information and copyright and a multiple-layer data hiding technique in spatial domain (LSB). PSNR has been used to measure the quality of picture. Moreover, based on [12] experiment, they used mammogram watermarking but the techniques for watermarking that has been used are DCT and DWT techniques.

Additionally, several advantages of watermarking in the medical image have identified by [13] such as:

1. By embedding watermarking in medical image, the patient can protect their information such as diagnosis result or personal details from being viewed by unauthorized person.
2. Medical image watermarking can help to authenticate the patient, if the connection between the image and patient is lost.
3. In addition, medical image watermarking will help the staff to identify or search the old medical image in the Hospital Information System (HIS) collection because there are some cases that medical images and patient's records need to be verified the integrity before use.
4. Images may help to discover new findings in medical case. Thus, it is needed to protect the copyright and integrity of the medical image by digital watermarking.
5. Embedding the authentication code in the image will make it less sensitive to attack than appending the information on medical image.

## IV. EMBEDDING PROCESS

In this paper, the breast area will be identified first before the process of watermarking. The analysis on the mammogram image has been done. Moreover, since different medical image will have different background color level, the background color of each mammogram samples will be checked by using data cursor tool in MATLAB software to get the suitable range for dark value. The development of algorithm and the prototype has been done by using MATLAB software.

Fig. 1 shows the overview design that has been used to develop an authentication of mammogram image by using watermarking technique. The input is a mammogram image and patient's information. Identifying breast area will be done before the embedding process. After that, extracting process will be executed and finally, the output will be a watermarked mammogram images.

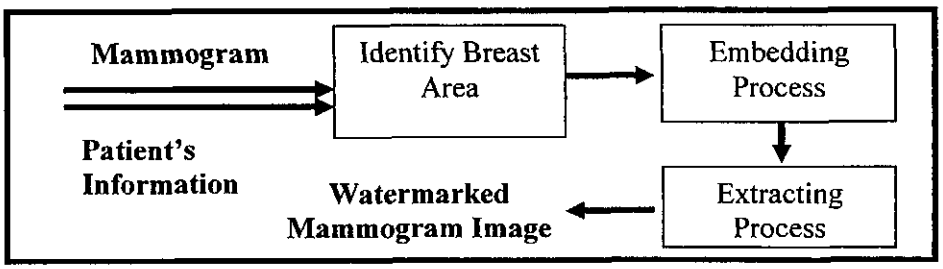


Figure 1. Best- Location Technique for Mammogram Authentication by LSB Based Watermarking Design

## V. PROTOTYPE DESIGN

The Activity flow diagram for the prototype design is shown in Fig. 2, while Fig. 3 shows the prototype design that has been developed by using MATLAB software.

This prototype has 4 buttons (Browse Mammogram image, Insert a data, Embedding button and Extracting button) to execute the below module.

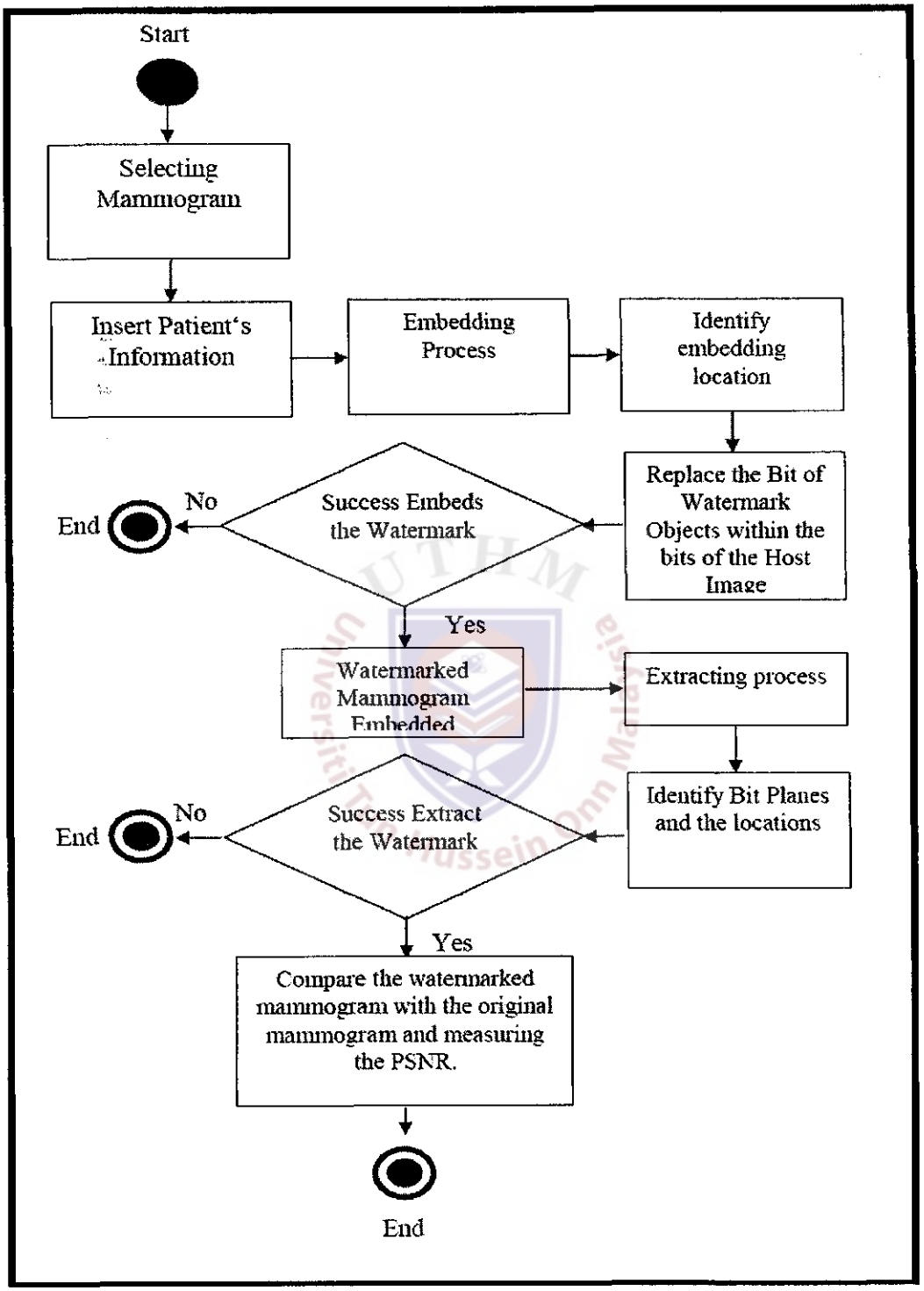


Figure 2. Activity Flow Diagram for the Prototype Design

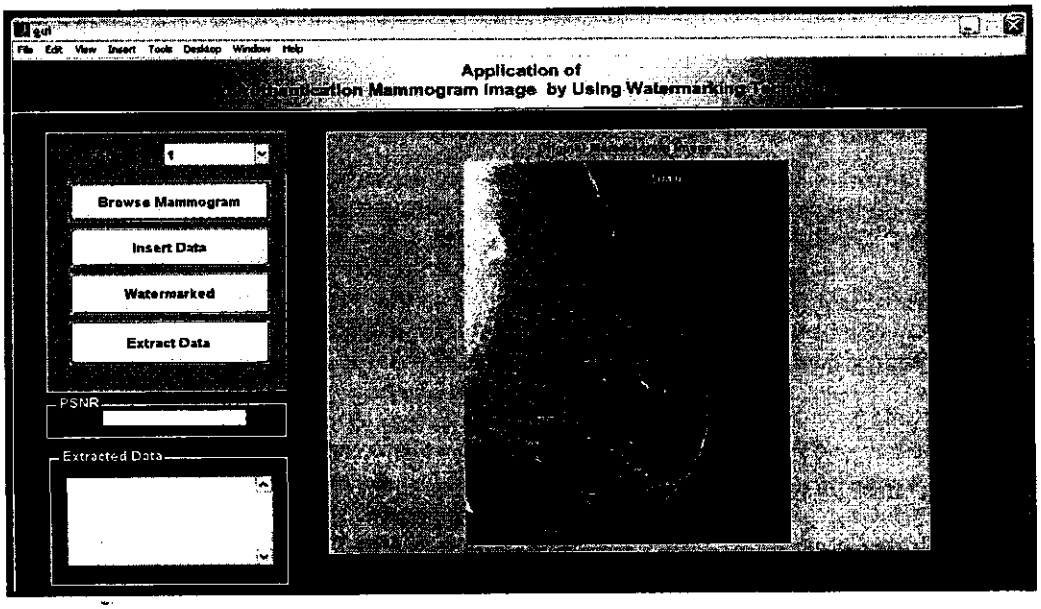


Figure 3. Prototype Design

The mammogram image will be displayed on the axes at the right screen. The watermark data in text format will be the patient's information such as Patient's Name, Patient's ID, Age, MyKad (Identity Card of Malaysia), Date, Physician's Name and Diagnosis. The data can be inserted by clicking on the button of 'Insert Data' as shown in the Fig. 4. All information must be inserted and will be saved in .txt format.

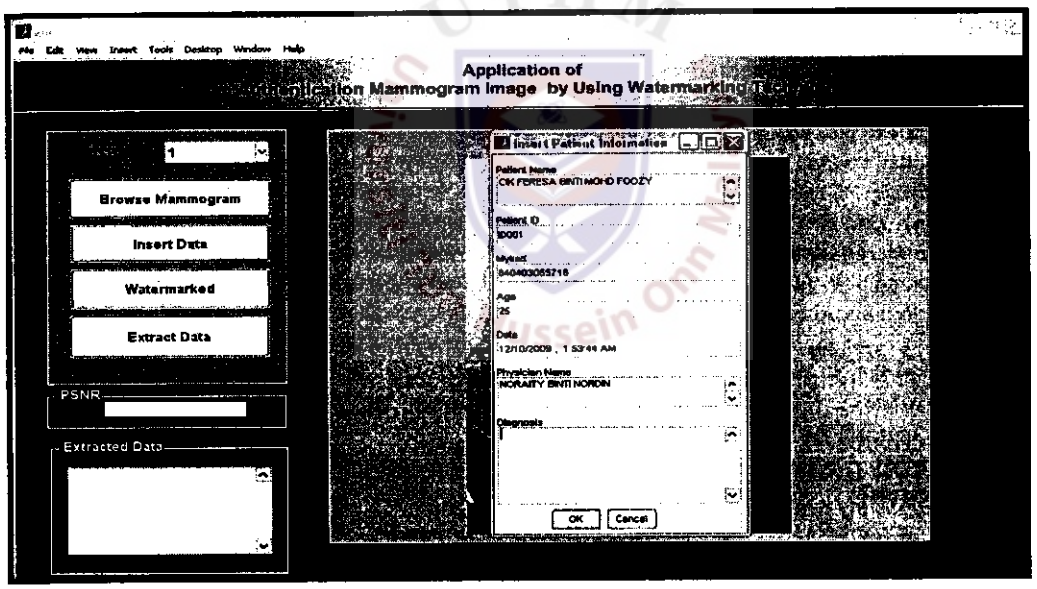


Figure 4. Selecting watermark data

The application measure the PSNR in order to test the quality of the watermarked image. Least Significant Bit (LSB) watermarking is used in this algorithm. After the selected image and the input patient's information have been changed into the binary format, Next step is to identify the location of breast area. This can be done by calculating the black (dark) and white (bright) pixel at both parts. The dark pixel has been set from 0 to 26. Based on the literature review, the background of mammogram will be in the black and gray colors. Thus, Data Cursor Tool on the MATLAB Software has been used to check the range of dark pixel of mammogram samples since it is hard to differentiate because the intensity of color looks similar.

By testing all the samples (25 samples of mammogram images), the results shows that the PSNR was greater than 45db for every embedding, and this value consider high quality images, since the quality of the image is still in a good condition and the PSNR result shows it is more than 30dB.

Extracting process is a process that can extract the patient's information on watermarked image. Based on the result, all information that has been embedded in the samples of mammogram images can be read back without

any interruption or data lost, this shows that the algorithm has successfully extracted the data and enables to authenticate the mammogram image.

## VI. CONCLUSION

A prototype for this paper has been developed where this algorithm has the ability to embed more information on mammogram images by using LSB technique. This algorithm is also able to identify the best location by calculating and comparing the dark and bright pixel intensity in the mammogram images. This is to differentiate the breast and background area of the mammogram images, the experiment shows the result of PSNR of this technique is more that 45dB, thus the images are still in a good quality.


## ACKNOWLEDGMENT

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# MODIFIED EQUIVALENT BOUNDARY SURFACE PRINCIPLES USING HYBRID FEM-FDTD ELECTROMAGNETIC MODELS

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*Abstract* - **A modified boundary surface between the two domains in the hybrid FEM-FDTD technique is presented. This permits a heterogeneous surface to be imposed, allowing selected parts to be represented as being conducting or non-conducting. This enables a reduced surface size to be used in cases where an antenna is above a conducting plane, as well as facilitating a range of other practical scenarios. Examples presented show stable results and good agreement with published data.**

***Keywords - Hybrid methods, Finite Element Method (FEM), Finite Difference Time Domain (FDTD).***

## I. INTRODUCTION

The finite element method (FEM) is widely used in computation of unbounded static and quasi-static electric and magnetic fields at DC and low frequencies, and for enclosed systems (cavities etc) at high frequencies. However, there have been problems in applying the method to high-frequency open-field (radiation and scattering) problems due to the relatively large size of the computational tasks that result. The finite-difference time-domain (FDTD) scheme is very popular for electromagnetic modeling because of its simplicity and efficiency. One drawback of FDTD is the staircase approximation of oblique boundaries, which often gives poor accuracy. The finite-element method (FEM) allows good approximations of complex boundaries and with edge elements it performs well for Maxwell's equations [1]. An obvious compromise is a hybrid that applies FDTD in large volumes, combined with FEM around regions with complex structure: the FEM may be applied in frequency domain to achieve very efficient solutions. Previously attempted hybrids of this type have only used time-domain FEM [2] and some have shown late-time instabilities [3,4].

## II. METHOD

The coupling between the hybridised methods is computed by using the equivalence-principle (EP) theorem. The objects in the different domains are not physically connected but need only be separated by a small distance, sufficient to permit the surface on which the equivalence principle is enforced to be located between them.

In this paper, a modified EP surface in which one or more faces are replaced by a conducting surface was investigated (see Fig. 1). In this modification, the conducting surface can be extended beyond the size of the EP surface, for example a handset box for a mobile phone, where only the antenna part is within the EP surface. The Inverted F-Antenna (IFA) was chosen for evaluation purposes since it is a common mobile phone design. The antenna, including a finite ground plane, was modelled by using a standard FEM software package [5]. In the first test, the EP surface boundary was chosen to reach to the edges of the finite ground plane representing the adjacent surface of the phone body (see Fig. 1a) and then the size of the EP surface was reduced and the antenna performance was again predicted, with and without the presence of an arbitrary conducting-sheet scatterer (see Fig. 1b), inserted below the 'ground plane'. Outside the FEM domain, the rest of the problem space was inserted in an FDTD region.

The procedure can be extended to two or more conducting surfaces partially coinciding with the EP surface. Due to the differing structures of FEM (normally non-uniform tetrahedral meshing) and FDTD (normally uniform rectangular cell distributions), a support program was written to link the field points that exist on either side of the EP surface.

## III. SIMULATION AND RESULTS

A program was written to simulate the details presented in the previous section. The operating frequency was chosen as 1800 MHz and the handset dimensions (finite ground) were 5cm x 8cm. The antenna was designed with minimum return loss of 10dB and 9% relative bandwidth at 1800MHz. The complete FEM problem space for the examples presented stretched well beyond the EP surfaces and was of size 12cm x 9cm x 4cm, with its lower surface coincident with the finite ground plane. Outside the metallic plane, the lower surface of the FEM model used the low reflecting boundary formulation [5]. The antenna was excited by a magnetic frill through a coaxial cable of radius 2.5-mm. The FDTD cell size and the time step were 2.5mm and 3.375ps respectively. The number of the FDTD PML (perfectly matched layer) cells was 6.

***Example 1:*** The total field (for 1 watt input power) as seen 1cm underneath the centre of the ground plane, on a line parallel to the x-axis, was examined; the scatterer plate was absent. The EP surfaces were considered at the edges of the handset (Fig. 1a) and closer to the antenna (Fig. 1b). A comparison between the two geometries, and with the pure MoM [6] is shown in Fig. 2. The FDTD problem space dimension was 54 x 54 x 38 cells. The EP surface sizes for Figs 1a and 1b were 5cm x 8cm x 3cm (equivalent to 32 x 20 x 12 cells inside the FDTD method) and 3cm x 4cm x 3cm (equivalent to 12 x 16 x 12 cells inside FDTD) respectively. The results show good agreement for all proposed equivalent

surfaces. The results also show that the difference between the total field and the scattered fields in the case of the FEM/FDTD hybrid method was 25 to 30 dB: this is in accord with expectations. However, the computer memory needed for the field points on the surface boundary with the modified equivalent surface (Fig. 1b) was reduced by 70% compared to the one in Fig. 1a and this directly contributed to reduce the execution time in updating the boundary difference equation inside the FDTD method.

***Example 2:*** In this example, a scatterer was considered underneath the handset as shown in Fig. 1b. The scatterer was a conducting surface of size 5cm x 6cm which is equivalent to 20 x 24 cells inside the FDTD method. The variations of the input impedance for different distances between the handset and the scatterer were computed and are shown in Fig. 3. The computed results were in acceptable agreement with those calculated from pure MoM [6].

## IV. CONCLUSIONS

A hybridisation technique between the FEM and FDTD has been presented. An equivalence-principle surface, including a partial conducting surface, was successfully implemented through the boundary that coupled the two methods. A reduced-size EP surface has been presented and was found sufficient to predict the antenna performance with and without the presence of a nearby scatterer. This saved approximately 70% of the required memory locations of the field points between the two domains and also accelerated the updating boundary equations inside the FDTD method. The results are stable and show good agreement between the different techniques.

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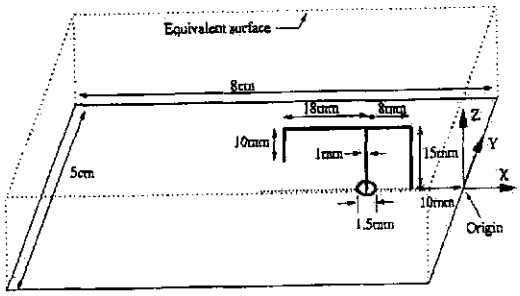
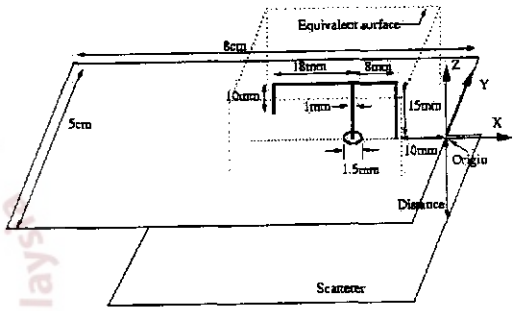
**Figures captions:**

Fig. 1 Antenna structure with EP surfaces, either reaching to the edges of the ground plane (a), or enclosing a reduced small volume (b). The lower scatterer plate was introduced in later tests (Fig. 3).




(a)




(b)

Figure 1

Fig. 2 The total field 1cm underneath the longitudinal centre line of the ground plane (no scatterer present).

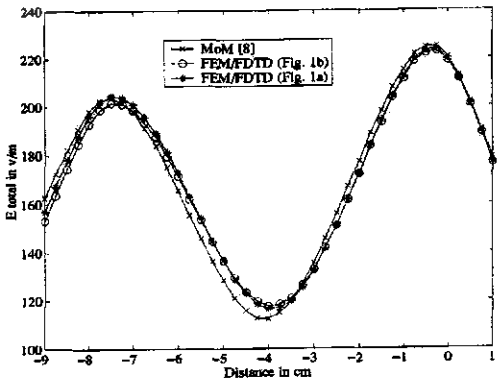



Figure 2

Fig. 3 The variations of the input impedance versus distance between the ground plane and the scatterer.

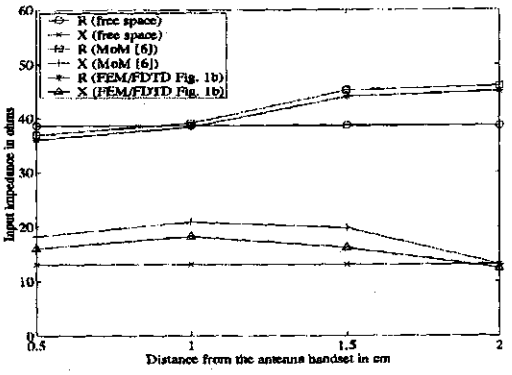



Figure 3