Analysis report of "Design of Millimeter Wave Microstrip Reflectarrays"

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1. First reading: introduction and conclusion (what is it about?)
2. Second reading: the authors are brilliant! (detect good ideas)
   (a) the authors had a strong motivation to perform this research: which one?
   (b) they established something successful in that direction that constitutes the main contribution of the article: what exactly?
   (c) what makes them/you enthusiastic about this result?
3. Third reading: the article has weaknesses! (scientific doubt)
   (a) real scope of the experimental results?
   (b) justified affirmations?
   (c) exaggerated extrapolations?
   (d) mostly obvious results?
4. Quality:
   (a) of course there is this "summary aspect" with the key points of the article, their links with the cited references, what novelty is offered by the article
   (b) but you should also check additional information, what is known elsewhere about the subject, from what sources you got it, and what is the reliability of these sources
   (c) lastly, you should have a critical view, to evaluate the real scope of the article, some assertions of the article may possibly be a little too "optimistic." Are they some extrapolations of external results, possibly a little abusive? is the structure of the article properly made with respect to the its goal? do the experimental results actually support the assertions? etc.

5. Scientific contribution:
    (a) What is the scientific domain and context of the contribution
    (b) In what respect is it original w.r.t. other contemporary or past publications?
    (c) avoid recursive readings from article references to article references: it rapidly goes deep in the past.
    (d) rather use keywords and your ability to explore bibliography
    (e) Have hindsight and do not neglect to put the article into context
6. Writing:
    (a) Is the introduction informative and motivating?
    (b) Are experimental material and methods properly described?
    (c) In the discussion, are the main affirmations actually deducible from their experiments and the current knowledge?
    (d) Are the results actually innovative?
        i. w.r.t. the year of the article,
        ii. in particular w.r.t. the previous publications of the authors.
7. Generally:
    (a) within 2 to 4 pages, you cannot go into all the technical details
    (b) rather have hindsight in order to understand the role of each technical aspect within the whole contribution
    (c) one (or a few) technical aspect(s) may be a major articulation of the contribution; in which case you should point it out and explain why this aspect is of major importance
    (d) being concise is also part of the exercise

General ideas or thoughts:

1. Reading 1: generally
2. the article is about design of microstrip reflectarrays and describing shortcomings of the approach
3. microstrip reflectarrays: microstrip is a printed patch, reflection antenna is a radio lens, antenna arrays are periodic pattern of antennas, that use wave phase shift to form beams
4. validation: the results of reflectarray analysis are compared to the experiments (several antennas are built)
5. the design and application are actually complex, as it requires accuracy in both solving the model and accuracy in materials and manufacturing

6. Reading 2: positive
7. The approach is designed to be adapted to several methods of feeding
8. The article is of high-quality: presents the (too) technical part, approach to applied design and verification in one concise package.
9. Features problems with different configurations: rectangular shape, for example, causes disturbance in electric field density, but collects more radiation from the feed, thus increasing spillover efficiency.
10. Phase errors: phase shift of patches is sensitive to accuracy as the dependency between the patch size and phase is really small; non-calibrated feed and substract choice can also introduce random phase errors.
11. Detailed description of experiments, a lot of explanations on causes of errors, but no mention of how measurements are done and their shortcomings (their accuracy and precision, number of experiment samples).
12. The method presented can also predict radiation pattern of the antenna, which is also compared and pretty well match the experiment data.
13. The authors admit that there are some things that they cannot explain, plus for honesty ("We are unable to explain the relatively high sidelobe levels for the reflector antenna, or the slightly low value of measured gain").
14. Reading 3: negative
15. There is no novelty: the authors already discussed (in a slightly more high-level manner) the idea behind the reflectarrays analysis and design in their previous papers ([2, 1]).
16. Not mentioned: how big the reflectarray can be depending on the frequency; it seems to me, that for some frequencies and speeds of frequency modulation, wave would be a complete unsynchronized mess on output aperture.
17. The images of reflectarrays are terrible, it is not possible to see anything (probably the images in the original publication were okay, but this is what we got in the available version).
18. Doesn't give any numerical comparison to the state of the art, nor classical antennas.
19. At the same time authors present the results like a justification for reflectarray feasibility, which is dishonest without direct comparison (it is possible that I am as an non-expert cannot understand the parameters, thus this point actually can be flawed).
20. The results thought support the claims that it is possible to create a reflectarray

Technical:

1. Reflectarray is a substitution for parabolic antenna.
2. Because it is flat and the output beam direction is controllable by the pattern on it, it is more flexible.
3. Array part of the name is explained by the same working principle of beam forming as the phase arrays: by delaying the same signal in an array, the output waves from each component of such array, constructively resonate in a chosen direction, destructively resonating in others.
4. This creates a planar beam.
5. To see it another way: the reflectarray pattern essentially performs distance compensation for the input wave.
6. This way changes in wave, like frequency modulation, which is used to transmit information, are observed uniformly at the aperture of the antenna.

References

[1] D. M. Pozar and T. A. Metzler. Analysis of a reflectarray antenna using microstrip patches of variable size. 29(8):657–658.

[2] S.D. Targonski and D.M. Pozar. Analysis and design of a microstrip reflectarray using patches of variable size. In *Proceedings of IEEE Antennas and Propagation Society International Symposium and URSI National Radio Science Meeting*, volume 3, pages 1820–1823 vol.3.