NASA/CR-97- 205828 NAG8-991

A Final Report of Bethune-Cookman College NASA JOVE Projects

Submitted To: Dr. Shirley B. Lee, Executive Assistant to the President/Coordinator For Federal and State Grants and Contracts.

JOVE Faculty Research Associates:

Dr. Lawrence C. Agba, Assistant Professor of Engineering
Dr. Sunil David, Assistant Professor of Physics
Dr. Narsing G. Rao, Profssor of Physics
Dr. Munir A. Rahmani, Porfessor of Biology

October 13, 1997

A Report
of
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Dr. Munir A. Rahmani, Professor of Biology

July 19, 1995

JOVE Participant: Lawrence C. Agba

Final Report on Contract Number NAG8-991
Title: NASA/University joint venture in space sciences (JOVE)
Research Mentor: Dr. Jerry Tucker / Langley Research Center

During the duration (1992 to 1995) of the contract number NAG8-991, the following tasks were accomplished.

Summer 1992, Faculty Research Associate, Flight Electronics division, NASA, Langley Research Center, Hampton, Virginia.

- Conducted general evaluation of an on-going ASIC design that interfaces a microprocessor system to High performance parallel interface (HIPPI) chips, SCSI drives, and memory, needed for the implementation of a Space Optical Data Recorder.
- Studied the Cadence Composer (a schematic entry tool) and Cadence Verilog (a hardware simulation tool), and FrameMaker (a drawing tool).
- implemented a logic interface circuit in a Programmable array Logic.
- Evaluated the Alliance VLSI hardware design package.
- Evaluated the Stuttgart Neural Network Simulation (SNNS version 3.0) package.

Summer 1993, Faculty Research Associate, Flight Electronics division, NASA, Langley Research Center, Hampton, Virginia.

- Designed a digital interface architecture for a microprocessor controlled sensors monitoring unit for a NASA Jitter Attenuation and Dynamics Experiment (JADE) project. The system consists of five sensor boards. Each board has four sensors connected to it. Task was to design a digital circuitry that will test, monitor and service the sensors.

I spent the remaining time developing an enhancement to the Back Propagation training algorithm. The result is the publication referenced below.

Agba, L.C. and Tucker J.H., "An Enhanced Back-Propagation Training Algorithm," IEEE International Conference on Neural Networks, ICNN'95, Perth, Western Australia, Nov 27, 1995.

I am currently using this algorithm in my handwritten alpha-numeric character recognition research. It definitely yielding better recognition rates. The performance of the system is approaching 99% correct recognition on never-before-seen characters. I hope to obtain funding to develop the system.

I also made five presentations to Spruce Creek high school physics students on NASA and its missions.

Project #1: Neural Network

An Enhanced Back-Propagation Training Algorithm

Dr. Lawrence C. Agba

Dr. Agba has been developing an enhanced back-propagation algorithm to address problems which are encountered during training layered neural network. The problems include slow convergence and possible terminations at a non-global solution. He has submitted a manuscript to be published in the international society of Neural Network. The annual meeting and symposium the Society will take place in Perth Australia during this Fall. A copy of the abstract of the poster that he presented in the Sixth Annual JOVE retreat is attached.

Project #2: Designing of Micro-Sensors

Dr. Sunil K. David

Project #3: Orthostatic Intolerance

Tail Suspension: Effect of Simulated Spaceflight on Aortic Contractility.

Dr. Munir Rahmani.

Dr. Rahmani has been working on vascular effects of gravitational stress in rats since the Summer of 1993. Special cages to simulate spaceflight in rats by tail suspension were built in his laboratory during the Summer of 1994. Since then effects of two durations 5 days and 10 days on aortic vasoreactivity has been investigated. Currently data from those experiments are being analyzed and a manuscript is being prepared to be published in either Journal of Exercise Physiology or Artery. A rough manuscript of the work and an abstract that was presented during the Sixth Annual JOVE seminar is attached.

Project #4: Astronomy and Space Communications

Bethune-Cookman College Local Net and Interface with INTERNET:

Dr. Narsing G. Rao:

Dr. Rao has developed a course in astronomy over the past two years and worked on the planning of B-CC local-net. This summer (1995) he is personally installing hubs in various strategic locations to provide the faculty and computer science computers access to the INTERNET. He has laid coaxial cable from Academic

Computer in Alice G. Mickens Science Lecture Hall to the first and second floors of Rabie J. Gainous science Annex as well as the two floors of Gross science Hall. From various hubs he has run twisted-pair telephone lines to computers in faculty offices and in computer laboratories of the Division of Science and Mathematics.

JOVE FACULTY RESEARCH ASSOCIATES

Poster Presentation Abstracts

JOVE Retreat

July 5 - 8, 1995

Monterey, California
and
Ames Research Center

Prepared by:

Universities Space Research
Association (USRA)

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A.1

AN ENHANCED BACK-PROPAGATION TRAINING ALGORITHM

Agba, Lawrence (Bethune-Cookman College) and Jerry H. Tucker

The enhanced back-propagation (EBP) algorithm presented in this paper addresses the problems encountered while training layered neutral network using the classical back-propagation (BP) algorithm. These problems include slow convergence and possible termination at a non-global solution. This EBP algorithm alleviates these problems by employing incremental training and gradual error reduction as a means of scheduling the sequence in which the vectors in the training set are deployed. The advantages of the EBP algorithm are, speed up of up to 46 times, ability to avoid local minima, and prevention of over learning. Moreover, it has the advantage of reduced computations when compared to other proposed enhancements of the BP algorithm.

(Dr. Agba is working with Dr. Jerry Tucker of the Langley Research Center.)

A.2

AN ASYMPTOTICALLY EXACT FINITE ELEMENT METHOD ERROR ESTIMATOR FOR PLANAR LINEAR ELASTICITY PROBLEMS

Pomeranz, Shirley (University of Tulsa) and Adrian W. Kirk

A *posteriori* finite element error estimation for planar linear elasticity problems is developed using a recovery operator based on a stress smoothing technique developed by Tessler, Riggs, and Macy. The error estimator that is developed is proved to be asymptotically exact under reasonable regularity assumptions on the mesh and the solution. Numerical results for a typical plane stress problem are given.

(Dr. Pomeranz is working with Dr. Alex Tessler of the Langley Research Center.)

LS.3

TAIL SUSPENSION: EFFECT OF SIMULATED SPACEFLIGHT ON AORTIC CONTRACTILITY IN RAT

Rahmani, Munir (Bethune-Cookman College) and A. R. Hargens

Spaceflight is known to alter the morphology as well as physiology of skeletal and cardiac muscles. However, no information is available concerning the effects of changes in gravity on vascular smooth muscle. (VSM) The purpose of this study is to evaluate the effects of simulated spaceflight on the VSM in rat. One group of rats was suspended from tails in special cages for five days and another group for ten days. At the end of the suspension period, Aortas were excised from experimental (N=6) and non-suspended control (N=6) rats. The rings prepared from aortas were tested in vitro for contractility in response to KC1 depolarization and α-adrenoceptor stimulation with phenylephrine (PE) and norepinephrine (NE). We report that in five-day suspension group contractility was attenuated 19.3% to KC1, 28.4% to PE and 12.6% to NE. In ten-day suspension group the reduction in contractility was 15.6% to KC1, 16.3% to PE and 28.9% to NE. Reduction in the active tension generated by aortic rings in response to KC1 depolarization is indicative of damage to the contractile machinery of VSM, where as, the shift to the left for dose response curve to the α-adrenoceptor stimulation indicates a reduction in the efficacy of Ca^{2+} signaling mechanisms. These results indicate that further studies are needed to elucidate the nature of effects hypogravic environment has on the regulation of Ca^{2+} conductance in VSM to fully understand the phenomenon of orthostatic intolerance encountered by astronauts on returning to Earth from space.

(Dr. Rahmani is working with Dr. Alan Hargens of the Ames Research Center.)

LS.4

OVARIAN AND UTERINE MORPHOLOGY AND HISTOLOGY IS UNALTERED IN FEMALE RATS SUBJECTED TO SIMULATED WEIGHTLESSNESS

Scheck, Stephen (Loyola Marymount University)

Bone demineralization is associated with changes in reproductive hormone levels during menopause. It is also experienced by all crew members during space flight and is not 100% recoverable. Since hormone regulation in women during extended space flight is unknown, it is impossible to rule out microgravity-induced changes in reproductive hormone cycling which in turn, may produce an exacerbative effect on microgravity-induced bone demineralization. The influence of microgravity on reproductive physiology in the rat via a simulated microgravity (SMG) technique has been investigated. Data show that reproductive physiology is unaffected by 16 days of SMG; 4 estrous cycles. This suggests that reproductive homeostasis remains intact in the spontaneous ovulator and -- exptrapolating to women -- that no exacerbative effect on bone metabolism should be predicted in premenopausal women. Whether the SMG technique is an appropriate model for reproductive endocrinology remains to be validated on future space flights.

(Dr. Scheck is working with Dr. Richard Grindeland of the Ames Research Center.)

JOVE Final Report: Academic Year 1995-96

Program Accomplishments and Research Continuation Plans

Munir A. Rahmani	Bethune-Cookman College	June 4, 1996
Name	Institution	Date

1. Research

Brief summary of research results to date on your project:

Under the NASA-Bethune-Cookman JOVE project in the summer of 1993 this PI completed a two month residency at Ames Research Center, Moffet Field, in the laboratory of Dr. Alan R Hargens. During the summer of 1993, this PI investigated the effect on the contractility of rats aortas that were exposed to hypo and hyper gravic environment. Upon return to Bethune-Cookman, special cages for tail suspension for rats were designed and constructed. This PI and his students have studied the effect of tail suspension on rat aortic contractility for five-days suspension and ten days suspension periods. Contractile response to KCl, phenylephrine and norepinephrine has been found to be significantly decreased in tail suspended animals as compared to non-suspended control rats. A manuscript is in preparation to be submitted for publication either to Journal of Exercise Physiology or to Artery. Further studies are needed to investigate if the decrease in aortic reactivity is reversible and the rate at which the ability to contract is fully restored after the animals have been exposed to varying time period of suspension. This PI intends to submit a proposal requesting support for a such a study later this year from NASA under the NRA-96-OLMSA-03 announcement.

Communication with NASA Colleague:

Dr. Alan R. Hargens, Space Station Project Scientist has served as the NASA mentor for this PI. His guidance and support is greatly appreciated. He has alerted this PI to various opportunities for research support in and outside of NASA. Partially based on work completed under JOVE auspices, this PI has been able to acquire NIH support for this laboratory to continue studies in vascular physiology. This PI will use the support of Dr. Hargens to its fullest in preparing the intended publication and the proposal application mentioned above.

Proposals Submitted: During the last three years this PI submitted the following proposal applications.

1. Agency submitted to: NASA $ amount 679,331

Tittle/PI: Effects of Space Flight on Aortic Smooth Muscle/ Rahmani, Munir A.

Period of Performance: January 1, 1994 through December 31, 1996

Status: Approved but not funded due to incompatibility with small payload mission.

2. Agency submitted to: NASA $ amount 229,461

Tittle/PI: Effects of Gravitational Stress on Vascular Smooth Muscle in Rat/ Rahmani, Munir A.

Period of Performance: October 1, 1994 through September 3, 1997

Status: Not Approved

3. Agency submitted to: NIH $ amount 2,720,426

Title/PI Bethune-Cookman College Biomedical Research/Aspirin Effects and Endothelial Regulation of Vascular Smooth Muscle in Hypertension/Rahmani, M.A.

Period of Performance: June 1, 1996 through May 31, 2,000.

Status: Approved for funding.

4. Agency submitted to: NIH $ amount 2,590,618

Title/PI Bethune-Cookman College RIMI Program/Rahmani, M.A.

Period of Performance: September 30, 1996 through September 29, 2,001.

Status: Pending Review.

II. Student Involvement:

Two under graduate students have been involved in this research over the three year period. Ms. Chemisa Harrison, an undergraduate aspiring to be an aeronautical engineer helped with the design and construction of Tail Suspension Cages for this study. She has since joined the research of Dr. Lawrence Agba an other JOVE associate. Mr. Mingtao Huang, a biology major who gradated from B-CC in the Spring of 1996, helped and with and conducted most of the physiographic assays to evaluate the contractility of aortas. He has been accepted at University of Rochester in the biochemistry department as a graduate student. He has received a graduate research fellowship at Rochester University.

Student Research Assistants

Undergraduate Assistants	Research Area	Major
1. Chemisa Harrison	Design and construction of Tail suspension cages	Engineering
2. Mingtao Huang	Vascular Contractility	Biology

III. Curriculum Development: None

IV. Outreach: None

V. Summer Programs: None

VI. "Roadblocks" to Progress/Suggestions: None

VII. Other Activities: Please see the description of other activities in section I. This associate has been involved extensively in research and proposal development activities over the past three years.

JOVE FINAL REPORT: Academic Year 1995-96
Program Accomplishments and Research Continuation Plans

Narsing G. Rao
Name

Bethune-Cookman College
Institution

1. **Research**

Brief summary of research results to date on your project:

In 1993 summer, the characteristics of Nd:YALO laser resonator in normal and Q-switched modes were determined at Langley Research Center with Dr. Norman Barnes as my mentor.

I was unable to continue high power laser research due to high costs of acquiring basic instrumentation.

Where do you see your JOVE research going after the initial JOVE funding expires?

My JOVE research experience will help me in pursuing research in the application of solid state lasers in environmental sciences and the use of communication technology in physics and astronomy class rooms.

Communication with NASA Colleague

My contacts with my NASA colleague were in 1993. I was unable to contact any other NASA colleagues in other areas of my interest.

Refereed Journal articles Published:

None

Refereed Journal articles submitted:

None

Other Publications Published:

None

Oral and Poster Papers Presented:

None

Are you utilizing the internet or other network? If other, which?

Using internet extensively in my teaching and research activities

Education

Assessment of student Impact

A new Physics Major Program at Bethune-Cookman College was established in 1993. Two students graduated with physics as their majors in 1996.
There are now eight students who declared their majors as physics.

Undergraduate Assistants	Research Area	Major
Rudolph Johnson	Optoelectronics	Chemistry
Theresa Lyons	Astronomy	Mathematics (Minor in Physics)

Curriculum Development

A new course PH 231, An Introduction to Astronomy has been developed and is being implemented since 1994. A new area in physics with an emphasis in electronics (Applied Physics) has been developed and is being implemented.

Outreach:

Obtained some copies of NASA videos from Kennedy Space Center. The videos are being shown to different groups of students.

Met with the students of Physics Club of B-CC several times and discussed about the opportunities in physics, space sciences and the combination of physics with other fields.

Summer Programs

None

"Roadblocks" to Progress

None

How could the Program be changed to make it more effective?

There should be more interaction and follow up among the NASA mentors and the college faculty. The projects should be modest enough in cost so that four-year colleges can establish and develop research infrastructure.

Overall, what has been your institution's greatest benefit from participating in JOVE.

1. Created an interest in physics among the students on campus; hence, the increase in enrollment in physics
2. Addition of a course in astronomy
3. An extensive use of internet, thanks to NASA/JOVE initiative
4. Gave students an opportunity to work at NASA centers
5. Students are participating in summer programs at various National labs and universities

Please list all subject inventions as a result of this award or provide a statement that there were none.

There is no subject invention as result of this award

Approved by:

Narsingh Rao

Principal Investigator or Program Coordinator

JOVE Final Report: Academic Year 1995-96
Program Accomplishments and Research Continuation Plans

Sunil K. David	**Bethune-Cookman College**	5/26/94
Name	Institution	Date

1. Research

Brief summary of research results to date on your project:

Following results were achieved (during June 1993 - June 1996) under original and modified project:

Under the original project:

1. A UNIX based computational physics environment is being set at B-CC to enable undergraduate students to carry their research on process, device and circuit simulations using tools such as S-SUPREM4, S-PISCES, SPICE, etc., on SUN SparcStation5.
2. Simulation of Ion-Implanted Thermistor was completed and the results were presented in jove retreat94.
3. A computer controlled thermistor Characterization facility is being set in the physics laboratory of B-CC.
4. Several linearization circuits were constructed and tested to obtain a linear temperature-frequency characteristics of thermistor based thermometers.

Under the modified project:

1. After receiving Internet Access facilities from NASA/JOVE, a TCP/IP based local area network of PCs and SUN workstations is being established around in the science building of B-CC.
2. A WWW server (NCSA httpd) is being set on the SparcStation5.
3. A complete home page for Bethune-Cookman College (URL: http://www.bethune.cookman.edu) is being created for implementing Internet assisted teaching of physics, applied mathematics and energy related courses at B-CC.

Where do you see your JOVE research going after the initial JOVE funding expires?

My Jove research will lead me to research in two directions.

First, in the field of gas detectors which involve thermistors and Tin-oxide films and neural networks. Work of proposal writing is just been completed. This research will be in collaboration with a colleague in Florida Solar Energy Center at Cocoa. We hope to get federal and foundation funding for this project.

Second direction is in the field of WWW based Educational Technology. With the facilities created during my JOVE research and with experience of computer simulations, I am looking forward to expand our WWW site as a resource bank which provides learning assistance to undergraduate science students n, and a modified approach of the conventional class room teaching to the faculty. It will help considerably in understanding basic concepts of physics through hyper-text, real images, visual graphic animation etc. This requires creation, collection, sorting and interlacing of about 50 topics of basic physics, each involving sample problems, tutorial-exercises, challenge-problems, generic project ideas, etc. In this regard, a research proposal is under consideration for funding.

Communication with NASA Colleague (Please indicate the extent of your contact with your NASA colleague. Is the communication producing qualitative results? Do you still consider the match to be viable, and do you anticipate continuing your research collaboration after formal JOVE funding expires?)

My contacts with NASA colleague were only during the first year. A survey of the relevant literature was done and possible research ideas were discussed. Due to typical nature of the research expertise of my mentor and the requirement of very expensive infrastructure facilities, we decided that I should be working on my own on a suitable connected topic. Later on I made contacts with other distinguished NASA colleagues at KSC and LaRC who agreed to help me. They are still helping me and perhaps will continue to do so even after JOVE funding expires.

Refereed Journal Articles Published: (title, authors, journal, date and attach a copy of full publication)

Not as yet

Refereed Journal Articles Submitted: (title, authors, journal, date submitted)

Not as yet

Other Publications Published: (i.e. abstracts, technical memorandums)

None

Oral and Poster Papers Presented: (title, date, conference name, etc., include co-authored presentations, and attach a copy of the abstract)

None

Proposal Awarded: (attach the signature page, title page, and table of contents)

1. Agency providing funding: None awarded so far ________ $ amount: ________

Title of project/PI: ________

Period of Performance: ________ Primary use of Funds: ________

2. Agency providing funding: None awarded so far ________ $ amount: ________

Title of project/PI: ________

Period of Performance: ________ Primary use of Funds: ________

3. Agency providing funding: None awarded so far ________ $ amount: ________

Title of project/PI: ________

Period of Performance: ________ Primary use of Funds: ________

Proposal Submitted:

1. Agency Submitted to: Florida Energy Office ________ $ amount: 1,340,938

Title/PI: An Energy Education Program / Dr. Theodore R. Nicholson, Sr.,

Period of Performance: One Year ________ Primary use of Funds: Labor and Equipment

Status: Under consideration ________

2. Agency Submitted to: None ________ $ amount: ________

Title/PI: ________

Period of Performance: ________ Primary use of Funds: ________

Status: ________

Are you utilizing the Internet or other network? If other, which?

Using Internet extensively ________

II. Education

Assessment of Student Impact Indicate the impact over your institution's three years in JOVE, that the Program has had on the student enrollment and/or recruitment? Please provide before and after numbers for science majors by discipline, course enrollments, etc. Attach additional sheets as required

A new Physics major program was started

B.S. with Physics Majors: Course enrollment before was 1, now it is 12

Student Research Assistants (Please complete the attached form for each student listed below.)

Undergraduate Assistants:	Research Area	Major
Paul Kinyungu	Device Simulation	Physics
Johnny Seymore	HTML	Physics
Lei Zhai	HTML	Physics
Ja'hill Forster	Programming	Physics

Graduate Assistants:

None (no graduate program at B-CC)

III. Curriculum Development:

New Curricula: (Please list any new majors, minors, or areas of concentration, which have been implemented as a result of your institution's participation in JOVE. Indicate current students enrollments, and attach a copy of the new curricula description from your institution's course catalogue)

Physics Major started from fall 1993, current enrollment is 12, curricula description attached

New Courses: (course title, department, student enrollments, attach copy of course syllabus and catalog description)

Electronic Circuits and Devices,	Physics,	15 (Expected)	PH-261
Digital Electro. & applications,	Physics,	15 ,,	PH-361
Electro. Instrum. for Scientists,	Physics,	10 ,,	
Microprocessors applications,	Physics,	5 ,,	PH-461

Computer based Sci. Instrum., Physic, 5 ,,

Amended Courses or Augmented Courses: (list new topics included, student enrollments and attach a copy of the course syllabus)

Topic on Fluid Mechanics is being modified to include supersonic fluid mechanics and measurement devices.

Reading or independent study courses: (course title, department, student enrollments and attach a copy of the course syllabus)

None

IV. Outreach: (Please indicate your outreach efforts in each of the categories below. List the type of outreach effort (lecture, workshop, etc.), location, and estimated number of attendees.

Students: (high school, middle, elementary, other)

Outreach Effort	Location	Estimated number of Attendees
1. Friendly Talks with high school students.	Mainland High	5
2. Project Ideas	B-CC campus	5
3. Physics Club	Physics Department	15

Teachers: (high school, middle, elementary, other)

Outreach Effort	Location	Estimated number of Attendees
1. Seminar on HTML	science lecture hall	3
2.		

Public: (civic, professional organizations, etc.)

Outreach Effort	Location	Estimated number of Attendees
1. None		

V. Summer Programs: (describe program, location, date(s), # of attendees, length of program, etc.)

For students:

One month training in HTML programming, XV and XPAINT applications, and Image processing.

For teachers, three.

VI. "Roadblocks" to Progress

None

VII. How could the program be changed to make it more effective?

There should be a three days workshop before Christmas vacation in which prospective mentors can precisely introduce the possible faculty research projects of their interest.

VII. Overall, what has been your institution's greatest benefit from participating in JOVE.

A substantial increase in enrollment of science students specially in Physics

IX. Please list all subject inventions as a result of this award or provide a statement that their were none.

There is no subject invention as a result of this award

Approved by:

Principal Investigator or Program Coordinator

Tail Suspension: Effects of Simulated Spaceflight on Aortic Contractility in Rats

M. A. Rahmani, V. David, M. Huang. Bethune-Cookman College Daytona Beach, Fl 32114
and
A. R. Hargens, NASA Ames Research Center, Moffet Field, California

ABSTRACT

TAIL SUSPENSION: EFFECTS OF SIMULATED SPACEFLIGHT ON AORTIC CONTRACTILITY IN RATS

M. A. Rahmani, V. David, M. Huang. Bethune-Cookman College Daytona Beach, Fl 32114

and

A. R. Hargens, NASA Ames Research Center, Moffet Field, California

Spaceflight is known to alter the morphology as well as physiology of skeletal and cardiac muscle. However, not much information is available concerning the effects of gravitational changes on vascular smooth muscle (VSM). The purpose of this study is to evaluate effects of simulated spaceflight on the VSM in rat. Rats were suspended from their tails in special cages for 5 and 10 days to simulate spaceflight. At the end of the suspension period, aortas were excised from experimental (N=6) and non-suspended control (N=6) rats. The rings prepared from aortas were tested in vitro for contractility in response to KCl depolarization, a-adrenoceptor agonists norepinephrine (NE), and phenylephrine (PE). Attenuation in responses to the aortic rings from rats suspended for five days and ten days, when compared to control rats were 19.3 & 15.6% for KCl, 12.6% & 28.9%, for NE, and 28.4% & 16.3% for PE respectively. Reduction in active tension generation in response to KCl depolarization is indicative of damage to the contractile machinery, where as, the shift to the left for force generated through a-adrenoceptor stimulation indicates a reduction in the efficacy of Ca^{2+} signalling mechanism. Further studies are needed to elucidate the nature of hypogravic effect on VSM in the tail suspended rats.

Supported by the NASA/JOVE Program at Bethune-Cookman College, Daytona Beach, FL 32114. Grant No. NAG-991 and NASA Grant 199-14-12-05

EXPERIMENTS AND RESULTS

General Techniques for Measuring Active Tension Produced by Aortic Rings: Space flight or microgravity was simulated by suspending rats from their tails in suspension apparatus constructed according to the plans described by Park and Shultz, (Aviat. Space Environ. Med. 1993; 64:401-4.) Two sets of three sprague Dowley male rats were suspended from their tails for periods of 5 and 10 days. The control animals were maintained at 1G in cages similar to suspension apparatus. Purina Labs Chow and Water were provided Adlibitum. At the end of suspension period (5/10 days) the experimental rats were dismounted from the suspension apparatus and sacrificed immediately to excise thoracic aortas. The excised aortas were placed in Krebs solution that was bubbled with O_2:CO_2: (95:5%) v/v, at room temperature. After removing fat and connective tissues, two 4mm rings were cut 3.0 and 3.6 cm below the arch. The rings were suspended between two stainless steel hooks inserted through the lumen and mounted in 25 ml water jacketed bath. One of the steel hook was stationary while the other was attached to a transducer which could be adjusted in vertical plane to apply 8 grams of pretension. The temperature in the muscle bath was maintained at 37^{O}C by circulating warm water through the jacketed tissue baths. The Krebs solution bathing the tissue was continually aerated to maintain the pH in physiological range. The Krebs solution in the baths was replaced every 15 minutes. The rings were equilibrated for 2 hours under 8 grams of pretension. The tension generated in response to cumulative doses of KCl, phenylephrine (PE) and Norepinephrine (NE) was recorded by a microdisplacement myographic transducers UC3 coupled to a physiographic recorder R511. At the end of the experiment the rings were dismounted, blot dried and weighed to compute tension generated per unit weight of aortic smooth muscle.

Effects of 5 and 10 days of suspension: Aortic tissues from the tail suspended rats and non-suspended controls were prepared as described above and contractility was recorded in response to depolarization due to cumulative doses of KCl (8 to 80mm). Also, contractility due to α-adrenergic stimulation was evaluated using (10^{-10}-10^{-4}M) Phenylephrine, an α_1-adrenoceptor agonist and Norepinephrine (10^{-10}-10^{-4}M), a general α-agonist. We observed a significant reduction in vascular contractility in suspended animals as compared to controls. The results of these experiments are presented in Fig 1 to 6. Attenuation in contractility were 19.3% for KCl, 28.3% for PE, and 12.6% for NE in 5 days suspension group. In 10 days suspension group, the reductions were 15.6% for KCl, 16.3% for PE, and 28.9% for NE. The calculated EC_{50}s were 11mM & 9mM for KCl; 1.1×10^{-7}M & 4×10^{-8}M for PE; 8.7×10^{-9}M & 1×10^{-8}M for NE in 5 days suspended and control rats respectively. The EC_{50}s for 10 days suspension group and control rats respectively were 15mM & 13mM for KCl; 1×10^{-7}M & 8×10^{-8}M for PE and 8×10^{-9}M & 2×10^{-8}M for NE.

INTRODUCTION

The cardiovascular systems of most terrestrial animals and humans have evolved under the pervasive gravitational force of the earth. Space flight subjects these systems to varying gravitational environments such as weightlessness during space flight and increased gravitational stress during take off, re-entry into atmosphere and landing. In microgravity, blood pressure is reduced below the heart and elevated above the heart . The compensatory fluid shift during space flight due to removal of gravitational pressure causes facial puffiness and cranial edema. Increased excretion of sodium (Na^+), potassium (K^+) and calcium (Ca^{2+}) accompanied by changes in the levels and responsiveness of adrenal hormones and sympathetic nervous system (SNS) has been documented. The above mentioned hormones and neurotransmitters are critical in the regulation of blood pressure, blood flow and blood volume. Thus, during prolonged space-flight, cardiovascular functions are altered. Subsequently, upon return to normal gravitational field, blood shifts to the lower extremities, increases leg size and produces orthostatic intolerance.

Data from experimental as well as evolutionary and developmental studies indicate that gravity affects the structure and function of vascular tissue. In tail-suspended rats as compared to caged rats presser response to phenylephrine injection is reduced. The resistance of mesenteric vasculature of tail suspended rats is significantly elevated. A state of compensated atrophy has been suggested for heart's function in microgravity. Data from COSMOS 2044 and tail-suspension studies indicate that exposure to microgravity (space-flight) results in cardiovascular and skeletal muscle atrophy This atrophy is apparent both in heart and skeletal muscle after 14 days of exposure to microgravity. Biochemical studies on rat skeletal muscle demonstrate that fiber size and enzyme properties are qualitatively similar in space-flight rats as well as tail-suspended animals. Light and electron microscopic studies of cardiac and skeletal tissues from COSMOS Biosatellite have shown significant changes in periosteal vasculature. Changes in the pre-translational control of gene expression for contractile proteins in heart and skeletal muscle have been reported which could be true for smooth muscle as well. The arterial wall and myocardium in adult giraffe as compared to new born and adolescent animals are hypertrophied. This hypertrophy is considered to be an adaptive response to increasing blood pressure in normal gravity during development.

Hemodynamically, the Vascular smooth muscle (VSM) plays an important role in compliance related aspects of blood flow. The VSM is known to regulate the flow of blood through various vascular beds by contraction and relaxation. The aim of this investigation is to study the effect of simulated microgravity on the contractility of VSM from rat thoracic aorta.

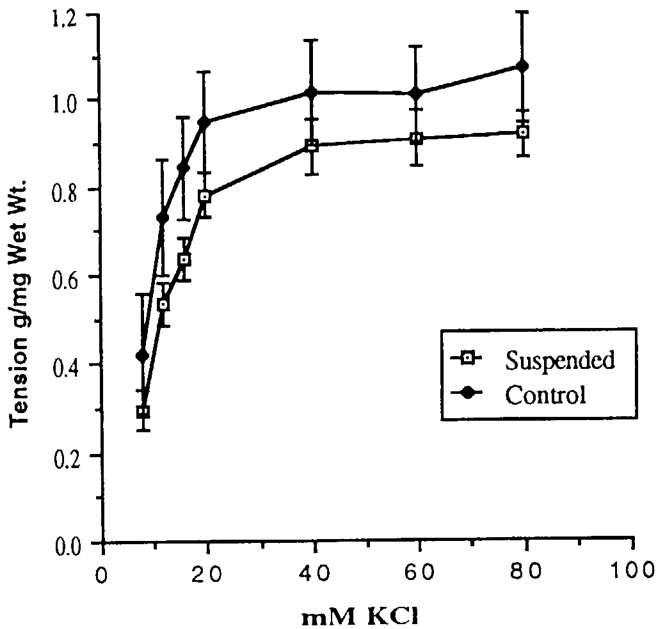

FIGURE 1.

A comparison of the active tension produced by aortic rings in responses to KCl from 5 day suspended animals (experimental N=3 controls N=3). 5 days suspension causes attenuation in the active tension. The EC_{50} is not adversely effected as calculated from this data. Each data point represents means of 6 rings, and the vertical bars represents ±SEM.

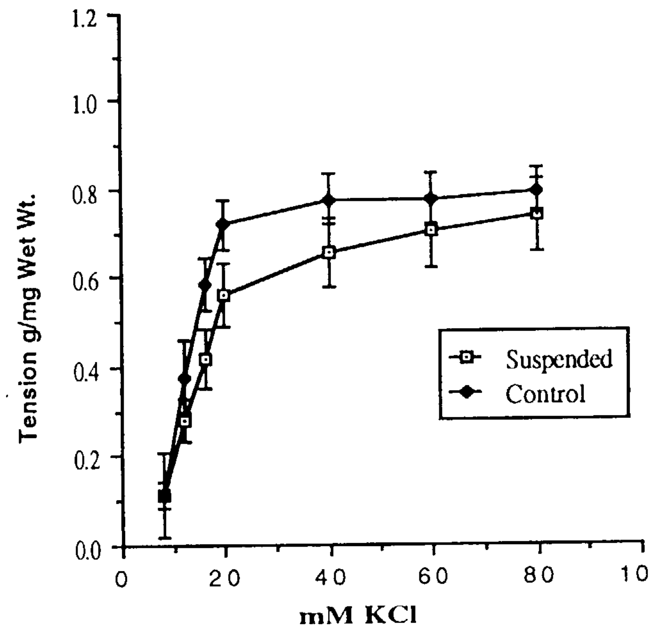

FIGURE 2.

A comparison of the active tension produced by aortic rings in responses to KCl for 10 days suspended animals (experimental N=3 controls N=3). The results show attenuation in the active tension caused by suspension. The calculated EC_{50}s are comparable to 5 day suspension. N=6 rings, and the vertical bars represents ±SEM.

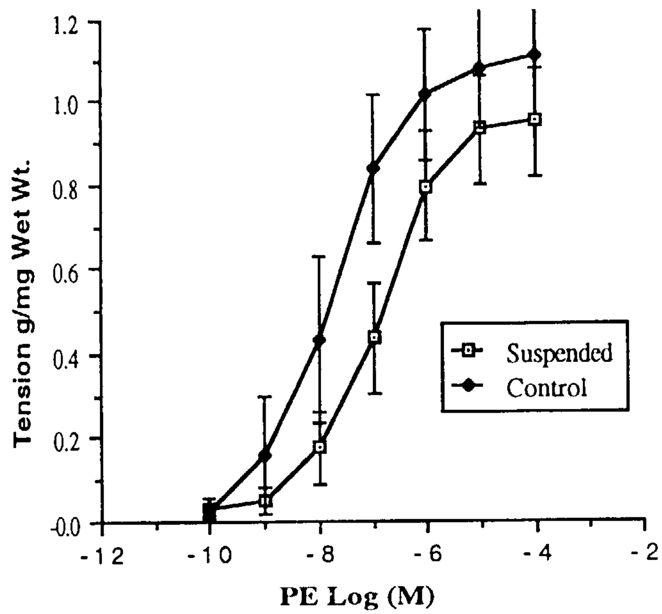

FIGURE 3.

A comparison of active tension produced by aortic rings from 5 days suspended rats in responses to PE (an α_1-agonist) (experimental N=3 controls N=3). 5 Days suspension causes attenuation in the active tension, and the calculated EC_{50} shows a significant shift in this data. Each point represents data from 6 rings. The vertical bars indicate ±SEM.

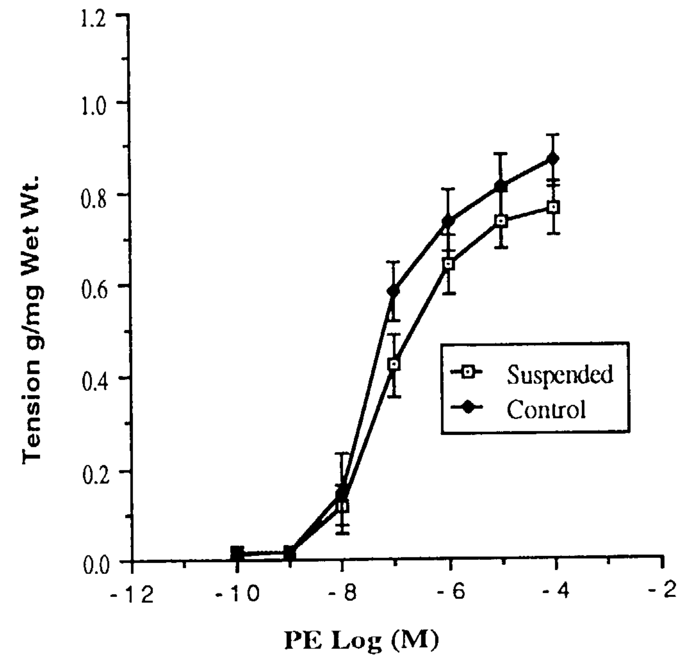

FIGURE 4.

A comparison of active tension produced by aortic rings from 10 days suspended rats in responses to PE (an α_1-agonist) (experimental N=3 controls N=3). Suspension for 10 days causes attenuation in the active tension, and the calculated EC_{50} shows a slight shift in this data. Each point represents data from 6 rings. The vertical bars indicate ±SEM.

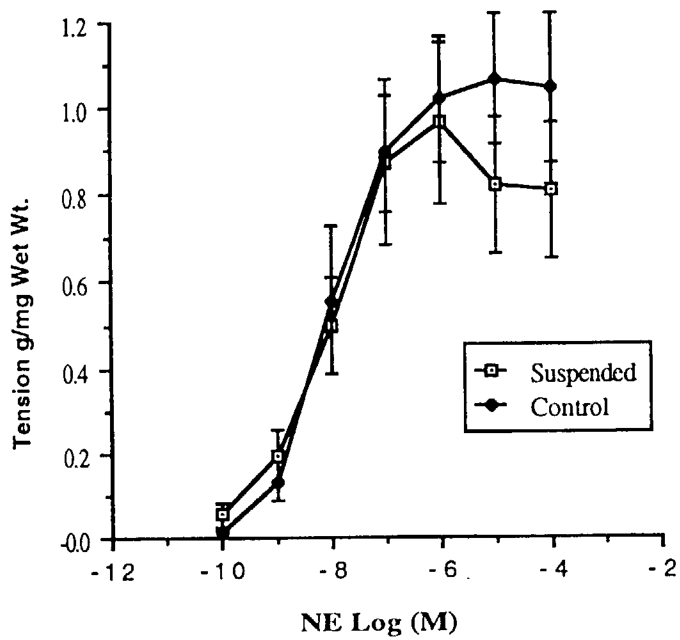

FIGURE 5.

The active tension produced by aortic rings in responses to NE (a general α-agonist) from 5 days suspended rats compared to tension of aortic rings from non-suspended animals (experimental N=3 controls N=3). 5 Days suspension causes attenuation in the active tension in response to NE. The calculated EC_{50} is not adversely affected. Each point represents data from at least 6 rings, the vertical bars indicate ±SEM.

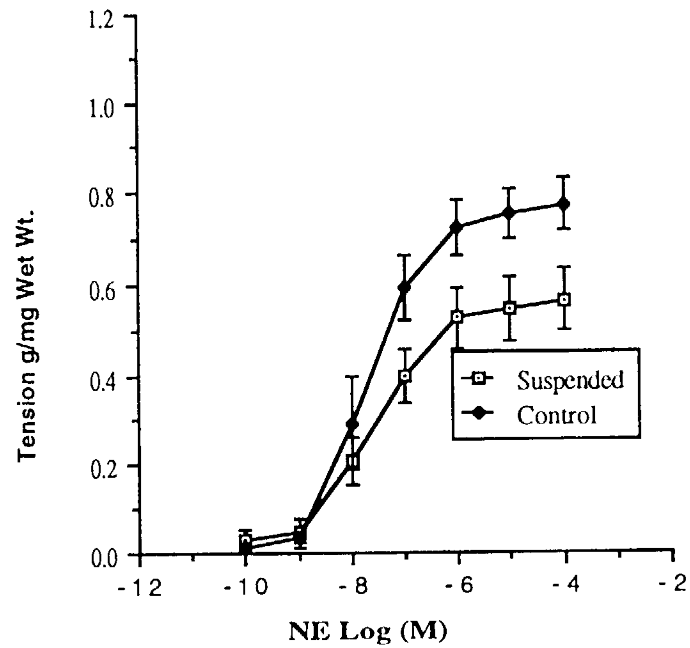

FIGURE 6.

The active tension produced by aortic rings in responses to NE (a general α-agonist) from 10 day suspended rats as compared to tension of aortic rings from non-suspended animals (experimental N=3 controls N=3). A 10 day suspension causes attenuation in the active tension in response to NE. The calculated EC_{50} shows a pronounced shift for rings from suspended animals. Each point represents data from at least 6 rings, the vertical bars indicate ±SEM.

CONCLUSIONS

As shown in figures 1 and 2 the curves for the active tension due to KCl depolarization for five day suspended and ten day suspended groups as compared to their respective controls are significantly lower suggesting that simulated space flight affects adversely the contractility of vascular smooth muscle. The dose response curve for PE in 5 day suspension group not only produced decreased maximal tension but the curve was also shifted significantly to the right indicating a reduction in the efficacy of alpha-1 adrenergic receptors. Similar effects are observed in prolonged suspension of 10 days for alpha-1 adrenergic stimulation. When total alpha adrenergic stimulation is evaluated in response to NE the results are similar to stimulation of alpha-1 adrenoceptor stimulation. The calculated EC_{50}s for PE and NE indicate adverse effect of tail suspension on the reactivity of vascular smooth muscle. These results from preliminary experiments indicate that hypogravic conditions affect the function of aortic smooth muscle in rat. These altered responses could be the result of damage to the contractile proteins or impairment of signaling mechanism(s) involving the release of calcium from extracellular or intracellular sources. Vascular smooth muscle signaling mechanisms and contractile machinery has evolved under a constant gravitational force of 1G. Abrupt decrease in gravity may cause stress that could damage either the integrity of contractile machinery or the structure and functions of signaling mechanism(s). Additional studies are warranted to further elucidate the exact source or sources of altered reactivity of rat vascular smooth muscle in response to gravitational stress.

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An Enhanced Back-Propagation Training Algorithm

Lawrence C. Agba
Division of Science and Mathematics
Bethune-Cookman College
email: agba@cookman.edu

Abstract

The enhanced back-propagation (EBP) algorithm presented in this paper addresses the problems encountered while training layered neural network using the classical back-propagation (BP) algorithm. These problems include slow convergence and possible termination at a non-global solution. This EBP algorithm alleviates these problems by employing incremental training and gradual error reduction as a means of scheduling the sequence in which the vectors in the training set are deployed. The advantages of the EBP algorithm are, speed up of up to 46 times, ability to avoid local minima, and prevention of over learning. Moreover, it has the advantage of reduced computations when compared to other proposed enhancements to the BP algorithm.

1 Introduction

Neural networks have been effectively employed in a number of applications. Most of these are the layered neural networks which use the back-propagation (BP) algorithm [1] as the learning algorithm. This back-propagation algorithm has several weak points such as slow convergence, and possible termination at a non-global solution. A number of algorithms have been developed to speed up the training of multi-layer feed-forward neural networks. Some proposed methods that accelerate the BP algorithm [2,3,4], while others developed new training schemes [5,6,7]. An enhanced back propagation (EBP) algorithm with several capabilities is herein presented.

It is demonstrated below that this EBP algorithm reaches convergence 2 to 46 times faster than the BP algorithm. Due to the fact that learning is incremental with gradual error reduction, it is able to avoid terminating at a local minimum. Moreover, gradual error reduction implies an attempt of this algorithm to maintain uniform error across the training vector. Thus, it is possible to terminate the training session at some target, for example (0.2, 0.8), before the on set of over learning thereby producing good generalization.

When working on a real world problem such as handwritten character recognition, there are usually several hundreds of training vectors for a particular character. It is conceivable that due to human error a few of the vectors can be wrongly labeled. This algorithm is also designed to tolerate any such mislabeled or ambiguous vectors in the training set. Another plus to this algorithm is that it is independent of weight adaptation routine, therefore, it can be used with other schemes of supervised learning. Finally, it will be seen that the overhead computation is in fact negligible.

2 The Enhanced Back-Propagation Algorithm

As stated above, the EBP algorithm employs incremental training and gradual error reduction as a means of scheduling the sequence in which the vectors in the training set are deployed. The idea behind this algorithm is simple. It seeks to uniformly reduce the error across the vectors in the training set. One can visualize this as a pegged board which should be fitted on a holed-platform. A gentle tap across the tops of the pegs will wrap the board uniformly onto the platform. In a similar manner, this algorithm gradually and uniformly reduces the error across the training vectors.

Next section explains the blocks in the flow chart of figure 1 and the parameters of the EBP algorithm. Following this, the EBP operation is explained.

2.1 The Flow Chart

The flow chart in figure 1 depicts the EBP algorithm. The following explains the actions in its blocks, and the parameters in the algorithm.

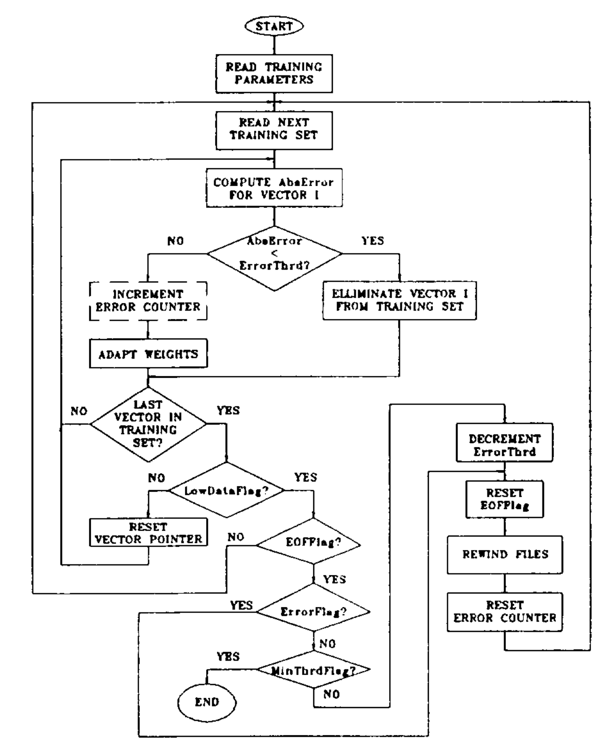

Figure 1 The Enhanced Back Propagation (EBP) Algorithm.

<u>READ TRAINING PARAMETERS:</u> In this block, the parameters read include the Gain, Momentum, NumberOfErrors, DelErrThd, and NumberOfGroups. The Gain and Momentum are used in BP algorithm [1].

NumberOfErrors: When working with a training set containing thousands of real world data such as the feature vectors from handwritten character images, it is conceivable that due to human error a few of the vectors will be wrongly labeled. Moreover, some of the images could be so distorted following the preprocessing, that they become ambiguous and should not be used in the training set. Setting the value of NumberOfErrors to about 1% of the number of the vectors in the training set enables the EBP to ignore vectors that are hard to learn, thereby improving generalization.

DelErrThd: Initially, ErrorThrd is set at 0.9. This value is gradually decreased by DelErrThd to the desired minimum (MinThrd). In our demonstrations our target was (0.25, 0.75), thus MinThrd was 0.25. This target could go as high as (0.1, 0.9). Setting the desired minimum guards against the phenomenon of over learning.

NumberOfGroups: This parameter is used to specify the number of groups in the training set. For example, in handwritten digit recognition there are 10 digits, hence NumberOfGroups is set to 10. Note, however, that this also specifies the number of files containing the training set. Before training, the training set is sorted, one class (group) per file.

READ NEXT TRAINING SET: The algorithm reads one training vector per class into the register, forming a training subset. Before adapting weights, AbsError, which is the absolute difference between the output of a vector and its desired output is computed and compared to ErrorThrd. If AbsError is greater, weight values are changed; otherwise, the vector is eliminated from the training subset. Training will continue with this subset until all vectors are eliminated or LowDataFlag is set. When training multi-output network with real world data, LowDataFlag is set when no more than one vector is left. This enables the algorithm to filter out bad data. In other situations LowDataFlag is set when no vector is left.

INCREMENT ERROR COUNTER: For a vector to be used in weight adaptation, its AbsError has to be greater than the prevailing ErrorThrd. The error counter records the number of different vectors used in weight adaptation per epoch. At the end of the epoch, ErrorFlag is set if this number is greater than NumberOfErrors.

Flags: EOFFlag is the end-of-files flag. It is set to indicate the end of all training files. MinThrdFlag is set when the target (minimum error) is reached. The rest of the blocks are self explanatory.

2.2 EBP Operation

This algorithm is designed to speed up convergence and produce good generalization by extricating the learning process from non global minima, preventing over training, and filtering out bad training data. In order to achieve these objectives and in preparation to the training process, the following has to be accomplished.

The training set is sorted into different files according to the groups in the training set. This produces the value for NumberOfGroups. It has been suggested that NumberOfErrors be set to about 1% of the total number of vectors in the training set. DelErrThd is the decrement step through which ErrorThrd approaches MinThrd. A value of 0.1 could be the default.

Having set the parameters and initiated the training process, the EBP reads in one training vector per group, forming a training subset. With each vector in this subset, it first computes the absolute difference (AbsError) between the actual output of the network and the corresponding desired output. If this AbsError is greater than the prevailing error threshold (ErrorThrd), adaptation of the weights occurs; otherwise, the vector is eliminated from the training subset.

Training continues with this subset until LowDataFlag is set. This flag is set when the number of training vectors remaining in the training subset is not greater than the value of LowData. At this point another set of training subset is read. This process of incremental training continues until all training vectors are read - completing an epoch. At the completion of an epoch, ErrorFlag is set if the value in the error counter is greater than NumberOfErrors. If ErrorFlag is set another epoch will be executed; otherwise, ErrorThrd is decremented and another cycle commences. These cycles continue until minimum error threshold is reached, which ends the training session.

3 Simulations and Results

We have tried the EBP algorithm on several problems including the classical XOR problem. These experiments also varied the training parameters, the network topology and the initial weights of the networks. In all cases the EBP was able to solve the problem faster than the BP algorithm. For the results presented in tables below, the weights were initialized in the range of ± 0.5, target values were (0.25, 0.75). The bias was held at zero.

Table 1 shows the simulation results of the XOR problem on a 2 inputs, 2 hidden nodes, and 1 output (2-2-1) network. It should be emphasized that the 'Number of Adaptations' is the number of times the weights were changed which is different from epochs. For this initial weight of ± 0.5 and zero bias and momentum values, the BP was not able to achieve convergence in 10,000 epochs (40,000 adaptations). Notice that EBP achieved faster convergence for the gain values greater than one.

Table 1. EBP simulation of XOR on a 2-2-1 feed-forward network.

Gain Value	Number of Adaptations
0.9	7277
5.0	2574
7.0	2430
10.0	3788

In fact, table 2, which is the simulation results on a 2-4-1 net of the XOR, shows that as the gain value increases (beyond 1 and to 10) the number of adaptations reduces significantly for EBP, while it increases when BP is in action. Table 3 shows the effect of gradual error decrement. Notice that as the step size in error decrement increases, the number of iterations increases. Table 4 shows that incorporation of the momentum parameters in the EBP does produce little speed up, yet.

Table 2. EBP simulation of XOR on a 2-4-1 feed-forward network.

Gain Value	Number of Adaptations		Speed up Ratio
	BP	EBP	BP/EBP
0.9	6664	2612	2
5.0	9372	237	39
7.0	8868	191	46
10.0	6516	183	35
15.0	15248	388	39

Table 3. EBP Simulations of XOR on a 2-4-1 network with DelThrold varying.

DelThrold	Number of Adptations	
	Gain = 5	Gain = 7
0.01	228	173
0.05	231	188
0.10	237	191
0.50	285	262
1.00	1003	240

Table 4 EBP Simulations ofXOR on a 2-4-1 network with Momentum varying.

Momentum Value	Number of Adptations	
	Gain = 5	Gain = 7
0.00	237	191
0.01	231	173
0.05	216	236
0.10	228	170
0.50	171	NC

The EBP successfully trained simultaneously three parallel 40-150-100-10 classifier network for optical character recognition. The training set consists of 3801 vectors. NumberOfErrors was set at 30. This parameter enabled the network to filter out 4 vectors from corrupted images and another 2 from mis-labeled images. On a different test set of 1888 vectors, a recognition rate of 95.87% was achieved.

4 Conclusions

The capabilities of the EBP algorithm have been highlighted. It has been demonstrated that this algorithm achieves fast convergence with good generalization. Contrary to how one would reason, table 3 clearly shows that smaller error decrements yield faster convergence. It is stated above that (0.25, 0.75) was set as the target. The is possible because this algorithm strives for uniform error across the training vectors. Maintaining uniform error also enables the learning process to avoid local minima. In turn, setting the target terminates the training before over learning occurs.

When working with real world data such as in optical character recognition where thousands of vectors are used to train for a particular character, it is noticed that this EBP algorithm actually adapts weights with only a fraction of the training vectors. These form the key vectors which are used to define the recognition hyper-plane. It can be argued that the use of key vectors will help to reduce the number of erroneous substitutions.

Finally, it is should be mentioned that the overhead computations resulting from the enhancement are minimal. Moreover, this algorithm can be adopted in other learning schemes.

Acknowledgement

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