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Perspective

Fundamentals of Radar Signal Processing

Joseph Stephen*

Department of Geography and Planning, University of Toronto, Toronto, Canada

DESCRIPTION

Signal processing for radar systems is a significant and fascinating field that covers several techniques and related to many application areas. It has since then evolved into an essential in all weather conditions, long range sensor. Military and security applications have usually been the principle drivers of radar development. However, recently, radar has become a key technology for civilian applications which includes air, maritime and ground traffic control, in addition to urban sensing and indoor monitoring. Radar not only impacts our present time in worldwide, but also shapes our future. According to its acronym radio detection and ranging, the classical radar mission is to detect and locate objects. With the advent of coherent pulse radar, velocity measurements have come to be possible through exploiting the doppler effect. In contrast to camera images and lots of different sensors, radar is capable to provide quantitative data on the range and speed. Today specialized radars measure range as well as azimuth and elevation angles, to enable target detection and localization.

Through Synthetic Aperture Radar (SAR), Inverse Synthetic Aperture Radar (ISAR), or Interferometric SAR (InSAR), a 3D picture of an object can be obtained. In recent years, passive radar systems were gaining considerable and increasing attention for both target detection and ground imaging. Applications of radar techniques span from ocean modern monitoring to Earth digital elevation mapping, from automotive to biomedicine, from industrial monitoring in IoT scenarios through the wall imaging, from the detection of essential signs and discerning the activities of daily living to UAV monitoring for a broad overview of many radar signal processing strategies and applications. There are also many key radar applications in agriculture, forestry, soil moisture monitoring, geology, geomorphology and hydrology, oceanography, land use, land cover mapping, and archeology. Radar has a long record and concluded from the growing applications of active sensing, it has an illustrious and bright future. Future radar systems should efficiently support a massive kind of applications with novel hardware solutions and innovative signal processing techniques. Sparse Sensing or Compressed Sensing (CS) has been successful in solving the issues of target detection, estimation and classification in radar applications.

It combines nonlinear reconstruction algorithms and pseudorandom linear measurements to resolve under determined linear equations that define many inverse problems. It describes the application of CS techniques for pulse compression, radar imaging and air space surveillance with array antennas. Over the last decade, CS and sparse signal reconstruction methods have been broadly implemented to tackle traditional radar problems, e.g., high-resolution target Direction of Arrival (DOA) estimation, in addition to emerging problems, e.g., spectrum sensing in cognitive radar. More recently, sparse sensing was blended with gadget mastering to remedy the trouble of lacking or restrained information. Optimization strategies with sparse regularizations and constraints had been applied in both phased arrays and Multiple-Input Multiple-Output (MIMO) radar platforms for efficient radar aperture design under a given number of frontend receivers.

CONCLUSION

Sparse array design with different objective and cost functions have benefited from recent advances in convex optimizations and Semidefinite Quadratic Programming (SQP). Global optimization methods, like particle swarms or simulated annealing, have been applied for array design with flexible antenna placements. Another successful design approach is the Cyclic Algorithm (CA) that optimally matches the designed and desired beam patterns through iteration.

Correspondence to: Joseph Stephen, Department of Geography and Planning, University of Toronto, Toronto, Canada, E-mail: jstephen@tor.cn

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