Robotica (2000) volume 18, pp. 219–223. Printed in the United Kingdom © 2000 Cambridge University Press

Book Reviews

HUMAN FACTORS IN MULTI-CREW FLIGHT OPERATIONS, by Harry W. Orlady and Linda M. Orlady, Ashgate, Aldershot, 1999, xx + 623 pp., ISBN 0-291-39838-3 (hardback), 0-291-39839-1 (paperback, £25)

This is a thoughful and well-informed discussion of a great many aspects of air safety, particularly from a pilot's point of view. It is backed up by substantial lists of references at the end of each of the 22 chapters, and by no fewer than 17 appendices packed with accident statistics and other historical data, as well as recommendations and pronouncements from regulatory bodies, and a list of relevant websites

The book also gives an interesting overview of the history of aviation. Leonardo da Vinci is mentioned, and the part played by rigid airships is acknowledged, but the beginning of flying as we know it today is attributed to the Wright brothers. At the time of their achievement they were by no means the only people working towards heavier-than-air powered flight, but they were the first to succeed. They also built the first flight simulator, the first flight data recorder and an automatic stabiliser. Photographs are reproduced of some early machines including a truly fantastic and unsuccessful Italian flying boat with eight engines and nine wings.

The main focus is, however, on the working environment of the pilots and other matters affecting safety. For example, the atmosphere inside even modern aircraft is not ideal and tends to be rather dry. This is not noticeable to passengers but can affect aircrew who are repeatedly exposed. The social environment, and particularly the relationship between pilot and co-pilot is clearly important. The pilot has to be in charge, but there is danger if the co-pilot is unduly submissive (as is likely to happen when the crews are from particular cultures), since one of his functions is to consider and possibly challenge decisions made by the pilot.

Matters of communication are also important, including the obvious possibilities of mistakes when air controllers or aircrew members have to use English although it is not their own first language. Attention is also given to conditions in which sensory illusions can arise, as for instance when acceleration gives a false impression of gaining height, and a variety of dangerous effects arise when visual depth cues are either absent or misleading.

The part played by the attendants in the passenger area is also important, especially in an emergency. Much attention is given to conditions that affect the pilots' state of alertness, which can be impaired by stress and fatigue and possibly boredom, and also depends on the individual's state of health. Means of maintaining the latter are described in detail, even to recommendations for exercise and diet.

The flying of modern aircraft is partly automated, not only by the use of autopilots but in some other respects besides, and at first sight this would seem to reduce the dependence on human performance. There is a sense in which the opposite holds, however, since all equipment can fail and the pilot is the ultimate safeguard. His task when the equipment malfunctions is more complex than if he had direct control. The authors quote the psychologist Lisanne Bainbridge (who was a member of Stafford Beer's group in United Steel) as saying: ". . . the increased interest in human factors among engineers reflects the irony that the more advanced a control system, is, the more crucial may be the contribution of the human operator".

The book's thorough treatment of these issues is obviously important to decision-makers in many areas relating to air travel, as well as being of interest to passengers. Many of the considerations have relevance outside the particular context of air travel, and the book is worth reading quite apart from that special focus. For example, the observations of Bainbridge about automation and the human operator, and those about social aspects of pilots cooperating in a demanding and critical task, are clearly of very general significance, as indeed are the recommendations about a healthy lifestyle for pilots. There is a deal of thoughtful discussion here as well as much useful and interesting reference material.

Alex M. Andrew
95 Finch Road,
Earley,
Reading, RG6 7JX
(UK)

STATISTICAL PATTERN RECOGNITION, by Andrew Webb, Arnold, London (Cambridge University Press, New York, for USA), 1999, xviii + 454 pp., ISBN 0-340-74164-3 (pbk, £29.99)

This gives an extremely comprehensive treatment of a range of topics under the general heading, treated in a style that is mathematically rigorous but at the same time allows the author's personality to show through in informal comments about the power and applicability of the methods. It is written in textbook style, with exercises for the reader, as well as brief descriptions of real-world applications, and five Appendices covering aspects of the underlying statistical mathematics. It is a valuable and up-to-date reference work, with something in the region of 800 references and the useful feature of an author as well as a subject index. Interestingly, there are also references to a surprisingly large number of websites at which relevant material is available, sometimes including downloadable software. Many but not all of the websites are maintained by American universities.

The main concern is with supervised classification, or the assignment of an incoming data vector to one of a known set of categories. Attention is also given to unsupervised classification or clustering, in which the categories are not prescribed in advance but determined by the data. One of the ten Chapters is explicitly devoted to clustering. Much of the treatment in the book is also relevant to regression analysis, a related topic though not in itself classificatory. Both parametric and nonparametric statistical methods are considered. It is acknowledged that some of the literature quoted, especially the earlier items, follow a cybernetic approach in discussing biological cognition and learning. These aspects are not explicitly treated in the present book, but this does not reduce its usefulness as a reference for workers in these areas.

Despite the dissociation from biological studies as such, perceptrons and other neural nets are introduced as means of implementing the methods, under the essentially-statistical general headings of linear discriminant analysis and nonlinear discriminant analysis. The self-oprganising feature maps due to Kohonen are also treated, this time under the general heading of clustering.

https://doi.org/10.1017/S0263574799232547 Published online by Cambridge University Press

Most chapters have a list of applications of the techniques introduced, as well as a section on "recommendations" suggesting how the reader should go about selecting and implementing a method in practice. Of the exercises for the reader, some refer to practical schemes and others are essentially mathematical. A number of them require use of computing facilities, for example to generate batches of data conforming to given criteria and then to apply methods of analysis to them.

The nature of the applications ranges far and wide and includes recognition of hand-written characters, speech, and faces, and detection of patterns in medical, economic and geographic data, and in radar echoes. A specific robotics application is mentioned on page 77, namely a robotic harvester for fruit, with sensory capability to classify images as belonging to one of the three classes of fruit, leaves and sky.

Despite making only one reference to a specific robot (or at least, only one that this reviewer has found) the book is an admirable textbook and reference work, covering the basis of recognition techniques that are essential in robotics applications. It is well presented, up-to-date and authoritative and will be a valuable addition to many bookshelves.

Alex M. Andrew
95 Finch Road,
Earley,
Reading, RG6 7JX
(UK)

SOFT COMPUTING IN MECHATRONICS, edited by Kaoru Hirota and Toshio Fukuda, Studies in Fuzziness and Soft Computing, vol. **32**. Physica-Verlag (A Springer-Verlag Company), Heidelberg, 1999, 186 pp., ISBN 3-7908-1212-9, (Hbk, £37.50)

The term "soft computing" is due to Lotfi Zadeh and includes fuzzy techniques as well as others that use neural nets, genetic algorithms and probabilistic reasoning, and that rely heavily on adaptation and learning. They are methods that use means other than rigorous analysis, and are often more effective than the latter in particular situations, including many in which the rigorous approach is not feasible. This is a collection of nine papers, from different groups of authors, reporting diverse studies in which a soft computing approach has been successful. The collection does not appear to have stemmed from a conference, and papers were presumably invited by the editors, one of whom is a participant author of three of them.

The tasks considered in the nine papers range widely, as do the varieties of soft computing applied in their solution. The first paper deals with a task that has now become a classic, namely that of learning to balance an inverted pendulum mounted on a trolley or cart. A fair amount of analysis for stability according to Lyapunov's method is applied, and fuzzy rules are introduced that produce a controller that is readily adaptable to pendulums of very different physical characteristics.

A later paper describes a solution to another classical problem, the building of a robot table-tennis, or ping-pong, player. The device can hit the ball with 77% success rate, and can play against a human opponent. Fuzzy methods are used in what seems a relatively subsidiary role, in achieving rapid response of the positioning servo systems without instability. The arrangements for positioning the bat horizontally and vertically are described in a fair amount of detail. The diagram also shows an air cylinder used to propel the bat forward for a strike, and a stepping motor used to tilt it, but it is not explained how these were controlled, nor exactly how the ball is tracked and its trajectory estimated.

In both of these papers the advantage of fuzzy methods appears to be achievement of a faster stable response from servomechanisms than is possible with linear methods In the report on the ping-pong player there is a direct comparison, since the 77% success rate is compared to only 24% with linear control. A recent paper that would seem to be relevant is by Golob,[1] who compares linear and fuzzy methods for control of magnetic suspension system.

Two papers acknowledge inspiration from biological systems in the design of artificial ones. One is on "Hybrid learning concepts for biologically inspired control of periodic movements for walking machines" and another has as its title the assertion "The cockroach escape response circuit provides an excellent basis for a crash avoidance system". The sense in which the work on walking machines can be said to hybrid is that it combines recent developments on reinforcement learning, as described by Sutton and Barto, with neuro-oscillators to generate rhythmic movements. Six-legged and four-legged robots are described, capable of learning simple locomotion on a level surface, and then adapting it appropriately when moved to rough terrain.

The work on crash avoidance refers to a wheeled vehicle avoiding a moving obstacle, but bases this on the rapid response of a cockroach to avoid a predator, when the latter is sensed by the cockroach because of the wind generated by its rapid approach and lunge. The neurons responsible in the cockroach have been mapped, and a similar arrangement is employed in the wheeled vehicle and trained by back-propagation. The teaching examples for the back-propagation training are derived by analysis of the requirements, where the appropriate escape response depends on estimation of the position and speed of the predator/obstacle and the orientation and speed of the escapee. The escape policy trained into the neural net subsequently gives a rapid response despite the complexity of the situation.

Three further papers refer to control of autonomous mobile robots. One stresses a mechanism for error recovery if a landmark is missed, with particular reference to a robot to operate on a construction site and to check the effectiveness of ceiling air vents in a building. The air vents themselves can be located visually and serve as waymarkers, but if one is not found a higher level of control takes over and the robot is not "lost", and the map of the environment on which the waymarker was indicated may be corrected for future use. This paper refers to a real project and there are pictures of the inspection robot. Another of the three papers describes "An evolutionary computation approach to robot planning and navigation" where a method amounting essentially to a genetic algorithm is applied to path planning, as an alternative to potential field and other methods with claimed advantages when avoiding moving obstacles or when operating in three dimensions rather than two. A further paper applies fuzzy methods to control of an automatic guided vehicle.

Of the remaining two papers, one discusses "Multimedia information acquisition for robotics" and the other is on the interesting and topical subject of "Welfare intelligent robots and their emotion oriented interfaces". The need for welfare robots is indicated by reference to the growing population of older people, relative to the population of youngsters to support them. (The paper refers to the situation in Japan, but of course the problem is world-wide). It is suggested that the old people, of whom many will be infirm, will be unable or unwilling to command their robot helpers directly, and the latter must respond sympathetically to gestures and sounds and movements. The paper considers robots primarily designed to serve perform practical tasks, but clearly their social interaction is important, and although robot pets are not explicitly mentioned they would be a consistent development. Both robot pets and personal robot servants are discussed in the "Reports and Surveys" section of *Robotica*, vol. **17**, Part 5.

The nine papers on Soft Computing are a useful introduction to some intriguing and slightly offbeat current lines of development in robotics.

Alex M. Andrew
95 Finch Road,
Earley,
Reading, RG6 7JX
(UK)

REFERENCE

1. M. Golob, "Decomposition of a fuzzy controller based on the inference break-up method", *Intelligent Data Analysis* **3**, No. 2, 127–137 (1999).

https://doi.org/10.1017/S0263574799232547 Published online by Cambridge University Press

MOBILE ROBOTICS: A PRACTICAL INTRODUCTION (APPLIED COMPUTING SERIES), by Ulrich Nehmzow, Springer, London, 2000, ISBN 1852331739, xii + 243 pp. (Pbk, £24.50)

The innovative nature of the contents of this little book is not immediately apparent from the title nor from a quick flick through the pages. There are pictures of a commercially-available "Nomad" robot, and of other self-propelled wheeled devices with which experiments have been conducted. A legged-locomotion device is mentioned, as are planetary rovers and devices for underwater exploration, etc., but only in passing. The suggestion of a rather pedestrian treatment (a rather strange suggestion to be supported by *lack* of attention to legged locomotion!) is reinforced by the author's careful development of basic topics, with discussion of the nature and characteristics of alternative sensors and actuators, and of statistical techniques used to assess performance.

In fact, however, the focus of the book is far from being pedestrian (in the metaphorical sense) and it contributes, as the notes on the back cover claim, to a cutting-edge research topic. It introduces a new approach to mobile robotics aimed at the achievement of animal-like robustness and versatility. This is contrasted with earlier work in which the computer control was based on accepted *AI* principles and was considered separately from what were seen as mundane engineering aspects of sensors and actuators. This approach is summed up by the equation:

Intelligent robot = classical AI system + right engineering

The use of a classical *AI* system requires symbols whose relevance to the "real world" stems from the insights of the programmer, and since he cannot visualise every eventuality the operation is "brittle". In the new approach, sensors and actuators are integrated more closely, without dependence on arbitrary symbols (even though a symbolic representation may be apparent in retrospect). It is acknowledged that this tighter linking of perception and action must be at the expense of complexity, but with the hope that the "intelligent bit" will arise as a result of interaction between various relatively simple processes. This would be an "emergent phenomenon" or "synergetic effect".

Ways in which a mobile robot can be controlled, with a minimum of built-in assumptions about the nature of the environment, are illustrated by twelve "case studies" which are experiments conducted by the author and colleagues, mainly using the Nomad robot mentioned earlier. The latter is equipped with several kinds of proximity sensor on each of its sixteen faces, and for no obvious reason is given the name "FortyTwo". It has a television camera and an on-board computer and the possibility of a radio link to a more powerful computer.

The case studies show ways of achieving an impressive set of kinds of learned behaviour, navigation and map-building. They are interesting not only from the point of view of robotics applications but also for their comparison with similar performance in animals. They employ an intriguing range of biologically-inspired techniques, including neural nets of the multi-layer perceptron type, especially a variant used as a pattern associator, and also of the self-organising feature map (SOFM) due to Kohonen. There is also application of the "adaptive resonance theory" (ART) associated with the pioneer of neuromodelling, Stephen Grossberg. The ART has been advanced as a theory of perception and classification in biological systems and this is a valuable exploration of its practical application. Frequent reference is made to the construction of a cognitive map in the animal nervous system, with the hippocampus known to be the site.

In each of the case studies the robot showed useful learning in an impressively small number of trials. The first studies were made with the robot initially under manual control, but with learning governed by simple rules referred to as "instincts" and leading quickly to useful patterns of autonomous action. Another study uses quite complex input data, from an omnidirectional camera, for perceptual localisation.

In another study the record of robot actions, corresponding to proprioceptive information in a nervous system, is used to establish location along a path. It is particularly interesting that this is done using Kohonen's SOFMs, but with a range of SOFMs operating in parallel and sensitive to different lengths of record. A great deal of new ground is explored here in ways of utilising these various adaptive schemes.

As mentioned earlier, the author develops his topics with care, and the material is presented in textbook fashion, including exercises for the student. Although the use of computer simulation is discussed, it is argued that simulation is never exact and there is no substitute for working with a real robot, and the student is strongly advised to acquire one.

The book is an admirable introduction to this modern approach to mobile robotics and certainly gives a great deal of food for thought. At present the concrete results are limited to navigation and simple tasks of box-pushing and floor cleaning, but it is easy to feel that there is the potential for very much more and that we are being given a glimpse of principles for future animal-like and humanoid robots. There are also implications for theories of biological evolution and development. Although the author clearly sees a big future for these new-style autonomous devices he does not commit himself to precise prediction of the rate of progress and acknowledges that the main application areas may be, for some time, in intelligent toys. Nevertheless, the book impinges on many profound and important issues and is an important work.

Alex M. Andrew
95 Finch Road,
Earley,
Reading, RG6 7JX
(UK)

CONFERENCE PROCEEDINGS OF THE 11TH INTERNATIONAL CONGRESS OF CYBERNETICS AND SYSTEMS, edited by Robert Vallée and John Rose. World Organisation of Systems and Cybernetics, Paris, France, 1999, XII + 398 pp. (Pbk: £50).

Readers of this journal with main interests in robotics and automation are well catered for in this interdisciplinary text. Cybernetics does, of course, cover most scientific disciplines with its multidisciplinary approach.

The proceedings of the 11th International Congress of Cybernetics and Systems, which was held at Brunel University, Uxbridge, U.K. in August 23–27, 1999, were published prior to the conference. In their Foreword the editors tell us that some thirty years have elapsed since this successful series of congresses was founded. The meetings are organised by the World Organisation of Systems and Cybernetics (WOSC). They are held triannually and previously have been in Europe, Asia and the Americas. One of the main reasons for the return to the United Kingdom was that it was held in memory of the late Professor Frank George who was the first holder of the Chair of Cybernetics at Brunel University.

The current practice of publishing abridged papers before the conference so that they are available to delegates, is now a necessary exercise. In many ways it is counter-productive since often the full papers never see the light of day, and certainly any changes that should have been made as a result of the discussions held after or during the presentation are never incorporated, Now, it seems, the cost of producing such a volume of proceedings precludes further updated versions being issued after the event. At this meeting, however, certain presented papers are to be selected for publication in a more comprehensive form in the official journal of WOSC, *Kybernetes*.

These Proceedings do cover a wide spectrum of topics and remain the only full record of all the contributions which range from automation to systems and cybernetics methodologies. There are 123 papers chosen because they describe recent developments in various areas and point in new directions in research and interest. They form a fascinating collection of contributions which the editors say should lead to fruitful and constructive discussion

https://doi.org/10.1017/S0263574799232547 Published online by Cambridge University Press

and criticisms. Most readers will undoubtedly agree with that, but of course, abridged papers do only whet the appetite. Fortunately, each paper published does contain not only the Contributor's name but also the corresponding address for further contact.

There are sixteen sections presented, each covering an important facet of the field. They include:

> Philosophical Cybernetics and Consciousness; Perception and Cognition; Biocybernetics; Bio-medical Cybernetics; Economic Cybernetics; Systems, Self-organisation, Informatics; Social Systems; Enviromental Cybernetics and Ecosystems; Systems and Cybernetics Methodologies; Acalugaritei Networks; Automation and Robots; Artificial Intelligence; Intelligent and Adaptive Systems; General Homeostatics; Applied Problems of Homeostatis

We are told that all the papers submitted were carefully refereed and the 123 that were selected for inclusion were taken from over 160 that had been submitted. There should, therefore, be no doubt about the quality of the work presented at the Congress and published in these proceedings. The publication also has the backing of a distinguished group of academics who formed the congress Patrons Committee and also of the International Scientific Committee of scientists from some 20 countries.

All the selected papers were grouped into the sixteen sections for ease of reference. Obviously since cybernetics is an interdisciplinary field and study there is bound to be cross-referencing and readers should expect to move between them to pursue their own lines of interest.

This is particularly true, for example, of researchers in robotics and automation who although tempted to study only the section titled 'Automation and Robotics' should also read almost all the other sections which have become so important in current researches in these fields of endeavour. The section on 'Artificial Intelligence' and the two part section on 'Intelligent and Adaptive Systems' are but some of the examples of subjects that are of direct relevance. Many of these chosen topics can then be further researched from the references provided and also with the contributors themselves.

With such a wealth of material in one volume and packed into over 400 pages it would have been helpful to provide both an author index and a general subject index. Unfortunately, the constraints imposed on the organisers of such congresses in the current climate preclude such luxuries! They are to be congratulated on cajoling their intending authors to submit their manuscripts on time for publication before the first day of congress registrations – a feat not always achieved even in the age of electronic publishing. The editors also managed by careful pruning of material to condense the submissions into readable abstracts that fit comfortably into one volume. Previous congresses have run to two or more volumes and whilst they were useful records of what was then presented, they were subsequently very cumbersome to use for reference purposes by busy academics and research teams.

The volume is recommended to all those involved in the new age of the information society and in particular, to working scientists who need to know about the direction of the new interdisciplinary and transdisciplinary approaches now being undertaken worldwide. It is an obviously essential text for any self-respecting library that intends to serve its scientists with links to current research and in the provision of references to the literature. Individuals working in the sciences will perhaps want their own copies for their reference shelves, and despite the minor criticisms of this review will find it good value.*

The World Organisation of Systems and Cybernetics is one of the earliest of the many cybernetics groups that currently provide the cybernetics community with a forum. Its reputation is as high as ever and the proceedings of its latest congress most certainly confirms this.

B.H. Rudall
Norbert Wiener Institute of Systems and Cybernetics

* Copies may be obtained from the WOSC (UK) Secretariat (Att. Professor J. Rose – Conference Proceedings), 5 Margate Road, St. Annes-on-Sea, Lancs., FY8 3EG, United Kingdom.

TASKS AND METHODS IN APPLIED ARTIFICIAL INTELLIGENCE: LECTURE NOTES IN ARTIfiCIAL INTELLIGENCE 1416, SUBSERIES OF LECTURE NOTES IN COMPUTER SCIENCE, edited by Angel Pasquel del Pobil, Jose Mira and Moonis Ali, Vol. 2, Berlin, 1998, xxiii + 943 pp.

It is the application of *AI* that is of importance to the readers of this journal and particularly to practitioners in the fields of robotics and automation. In this volume we have the opportunity of reviewing current tasks and methods.

The second volume of the proceedings of the 11th International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems – IEA-98-AIE, held at Benicássim, Castellón, Spain in June 1–4, 1998 has the title: *Tasks and Methods in Applied Artificial Intelligence. Volume I; Methodology and Tools in Knowledge-Based Systems* is reviewed above.

The division of the conference proceedings into these two sections was cleanly done, and volume two concentrates on the contributions dealing with aspects that are more directly relevant to applications development. The best insight into the types of applications is seen by examining the grouping of the contributions into the five parts and their subtitled topics. Contents were arranged as: Synthesis Tasks (2 papers), Modification Tasks (5 papers), Machine Learning (5 papers), Applied Artificial Intelligence (1 paper), and Validation and Evaluation Criteria (4 papers). These titles give an insight to the range of topics presented and, indeed, to the popularity of some of the subjects with the participants and, once again, with the selectors and referees chosen by the conference organisers. The organisers were aware, as the editors of Volume I were, that there are grand challenges for *AI* concerning artificial behaviour for agents that have to deal with the real world through perception and motor actions. Most users of systems know of the great lack of balance between existing *AI* endeavours and in some aspects of their competence. The editors of this text make this point in their preface to both volumes. They neatly sum this up by writing:

> "Whereas in some formal microworlds *AI* systems have reached the highest human level of competence – the recent success of chess playing systems being a paradigmatic example – or there are knowledge-based systems exhibiting human expert competence in narrow technical domains, such as medical diagnostics etc., few systems exist surpassing the competence of a cockroach, for instance, in moving around pursuing a goal in an unstructured world."

This is why most scientists see the great gap between the pure abstract intellectual tasks, on the one hand, and those that involve sensorimotor interaction with the physical world, on the other. The editors of this volume, quite rightly, call for an emphasis on research on robotic agents. They blame the Turing Vision, that is the vision of a more disembodied, abstract, symbol-processing intelligence. Robotic capacities have been extended to the Turing test and new approaches made. Indeed, studies in robotics have not been neglected in this text and the section in group 1 on Motion Planning for Robots could be the basis for a conference in its own right. Similarly, in the Group 3 the section on Perceptual Robotics has a wealth of detail that could well have been enlarged upon but for obvious constraints of both conference time and space in the published proceedings. The volume also has mention of the fuzzy and neurofuzzy approaches to robot control and it was disappointing to see only two papers on this essential topic. The papers

https://doi.org/10.1017/S0263574799232547 Published online by Cambridge University Press

published on *Neural Networks* (7 papers) could only be described as providing an awareness of an approach to problems in a subsymbolic manner. Its strength will be as one perspective amongst others that should be part of a mutually supporting strategy for problem solution.

It is interesting to note the editor's comments that the emphasis on perception and robotics had obtained a satisfactory response in terms of the number of submitted papers, as compared with previous conferences. Not all of those published in this volume would have been selected by hard-nosed journal editors in the robotics field for inclusion in their publications. Even so, this volume does follow the conference theme enthusiastically, and new methodologies, knowledge modelling and hybrid techniques were well focussed and are truly representative of current activity in the fields.

The editors of the text are right in believing that the global assessment of these published contributions will be positive and it should certainly be recommended to researchers and developers in these fields. Since it is a representative 'state-of-the-art' volume its shelflife will be limited, even so it does make a major contribution to Applied Artificial Intelligence and Knowledge Engineering and is worth consulting both for reference and for an overview of what is still a new and fascinating study area.

C.J. Harwood (USA)
Norbert Wiener Institute

https://doi.org/10.1017/S0263574799232547 Published online by Cambridge University Press