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Preface

This volume of Advances in Soft Computing and Lecture Notes in Computer Science vols. 5551, 5552 and 5553, constitute the Proceedings of the 6th International Symposium of Neural Networks (ISNN 2009) held in Wuhan, China during May 26–29, 2009. ISNN is a prestigious annual symposium on neural networks with past events held in Dalian (2004), Chongqing (2005), Chengdu (2006), Nanjing (2007) and Beijing (2008). Over the past few years, ISNN has matured into a well-established series of international conference on neural networks and their applications to other fields. Following this tradition, ISNN 2009 provided an academic forum for the participants to disseminate their new research findings and discuss emerging areas of research. Also, it created a stimulating environment for the participants to interact and exchange information on future research challenges and opportunities of neural networks and their applications.

ISNN 2009 received 1,235 submissions from about 2,459 authors in 29 countries and regions (Australia, Brazil, Canada, China, Democratic People's Republic of Korea, Finland, Germany, Hong Kong, Hungary, India, Islamic Republic of Iran, Japan, Jordan, Macao, Malaysia, Mexico, Norway, Qatar, Republic of Korea, Singapore, Spain, Taiwan, Thailand, Tunisia, United Kingdom, United States, Venezuela, Vietnam, and Yemen) across six continents (Asia, Europe, North America, South America, Africa, and Oceania). Based on rigorous reviews by the Program Committee members and reviewers, 95 high-quality papers were selected to be published in this volume. These papers cover all major topics of the theoretical research, empirical study and applications of neural network research. In addition to the contributed papers, the ISNN 2009 technical program included five plenary speeches by Anthony Kuh (University of Hawaii at Manoa, USA), Jose C. Principe (University of Florida, USA), Leszek Rutkowski (Technical University of Czestochowa, Poland), Fei-Yue Wang (Institute of Automation, Chinese Academy of Sciences, China) and Cheng Wu (Tsinghua University, China). Furthermore, the ISNN 2009 also featured five special sessions focusing on emerging topics of neural network research.

ISNN 2009 would not have achieved its success without the support and contributions of many volunteers and organizations. We would like to express our sincere thanks to the Huazhong University of Science and Technology, The Chinese University of Hong Kong, and the National Natural Science Foundation of China for their sponsorship, to the IEEE Wuhan Section, the IEEE Computational Intelligence Society, the International Neural Network Society, the Asia Pacific Neural Network Assembly, and the European Neural Network Society for their

technical co-sponsorship, and to the Systems Engineering Society of Hubei Province and the IEEE Hong Kong Joint Chapter on Robotics & Automation and Control Systems for their logistic co-operations.

We would also like to sincerely thank the General Chair and General Co-Chairs for their overall organization of the symposium. Also we would like to thank the members of the Advisory Committee and Steering Committee for their invaluable assistance and guidance in enhancing the scientific level of the event, the members of the Program Committee and additional reviewers for reviewing the papers, and members of the Publications Committee for checking the accepted papers in a short period of time. Particularly, we deeply appreciate Prof. Janusz Kacprzyk (Editor-in-Chief), Dr. Thomas Ditzinger (Senior Editor, Engineering/Applied Sciences) and other Springer-Verlag staff for their help and collaboration in this demanding scientific publication project – it is always a great pleasure to work with them. There are still many more colleagues, associates, friends, and supporters who helped us in many ways, we would like to say "Thank you so much" to all of them.

We also would like to express our heartfelt gratitude to the plenary and panel speakers for their vision and discussions on the state-of-the-art research development in the field as well as promising future research directions, opportunities, and challenges. Last but not least, we would like to express our most cordial thanks to all of the authors of the papers constituting this volume in Advances in Soft Computing: it is the excellence of their research work that gives value to the book.

May 2009

Hongwei Wang
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The Initial Alignment of SINS Based on Neural Network

Tingjun Li

Abstract. Strap-down Inertial Navigation System (SINS) is the development direction of the inertial navigation technology. Its working precision based not only on the inertial measurement units, but also on the initial alignment. This paper uses the N-Tupple neural network in their research, gives principal algorithm and the training algorithm of N-Tupple, and the computer simulation is done. The simulation shows that, the alignment precision of the neural network method is higher than the normal methods, and the greatly reduced alignment time shows the advantage of the new method.

Keywords: Strap-down Inertial Navigation System (SINS), N-Tupple neural network, Training algorithm of N-Tupple.

1 Introduction

Modern intelligence technique has been successfully used in both pattern recognition and function approximation task, and has been used in the inertial alignment of INS. It adopts BP neural network as well RBF neural network to carry out the inertial alignment of INS. This technique simplifies the algebra structure of system operation, and the real-time of system is better than that of distributed Kalman filter, and the precision is almost the same as that of Kalman filter.

Theory N-Tupple neural networks have been successfully applied to both patters recognition and function approximation tasks. Their main advantages include a single layer structure, capability of realizing highly non-linear mapping and simplicity of operation. This network is capable of approximating complex probability density functions (PDFS), and deterministic arbitrary function mappings. The main advantages of N-Tupple network is the fact that the training set points are stored by network implicitly, rather than explicitly, and thus the operation speed remains constant and independent of the training set size. Therefore, the network performance can be guaranteed in practical implementations. This paper uses N-Tupple network to realize the initial alignment of SINS, the computer simulation results show that this method meet the need of engineer.

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2 Algorithm of N-Tupple Network

We consider a general system taking a D-dimensional real-valued vector, X, as its input and producing a scalar real-valued output, Y (a scalar rather than vector output form is considered for simplicity). The input and output are realizations of random variables X and Y, respectively. It is assumed that X and Y are distributed according to a continuous joint probability density function (pdf). We seek to find an input/output relationship of the system in terms of the regression or a conditional mean of the dependent variable Y for any particular value of the input.

$$m(x) = E\{Y / x\} = E\{Y / X = x\} : \Re^D \to \Re \tag{1}$$

Where it is assumed that the conditional mean exists, i.e., $\forall x \quad E\left|m(x)\right| < \infty$. For a known underlying PDF the regression function is given by

$$m(x) = E\{Y / x\} = \int_{-\infty}^{\infty} y \cdot f(y / x) dy \tag{2}$$

And for any particular (x, y) pair generated by the system: $y = m(x) + \varepsilon$, where the random error component, ε , disappears in the average (i.e., $m(x) = E\{Y / x\}$). However, when no explicit knowledge about the system is available, the regression function can only be estimated from a finite set of point according to its distribution. Regression analysis plays a major role in statistics. In this work we are concerned only with one kind of non-parameter regression, based on the kernel method for probability density estimation. From the definition of the conditional mean it is apparent that if an estimate of the system joint PDF was available, it could be used directly for estimating the regression function. The kernel method provides a means of estimating $f(x, y)$ with no assumptions being made about its form, allowing approximation of the regression function in the general case.

The unvaried, real and even kernel function, $\varphi(x)$, satisfies the following conditions.

Additionally, if h_T denotes a smoothing parameter (also called bandwidth or window width of the kernel function) dependent on the number of training samples, T, and satisfying the condition.

$$\lim_{T \to \infty} h_r = 0 \quad \lim_{T \to \infty} T \cdot h_T = \infty \tag{3}$$

Then the estimator, $\hat{f}(x)$, given by

$$\hat{f}(x) = \sum_{i=1}^{T} \phi(\frac{x - x_i}{h_T}) \bigg/ [T \cdot \int_{-\infty}^{\infty} \phi(x) dx] \tag{4}$$

Approaches asymptotically the unvaried distribution density $f(x)$. This provides a consistent and asymptotically unbiased estimate of $\hat{f}(x)$.

$$\phi(x) \geq 0 \quad \int_{\Re} |\varphi(x)| \, dx = 1 \tag{5}$$

Approaches asymptotically the univariate distribution density $f(x)$, this provides a consistent and asymptotically unbiased estimate of $\hat{f}(x)$.

$$\varphi(x, y) = \varphi_x(x)\phi_y(y) \tag{6}$$

Where $\varphi_y(y)$ is a univariate kernel function satisfying the conditions (3) and (6). Thus, PDF is：

$$\hat{f}(X, y) = \frac{1}{T}\sum_{i=1}^{T} \Phi_X(X - X^i) \cdot \varphi_y(y - y^i) \tag{7}$$

And the regression function can be estimated as:

$$\hat{E}(Y / X) = \frac{\sum_{i=1}^{T} y^i \cdot \Phi_X(X - X^i)}{\sum_{i=1}^{T} \Phi_X(X - X^i)} \tag{8}$$

Where $\Phi_X(X)$ satisfies the following conditions

$$\sup_{X \in \Re^D} |\Phi(x)| < \infty \qquad \sup_{X \in \Re^D} |\Phi(x)| < \infty$$

$$\sup_{X \in \Re^D} |\Phi(x)| < \infty \tag{9}$$

According to the above analysis, we know the fact that if the function $\Phi_X(X)$ can be realized, then this network can response the input/output relationship. The literature (3) gives the N-Tupple network. The network consists of an R-bit binary array, and a set of K memory nodes, each having a N-bit long address word (i.e., having 2^N addressable locations), the structure is showed in Fig.1. The $\Re^D \to \Re$ mapping performed by the network consists essentially of three stages:

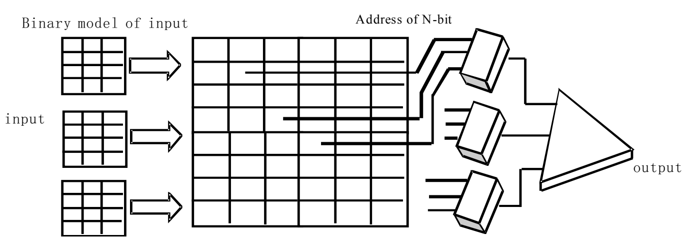

Fig. 1 Structure of N-Tupple Network for Initial Alignment