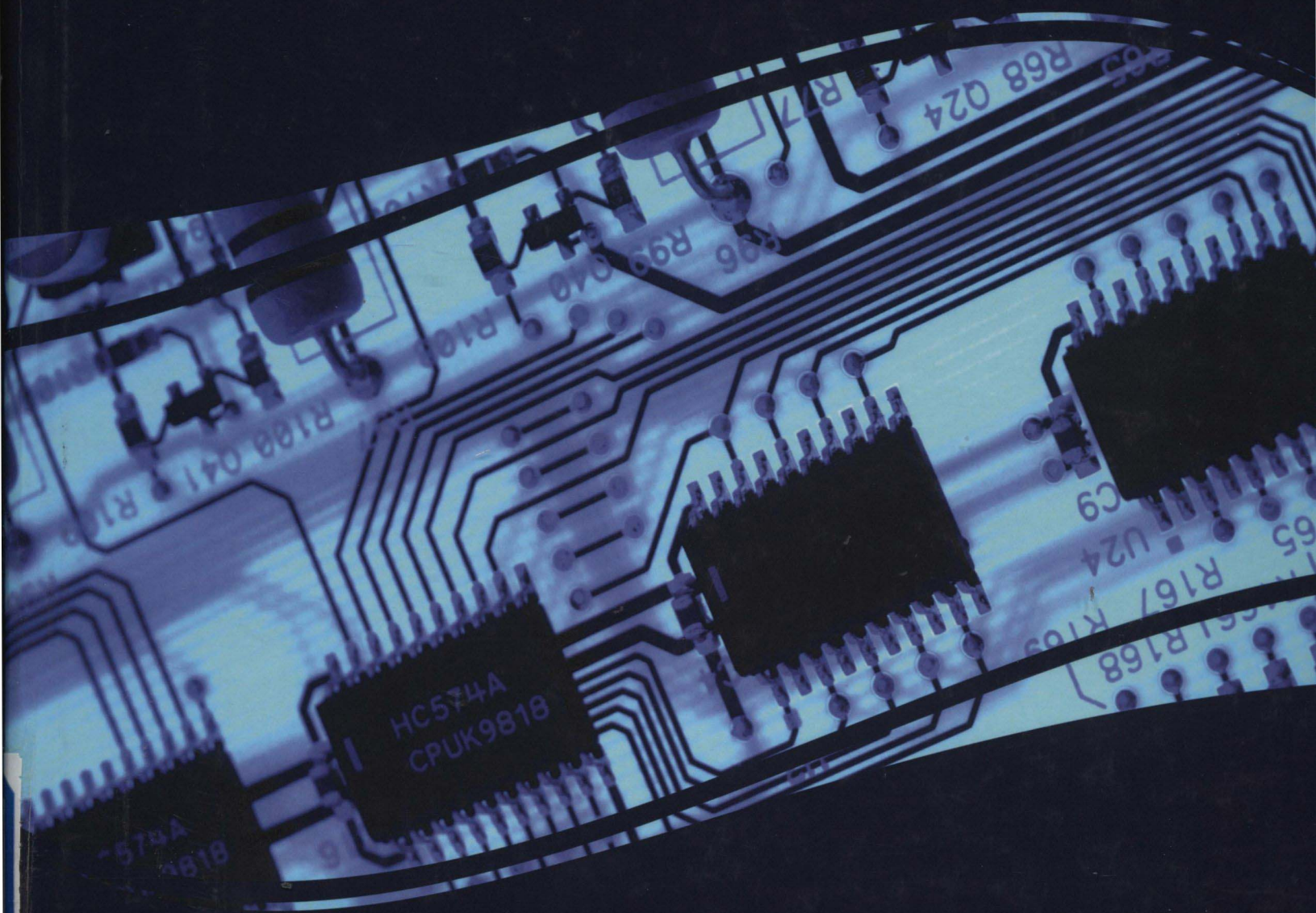


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Kandarpa Kumar Sarma, Manash Pratim Sarma,
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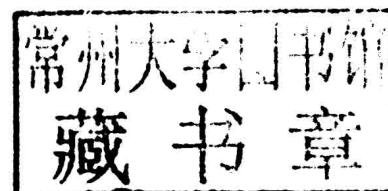


Intelligent Applications for Heterogeneous System Modeling and Design

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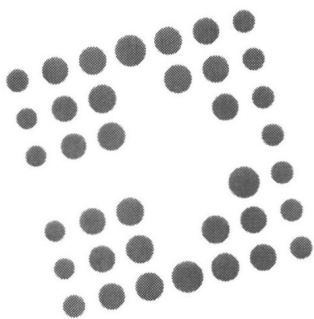
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Preface

Of late, intelligent system and related designs have become important instruments of innovative designs for automated control and interaction with computers and machines. Such systems depend upon methods and tools for solving complex learning and decision-making problems under uncertain and continuously varying conditions. A range of areas covering many disciplines of science, engineering and technology in a composite form, incorporating modifications with certain autonomy and decision making in methods and instruments constitute intelligent system design. Frameworks based on knowledge-aided systems, natural-language processing, machine learning, data mining, adaptive robotics, etc working in concert have driven research and innovation towards design of intelligence aided approaches of interaction between human and machine. These aspects currently have been receiving attention not only from the research community but have also influenced social dimensions. Such aspects need proper discussion, documentation and discrimination. The present book titled *Intelligent Applications for Heterogeneous System Modelling and Design* is a collection of selected submissions derived out of continuous research in the related areas. The book is intended to provide a compilation of contemporary research and include certain significant contributions representing critical developments in intelligent and emerging system design. Considerable work has been reported in this area and there is always a necessity to compile such works. This book is an attempt in this direction and is intended to include some of the recent works related to intelligent and emerging system design. The book attempts to cover the recent trends in intelligent and emerging system design using a range of tools including soft-computation. The book includes review, discussion and experimental work in the areas of communication, computation, vision sciences, device design, fabrication, upcoming materials and related process design etc. Its objective is to provide a glimpse about the ongoing and emerging areas of research in the areas of intelligent and emerging system design and related domains.

Several chapters are included in the book. Jens Alfredson et. al discusses intelligent support to fighter pilots operating with distributed unmanned and manned platforms and decision making. This chapter highlights important aspects of an intelligent fighter pilot support for distributed unmanned and manned decision making. First the background is described including current trends within the domain, and characteristics of a decision support system are discussed. After that a scenario and example situations are presented. The chapter also includes reflections of an intelligent fighter pilot support for distributed unmanned and manned decision making from the joint cognitive systems view, regarding human interoperability, and function allocation.

Razib Hayat Khan et. al discusses the quantitative analysis of a complex distributed system, at the early stage of the system development process is always an essential and intricate endeavour. To meet the challenge of conducting quantitative analysis at the early stage, this chapter introduces an extensive

framework for performance modelling of a distributed system. The goal of the performance modelling framework is the assessment of the non-functional properties of the distributed system at an early stage based on the system's functional description and deployment mapping of service components over an execution environment. System's functional description with deployment mapping has been specified using UML. To analyse the correctness of the UML specification style, we have used temporal logic, specifically cTLA, to formalize the UML model. We have shown in detail how UML models are formalized by a set of cTLA processes and production rules. To conduct the performance evaluation of a distributed system, the UML model is transformed into analytic model SRN. We have specified an automated model transformation process to generate SRN model from UML, which is performed in an efficient and scalable way by the use of model transformation rules.

Detection of diabetes using bloodless technique is an issue which is in the limelight of research in the field of machine learning and artificial intelligence (AI). It primarily intends to contribute towards faster and efficient means of detection and subsequent diagnosis of diabetes. Here, in a chapter by Sah et. Al. working of a system designed to detect the abnormality of the eye with pain- and blood-free method is discussed. The typical features for diabetic retinopathy (DR) are used along with certain soft computing techniques to design such a system. The essential components of DR are blood vessels, microaneurysms, haemorrhages and exudates. This chapter formulate a framework for bloodless diagnosis of diabetes using a unique feature set derived from the retinal image of the eye. The feature set is applied to a soft computational tool Support Vector Machine (SVM) which provides us the decision regarding the state of infection of the eye. The classification ability of the proposed system for blood vessel and exudate is 91.67% and for optic disc and microaneurysm is 83.33%.

Medical issue are vital for human survival, hence have been a fertile area of application of knowledge-aided systems. Such an aspect has been covered by Medhi et. al. Prolonged Diabetes Mellitus causes massive destruction to the retina, known as Diabetic Retinopathy (DR) leading to blindness. DR has become the most prominent cause of the new cases of blindness occurred in individuals of aged 20-70 years among world population. The blindness due to DR may consequence from several factors such as (a) Blood vessel (BV) leakage and new BV formation on retina at severe stages lead to retinal detachment causing irreversible vision loss; (b) The peripheral vision loss occurs due to imbalance of Optic Disc (OD) to Cup ratio and its central depression Cup are the bright region of retina) resulting from Glaucoma; (c) The effects become more threatening when abnormalities involves the macular region. The macula—and its center fovea—of the retina are responsible for sharp vision. The accumulation of abnormalities over fovea leads to blindness. Patients diagnosed with diabetes are therefore must have to undergo regular eye examination at least once a year, to find out the presence of DR. A non-invasive, low cost method for obtaining retinal photographs is Fundus photography. Thus, now-a-day's ophthalmologists mostly use fundus photograph for the analysis of DR. The number of eye care professionals with the essential skills to diagnose DR is currently inadequate compared to the number of cases registered with DR. There are many unidentified cases because of the high cost involved in screening procedures. Under these circumstances, mass screening would not be possible. Here automatic screening comes into picture. Automatic screenings are performed on fundus images and algorithms are applied. An automatic report can be recorded by the system to check out any abnormality. This approach will help the ophthalmologists to analyze more number of cases. The main objective of this chapter is to analyze macular edema in fundus images and use image processing tools for its automatic detection and grading. After detection, the macular regions are to be marked for the identification of maculopathy stages. The Macular Edema (ME) severity stages are located based on the presence of abnormalities from neighbor-

hood of macula towards its center. In this chapter, a study on analysis of macular edema is performed and an algorithm is introduced for the same.

Sharma et. al have covered another related area in a chapter. Biological signals can be classified according to its various characteristics like waveform shape, statistical structure and temporal properties. Among various bioelectric signals, one of the most familiar signal is the ECG. It is a signal derived from the electrical activity of the heart. The heart is an important organ which supplies body with oxygen. ECG is widely used in monitoring the health condition of the human. Cardiac arrhythmias can affect electrical system of the heart muscles and cause abnormal heart rhythms that can lead to insufficient pumping of blood and death risks. An important step towards identifying an arrhythmia is the classification of heartbeats. Modern analysis of electrical activity of the heart uses simple as well as sophisticated algorithms of digital signal processing. With the advent of technology, automatic classification of electrocardiogram signals through human-computer interactive systems has received great attention. This chapter discusses some computer assisted classification techniques based on statistical features extracted from ECG signal.

How biological signals and intelligent systems can be combined for assistance of persons with special requirements have been demonstrated in a chapter by Bordoloi et. al. This chapter describes a real-time control machinery of wheelchair system using Electrooculography (EOG) signals. The system was initially verified using a test signal which had been provided by a 10k potentiometer. The movement of the human eye signal is used as a control signal for the wheel chair movement, called human-machine interface (HMI) system. The goal is to design a sophisticated EOG based system which can prove to be a supportive mechanism for physically handicapped person.

Importance of intelligent control has been highlighted by Kashyap et. al. in a chapter related to locomotive engine control. This chapter discusses about a prototype of Driverless Train Operation (DTO) mode. In DTO, driving is controlled and monitored automatically, without human assistance. A train attendant can intervene in emergencies. The automatic driving system takes care of the departure, the movement between two stations, and the automatic and precision stopping of the train and opening of the doors. If required, the door is automatically opened again. When passenger volume is high, additional trains are automatically sent into operation straight from the depot at the push of a button. The driverless metro train in our work is basically an embedded system based framework, which is designed to provide solutions for smooth a human machine interface while controlling high speed metro train using automated actuation and regulation mechanisms. In this work, the modelling of the metro train is done in a more precise way using an AVR microcontroller.

Communication continues to improve the way people remain connected and build greater reach. Certain works in this area has been highlighted in the book. Das et. al. discuss design of interleavers and application in stochastic wireless channels. Wireless communication is an inevitable part of modern technology. It plays a significant role in almost every sphere such as education, communication, entertainment, etc. In wireless communication, accuracy and constancy of the transmitted data is always an issue, therefore continuous attempts are being carried out in order to accomplish ascertainable results over several wireless media. Different techniques and ideas are suggested and executed for this purpose. Still there remains certain limitations in the system which needs to be addressed. So in order to mitigate such limitations, a technique called interleaving is proposed here. The use of interleaver can enhance the performance of wireless communication up to a great extent. Here in this chapter, some system parameters are discussed and analysed, which are important to determine the performance of a wireless communication system. Bit Error Rate (BER), computational time, mutual information and

correlation are the parameters analysed, using four types of interleavers viz. general block interleaver, matrix interleaver, random interleaver and convolutional interleaver, considering a fading environment. Efforts to design hardware architectures have yielded encouraging results, yet there are considerable amount of challenges which are to be met during implementation. The hardware implementation using a block interleaver is reported as performed as a part of this work that shows encouraging results and maybe considered to be a part of a communication system with appropriate modifications.

Wireless communication has grown largely in last decade and it is constantly expanding. It can also be used for data communication to control various remote devices such as airplanes, cars etc. Data security plays a vital role in these kinds of design issues. Different coding schemes can be used to encrypt the data. Such possibilities have been reported by Saikia et. al. in the chapter, the authors reported the implementation of a simple and unique coding scheme by generating a bit sequence to secure the data transmission along with already available coding schemes. A radio-controlled plane or aircraft, often called RC aircraft or RC plane, is controlled remotely by a hand-held transmitter and a receiver within the craft. The receiver controls the corresponding servos that move the control surfaces based on the position of joysticks on the transmitter, which in turn affect the orientation of the plane. Flying RC aircraft as a hobby has been growing worldwide with the advent of more efficient motors, lighter and more powerful batteries and less expensive radio systems. Scientific, government and military organizations are also utilizing RC aircraft for experiments, gathering weather readings, aerodynamic modeling and testing, and even using them as drones or spy planes.

Tiru et. al discuss about using the available power line as a communication media for various requirements. With the advance of digital signal processing techniques, power line carrier communication (PLCC) have come out as a strong competitor in the networking market. The power line network is heterogeneous in nature constituted of pieces of transmission line of different characteristics and loaded with variable loads offering a most unsuitable channel for signal transfer. The workable devices have to overcome the harsh channel conditions using complex mitigation schemes; adhering to strict mandates at the national and international levels. In spite of these, PLCC offers a market for investors and researchers alike due to its cost effectiveness and promising efficiencies in utilities leading to sustainable development. This chapter describes the salient features and the future prospect of this communication technique.

The book has a rich collection of works related to human machine interface. Mandal et. al. discuss about the design of power aware systolic processor design for certain computer vision applications. Real-time implementation is becoming necessary for a wide range of applications related to computer vision and image processing, security, bio-informatics, and several other areas. Efficient hardware implementations of machine-learning techniques yield a variety of advantages over software solutions which includes increased processing speed, reliability and battery life as well as reduced cost and complexity. Efforts to design hardware architectures have yielded encouraging results, yet there are considerable amount of challenges which are to be met during implementation. This chapter presents a method for generating binary and multiclass Support Vector Machine (SVM) classifier with multiplierless kernel function. This design provides reduced power, area and reduced cost due to the use of multiplierless kernel operation. Binary SVM classifier classifies two groups of linearly or nonlinearly separable data while the multiclass classification provides classification of three nonlinearly separable data. Here, at first SVM classifier is trained for different classification problems and then the extracted training parameters are used in the testing phase of the same. The dataflow from all the processing elements (PEs) are parallelly supported by systolic array. This systolic array architecture provides faster processing of the whole system design.

A review of important vision based gesture recognition is presented by Choudhury et. al. In the present scenario, vision based hand gesture recognition has become a highly emerging research area for the purpose of human computer interaction. Such recognition systems are deployed to serve as a replacement for the commonly used human-machine interactive devices such as keyboard, mouse, joystick etc. in real world situations. The major challenges faced by a vision based hand gesture recognition system include recognition in complex background, in dynamic background, in presence of multiple gestures in the background, under variable lighting condition, under different viewpoints etc. In the context of sign language recognition, which is a highly demanding application of hand gesture recognition system, co articulation detection is a challenging task. The main objective of this chapter is to provide a general overview of vision based hand gesture recognition system as well as to bring into light some of the research works that have been done in this field.

Authentication, verification etc are integral issues of intelligent system design. Such issues are highlighted by Kashyap et. al. Authentication and identification is a fundamental issue to critical part in many security protocols. The Three Phase Security System is an especially designed system to provide best possible security for places where only authorized persons are allowed. The system comes with the combination of three technologies i.e. RFID (Radio Frequency Identification), Password and, Fingerprint Impression. Passwords or smart cards have been the most widely used authentication methods due to easy implementation and replacement. However, one can easily steal the RFID tag or hack the password. fingerprint scanner which is now a day's quite popular for its demand and efficiency holds an important place in security system. But alone a fingerprint scanner also cannot guaranty a protected system, because of various new and advanced fingerprint manipulation technology. This leads to the development of 3 phase security system: using RFID, password and fingerprint which is likely to overcome certain limitations. Moreover, the system is designed such that a random number or alphanumeric code of fixed length is automatically generated by the system and is sent to the mobile number of the user with the help of Global System for Mobile Communication (GSM) modem via short messaging service (SMS) connected for login verification. . The system also creates a log containing check-in of each user along with basic information of user. This ensures the reliability of the system and makes it difficult to breach.

Sarma et. al highlights some of the issues related to a soft-computing framework related to speech processing. Acoustic modelling of the sound unit is a crucial component of Automatic Speech Recognition (ASR) system. This is the process of establishing statistical representations for the feature vector sequences for a particular sound unit so that a classifier for the entire sound unit used in the ASR system can be designed. Current ASR systems use Hidden Markov Model (HMM) to deal with temporal variability and Gaussian Mixture Model (GMM) for acoustic modelling. Recently machine learning paradigms have been explored for application in speech recognition domain. In this regard, Multi Layer Perception (MLP), Recurrent Neural Network (RNN)etc. are extensively used. Artificial Neural Network (ANN)s are trained by back propagating the error derivatives and therefore have the potential to learn much better models of nonlinear data. Recently, Deep Neural Network (DNN)s with many hidden layer have been up voted by the researchers and have been accepted to be suitable for speech signal modelling. In this chapter various techniques and works on the ANN based acoustic modelling are described.

These are expected to constitute a ready reference for subsequent researches. The document is intended for a wide audience constituted by students, researchers, academicians, professionals, practitioners etc. Readers related to intelligent and emerging system design through mathematical and computational modeling and experimental designs shall find the book to be a new addition to the already existing repository. The book is specifically intended for a wide audience who are broadly involved in the do-

mains of electronics and communication engineering, electrical engineering, cognitive system design, mathematics, computer science, other applied informatics domains and related areas.

There had been a thorough scrutiny of the submissions. The first stage was chapter proposal submission. Each of the proposals submitted have been thoroughly reviewed. Next, complete chapters were requested to the approved proposals. After the chapters were submitted, another round of review was conducted and detailed comments were passed on to the authors to make necessary revisions. The modified, revised and updated manuscripts were again subjected to another round of review and the decisions regarding inclusion taken. In this process, inputs from the editorial advisory board members were helpful. The editors are thankful to the reviewers who despite their busy schedules have shared their time to provide the feedbacks by carefully going through the submissions. The entire process was tedious and the final outcome had been due to the dedication of the team involved including the staff members of IGI Global. It has been a pleasant experience. If the contents in the book motivate researchers to take up work in this area, the efforts of the editorial team shall be considered to have been rewarded.

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Section 1

HCI and Intelligent System Design

This section includes six contributions related to review and experimental work on the area of Human Computer Interaction (HCI) and Intelligent System Design.

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