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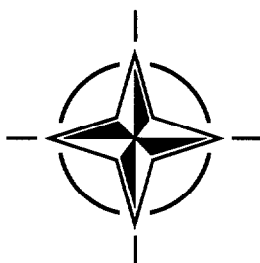
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RTO LECTURE SERIES 214

Advanced Pattern Recognition Techniques

(Techniques avancées de reconnaissance de forme)

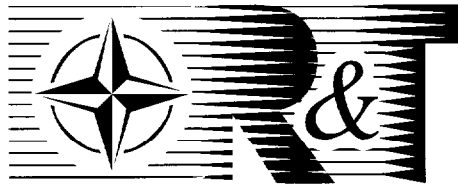
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RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also coordinates RTO's cooperation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of initial cooperation.

The total spectrum of R&T activities is covered by 6 Panels, dealing with:

- SAS Studies, Analysis and Simulation
- SCI Systems Concepts and Integration
- SET Sensors and Electronics Technology
- IST Information Systems Technology
- AVT Applied Vehicle Technology
- HFM Human Factors and Medicine

These Panels are made up of national representatives as well as generally recognised 'world class' scientists. The Panels also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier cooperation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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Advanced Pattern Recognition Techniques

(RTO EN-2)

Executive Summary

Pattern recognition has its roots in biological evolution. It is the extraction of consistent information from noisy spatiotemporal data and is currently being used in systems for battlefield supervision, smart weapons, anti-counterfeiting of all kinds, and for the reduction of false-alarm rates in the detection of land mines and unexploded ordnance.

Conventional methods of pattern recognition are mainly based on statistical approaches, such as density estimates or discriminant analysis. In this sense artificial neural networks can be regarded as an extension of these techniques. Fuzzy methods originate from control theory, but have also proven successful in pattern recognition. Over time, neuro-fuzzy methods have emerged that try to combine the advantages of each method and minimize the drawbacks.

An important task in pattern recognition is to choose the right features. Therefore a main part of this Lecture Series was devoted to feature extraction. This can be achieved in several ways: by electromagnetic and acoustic singularity expansion methods, by model based scattering signatures, also by using multiresolution time and frequency domain analysis, by SAR/ISAR imaging, bistatic microwave imaging and electromagnetic inversion techniques.

Practical applications of pattern recognition techniques were demonstrated with focus on statistical methods and artificial neural networks. Real-time software for discriminant and principal component analysis as well as PC based accelerator boards with on chip artificial neurons were introduced. Different methods for feature extraction with examples for automatic pattern recognition were shown.

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Sensors and Electronics Technology Panel and the Consultant and Exchange Programme of RTO presented on 14-15 September 1998 in Bristol, UK, on 17-18 September 1998 in Rome, Italy, and on 21-22 September 1998 in Lisbon, Portugal.

Techniques avancées de reconnaissance de forme

(RTO-EN-2)

Synthèse

La reconnaissance de forme tire son origine de l'évolution biologique et peut être définie comme l'extraction d'informations cohérentes à partir de données spatio-temporelles brutes. Elle est utilisée pour la surveillance du champ de bataille, dans les munitions intelligentes, pour la contre contrefaçon et pour la réduction des taux de fausses alarmes dans la détection des mines terrestres et des munitions explosives non explosées.

Les méthodes classiques de reconnaissance de forme s'inspirent essentiellement d'approches statistiques, comme les estimations de densité et l'analyse discriminante. De ce point de vue, les réseaux neuronaux peuvent être considérés comme l'extension de ces techniques. Les méthodes floues dérivent de la théorie de commande, mais elles ont été employées avec succès pour la reconnaissance de forme. Suite à ces développements, sont apparus des neuro-méthodes ayant pour ambition de combiner les avantages de chaque méthode tout en réduisant au minimum leurs désavantages.

Le choix des caractéristiques appropriées est l'une des tâches essentielles de la reconnaissance de forme. Par conséquent, l'une des sessions principales de ce cycle de conférences a été consacrée à l'extraction des caractéristiques. Un certain nombre de techniques ont été examinées à savoir :

- les méthodes SEM acoustiques et électromagnétiques
- la modélisation des signatures de diffusion
- l'analyse dans les domaines temporel et fréquentiel
- l'imagerie SAR/ISAR
- l'imagerie hyperfréquence bistatique et les méthodes inverses

Des applications de techniques de reconnaissance de forme ont été présentées, l'accent étant mis sur les méthodes statistiques et les réseaux neuronaux artificiels. Des logiciels de gestion temps réel pour l'analyse discriminante et pour l'analyse des principaux composants ont été démontrés, ainsi que des cartes accélératrices pour PC intégrant des neurones artificiels sur puce. Différentes méthodes d'extraction de caractéristiques ont été exposées avec des exemples relatifs à la reconnaissance de forme.

Les textes contenus dans cette publication ont servi de support au Cycle de conférences 214 présenté sous l'égide de la Commission des senseurs et technologies de l'électronique dans le cadre du programme des consultants et des échanges de la RTO du 14 au 15 septembre 1998 à Bristol, au Royaume-Uni, du 17 au 18 septembre 1998 à Rome en Italie, et du 21 au 22 septembre 1998 à Lisbon au Portugal.

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14. Abstract	Pattern recognition is the extraction of consistent information from noisy spatiotemporal data. It can be and is currently being used in systems for battlefield supervision, smart weapons, and anti-counterfeiting of all kinds. A current application is the automatic detection of land mines and unexploded ordnance (UXO). The methods employed can be subdivided in the following manner: (i) statistical methods, (ii) neuro-methods, (iii) fuzzy-methods, and (iv) neuro-fuzzy methods. Each of these methods has its special advantages and drawbacks, but all of them require the computation of feature variables from measurement or simulation data, e.g. from microwave backscattering. The Lecture Series covers the following topics: • Introductory Overview on Pattern Recognition Techniques, (i)-(iv) • Feature Extraction for Pattern Recognition by – Electromagnetic, magnetic, and acoustic singularity identification – Model based scattering signatures – Wavelet techniques – SAR/ISAR imaging – Bistatic microwave imaging – Electromagnetic inversion techniques • Real-time Implementation of Pattern Recognition Methods • Introduction to Software and Hardware for Pattern Recognition This Lecture Series, sponsored by the Sensors and Electronics Technology Panel (SET) of RTO, has been implemented by the Consultant and Exchange Programme.																



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