APPLICATION of GENETIC ALGORITHMS FOR SOLUTIONS OF THE TASK IS FREQUENT - TERRITORIAL PLANNINGS GROUP RADIO ELECTRONIC EQUIPMENT

Kulaga V.V., Muravjev S.A., Spiridonov S.V., Telyatnikov R.V.
Republic Belarus, Military academy RB, ph.: 269-48-82

Abstract - One from the important problems, is a problem of limited frequency's number between radio electronic equipment's (REE) within large group. It is necessary that all REE may operate with specific correlation of signal-noise (interference) on boundaries of their service's zones, con sideling of electromagnetic compatibility. The aim of the work is the process of recommendations on application of genetic algorithms (GA) for solution of the optimal forming of frequencies - territorial scale of REE.

Key words - electromagnetic compatibility, genetic algorithms.

The high efficiency of REE stimulates fast rates of their distribution in all areas of human activity. According to this the electromagnetic situation becomes moke difficult, consequently arises the problem of electromagnetic compatibility in condition frequencies's channel limitation. One from such problems, is the problem is distribution frequency channel in limited condition, within a large group of REE, with a proper correlation of signal-noise at the boundaries of their operational zones. The solution of given problem amount to optimization is frequent - territorial scale (FTS). At a moment this problem is decided by consideration review of several pairs, with the consequent complex processing results of researches. For example, a radio set is selected with which a individual assigned frequency. Then the pair variants of operation this REE with other one are examine, next the most appropriate frequencies for these of REE of classification are selected. This procedure is repeated a lot of times for all classification. As a result each REE has a specific frequencies, but in case that the radios received frequency in last turn the station in which the last REE will has not appropriate level of signal-noise on boundary of operating zone.

The aim of this publication is processing of the recommendations on application of GA for the solution of frequency-territorial distribution for all REE classification's.

The simple GA, includes three simples operators, there are the following:

- Operator of reproduction (OR)
- Operator of crossing (OC)
- Operator of mutation (OM)

OR is know as the artificial version of natural selection. The OR realizes a choice best of chromosomes for the next operation of GA, it is operation of crossing. OC is a casual rupture chromosomes of the same size with their consequent connection in a new casual combination. This fact supports the search of an optimum on all area of acceptable solutions. The OG realizes "moving" on total area of solutions using the "jump". It allows to quit from local optimum, but also detection of global extremum does not guarantee. The mutation is a casual genetic changes within chromosome, were intended for finding news qualitative properties, intrinsic defined solution.

The GA provide a random search of suitable solutions, the way of optimization fitness function (FF). In a role of FF for given problem, it's to use value describing a level a signal - noise on a boundaries of operating zones all REE in classification. The value of genets can accept values of all allowed frequencies in classification. After casual creation of a source population (set chromosomes) the OR selects chromosome for OC and OM, which create qualitatively new by casual image. If the values FF of these solutions a rather great, they can get in a new population and to participate in the next cycles of operation of GA. This the population chromosomes with good values of FF is created, from this values (as the best) chromosomes are selected (for given problem it is a best FTS).

Accuracy and rate of finding of the best solution depend on parameters GA, manner of coding information in chromosomes, also from the size of an initial population.

The number of experiments was conducted. The aim of it was detection of degree of influence of varied parameters GA on tate and accuracy of solution's finding of given above problem. These parameters were the various procedures of choice chromosomes

on reproduction stage, level and degree of mutation in strings (lines), also the number of chromosomes in an initial population.

The experiments have shown, that the it is more chromosomes in initial population, then the faster GA finds appropriateble solution. It's a fact that calculating difficult is increasing and there fore process of operation GA becomes more durablis in time. It'is necessary to find the conciliatory proposal. According to the authors opinion, such solution is the size of initial population approximately equal (0.25 — 0.30) *n chromosomes, where n — amount of researched objects (for our case, n the number REE in classification).

In reproductions stage the procedure of chromosome's choice renders significant influence to a course of calculating. Were investigated a simples, biquadratic, relative roulette and procedure of cut of the worst solutions. In usual roulette game, the ball has absolute identical chances to stay in anyone sectors. But if the roulette is divided into unequal sectors (fig.1), the probability roulettes ball will stay in broad sector, is great, and narrow — is small.

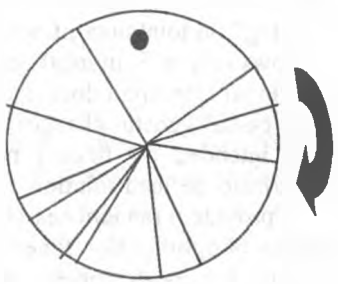

Fig. 1

With the reference to function of GA, each sector of formed simple roulette corresponds to one chromosomes and the size of the sector is proportional to this chromosome's goal function. The inequality of roulette sectors leads to nonuniformity of chromosomes choice. The casual character of choice can not lead in choice chromosomes with extremely good value FF, but for average OC and OM will be selected the best chromosomes, which will participate in creation of acceptable solution.

The main difference between biquadratic and simple roulette is, that FF of each of chromosomes is raised in the fourth degree. It provides increasing of probability of a choice chromosomes with large value of FF. For example: let there are two chromosomes in population the values of these chromosomes are equal 0.4 and 0.6. The probabilities of choice these chromosomes using simple roulette are equal 0.4 and 0.6 accordingly, and using biquadratic are equal 0.16 and 0.84. The wide difference is observing on initial stages of operation GA, then the FF chromosomes have small values. On final stage, when FF chromosomes are rather great and are identical, biquadratic roulette operates as simples.

The operation of relative roulette considerably differs from simple one. The operation of relative roulette can be described as follows: the worst line must be selected from all population, it value of FF is multiplied on 0.95. The obtained result takes as a start of counting. Next recalculating FF from each of chromosomes of population in relative values is further produced. These values are calculated as difference between the value of FF each chromosomes and starting of counting. The is "stretching" range of values FF chromosomes of population is produced. The total value of all relative values FF chromosomes of population undertakes square of all slabe of roulette, and sectors of formed roulette are the relative values from each chromosomes. It is a fact that the best chromosomes in relative roulette have probability of a choice for the next procedure more than ten times greatly than worse ones. Let's return to an offered example: the worse lines or (chromosomes) with FF equal 0.4 is multiplied on 0.95. As a result we have value equal 0.38, this number must be received as a beginning of counting. The relative value of worst chromosomes is equal 0.4-0.38 = 0.02, and for best ones 0.6-0.38 = 0.22. Therefore probability of choice for best chromosomes 0.22 / (0.22 + 0.02) = 0.92, and worse ones is - 0.08. Utilization of relative roulette gives advantages before idle time on initial stages of operation GA. In a final phase of algorithm operation the application of such means is undesirable, as the probability of choice chromosomes using relative roulette does not depend on values of them FF. The relative registres residual between the best and worst chromosomes only, and for OC and OM will be selected same chromosomes. It provides narrowing of searching space of suitable solution.

OR operation "cut" deletes from populations the worst solutions. This procedure perfectly operates, when the researched function has "smooth" sort fig.2a, or it has some equivalent extremums fig.2b. In case that researched function has sort shown at fig.2c, the application of the given procedure very seldom leads to finding sought solution, thus in case of hitting in one of local extremums "cut" leads in fast convergence of population. OC here does not operate. It does not allow to leave from deep local extremum.

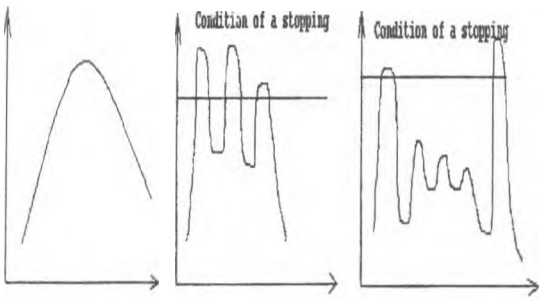

Fig. 2a Fig.2b Fig.2c

This or that procedure uses depending on stage of calculations. In the beginning of calculations, when FF has small values, the relative and biquadratic roulette "operates" perfectly, just these procedures provides " most directed " search at the expense of selection only best chromosomes, that on initial stage is positive feature. At this stage "direction" of search is selected and the eventual result depends on its selection. On final a stage, when the founded solution differs insignificantly from the value of stopping criterion of GA, it is recommended to use a simples roulette, which in difference from relative, allows to select not only best chromosomes populations, but also chromosomes with a small value FF. It provides the extension of searches area of acceptable solution. The fig.3 is represented the dependence's between finding of acceptable solution and the number of steps of GA's operation with a diverse procedures of selection chromosomes at stage of reproduction.

If during function GA has got in a local extremum, it is recommended to use "biquadratic" roulette, with high level of mutation, or depositing in population of so-called "chaos". In a role of "chaos" it is recommended to introduce to population accidentally generated chromosomes.

The leaded researches also have shown, that according to amount of steps GA and intermediate results of FF it is possible to judge about the degree of "variability" of researched function surface. For example, if GA during small number of operation cycles

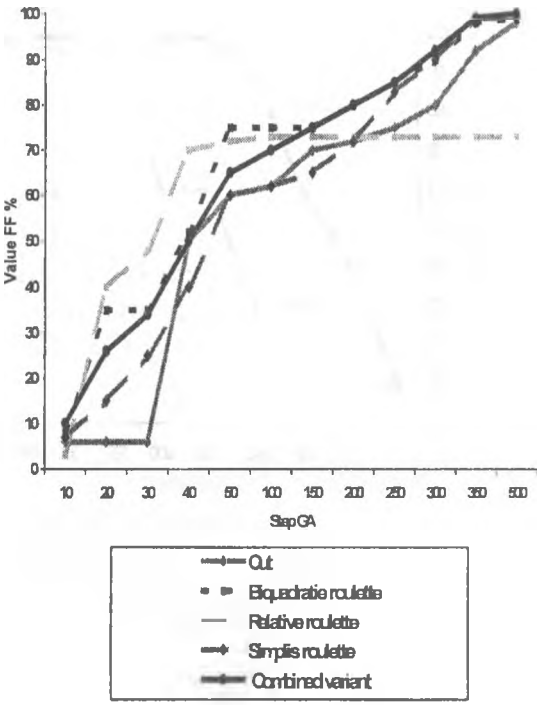

Fig. 3

finds suitable solution and the procedure of "cutting" is used, that researched function has "smooth" form with exactly expressed by one or several identical local extremums, satisfying to creation of stopping. If GA finds the suitable solution with using biquadratic or simples roulette only, and at that values of FF best of chromosomes populations are stationary for a long time, it is possible to draw a conclusion, that the researched function has "ravine" kind. The fig.4 has presented two graphic, which permitting to judge about degree of "variability" of the researched function. One of them is corresponded to the "smooth" function, and another one to "ravine" kind.

The recognition of the researched function allows to give the recommendations at the choice of parameters GA for providing solution of the concrete optimization problem.

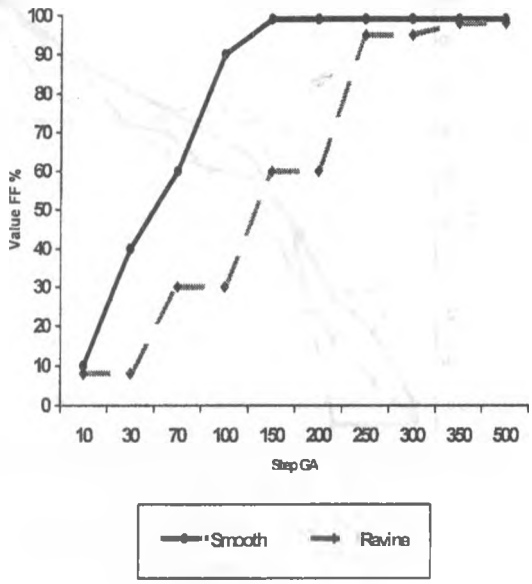

Fig. 4

In the conclusion it would be desirable to notice, that GA can use successfully for other problem of integral optimization, such as the problem of direct-sales, representative of the problem of tracing and packing, but each new problem requires the unique customizations.

The literature

Апорович А.Ф. Статистическая теория электромагнитной совместимости радиоэлектронных средств. Минск: Наука и техника. 1984г.