Receive Mode Analysis and Design of Microstrip Reflectarrays

A new method developed for the design of microstrip reflectarrays is extremely efficient.

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Traditionally microstrip or printed reflectarrays are designed using the “transmit mode” technique. In this method, the size of each printed element is chosen so as to provide the required value of the reflection phase such that a collimated beam results along a given direction. The reflection phase of each printed element is approximated using an infinite array model. The infinite array model is an excellent engineering approximation for a large microstrip array since the size or orientation of elements exhibits a slow spatial variation.

In this model, the reflection phase from a given printed element is approximated by that of an infinite array of elements of the same size and orientation when illuminated by a local plane wave. Thus the reflection phase is a function of the size (or orientation) of the element, the elevation and azimuth angles of incidence of a local plane wave, and polarization. Typically, one computes the reflection phase of the infinite array as a function of five parameters in the rectangular patch array as a function of five parameters in the rectangular patch array. Further, if the beam peak is in the broadside direction, the receive mode design is expected to be substantially simpler than the traditional transmit mode design. In addition, when a designer needs to generate the reflection phase data using a commercial code such as Ansoft HFSS, the reduction of computational effort in the receive mode will result in a substantial saving in design turnaround time. Similarly the receive mode analysis technique has potential to save computer time for large reflectarrays.

Microstrip reflectarrays have desirable features such as ease of design, manufacturability, and deployment for application in many space-based radar and remote sensing systems. They are being investigated for many JPL systems such as SWOT (Surface Water Ocean Topography). The receive mode design and analysis technique is expected to find many future applications in NASA.

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Chance-Constrained Guidance With Non-Convex Constraints

This solution can be used for non-convex guidance problems in small-body rendezvous, formation flight, and uninhabited aerial vehicle applications.

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Missions to small bodies, such as comets or asteroids, require autonomous guidance for descent to these small bodies. Such guidance is made challenging by uncertainty in the position and velocity of the spacecraft, as well as the uncertainty in the gravitational field around the small body. In addition, the requirement to avoid collision with the asteroid represents a non-convex constraint that means finding the optimal guidance trajectory, in general, is intractable.

In this innovation, a new approach is proposed for chance-constrained optimal guidance with non-convex constraints. Chance-constrained guidance takes into account uncertainty so that the probability of collision is below a specified threshold. In this approach, a new bounding method has been developed to obtain a set of decomposed chance constraints that is a sufficient condition of the original chance constraint. The decomposition of the chance constraint...
enables its efficient evaluation, as well as
the application of the branch and bound
method. Branch and bound enables
non-convex problems to be solved effi-
ciently to global optimality.

Considering the problem of finite-
horizon robust optimal control of dy-
namic systems under Gaussian-distrib-
uted stochastic uncertainty, with state
and control constraints, a discrete-time,
continuous-state linear dynamics model
is assumed. Gaussian-distributed stochas-
tic uncertainty is a more natural model
for exogenous disturbances such as wind
gusts and turbulence than the previously
studied set-bounded models. However,
with stochastic uncertainty, it is often im-
possible to guarantee that state con-
straints are satisfied, because there is typ-
ically a non-zero probability of having a
disturbance that is large enough to push
the state out of the feasible region.

An effective framework to address ro-
buseness with stochastic uncertainty is
optimization with chance constraints.
These require that the probability of vio-
lating the state constraints (i.e., the
probability of failure) is below a user-
specified bound known as the risk
bound. An example problem is to drive
a car to a destination as fast as possible
while limiting the probability of an acci-
dent to $10^{-7}$. This framework allows
users to trade conservatism against per-
formance by choosing the risk bound.
The more risk the user accepts, the bet-
ter performance they can expect.

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