Analysis of Genetic Algorithms Convergence Applied to Mensuration Problems in Computer Vision

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1 Results

Design of multi station sensor configurations implies the optimal planning of camera positions in order to obtain high accurate measurements. In this way visual measurements can be achieved by the well known triangulation process. However, multiple constraints and design considerations must be taken into account by the designer in order to overcome the complexity of the problem. Automation of this process has been achieved through genetic algorithm methodology [1].

The understanding about the convergence time rates of genetic algorithms it's necessary in order to know how long it takes. Huber's analysis about the total expected time with respect to the input data gives the following approximation:

$$E_N \approx (\frac{1}{p}) \sum_{i=1}^{N} \frac{1}{i} \approx 2^K \ln N \tag{1}$$

The major point in this analysis is that the performance of the algorithm can be greatly improved if:

- The sampling of each parameter in the optimization is made independently, and
- The evaluation represented by the fitness function is highly discriminant.

Under these circonstances the genetic algorithm must follow its ideal form. The speed of execution will be N times faster than any hill climbing random search. After computing the data, the final curves do not fit the proposed theoretical model, see Figure 1. Moreover, this graph shows that the number of generations needed to converge is independent of the number of parameters, that the calculation cost is about proportional to the number of parameters involved, and that the final expected time is lower than the theoretical model for a higher number of variables, considering that the theoretical model always increase and the real value stabilizes around a single value.

A series of experiments to test the properties of convergence time and accuracy, in the case of different crossovers

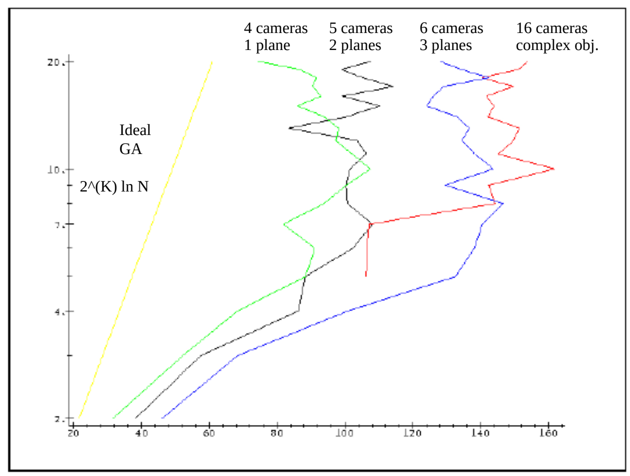

Figure 1 *The following graphs show the curves plotting in the Y axis the number of cameras in a logarithmic scale. It let us see that the computed data does not follow the proposed model.*

as well as the gray code, corresponding to the case of 4 cameras measuring a plane has been computed. No significant differences have been obtained through these different variants of the algorithm. These results significantly differ from other researchers as Fogel, which has reported a leading edge in the convergence time as well as in accuracy for the uniform crossover. A report about these aspects and others involved in this research can be obtained by request to the autor.

Acknowledgments Author is grateful for research founding of CONACYT México (grant 66291).

References

[1] Gustavo Olague. *Planification du placement de caméras pour des mesures 3D de précision*. PhD thesis, Institut National Polytechnique de Grenoble, Octobre 1998. ftp://ftp.imag.fr/pub/Mediatheque.IMAG/theses/98-Olague.Gustavo/notice-francais.html