HIGH RESOLUTION LONG RANGE ISAR IMAGING SYSTEMS

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ABSTRACT

The requirements for high resolution, long range ISAR imaging systems capable of recognising targets have been outlined. Systems meeting these requirements and operating at mm-wavelengths have been proposed. The systems consist of N phased locked transmitters feeding as many antennas in phase. Quasi-optical power addition at the target occurs. In the receive mode all antennas are connected in phase. These systems can at least double the range obtained by utilising a system having one transmitter/antenna combination. Several realisation options have been studied including the annular synthesis antenna systems which offer some advantages over more conventional realisations.

1. INTRODUCTION

Historically the primary roles of radars were to detect targets of interest in the antenna beam and measure their ranges from the radar; lately however the emphasis on active surveillance augmented radar roles to include the recognition of targets. One for example would like to know the nature of detected targets so that a distinction can be drawn between a fishing boat and a frigate or between a passenger and a fighter plane. Ideally recognition of detected targets is required at ranges as long as possible and the resulting images of the targets ought to have as high a resolution as possible.
Inverse synthetic aperture radar (ISAR) produces target imagery by processing target reflectivity data, collected over a wide bandwidth, as the target is viewed from a range of angles made available by the rotational and linear motion of the target[1].

The aim of this paper is to define the requirements for high resolution and long range ISAR imaging systems and propose systems which meet these requirements.

2. THE REQUIREMENTS

The resolution of ISAR images is inherently independent of range, \( R \), but improves directly with radar bandwidth in the slant-range dimension (along the line of sight (LOS) of the radar and target) and with radar frequency in the cross-range (along a direction perpendicular to the LOS); more explicitly the slant- and cross-range resolutions \( \Delta r_s \) and \( \Delta r_c \), respectively, are given by the equations

\[
\Delta r_s = \frac{c}{2B} \tag{1}
\]

and

\[
\Delta r_c = \frac{\lambda}{2\omega T} \tag{2}
\]

where

- \( B \) is the system's bandwidth processed coherently;
- \( \lambda \) the wavelength of operation;
- \( \omega \) the target's rotation rate; and
- \( T \) the integration time.

The detection range, \( R' \) in meters, of a radar operating in a uniformly absorbing medium is given by the equation