Bioinspired symbiosis algorithm

Another focus in multiobjective optimization

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***Abstract*— This paper presents a brief notion of multiobjective optimization and proposes the development of a new optimization method based on the symbiosis of lichens and the principle of Pareto efficiency.**

Keywords*— *electromagnetic; algorithm; multiobjective; symbiotic.

I. INTRODUCTION

When studying the analysis and synthesis of systems for wireless communication, including integrated systems of filters and antennas, it is common to find situations where there will be two or more conflicting objectives, such as input gain and impedance, both have a Small dependence on each other, even if they are measured in different units (dB / Omhs) [1]. In these types of problems it is not possible to obtain a solution that meets the two objectives optimally, instead it is possible to obtain a set of alternative solutions, among which it will be possible to indicate a solution that is optimal when considering all the constraints of the objectives involved In the problem, these solutions are also known as Pareto optimal [2].

II. BIOINSPIRED ALGORITHMS

One form of optimization that has yielded good results are bio-inspired algorithms, or algorithms inspired by nature. These algorithms apply metaphors to biological systems models to design ways to solve complex computational problems [3], [4].

In the literature, there is a wide range of bio-inspired approaches to solve various problems, and recently satisfactory results have been presented for solving complex problems with these techniques. The three predominant classes of bio-inspired algorithms involve evolutionary, swarm-based, and nature-based algorithms that are inspired by natural evolution, collective behavior of animals, and the integration of elements of nature into the environment [5].

Evolutionary algorithms are all population-based, with stochastic search algorithms using the best sample criteria. Swarm algorithms are based on the social behavior of organisms and are the implementation of collective intelligence, based on animals or insects to solve problems, displaying decentralized and self-organized patterns in the search process of the solution. The third classification of these algorithms is ecology, where they are made analyzes of the interaction of the organisms inserted in the environment with the abiotic elements present in it as air, soil, water, among others [6]–[8].

III. MULTIOBJECTIVE OPTIMIZATION

As already mentioned, multiobjective optimizations seek to solve problems characterized by the existence of more than one criterion to be optimized and, in most cases, they are conflicting criteria. When dealing with mono-objective problems, the optimal ones correspond to the extreme solutions of the objective function of the problem in question, as can be seen in Fig. 1, the values obtained as solution of this problem are the values framed as global maximum or minimum.

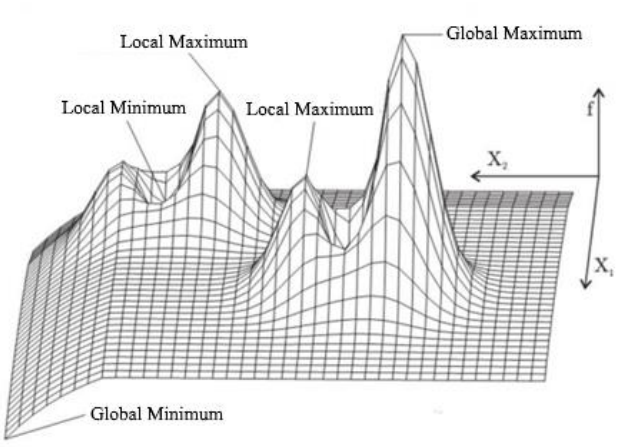

Fig. 1 - Examples of maximum and minimum points in a function.

Thus, it can be said that for multiobjective problems this form of resolution is not acceptable because it is not possible to adopt the extreme solution of one of the objectives when the other criteria are relevant to the problem, that is, solutions located in the extremes for a single objective Will require a compromise of the other objectives, from there we will have a conflicting scenario.

Multiobjective problems require that the resolution take place in two spaces simultaneously, being a space of variables or decision and a goal space, and thus a mapping of all the solutions (points) of the space of variables to the space of objectives of the problem

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IV. SYMBIOSIS OF LICHENS

Lichen is a living being originated from the symbiotic relationship of mutualism between fungi and algae. The components of the lichen symbiosis are given their own names. green algae and cyanobacteria, which are responsible for photosynthesis, are called photobionts (photo = light; biont = living), and fungi are mycobionts (myco = fungus). Therefore lichen will be the result of a photobiont with a mycobiont, as can be observed in Fig. 2.

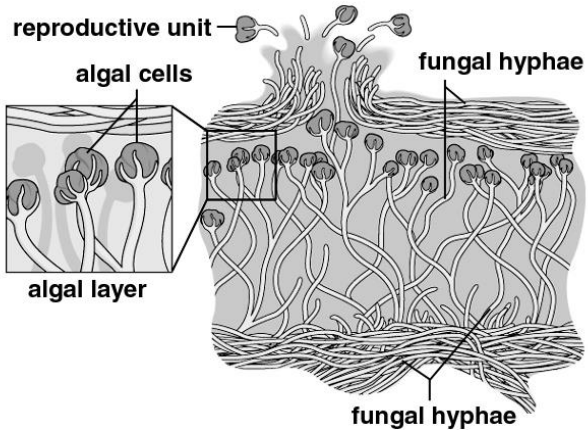

Fig. 2 - Elements of the mycobionte involving photobiont cells

In the relation of the lichens the photobionte is responsible for providing the food for the mycobionte, whereas the mycobionte provides the favorable environment for the survival of the photobionte. Fungi are known in nature as decomposers of organic matter, so they degrade matter to obtain their food. So usually fungi are found inside some substrate, such as rotting tree trunks. Since lichens, or lichenized fungi as they are also known, do not need to decompose the matter, since the photobionte provides the food. This only needs light to produce the food, so that usually the lichens are found on the substrate and not inside it, and are not decomposing this substrate, so they are not parasites [9], [10].

V. PRINCIPLE FOR ALGORITHM DEVELOPMENT

Using as a base the symbiosis observed in the lichens and searching for other techniques that allow the resolution of multiobjective problems with conflicting criteria.

It was observed that the principle of efficiency, or optimal, Pareto, which says that the set of solutions of a multiobjective optimization problem is all the decision vectors for which the corresponding vectors objectives can't be improved in any dimension without any degradation in the other, associated with the symbiosis of lichens can solve complex multiobjective electromagnetic problems with greater efficiency [2], [11].

All decision vectors that are not dominated by any other decision vector of a given set are called non-dominated in relation to this set. The non-dominated decision vectors throughout the search space are now called Pareto optimal and constitute the group known as the Pareto front, as can be seen in Fig. 3. This set of non-dominated solutions are the possible solutions to the multiobjective problem.

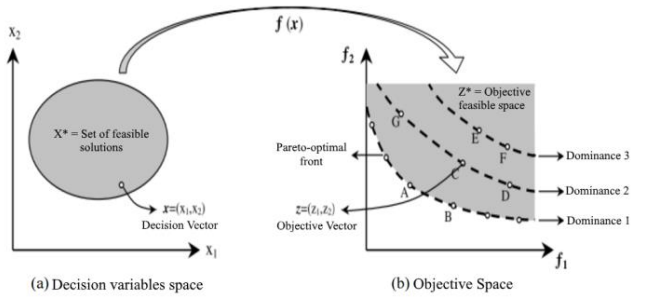

Fig. 3 - Set of feasible solutions and feasible objective space with degree of dominance in a minimization problem

The next objective in this research is to improve the Pareto algorithm, using principles observed in the symbiosis of lichens, so that it can be used to optimize the integration between filters and antennas, and to compare the results obtained with the implementation of other existing algorithms in the optimization Multiobjective and check what has the best result.

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