

# Back Projection Histogram Method in Homogeneous Field for Microwave Subsurface Radar

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## Abstract

The back projection histogram method has been proposed as the method to construct an image from waves reflected from a buried object for subsurface radar. This method is composed of two phases, i.e., a back projection image construction process and a back projection image superposition process. A simulation analysis of this method has been studied. In this paper, an experimental study is demonstrated in air as the homogeneous field using three cylinders as buried objects.

## 1 Introduction

Microwave subsurface radar has found many important applications in identifying various target objects. It is, however, difficult for non-experts to recognize the target objects from the subsurface radar image due to its low horizontal resolution. Many methods have been studied to improve the horizontal resolution of the subsurface radar image[1][2]. Since these studies are based on the subsurface radar image, we must continuously measure along a straight line, to construct the subsurface radar image. It is difficult to construct the subsurface radar image on a non-flat plane, because we cannot continuously measure along a straight line.

A novel back projection histogram method by which an image can be constructed from the measurement points has been proposed and has been studied by simulation[3][4].

In the back projection image construction process which is the first phase of the proposed method, an image is constructed from a reflected wave by considering the directional properties of the microwave antenna. In the back projection image superposition, which is second phase of the proposed method, a back projection

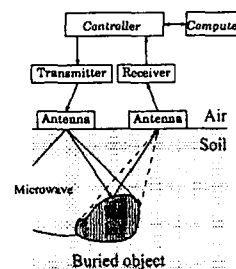


Figure 1: Block diagram of microwave subsurface radar system

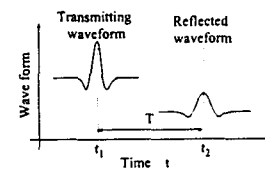


Figure 2: Transmitting and reflected waveforms, and propagation time  $T$

histogram image is made from multiple back projection images constructed by the back projection image construction process.

In this paper, we introduce a vector histogram  $(h, w)$  where  $h$  and  $w$  are a histogram value and a weight for histogram value operations. The back projection histogram method is examined by experiment in air as a homogeneous field using three sizes of cylinders as objects.

## 2 Microwave Subsurface Radar

The principle of the microwave subsurface radar is essentially the same as that of normal radar and sonar[5]. A short impulse wave is radiated into the subsurface from a transmitting antenna arranged close to the ground surface as shown in Fig.1. The wave is reflected on a boundary surface between the soil and the reflective objects having different electrical characteristics. The reflected wave comes back to the ground surface and reaches the receiving antenna arranged near the ground surface.