Evaluation of the Effects of Noises by Experiments Using a Mobile Robot

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1 INTRODUCTION

In practice applications, the systems include many types of errors and noises, such as sensor noise, manipulation error and time dependency of environment. There are many studies which report that the search abilities of GA suffer from noises (Nissen 1998). Also, there are some theoretical analyses of effects of noises on GA performance (Miller 1996, Sakamoto 1997). The mostly model of the theories are employed the assumption of additive fitness-independent noise. Thus, the observed fitness function f' is indicated as

$$f' = f + \mathrm{n}(\sigma),$$

where f is a true value of fitness in noiseless environment and $\mathrm{n}(\sigma)$ is normally distributed noise with variance σ. To testify the assumption for real-world problem, we have carried out experiments of a mobile robot navigation.

2 EXPERIMENTS AND RESULTS

The lawn mower problem, which task is to pass though a whole arena in the while avoiding obstacles and walls (collision-free), was employed. We made an simulator considering sensor noises, which simulates a real robot called "Khepera" in the arena of 0.6m by 0.6m. The experiments were performed using a simple GA with a population size of 200, tournament selection, and uniform crossover.

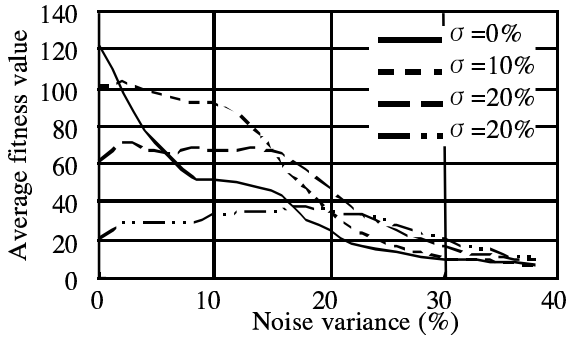
At first, we have carried out simulations in different sensor noise-levels. The results represent that convergence times become longer with increasing the noise levels, what is predicted by the theory mentioned above. Moreover, those show that the converged fitness values are decreased as the noise increasing. The results suggest that the assumption is not adequate to a mobile robot navigation problem with the sensor noise.

One of the hypotheses is that the fitness function in noisy environment is determined by the noise-level. To confirm the hypothesis, the strings converged in environments fixed noise-level of σ=0% (noiseless), 10%, 20%, and 30%, were put into various noise-level environments. The figure shows the average fitness-values of the strings in terms of noise variance. According to the model using the assumption, because the mean of the noise is a constant, the fitness value must be independent of noise-level. Also, it is possible to imagine the limitation boundaries of fitness value in terms of noise-level. Consequently, the fitness values are depend on the noise-level.

In the figure, the lines of σ=20% and 30% have peaks nearby the noise-level of 20% and 30%. It implies that a best niche is the noisy environment, not a noiseless environment. They are specialized in the noise-level in which the strings are evolved.

3 CONCLUSIONS

The experimental results indicate as follows: 1) the assumption of additive fitness-independent noise is not satisfy the experimental results, 2) there is the boundary of fitness value depending on control methods in the noisy environment, and 3) the strings grown in the fixed noise-level is adapted the environment, that is, the string is specialized the noisy environment.



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