Identification of noise source on PWB by confocal array

Hideyuki KONDO, Yoshihiko KUWAHARA
Graduate School of Engineering, Shizuoka University
3-5-1 Johoku,Nakaku,Hamamatsushi,432-8561 Japan, tykuwab@ipc.shizuoka.ac.jp

Abstract

We have visualized the noise source by **a** temporal-spatial beam forming algorithm to locate the position on PWB. We demonstrate imaging results for undesired emission from PWB by experiment.

Keywords : passive imaging noise source time-space beamforming

1. Introduction

Depend on development of high speed digital circuit undesired emission from electronic device becomes a serious problem. Until now DOA estimation with super-resolution such as MUSIC algorithm [1] and measurement of emission power by a scanning probe are used to find the noise source [2]. Though such super-resolution technique as MUSIC needs to know the steering vector, it is not practical to estimate them in the complicated structure.

We focus MAMI that consists of 2-stages robust CAPON including steering vector estimation [3]. When robust CAPON is used for the confocal array, it suppresses emission of nonfocus position. Steering vector for each pixel is estimated based on the maximization of array output. For the maximization, the least square approach and CAPON is used. By use of MAMI, we can reconstruct 3D image of the scattered power with high resolution and need not to move the probe along the measuring object. However, MAMI is an algorithm of active imaging, so it is necessary to modify.

In this article, we report visualization of a wave source by the modified MAMI algorithm to identify noise source on PWB. For comparison, another imaging algorithms are also evaluated. First, we analyse the radio propagation by FDTD. Then, we visualize a noise source by numerical simulation. Then, we demonstrate the experimental results of emission from microstrip line with gap.

2. Principle of Imaging

2.1 **Imaging Algorithm**

We examine three algorithms for imaging in this article. First algorithm is Delay and Sum (DAS). Received signal on each antenna is time-aligned based on the propagating delay corresponding with the specified focal point and is combined. The focal point is set over the imaging area. Combined signal is multiplied by the time window and the power of the specified pixel is calculated. Second Algorithm is Microwave Imaging via Space-Time Beam forming (MIST) [4]. In MIST, frequency dependence is considered. Third Algorithm is MAMI. It mitigates interference and estimates the steering vector based on the maximization of array output and CAPON.

2.2 **Application of MAMI**

MAMI is an active imaging algorithm and steering vector estimation consists of two stages CAPON. In the first stage, multistatic radar response (called by probing signal) is estimated. In the second stage, the probing signal is treated by the snapshot of a virtual array antenna. So, if we start from the second stage of MAMI, we will able to use MAMI for passive imaging.

3. Simulation

We have evaluated the visualization of the wide-band frequency source on PWB by numerical simulation. Emission from the microstrip line is received by the planar array that is located in front of the PWB as shown in Fig.1. The Electromagnetic field is calculated by FDTD. It is assumed that Gaussian pulse propagates on the microstrip line with a gap to simulate wide-band noise source. Simulation condition and calculation load are shown in Table 1. The simulation results are shown in Fig.2. We can see the location of emission for 3 imaging algorithm. Especially, it seems that MAMI has the best performance.

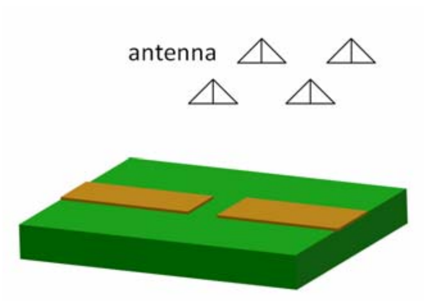
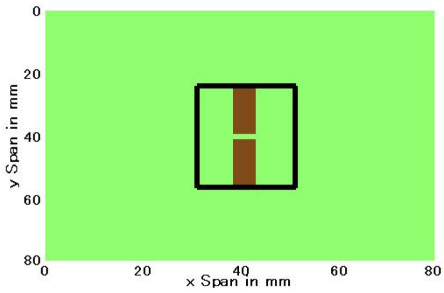


Fig. 1: Simulation model

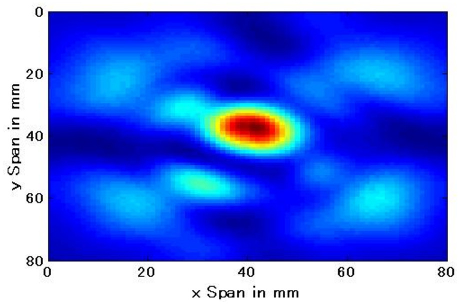
Table 1: Simulation condition and calculation load

microstrip width[mm]	4	Computation time[second]	
Number of antenna[element]	81	DAS	0.013
Interval of antenna [mm]	10	MIST	0.5
Distance between antenna and PWB [mm]	48	MAMI	0.7

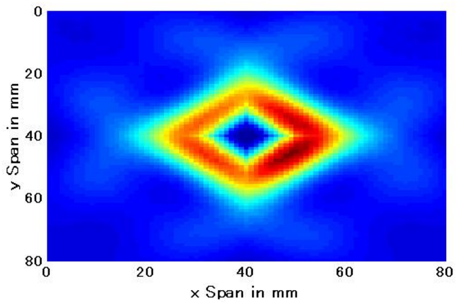
4 . Experiment



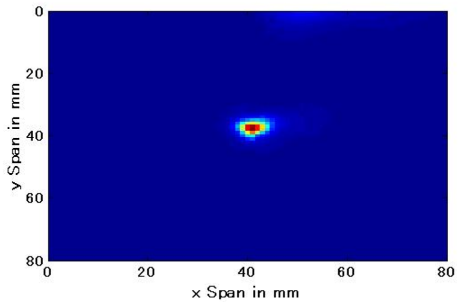
circuit pattern



DAS



MIST



MAMI

Fig.2 Simulation Results

In the experiment, we prepare an experiment system as shown in Fig. 3. A probing antenna and a circuit board are connected to the network analyser. We measure S_{12}. Distance between the probing antenna and circuit board is 48 mm (same as simulation). As scanning range of the probing antenna is 80mm×80mm, probing point is 81(9×9). Noise source is a microstrip line with a gap on the circuit board of 20mm×30mm. Measured frequency band is 3-13GHz because of VSWR of the probing antenna. The probing antenna is a wide-band slot antenna [5]. Antenna's VSWR is almost under 3 over 3 to 13GHz. The results are shown in Fig.3. We can also see the location of emission for 3 imaging algorithm. Especially, it seems that MAMI has the best performance.

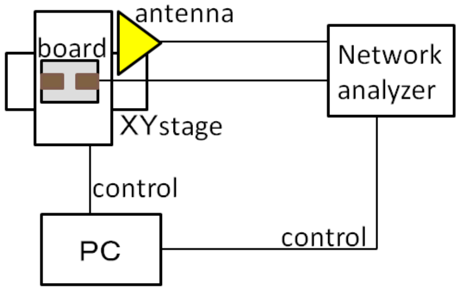


Fig. 3: System diagram of experiment

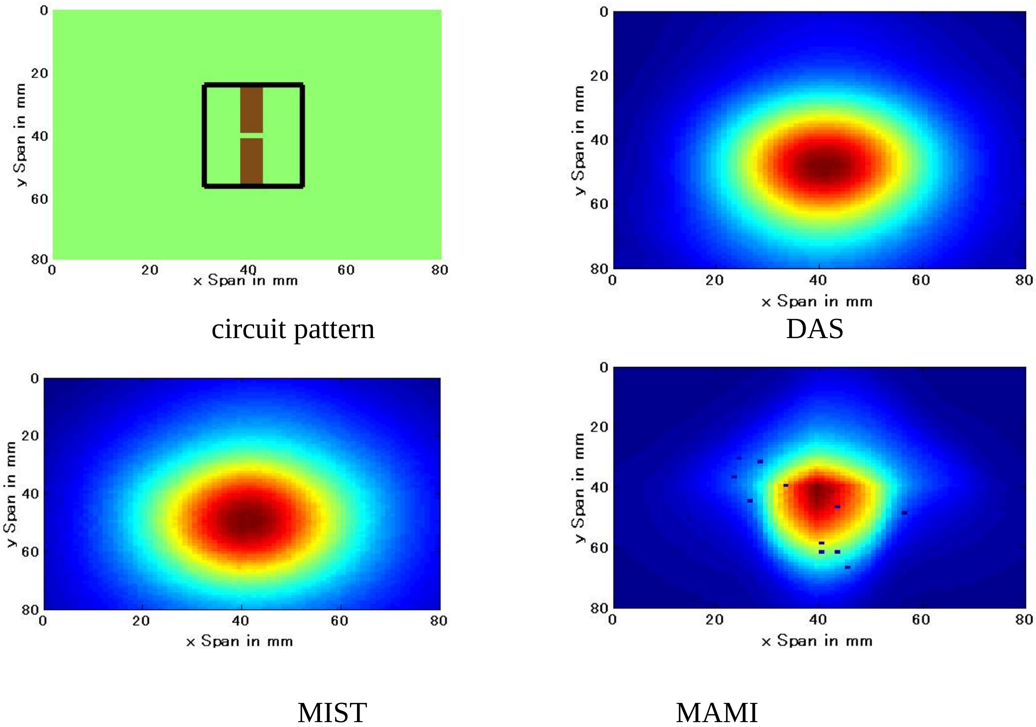


Fig. 4 Results of experiment

5. Conclusion

We can confirm location of noise source by DAS, MIST, and MAMI by numerical simulation. Location error is less than 10mm. In the experiment, we can confirm capabilities of the location as well as simulation. Especially, the modified MAMI has the best performance to locate the source. In the future, we are to examine the resolution of plural sources and to identify noise sources on the real circuit board.

References

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