Air and Spaceborne Radar Systems: An Introduction

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Foreword

The history of airborne radar is almost as old as that of radar itself. The improvement in detection range provided by an airborne platform was realised early during the Second World War, and the development of the cavity magnetron at almost the same time allowed higher radar frequencies and, hence, directive antennas to be used. Nowadays, radars on aircraft have a great variety of functions: from navigation and meteorological purposes, to more specialised purposes on military aircraft associated with surveillance and weapon delivery. Development of processing techniques such as coherent Moving Target Indication and Synthetic Aperture Radar have been matched by huge advances in technology, such as digital processing and solid-state phased arrays. More recent decades have seen the development of satellite-borne radars for geophysical environmental monitoring and surveillance applications.

A book that brings together a detailed theoretical treatment and a systems-level engineering understanding of the subject is both unusual and of great potential value to the radar community. The structure of the book combines a coverage of the principles of radar with a discussion of different applications and missions, showing how the design of the radar is adapted to each. The final chapters are devoted to a view of future technological developments and the ways that airborne and spaceborne radars may be expected to develop in response to new types of targets and missions. The French radar industry has played a significant role in the development of many of the innovations in airborne and spaceborne radar. The authors of this book are acknowledged as experts in the field and they provide a uniquely European perspective on the subject.

For all of these reasons, this book will be of value to a wide audience, both as a reference to radar engineers and those responsible for the specification and procurement of airborne and spaceborne radar systems, and as a textbook in graduate-level courses on radar.

Hugh Griffiths
Professor, University College London
IEE PGEL5 Committee, IEEE Radar Systems Panel

Preface

For over half a century, radar has been a permanent feature of surveillance activities. Practically unaffected by meteorological conditions, it operates independently of sunlight, while its detection ranges and the angular domain it covers make it an essential tool for continuous surveillance of a very wide area. Over the last fifty years, radar operational capability and performance have continued to improve, and one can safely assume that this will hold true for the coming decades.

This book, devoted to airborne and spaceborne radar, avoids a purely theoretical approach and is certainly not intended for an "elite" group of specialists. Rather, it is a practical tool that we hope will be of major help to technicians, student engineers, and engineers working in radar research and development. The many users of radar, as well as systems engineers and designers, should also find it of interest.

Airborne and spaceborne radar systems, themselves highly complex systems, are fitted to mobile and often rapidly changing platforms that contain many other items of equipment. Radar can therefore not be considered as a separate entity. Its design must ensure its "compatibility" with the systems of which it forms a part, and with the dense electromagnetic environment to which it is often exposed. Naturally, and most importantly, it must also satisfy operating requirements.

Radar technology evolves at a rapid pace and can quickly appear obsolete. For this reason it is only briefly developed in this work. However, we have taken the major trends into account when describing the next generation of radars, as their feasibility is largely dependent on these new developments.

The book is divided into five parts:

- General Principles
- Target Detection and Tracking
- Ground Mapping and Imagery
- Principal Applications
- Radars of the Future

Following a historical overview and a reminder of the main principles behind radar, the functions, modes, properties, and specific nature of modern airborne radar systems are studied in detail. Next, the book examines radar's role within the mission system when carrying out missions assigned to the aircraft or the satellite. The fourth section covers

the possibilities of radar as well as its limitations and constraints. Finally, given changing operational requirements and the potential opened up by technological development, the final section describes how radar may evolve in the future.

Remark

As airborne and spaceborne radars are often used in military applications, and in order to comply with security regulations, in this book we refrain from quoting existing systems or equipment that are either under development or in use. Explanations and examples are therefore based on the laws of physics (i.e., information that is in the public domain) and on hypothetical "equipment."