Evolved Microstrip Patch Antenna by Genetic Programming

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Current methods of designing and optimizing antennas by hand are time, effortful, limit complexity and require significant professionalism and experience. With this approach, an antenna engineer will select specific class of antenna and then spend huge amount of time for adjusting and testing to get desired results. Also, the antennas need to be inexpensive, efficient, and robust for the installation environment. The conventional optimizers can only find the best solution among pre-defined shapes of antenna [1]. As another approach which can overcome these limitations is building an evolutionary software that can find out the effective design solution that would originally not be found [2] and has capable of solving the need of conformal and multiband in restricted area. Therefore, this work places emphasis on new approach to automatically design the antennas and describe an example of innovative microstrip patch antenna (MPA) created using this technology that operates at 3.5 GHz as an ideal and suggested bandwidth of 5G technology.

An evolved antenna is an antenna designed fully or substantially by an automatic computer design program that uses an evolutionary algorithm. In this article, we present our work in using evolutionary algorithms to an automated antenna design system. Based on the primal individual structure of genetic programming (GP) is a tree form, a new data-structure computer program which can be represented as entire parameters of an antenna has been explored (as an example shows in Figure 1 (a)). Then, the parallelism technique is used to evaluate the fitness of all tree-structured via electromagnetic simulator HFSS. The first experiment has been done successfully for automated design the antenna for 5G mobile device which is MPA that operates at 3.5 GHz with greater 100 MHz of bandwidth. The innovative MPAs are obtained by this software. This work shows a great potential of the development of the intelligent computer program for automated synthesis antenna as well as conformal antenna.

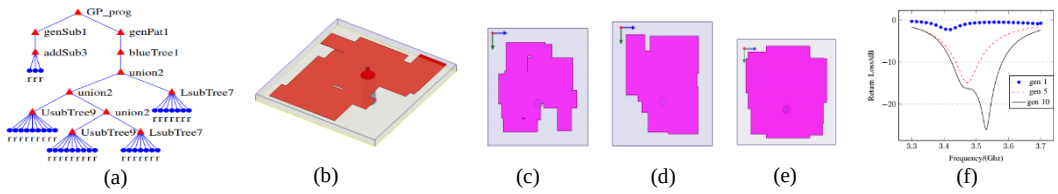

Figure 1. Example of progam architecture (a), it's antenna structure (b), (f) show the antenna become better after generation 1 (c), generation 5 (d) and generation (10)

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To show the antenna to be better during the evolution, Figure 1 (f) shows the difference of three best antenna found in generation 1, 5 and 10. This work shows the development and application of GP to synthesizing and optimizing the antenna. The synthesis process can match the antenna impedance and do so with minimal human effort required. Also, this new capability within HFSS can be used for many applications in addition to MPAs design. The software has automatically synthesized new MPAs according to user specifications.

Future work in this area will adding multiple bands, synthesis, and exploring the limits of how small the antenna can be when synthesized in this fashion. Especially, trying with other type of antenna like conformal antenna, PIFA antenna, RFID antenna, etc will be implemented. Finally, performance of the GP software will be increased by hybridization of GP with a low-level optimizer.

1 Ho Manh Linh, M. Mussetta, F. Grimaccia, R.E. Zich "Differentiated Meta-PSO for Rectangular Ring Antenna with Proximity-Coupled Feed" 2013.

2. Gregory. S. Hornby ; Jason D. Lohn ; Derek S. Linden "Computer-Automated Evolution of an X-Band Antenna for NASA's Space Technology 5 Mission" 2011.