Chapter 8

SUMMARY AND FUTURE WORK

8.1 Summary

This book investigates the efficacy of evolutionary computation such as a variety of genetic programming and genetic algorithms in learning programs/procedures and selecting features for object detection and object recognition. The reason for incorporating learning into object detection and recognition is to avoid the time consuming process of feature generation and selection. With learning incorporated, an object detection and recognition system can automatically explore many unconventional features that may yield exceptionally good detection and recognition performance, thus overcoming human expert limitations of concentrating only on a small number of conventional features. A learning integrated system is more flexible and is able to automatically generate features on the fly that are particularly effective to the type of objects and images to which it is applied. The ultimate goal is to lower the cost of designing object detection and recognition systems and to build more robust and flexible systems with human-competitive performance.

The contributions of this book include:

- Investigates the effectiveness of genetic programming in synthesizing composite operators and composite features for object detection. It shows that GP is effective in synthesizing effective composite operators based on

domain-independent primitive operators and domain-independent primitive feature images that can be easily generated from the original image for object detection. The synthesized composite operators can be applied to other testing images that are similar to the training images. The composite features discovered by GP are much more effective than the human-designed primitive features from which they are built. The GP learned composite features are generally unconventional features and different than the features designed by human experts. Thus, the learning method will be of a great help in the design of practical object detection and recognition systems.

- Proposes an MDL-based fitness function and smart GP operators to improve the efficiency of genetic programming. An MDL-based fitness function is proposed to address the well-known code bloat problem of GP. The MDL-based fitness function takes the size of a composite operator into the fitness evaluation process to prevent composite operators from growing too large without setting a hard limit on the size of a composite operator, imposing relatively less restrictions on the GP search and greatly improving the GP efficiency. To further improve the efficiency of genetic programming, smart crossover and smart mutation are proposed to identify and prevent the effective components of composite operators from being disrupted by destructive crossover and mutation. Also, a public library is set up to keep effective components for later reuse. Compared to traditional genetic programming, the smart GP, driven by the MDL-based fitness function and equipped with smart crossover and smart mutation, synthesizes composite operators with better performance and smaller size, reducing the computational expense during recognition and the possibility of overfitting the training images.

- Proposes an MDL-based fitness function to drive GA in the selection of features for object detection and recognition. The performance of the MDL-based fitness function is compared with those of three other fitness functions. The MDL-based fitness function balances the number of features selected and the recognition error rate very well and it is the best fitness function compared to other three functions. With fewer features selected, the computational expense and the possibility of overfitting the training data is reduced.