石油化工专业英语系列丛书

仪表自动化专业英语

石油化工专业英语教材编委会 编

中国石化出版社
HTTP://WWW.SINOPEC-PRESS.COM
教·育·出·版·中·心

责任编辑　杜毅漫
责任校对　丁亚玲
封面设计　华海文化

ISBN 978-7-5114-0134-2

定价：150.00元（全套）

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图书在版编目（CIP）数据

仪表自动化专业英语/石油化工专业英语教材编委会编．—北京：中国石化出版社，2009
（石油化工专业英语系列丛书）
ISBN 978－7－5114－0134－2

Ⅰ．仪…　Ⅱ．石…　Ⅲ．工业仪表－自动化－英语－教材
Ⅳ．H31

中国版本图书馆 CIP 数据核字（2009）第 197891 号

中国石化出版社出版发行
地址：北京市东城区安定门外大街 58 号
邮编：100011　电话：(010)84271850
读者服务部电话：(010)84289974
http://www.sinopec-press.com
E-mail:press@sinopec.com.cn
北京金明盛印刷有限公司印刷
全国各地新华书店经销
＊
787×1092 毫米 16 开本 86.25 印张 3250 千字
2009 年 11 月第 1 版　2009 年 11 月第 1 次印刷
定价：150.00 元(全套)

本书编写人员

岳立志　刘晓琴　邵雪梅　高　平　崔青竹　薛　颖

前　言

在经济全球化和高等教育国际化的21世纪，中国高等教育正在与国际接轨，从教育理念、培养目标、育人环境到教材更新和教学方法等方面更加注重学生基本素质、知识结构及实际操作能力的培养，旨在使学生具备较强竞争力和发展潜质，能够在未来的专业领域和职业生涯中迅速适应环境，胜任所从事的工作，成为有所作为的人。专业外语水平是衡量大学生基本素质和综合能力的重要指标之一，在一定程度上决定着学生未来的学术潜力和工作能力。在实际教学过程中，我们发现目前适合工科大学专业外语教学需求的教材比较匮乏。我们应邀编写本系列专业外语教程，就是为了满足工科大学学生和相应读者群的迫切需求。

本套专业外语系列教程包括《仪表自动化专业英语》《材料科学与工程专业英语》《环境科学与工程专业英语》《石油加工专业英语》《过程装备与控制工程专业英语》五部教材。每部教材由30个单元组成，每单元包括课文、词汇表、注释、阅读材料及其注释。课文与阅读材料均选自原版外语教科书、学术报告、专业著作及学术期刊等，语言标准，文体规范，学术性强，难易适度，具有较高的可读性和实用性。

大学本科生在经历基础阶段外语学习之后，通过阅读本教材，能够初步接触本专业领域的基础外语词汇、专业术语和表达方式，领略专业外语的文体和风格，提高专业外语阅读理解能力，为将来直接阅读专业外语文献、进行专业外语写作和学术交流打下良好基础，从而使自己的专业外语水平取得实质性跃进。我们希望本系列教程会对有志于相关专业领域学术研究与发展的学生和读者提供有益的帮助和参考。

为了使这套系列专业外语教程取得理想的教学效果，编者建议选用本教程的学生课前务必认真预习，课堂上教师可组织学生采用介绍、讲述、问答、讨论、归纳等方式，创造积极活跃的课堂气氛，使学生能够得到充分的实践机会，以期达到熟练掌握之目的，尽量避免把专业外语课上成枯燥乏味的翻译课。

《仪表自动化专业英语》是为仪表自动化专业三、四年级本科生编写的专业英语教材。本书内容包括仪表自动化专业领域的专业基础知识和科技文献，旨在丰富学生专业英语知识广度和深度，开拓学生视野。本书选材严谨，内容新颖，适用面宽，针对性强，可以作为仪表自动化领域的专业英语教材，也可以作为相关领域工程技术人员的备用参考书。

本系列教程由辽宁石油化工大学外国语学院英语教师和相关专业英语教师共同编撰。由于时间仓促、水平有限，编写过程中难免出现纰漏，欢迎广大读者在使用过程中不吝赐教，在此我们深表谢意。由于课文选材比较广泛，故未能一一注明出处，在此一并向原作者表示感谢。

Contents

Unit 1

Text

Digital Filter Design Using Multiple Pareto Fronts

Introduction

Evolvable hardware(EHW)refers to one particular type of hardware whose architecture/structure and functions change dynamically and autonomously in order to improve its performance in performing certain tasks. The emergence of this new field in recent years has been influenced profoundly by the progresses in reconfigurable hardware and evolutionary computation.

Conventional and Evolutionary Digital Filter Design

Digital filter design has a number of features that make it very attractive as test problems for our research.

—The problem hasengineering relevance. Digital filters play an important role in communication systems, often at the interface between digital and analog signal processing systems. Examples are mobile communications, speech processing, modems, etc.

—While the science of digitalfilter design is very well established and researched, there are no'conventional'design procedures that lead to optimal designs with acceptable effort in the general case. A survey of relevant journals reveals that digital filter design is an active area of research. For example, the leading IEEE Transactions on Circuits and Systems II published 12 papers on different approaches to filter design in only two years(1998—1999), to name just a few.

—The design space for digitalfilters is well defined but large and complex. A well defined space facilitates comparison of different results. A large and complex design space will challenge our evolutionary system and will be good at evaluating our system's suitability in dealing with tough design problems.

—A quantitative measure of filter performance is generally available, providing a fitness measure for EAs that is relatively easy to compute. It also provides a straightforward metric in comparing different designs. There are many different kinds of digital filters, depending on types of components used(e. g. , linear or non-linear components), restrictions on interconnections(e. g. , with or without feedback)and the intended characteristics of the filters. The difficulty in designing individual filters depends on the exact type of filters. For some, analytical methods are available. For others, approximation methods have to be used. In any case, different filters generally need different design approaches. 44 A human designer specialized in designing one type of filters might not be able to design an optimal filter of a different type. Since no general design methodology is available, evolutionary design will be a good and automatic alternative to manual design.

Advantages of evolutionary design

Evolutionary Algorithms (EAs) refer to a class of population-based stochastic search algorithms that are developed from ideas and principles of natural evolution. They include evolution strategies(ES), evolutionary programming(EP), and genetic algorithms(GAs). One important feature of all these algorithms is their population-based search strategy. Individuals in a population compete and exchange information with each other in order to perform certain tasks.

An evolutionary design approach offers a number of advantages over the conventional one used by human designers although there are some important issues that remain open. ⑥

First, the evolutionary design approach can explore a much wider range of design alternatives than those could be considered by human beings. This has been shown by many experiments in other design tasks, such as evolutionary design of neural networks, or of building architectures. These experiments demonstrated how evolutionary techniques could be applied to evolving novel designs which were difficult to discover by human beings. ⑦

Second, the evolutionary design approach does not assume a priori knowledge of any particular design domain. It can be applied by users without resorting to domain experts. It can be used in domains where little a priori knowledge is available or where such knowledge is very costly to obtain.

Third, the evolutionary design approach is veryflexible. It can deal with non-differential or even discontinuous objective functions. ⑧ It can deal with various linear and nonlinear constraints as well as objectives. Its population-based nature makes it ideal in tackling multi-objective design problems. Although the evolutionary approach can work with little a priori domain knowledge, it can incorporate domain knowledge in the chromosome representation and search operators easily if such knowledge is available.

Limitations of Conventional Design

Designing digitalfilters, especially recursive filters, is not a straightforward problem. ⑨ For certain design problems with particular characteristics, it is possible to mathematically derive the optimal filter configuration; but in the general case, no such method exists. Instead, a number of approximation methods have been developed, usually applicable only for a particular class of design problems.

There are two problems with this design method. First, for new problem classes, an approximation approach has to be developed first. As the title indicates, the class of filters that the method is applicable to is fairly limited. This is different from evolutionary approaches, which can generally be written for much larger classes of problems, allowing it to be used for many different filter design problems.

The second problem with the conventional approach is that, depending on the exact approach taken, the resulting design is likely to be suboptimal.

—Linearization of constraints: All constraints have to be formulated as linear inequalities. Constraints that are not initially linear have to be linearized. To ensure that the linearized constraint still excludes all designs that initially violated the constraint, it has to exclude some viable designs (otherwise the linearized version would have to be identical to the original).

—Objective as least-square problem: the objective has to be implemented as a weighted least-square function. Often, this is not exactly the same as the actual design goal. While the maximum deviation is the 'real' design goal, the accumulated weighted square error is used for the design algorithm.

Mathematical Description of Linear Digital Filters

Any linear digitalfilter can be mathematically specified by a complex-numbered polynomial function, i. e., the transfer function (Eq. 1. 1). This polynomial function, i. e., Eq. 1. 1, can be rewritten as the quotient of two product terms with the numerator specifying the zeroes of the polynomial and the denominator specifying the poles. The function (i. e., Eq. 1. 2) usually has a scaling constant. The two descriptions are equivalent. It is easy to transform a pole-zero description to a polynomial description, but not vice versa. The frequency response can be derived from the transfer function by calculating the values for, $z=e^{j\omega T}$ where $T=2\pi/\omega_s$.

$$H(z)=\frac{\sum_{i=0}^{n} b_i z^{n-i}}{z(n-r)\sum_{i=0}^{r} b_i z^{r-i}} \tag{1.1}$$

$$H(z)=b_0 * \frac{(z-z_{z0})(z-z_{z1})\cdots(z-z_{zn})}{z^{n-r}(z-z_{p0})(z-z_{p1})\cdots(z-z_{pr})} \tag{1.2}$$

Where nis the number of zeros, ris the number of poles, and n−r the number of poles at the origin.

It should be noted that not all transfer functions are generally realizable in hardware. Two main requirements have to be observed.

Real Coefficients

The coefficients in the polynomial description directly translate to multipliers in the hardware implementation. Since it is very difficult to multiply a signal with a complex number, it is important that all coefficients are real. In terms of poles and zeroes, this can be achieved if all poles and zeroes are either real, or exist in conjugate-complex pairs (i. e. $a+jb$ and $a-jb$).

Stability

Because a general IIRfilter has feedback loops, the output may grow without bounds (or in hardware until overflow), or oscillate. In a stable filter, a bounded input will always produce a bounded output. A filter is only stable if all poles are within the unit circle, i. e. $\| a+jb \| < 1$. While there are uses for unstable filters in specific applications, most filters are designed to be stable.

The Evolutionary Design Algorithm

The implementation of an evolutionary algorithm forfilter design faces a number of challenges. The space of possible filters is very large, and individual parameters are tightly coupled, making it more likely for the algorithm to converge onto local, unsatisfactory sub-optima. For this reason, a number of new techniques have been introduced into the selection process. In this article, we will concentrate on the two main techniques, clustering and per-cluster self-adaptive constraints.

Clustering Pareto Optimization

A selection scheme based on Paretofitness is a natural choice for our EA. In Pareto selection, any number of criteria can be used. Only a partial order among individuals, based on dominance, needs to be established. One individual dominates another if and only if its fitness is higher than the other's according to at least one criterion and as good as the other's according to the rest of criteria. 1010 A population will usually contain a number of non-dominated individuals, which are referred to as the Pareto front. Among individuals in the Pareto front, it is not possible to say which one is better than the other.

Different individuals from different regions in the Pareto front can have very different genotypes. Pareto selection allows individuals at the Pareto front to co-exist as long as they are not dominated. Fitness sharing can help increase and maintain population diversity. However, these two techniques are not very good at helping dominated individuals to survive in a population. We are interested in some of the dominated individuals because they may be on different fitness peaks from those occupied by non-dominated individuals.

In order to allow more than one Pareto front to develop independently in the population, we have introduced a clustering operation. This operation will separate the population into a number of semi-independent sub-population according to their genotypes. Selection of parents and for survival is performed on a per-cluster basis, individuals can therefore survive and create offspring as long as they are on or near the Pareto front for that particular cluster.

The clusters in the population are initially established by applying the k-means algorithm to the random, initial population. The algorithm we implemented then distinguishes between an early 'exploration' phase and a main 'exploitation' phase. In the exploration phase, individuals will cover large parts of the search space, and we encourage exploration of the search space by allowing unrestricted crossover. During this phase, we periodically re-cluster the individuals using k-means clustering. At the end of the exploration phase, the population should have discovered a number of promising areas in the search space, and the algorithm switches to 'exploitation' mode. 1111 Here, crossover is restricted to parents of the same cluster only.

Clustering has its largest effect during the selection of the next generation from the current generation and the offspring. In this operation, the cluster memberships are established, and an individuals chance of survival depends very much on which cluster it is in. The following section describes the operation in detail.

Per-clusterParent Selection and Self-adaptive Fitness Sharing

As well as the selection for the next generation, we have also implemented versions of fitness sharing and parent selection that are optimized for a clustered population.

Self-adaptive Fitness Sharing

Analyzing the runs using fitness sharing and clustering, we noted that within each cluster, the population was quickly converging towards a small area of search space. Because each cluster only represents a fraction of the overall population, the number of individuals in the cluster is small, and convergence is therefore more likely to occur prematurely.

To counteract this, we use a niche-count basedfitness sharing. The niche count produces a measure of how many other individuals 'inhabit' the same niche in the population. To do this, distances are computed between individuals and individuals already in the population. This distance is based on a comparison of the genotypes, by computing the geometric distance of the locations of the corresponding poles and zeroes. Since distance calculation is computationally expensive, each individual is only compared to a small random sample of individuals in the population in our EA. This is somewhat similar to implicit fitness sharing. If the distance between two individuals as calculated above is below a threshold(i. e. , the sharing radius), the niche count of the individual is increased by a value inversely proportional to the distance. The niche count will be normalized by the number of samples this individual has been compared with.

This niche count is used in selection of both parents and next generation, individuals with higher niche counts are less likely to become offspring and to survive into the next generation.

An important parameter in niche-basedfitness sharing is the niche radius. This radius defines the size of the niche, only individuals with a distance less than the niche radius are counted in the niche count. The size of the niche radius is therefore critical for the success of niche based fitness sharing. If the value is set too low, very few individuals will be defined as 'sharing a niche'; the niche count therefore provides little information about the distribution of the individuals. Similarly, with a niche size too high, most of the individuals would share one or a few niches again the niche count provides little information about the individual distribution.

The optimal niche radius depends on the distance measure employed, and on the actual distribution of individuals in the search-space. During any particular run, this distribution will change, as the population moves from the random distribution of the initial population towards areas of the search space with good fitness. This in itself is not a problem, as the premature convergence only becomes a concern once the population has concentrate on a few areas. [12] The niche radius is usually set so that it optimal for this phase of the evolutionary run.

In our cluster based implementation, each cluster contains only one or a few majorfitness peaks, and the size of these peaks in the fitness landscape varies from cluster to cluster. As a result, the distribution of the individuals in each cluster varies. The optimal niche size needs to vary too. In order to have different niche sizes for different clusters, we have implemented a new self-adaptive per-cluster fitness sharing algorithm.

In this algorithm, each cluster uses a different niche size. After the creation of new individuals, the new individuals are evaluated. For each individual, the niche count is then computed by comparing it to a number of individuals from the population. The individuals are only compared to other individuals in the same cluster, using the cluster-specific niche radius. The niche count has to be recalculated for all individuals in the population, not just for the new individuals, because the new individuals will have changed the overall distribution of the population. While computing the new shared fitness, the algorithm also computes the average distance between individuals in each cluster. From these values, the new niche radius is computed, simply as a fraction(for example 50%)of the average distance.

Selected from Digital Filter Design Using Multiple Pareto Fronts, T. Schnier, X. Yao, P. Liu, 2003

New Words and Expressins

1. **filter**/ˈfiltə/*n.* 滤波器，过滤器，滤光器，筛选；*vt.* 过滤，渗透；*vi.* 渗入，慢慢传开
2. **filter design**[电子]滤波器设计
3. **autonomous**/ɔːˈtɔnəməs/*adj.* 自治的
4. **reconfigurable**/ˌriːkənˈfigjuurəbl/*adj.* 重构
5. **relevance**/ ˈrɛləvəns/*n.* 关联，中肯，适当
6. **interface**/ˈintə(ː)ˌfeis/*n.* 接触面，接口，分界面
7. **quantitative**/ ˈkwɔntitətiv/*adj.* 数量的，定量的
8. **straightforward**/ streitˈfɔː wəd/*adj.* 正直的，坦率的，简单的，易懂的，直接了当的
9. **stochastic**/stəuˈkæstik/*adj.* 随机的
10. **a priori**/eɪ praɪˈɔːraɪ/*adj.* 推理的，演绎的
11. **chromosome**/ˈkrəuməsəum/*n.* [生物]染色体
12. **fairly**/ ˈfɛəli/*adv.* 相当地，公正地，正当的，公平对待某人，公平地，还算，清楚地
13. **suboptimal**/ ˈsʌbˈɔptiməl/*adj.* 未达最佳标准的，不最理想的，不最适宜的，不最满意的
14. **inequality**/ ˌini(ː)ˈkwɔliti/*n.* 不平等，不同，不等式，不平均，(表面)不平坦((用复数)
15. **linearize**/ˈliniəˌraiz/*vt.* 使线性化
16. **violate**/ˈvaiəleit/*vt.* 违犯，冒犯，干扰，违反，妨碍，侵犯
17. **least-square** 最小平方，最小二乘方
18. **weighted square error** 加权均方误差
19. **scaling**/ˈskeiliŋ/*n.* 缩放比例
20. **real coefficients** 实系数
21. **oscillate**/ˈɔsileit/*v.* 振荡
22. **cluster**/ˈklʌstə/*n.* 串，丛
23. **partial**/ˈpɑːʃəl/*adj.* 部分的，局部的，偏袒的，偏爱的
24. **genotype**/ˈdʒenətaip/*n.* 基因型
25. **sub-population**(从其他人口分出或构成总人口的)分组人口
26. **initial population** 原始群体[种群]
27. **convergence**/kənˈvɜːdʒəns/*n.* 集中，收敛
28. **counteract**/ˌkauntəˈrækt/*vt.* 抵消，中和，阻碍
29. **niche**/nit/*n.* 小生境
30. **threshold**/ˈθreʃhəuld/*n.* 开始，开端，极限

Notes

1. Pareto fronts 帕累托前沿
2. Digital filter design has a number of features that make it very attractive as test problems for our research.

   数字滤波器设计有许多特性使它非常有吸引力，作为检验我们研究的问题。test for 是"对……进行测验"。

3. For example, the leading IEEE Transactions on Circuits and Systems II published 12 papers on different approaches to filter design in only two years(1998—1999), to name just a few.

例如：最主要的电气和电子工程师协会学报仅两年在《电路与系统 II》上就发表了 12 篇关于滤波器设计的不同方法的论文(1998—1999)，仅举几例。IEEE 指的是“电气和电子工程师协会”。

4. In any case, different filters generally need different design approaches.

无论如何，不同的滤波器通常需要不同的设计方法。in any case 是“无论如何，在任何情况下”的意思。

5. Since no general design methodology is available, evolutionary design will be a good and automatic alternative to manual design.

由于没有通用的设计方法，进化式设计将是一个良好的和自动的手工设计替代物。alternative, choice, option, selection 这些名词均含有“选择”之意。alternative 指在相互排斥的两者之间作严格的选择，也可指在两者以上中进行选择；choice 侧重指自由选择的权利或特权；option 着重特别给予的选择权利或权力，所选物常常相互排斥；selection 指作广泛的选择，着重选择者的识别力或鉴赏力。

6. An evolutionary design approach offers a number of advantages over the conventional one used by human designers although there are some important issues that remain open.

尽管有一些重要问题仍然有待解决，进化设计方法提供了相对于人工设计使用的传统方法的众多优势。advantage over 此处为“胜过，优于”的意思。表示方位的介词 above, over, below, under, beneath, beyond, before, behind 等可用来表达比较，在表达比较概念时，这些介词的含义通常是其基本意义的引申，即表示“在等级、标准、地位、价值、品质、能力等方面优于(超过)……或落后于(低于)……”等。open 此处表示“未决定的”。

7. These experiments demonstrated how evolutionary techniques could be applied to evolving novel designs which were difficult to discover by human beings.

这些实验表明进化技术是怎样能应用于为人类很难发觉的不断进化的新颖的设计中。novel在这里是形容词，意思是“新颖的，新奇的”。

8. It can deal with non-differential or even discontinuous objective functions.

它可以处理不可微甚至不连续目标函数。

9. Designing digital filters, especially recursive filters, is not a straightforward problem.

数字滤波器的设计，尤其是递归滤波器，不是一个简单的问题。recursive filters 递归滤波器。

10. One individual dominates another if and only if its fitness is higher than the other's according to at least one criterion and as good as the other's according to the rest of criteria.

一个个体主宰另一个当且仅当根据至少一个标准它比另一个适当，或根据其它标准和另一个一样适当。only if 指“只有当”；if only 则表示“要是……就好了”。

11. At the end of the exploration phase, the population should have discovered a number of promising areas in the search space, and the algorithm switches to 'exploitation' mode.

在勘探阶段结束时，人口应该已经在搜索空间发现了一些有希望的领域，且运算法则切换到“开采”模式。switch to 是“切换到，转变成”的意思。

12. Thisin itself is not a problem, as the premature convergence only becomes a concern once the population has concentrate on a few areas.
在本质上这不是一个问题，因为过早集中只有在人口集中在少数几个领域时才变得让人担心。

Supplementary Reading

Transmission Line Basics

To understand the following sections, it is essential to fully understand a transmission line and its properties. In broad terms, a transmission line is a uniform system or line consisting of two parallel conductors. This means that the dimensions, materials, and cross-section of the line and its surrounding environment remain constant throughout its entire length. These conductors do not need to be the same material or similar in anyway between each other, but rather they, in and of itself, must remain the same for its length.

A second requirement is that the current flowing through the conductors flow in the direction of the line, and that the instantaneous current in the two conductors are equal in magnitude and opposite in direction.

Another requirement is that the transmission line can be completely described by four electric circuit coefficients whose value per length are constant everywhere along the line. These coefficients are inductance, resistance, capacitance, and leakage conductance. The inductance and resistance are series coefficients, whereas the capacitance and leakage conductance are shunt. Below is a model of a transmission line using these four coefficients.

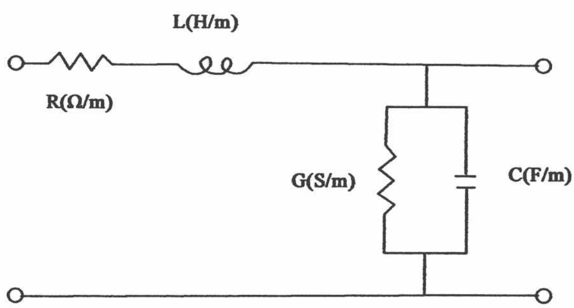

Fig. 1. 1　Transmission line model with lumped elements

These parameters do vary with frequency, line voltage, or current and are explicitly determined by the materials and dimensions of the line conductors and their surrounding medium. The materials and physical geometry of the line determines the impedance of the line, and therefore, any physical change made throughout the transmission lineaffects these parameters and therefore its impedance. These changes in impedance are called discontinuities.

We are familiar with transmission lines, such as TV coaxial cable, being round and therefore contain long, round conductors. Conductors can be round, flat, hollow, solid, or any