Small Business Innovation Research (SBIR) Program

Proposal Cover Sheet
Proposal Number: F041-062-1211 Agency: Air Force DUNS: 102385056
Topic Number: AF04-062 CAGE:
Proposal Title:

Multivariate Statistical Analysis Techniques for Automatic Speech Identification

Firm:
Firm Name: RBI
Mail Address: 9511 W. Waneta Lake Rd.
Hammondsport, NY 14840-9511
Website Address: linkny.com/edrice4/engnr
Proposed Cost: 87022 Phase: I Duration: 9 Months
Business Certification: (Check all that apply)
Are you a small business as described in paragraph 2.2 (note: wholly owned subsidiaries are not eligible)? YES
Number of employees including all affiliates (average for preceding 12 months): 1
Are you a socially or economically disadvantaged business as defined in paragraph 2.3 ? NO
Are you a woman-owned small business as described in paragraph 2.4 ? NO
Are you a certified HUBZone small business concern as described in paragraph 2.9 ? NO
Are you a service-disabled veteran-owned small business as described in paragraph 2.11 ? NO
Are you a veteran-owned small business as described in paragraph 2.12 ? YES
Are you proposing to use a Federal facility or FFRDC? NO
Has a proposal for essentially equivalent work been submitted to other US government agencies or DoD components?
NO
If yes, list the name(s) of the agency, DoD component or other SBIR office and Topic Number in the space below.

Project Manager/Principal Investigator Corporate Official (Business)
Name: Mr. Edward G. Rice Name: Mr. Edward G. Rice
Title: Principal Engineer Title: Sole Proprietor
Phone: (607) 292-6639 Phone: (607) 292-6639
Fax: (607) 292-6639 Fax: (607) 292-6639
E-Mail: edrice4@linkny.com E-Mail: edrice4@linkny.com

Proprietary Information (list page numbers): 0

_____ _____

_____ _____
Signature of Principal Investigator Date Signature of Corporate Business Official Date

Technical Abstract

(Limit your abstract to 200 words with no classified or proprietary information)

The proposed effort entitled *"Multivariate Statistical Analysis Techniques For Speech Identification"* will exploit little used multivariate statistical analysis techniques to develop an automated voice recognition capability. These multivariate techniques have had rapid development in the processing rich environment of the past few years, but their power has not been exploited in any engineering disciplines. The system engineer can use these powerful techniques to perform correlation, clustering and factor analysis on a myriad of technical parameters used in speech, voice, signal and threat ID. This effort will utilize multivariate statistical methods to evaluate and develop an automated voice recognition prototype. Multivariate statistics evaluates variable interreltionships. This will be used to evaluate the many variables found in voice biometrics. The correlations and factor analysis utilized will lead to a set of variables (factors) applicable to voice recognition. These variables will then be optimized into algorithms which use the multivariate statistics to categorize/cluster signals to their smallest likely grouping, even down to the single identification of a voice/word. An automated voice recognition capability and the multivariate tools developed will be put in an open architecture which will be prototyped and tested in a Phase II development.

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

(No classified or proprietary information)

The commercialization of the multivariate statistical methods is pending the open architecture development of powerful data analysis modules. RBI expects to drive this R&D to that end. The tools used by the statistician to perform the correlations, factor analysis and clustering of diverse data require expert handling and understanding. The less diverse data used in the engineering environments enable the honing of these statistical methodologies into automated data processing modules which perform specific correlations and factor analysis to enable powerful understandings of raw data. These modules can be interconnected to perform multiple functions in the same way that business modules are interconnected in the open architecture of Java Beans. Thereby the engineer can use these statistical methods to do whatever he wants with myriad's of data.

RBI expects to use this multivariate statistical methodology to 1) find powerful solutionis to voice and signal identification challenges, 2) to perform geopositioning, tracking and fusion applications in the missile defense arena , 3) to perform data correlations and factor analysis for homeland defense functions and 4) to perform level 2+ data fusion advancements. As a new start company operating in a recession RBI has no material resources to invest in these four development areas. However, RBI has found an ample human resource of engineers operating out of their areas of expertise who are eager to invest their talents in the possibilities found in this vision. The opportunity for patents and sales of specific modules is expected to result from the Phase II development. The synergism from the addition of programmers and talented system engineers for a Phase II development will generate more opportunities for spin-offs of this technology. These diverse applications of such a powerful set of modules is expected to reap financial benefits within two years of their availability. The advancements to be retrofit into the modules for even more diverse applications will generate more benefits as well as advanced R&D investments

List a maximum of 8 Key Words or phrases, separated by commas, that describe the Project.

Keywords: Speech Recognition, Voice Recognition, Voice Biometrics, Foreign Accent, Multivariate Statistics, Factor Analysis, Cluster Analysis, Statistics

2. IDENTIFICATION & SIGNIFICANCE OF THE OPPORTUNITY

Automated voice Identification algorithms have not been adequate to perform some demanding tasks of law enforcement and military intelligence applications. Multivariate Statistical Analysis techniques have emerged in the past 5 years of processing advancements, as the premier comparative and signal fingerprinting methodology. This effort will marry the essential Voice Biometric parameters to the Multivariate Statistical Analysis methodology and evaluate an automated voice print recognition system that performs real time automated voice recognition for military/homeland intelligence purposes.

Current voice ID capabilities face two systematic limitations. The first limitation is in the comparative analysis method. Current methods reduce the multiple biometric variables of human speech into a two dimensional plot of 3 variables. The time scale is portrayed on the horizontal axis, the frequency on the vertical axis and the magnitude of each frequency is portrayed in a gray scale of color pattern. This marvelous and powerful technique was developed and popularized by Bell Laboratories in the 1950's. It is used as a visual voice print along with an audible voice characterization by a trained analysts to make a probabilistic voice identification. Such visual voice print analysis is inadequate for an automated real-time voice identification methodology. Current multivariate statistical analysis techniques allow the comparison of a myriad of pitch, pause and tonal parameters found in human voice biometrics. Advance processing capabilities allow these statistical comparative algorithms to operate in real time.

The second systematic limitation on automated voice ID capabilities is the necessity of key word comparison. It should be noted that humans do audible voice ID without this key word necessity and real time automated voice ID must operate on the tonal and pitch variation found in an individual voice rather than on the voice print pattern of a key word or phrase. Again, multivariate statistical analysis techniques have proven extremely effective at dynamically sorting through a vast sea of variable data and choosing the key parameters which provide the greatest differentiation and grouping between samples or types. It is expected that this versatility and diversity will eliminate the dependence on key words in an automated real time voice identification capability.

The multivariate statistical algorithms employed for this research use a comparison of the statistical distributions of each parameter under investigation. The slight variations of an individual parameters may not be a discriminating feature on its own, but when combined statistically with other parameters it can provide information that results in a combined high fidelity discrimination. With multivariate grouping techniques voice biometrics data may be compared to other voice samples or categorized into a bin based on pitch and tonal attributes of various sounds. This characterization of a particular voice type implicitly segregates a voice pattern down to the highest discriminate for the parameters selected. The addition of multivariate techniques provides a probabilistic measure which must be present to remove the necessity of an expert analyst and completely automate voice ID.

2.1 Background. Voice ID has come a very long way in the powerful computational environment of the past 5 years. The superb processing capabilities of the last few years has fielded powerful tools for the expert voice analysts. These tools have relied on the experts analytical ability to differentiate and group the voice patterns and perform voice identification to a high probability. There is a necessity to remove the human expert from this scenario and machine automate this identification to an equally high, or higher probability.

Multivariate Statistical analysis has come a very long way in the powerful computational environment of the past few years. The superb processing capabilities of late has fielded powerful tools for the statistician to perform market

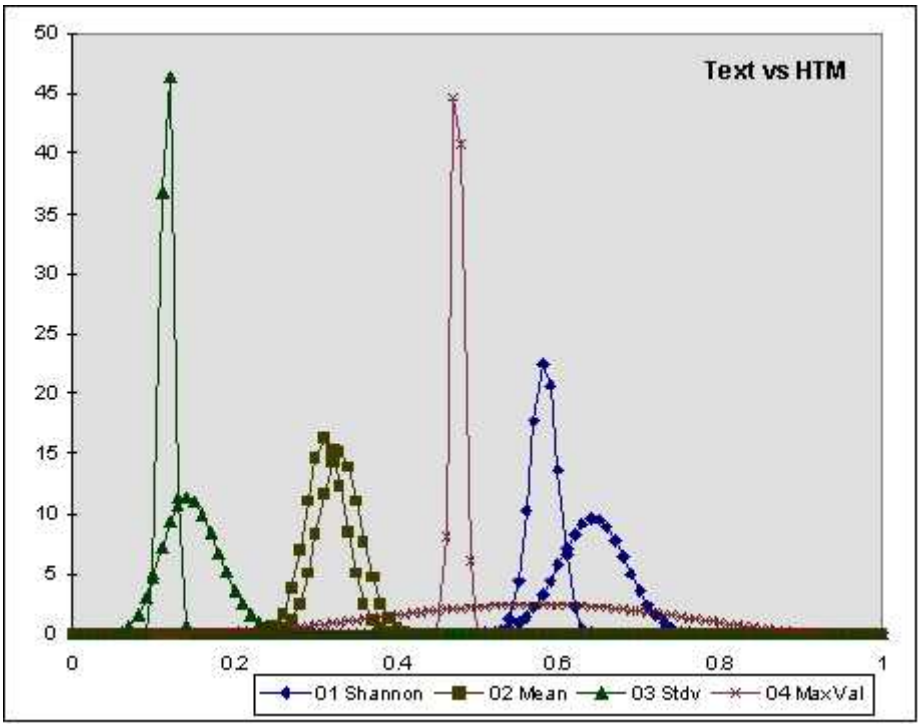
analysis, political estimation and social/medical groupings based on multiple variables and variations. These probabilistic multivariate analysis techniques are just now finding powerful applications in the less abstract fields of signal processing and computer data analysis. Multivariate Statistical Analysis techniques enable powerful data groupings and signal identifications. They supply dynamic probability values that confirm very high fidelity discriminations.

The marrying of Voice ID with Multivariate Statistical Analysis deserves a systematic evaluation. The benefits of such a marriage loom just out of reach of the statistician and just beyond the expert voice analyst. A system engineer with training in statistics and experience in digital signal processing can unite the two powerful fields.

2.2 Multivariate Statistics used in Signal ID Background

The arbitrary bit stream identification challenge provided an ideal environment to test these multivariate statistical analysis tools for the engineering discipline. An Arbitrary Digital Bit Stream is encountered when an intelligence intercept of digital data has been demodulated. An arbitrary bit stream may be text, voice, graphics, or other data that may be compressed or not, encrypted or not, and scrambled or not. Before useful intelligence can be obtained from the intercept it is essential that the signal be categorized as to the previous processes which acted upon it. The arbitrary bit stream classifiers currently in use rely on only one or two parameters for grouping. Shannon entropy measures have been reasonably effective at separating encrypted data from the rest, however using multivariate statistical techniques has given promise to higher fidelity classifications. With multivariate statistical methods RBI has been able to differentiate scrambled datas to even tell which type of scrambler algorithm was employed. This was accomplished using only entropy and histogram characteristics. By employing the frequency characteristics, now being pursued as additional factors, and the power of multivariate statistics to perform factor analysis and Eigen Vector clustering, high fidelity ID of all signal types is imminent and insights into the compression, scrambling and encryption algorithms which were employed are assured. It is promising that even the encryption password length can be detected for most of the encryption algorithms employed today. The power of this new signal classifier capability is equally viable for speech recognition and voice ID challenges.

This ability to extract powerful signal grouping/identification characteristics is illustrated in the figure below.



The multivariate statistical methods are used here to calculate distribution curves for parameters of several arbitrary bit streams. The area shared beneath the two distribution curves for the Shannon entropy variable indicate the probability that an entropy measurement could not be categorized into either group with certainty. Likewise for the other three distributions. With the use of Bayes theorem of probabilities one can use information of all four of these distribution to group a sampled bit stream into either text, htm, or neither with very high probability. A single parameter cannot perform this classification, but multiple parameters, even when some are dependent variables, can add a powerful synergism to signal grouping/identification methods. This multivariate statistical method of grouping/identification of signals with very high fidelity is only the beginning of the multivariate methods now found available to a statistician, and multivariate statistics is relatively untapped by the engineers doing signal identification.

This effort will use these multivariate statistical methods to explore their direct application to speech recognition and voice identification. The classification of voice biometrics is suited as the catalyst for a continued development of multivariate statistical modules which will soon find direct application in several engineering applications. Applications which include speech recognition, voice ID, signal ID, geopositioning, tracking, data correlation and data fusion disciplines.

2.3 Voice ID Background

To better understand the challenge of voice identification an excerpt from a "History of Voice ID" article is here fitting.

> Several years ago a law enforcement group inquired about what help they could get in combating telephoned bomb scares to airlines and public buildings. Their particular interest was in being able to identify the voice of the perpetrator of such crimes. The problem was referred to the Acoustic and Speech Research Dept. of the Bell Telephone Laboratories.
>
> The author, one of four research experimental lists working in that area, was optimistic about the possibilities of voice identification on the basis of the unique naturalness factors which have so long confounded efforts to design machines that were capable of reliably recognizing human speech. He requested permission to study the area for two years and if encouraging results were not obtained at the end of six months, the study would be discontinued.
>
> At the conclusion of this time period, the evidence obtained appeared encouraging and study was

continued. The study was largely dependent on the use of the improved sound spectrograph which acted as an automatic wave analyzer recording the acoustic patterns of speech in the dimensions of time, frequency, and intensity. The acoustic patterns called voiceprints permitted side-by-side visual comparison of speech sounds, instead of requiring that an investigator listen to the sounds one after another with uncertain dependence on memory. The eye is more sensitive to minute changes in a complex pattern than is the ear to small changes in a complex sound. The ear is an averaging instrument and is sometimes tricked in discrimination trials. "History of Voice ID" pg. 2 by K&R's All Media Productions Inc.28533 Greenfield, Southfield, Mi 48076(248) 557-8276 * Toll Free (888) 802-0420Email: recordav@knr.net

If the eye is more discriminating than the ear in this article, understand that multivariate statistical analysis afforded by modern processors makes the computer far more sensitive than the eye at discerning minute changes in the myriad of variables applicable to voice biometrics.

The sophisticated voice identification techniques of today are still reliant on a trained certified examiner as illustrated in the two excerpts from an article in "Voice Identification" below:

> Today voice identification analysis has matured into a sophisticated identification technique, using the latest technology science has to offer. The research, which is still continuing today, demonstrates the validity and reliability of the process when performed by a trained and certified examiner using established, standardized procedures. Voice identification experts are found all over the world. No longer limited to the visual comparison of a few words, the comparison of human voices now focuses on every aspect of the words spoken; the words themselves, the way the words flow together, and the pauses between them. Both aural and spectrographic analysis are combined to form the conclusion about the identity of the voices in question. "VOICE IDENTIFICATION: The Aural/Spectrographic Method" by: Michael C. McDermott (mike@mcdltd.com), Tom Owen (owlmax@aol.com), Frank M. McDermott, Ltd. Owl Investigations, Inc.
>
> Recent developments in sound spectrography have produced computerized digital sound spectrographs ranging from dedicated digital signal analysis workstations to PC-based systems for acquisition, analysis editing, and playback. These sophisticated computer-based systems provide high fidelity signal acquisition, high- speed digital processing circuitry for quick and flexible analysis, and CD-quality playback. The computerize-based systems accomplish all the same tasks of the analog systems, but with the computer-based systems the examiner gains a host of comparison and measurement tools not available with the analog equipment. The computer-based systems are capable of displaying multiple sound spectrogram, adjusting the time alignment and frequency ranges and taking detailed numeric measurements of the displayed sounds. With these advances in technology, the examiner widens the scope of the analysis to create a more detailed picture of the voice or sound being analyzed.
> The accuracy and reliability of the sound spectrograph, either analog or digital, has never been in question in any of the courts and never considered an issue in the admissibility of voice identification evidence. This may be due in part to the wide use of the instrument in the field of speech and hearing for non-voice identification analysis of the human voice and, in part to the fact that given the same recording of speech sounds the sound spectrograph will consistently produce the same spectrogram of that speech. The contest comes in the interpretation of the spectrograms. "VOICE IDENTIFICATION: The Aural/Spectrographic Method" by: Michael C. McDermott (mike@mcdltd.com), Tom Owen (owlmax@aol.com), Frank M. McDermott, Ltd. Owl Investigations, Inc.

With all the sophisticated computer based systems employed against this challenge the power of multivariate statistics analysis methods have not been employed. This effort will utilize these techniques and demonstrate their power to automate and empower both speech recognition and voice identification resources.

2.4 Multivariate Statistics Background. Multivariate statistics are used extensively to :

1) develop taxonomies (or system of classifications.)
2) to investigate useful ways to conceptualize or group items.
3) to generate hypothesis, and

4) to test hypothesis.

Many mathematical and statistical computer tools are available to accomplish theses purposes. The massive computer power unleashed with multivariate analysis tools is revolutionizing the analysis capability of marketers, politicians, sociologists and graduate statistics students. These powerful tools unleash faster analysis methods, multidimensional scaling techniques and cluster analysis advances to look at and understand interrelationships among multiple variables. Politicians, Sociologists, and Business Marketers are on the leading edge of this technology breakthrough. Engineers doing signal analysis, geopositioning, target ID and level 1 fusion are on the trailing edge when it comes to utilizing these powerful multivariate analysis techniques.

Multivariate statistics can do two major functions to edify the fusion or signal processing tasks of the systems engineer. First it looks at multiple variables related to the task and through the use of correlation's and Eigen vector analysis it determines the interdependence of the various variables. One method of revealing the interdependence of variables is through multidimensional scaling (MDS). We can define MDS as "a set of multivariate statistical methods for estimating the parameters in and assessing the fit of various spatial distance models for proximity data" (cf. Davison, M.L. (1992)) The more powerful tool for this interdependence is with factor analysis. (cf. Kim, J., and Mueller, Charles W. (1978)) When making threshold decisions in either signal processing or in data fusion the interrelationship of the factors in the decision process provide vital information. With a clear understanding of the interrelationships the key factors for a particular decision may be separated from the myriad of data and be used to clarify and validate the decision.

Secondly the multivariate statistical analysis enables groupings of data into categories of similarities. These groupings can be as wide or as narrow as desired. The categorization can use the fidelity of multiple variables to single out an individual entry and even perform ID or fingerprint type classifications. This type of grouping is done via cluster analysis (Aldenderfer, M.S., and Blashenfield, R.K. (1984)) or MDS methods previously mentioned. Previous statistical analysis used dependence methods whereby multiple regression and analysis of variance used several variables but one dependent variable was predicted by means of several independent variables (Hair, J.F. et al. (1992)). These multivariate statistical methods allow examination of interrelationships among variables thereby enabling powerful new abilities to enhance signal processing, identifications or 'fingerprinting' of signals or data sources, and the fusion of related data into situational awareness. Multivariate statistics has powerful applications being utilized by statisticians yet still untapped by system developers.

3. PHASE I TECHNICAL OBJECTIVES

The phase I objectives are to re-evaluate the parameters and biometrics used in speech ID and optimize an automated ID capability using multivariate statistics. The parameters will be evaluated using the correlations, cluster analysis and factor analysis tools of the multivariate statistics trade. The interrelationships of the factors will enable the optimization of a set of parameters to perform effective speech ID. These optimized parameters and the measure of their effectiveness will then be used to advance an automated speech recognition/identification prototype which can be coded and tested in an open architecture environment during Phase II of the effort.

4. PHASE I - WORK PLAN

The Phase I work will 1) re-evaluate the speech parameters and biometrics applicable to speech identification, 2) evaluate the multiple variables with multivariate statistic tools to correlate and group the parameters or factors, 3)

investigate the interrelations of the speech parameters and 4) optimize an automated recognition/identification capability.

The Phase I work plan will include the following tasks for achieving the stated objectives:

4.1 Speech Paramaterization (100 hr.)

The data parameters necessary to perform speech ID will be explored in this task. Several parameters have already demonstrated powerful metrics for grouping data, but a diverse set of parameters will be explored in the time and frequency domain. Multiple parameters, even if they are interrelated, can be optimized and analyzed with the multivariate statistics tools. The key in this task is to capture every conceivable parameter that might add weight to the grouping/ID fidelity of an automated process.

4.2 Multivariate Analysis Methods (300 hr.)

Multivariate statistical analysis tools are generally made to analyze dichotomous data from survey or polling inputs. These tools are robust and powerful but are not automated nor versatile. The data to be input to these statistic methodologies in this effort will in general be continuous. Most of the data will fit a normal statistical distribution but many times the data will better fit a Beta distribution. The tools will need to be modified or developed to efficiently handle both distributions of continuous data. The Eigen vector and correlation analysis tools will likewise need some modification to handle these diverse data requirements. The power of the multivariate statistics methods will be defined/refined and developed in Java in this task.

4.3 Correlations & Clustering (150 hr.)

The power of the multivariate statistics analysis methods will be unleashed in this task. The parameters/factors which provide the best fidelity for the groupings and ID will be selected and isolated in this task. The tools of this trade include the ability to 'rotate' data into independent variables. These data transformations must be done without loss of valuable discriminating information. The evaluation of parameter interrelationships and the transformations into independent variables done in this task will preserve optimized information for automating an ID process.

4.4 Performance Optimization for Automation (200 hr.)

In this task the multivariate statistics output will be optimized to benefit automation of speech recognition and/or voice identification. The test cases will be exercised to evaluate the effectiveness and advantages of the multivariate statistic package. The overall architecture of the inclusion of the statistics tools in this approach will be examined and the architecture and statistics modules will be tweaked to finalize the multivariate statistical approach to speech recognition and/or voice identification.

4.5 Reporting. (50 hr.)

A. Bimonthly Progress reports: In addition to day-to-day informal contacts with the program monitor, technical progress reports will be submitted every two months.

B. A Final Report will be generated. A final report detailing all of the development and evaluation will be submitted at the end of Phase I.

The Phase I work would follow the tentative schedule below:

Task	Days	Hrs	Start	Stop
SBIR Phase I MVSAT for Speech ID	280	800	03/01/04	12/06/04
Task 4.1 Speech Paramaterization	35	100	03/01/04	04/05/04
Task 4.2 Multivariate Analysis Methods	105	300	04/05/04	07/19/04
Task 4.3 Investigate Interrelations	52.5	150	07/19/04	09/09/04
Task 4.4 Optimize Automation	70	200	09/09/04	11/18/04
Task 4.5 Reporting	17.5	50	11/18/04	12/06/04

Waterfall Chart of Tasks

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SBIR Phase I         ...A.....M.....J.....J.....A.....S.....O.....N.....D.
4.1 Invst Paramrs    XXXXXXX.....................................................
4.2 MVA Methods      .......XXXXXXXXXXXXXXXXXXXXX.....................
4.3 Interrelatons    ............................XXXXXXXXXX..............
4.4 Optim Automat    ....................................XXXXXXXXXX.....
4.5 Reporting         ................................................XXX.
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5. RELATED WORK

The Principal Investigator is the sole proprietor of RBI and has been involved in pursuing categorizing arbitrary bit streams for the past several years. While in the USAF he was responsible for the programs that enhance the performance of numerous intelligence collection platforms. With minimal funding and resources RBI is staying abreast of the current technologies and intelligence mission requirements. RBI has used multivariate statistical analysis methods to perform classifications and identification of arbitrary bit streams. The multivariate methods as used in that task will have direct application to several system engineering challenges found in the military intelligence R&D incentives. RBI maintains connections with both DOD military intelligence R&D efforts and multivariate statistics R&D advancements to stay on the leading edge of this breaking technology.

6. Relationship With Future Research Or R&D

The successful use of multivariate statistics methods in the speech recognition arena will open doors of opportunity for many types of signal ID, for data fusion and for this powerful factor analysis methodology. If these statistical methods mark notable improvements for speech recognition in Phase 1, the follow on phases of prototyping will field open architecture Java modules which will find application in multiple fields of both speech recognition and digital processing. RBI will advance it's system engineering arm to lead in other R&D efforts which will exploit these little used methodologies in areas of military intelligence collections, missile defense missions, homeland security intelligence collections and level 2+ data fusion areas that are currently stalemated without adequate correlation and clustering techniques to sort through their myriad of mitigating factors.

7. Commercialization Strategy

The commercialization of the multivariate statistical methods is pending the open architecture development of powerful data analysis modules. RBI expects to drive this R&D to that end. Multivariate statistics is currently in vogue and application in college, in social/political polling and in marketing positions. The tools used by the statistician to perform the correlations, factor analysis and clustering of diverse data require expert handling and understanding. Thereby the statistician can make the statistics say whatever he wants. The less diverse data used in the engineering environments enable the honing of these statistical methodologies into automated data processing modules which perform specific correlations and factor analysis to enable powerful understandings of raw data. These modules can be

interconnected to perform multiple functions in the same way that business modules are interconnected in the open architecture of Java Beans. Thereby the engineer can use these statistical methods to do whatever he wants with myriad's of data.

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8. KEY PERSONNEL

Edward G. Rice, Senior Engineer

EDUCATION:
M.S., Electrical Engineering, Air Force Institute of Technology, Wright Patterson AFB Ohio, March 1992.
B.S. Electrical Engineering, Ohio State University, Columbus Ohio, March 1982.

CURRENT POSITION AND RESEARCH:

Edward Rice is a retired USAF officer and the Sole Proprietor of RBI. He has more than 18 years of experience in USAF intelligence systems. RELEVANT EXPERIENCE: Prior to starting RBI Ed Rice was the consultant that developed and tested the basic Euclidean Distance Vector Fitting Technique for Categorizing Arbitrary Bit Streams. From 1989 to 1995 he was assigned to Rome Laboratories where he managed numerous intelligence collection technology initiatives. From 1984 to 1989 as a USAF Electrical Engineer he worked with numerous data collection and weapon delivery systems furthering and rounding out his background in intelligence systems. He is currently Pastoring a Baptist Church and teaching high school math and science part-time, while pursuing a M.Div. Degree. He is available to work on RBI efforts up to 40 hours per week.

9. FACILITIES/EQUIPMENT

Due to cutbacks and limited resources RBI currently has no facilities and minimal equipment. The economic recession in the New York area makes available ample office space and computer resources which can be in place with minimal investment and time. Currently algorithm development and statistical analysis is performed on a desktop computer in an office in the basement of my home. A Java development environment , Excel Spreadsheets utilizing Visual Basic, tools in Microsoft Office and Lotus Millennium have proven very adequate on a PC to perform all research and module developments. Should RBI be funded for a multivariate statistical development ample facilities and equipment could be in place within 30 days.

10. CONSULTANTS

Several engineers with backgrounds in statistics, intelligence and computers are available to act as consultants for this effort. RBI is close to Cornell University, Rochester and Syracuse NY where unemployed engineers await a call and opportunity to get involved in a visionary development for RBI. Additionally the internett makes available a world of

such expertise which can be utilized to perform this multivariate statistical development. Any consultants utilized by RBI for this effort will be paid by RBI, are not reflected in the cost proposal and shall not alter the cost proposal of this effort.

11. PRIOR, CURRENT OR PENDING SUPPORT

RBI has 3 SBIR proposals submitted which utilize the powerful advantages of multivariate statistical analysis techniques. There is great potential in any one of these proposals, if two or three of them are initiated the synergism between them will benefit all. RBI can pull together the resources necessary to perform all three of these efforts simultaneously with advantage to each participant. The three proposals are titled as follows:

Multivariate Statistical Analysis Techniques For Data Fusion 2 +

SBIR Topic Num: AF04-115
SBIR Title: Innovative Approaches to Fusion 2 +
SBIR Research & Technical Areas: Information Systems
SBIR Topic Author: Michael Hinman,
Phone: (315) 330-3175 Fax: (315) 330-4380
Email: hinmanm@rl.af.mil

Multivariate Statistical Analysis Techniques For Arbitrary Bit Stream Pattern Recognition

SBIR Topic Num: MDA04-020
SBIR Title: Innovative Techniques for Missile Defense
SBIR Research & Technical Areas: Weapons
SBIR Topic Author:Mr. Vincent Nguyen
Phone: (703) 695-0285 Fax: (703) 695-6222
Email: Vincent. Nguyen@mda.osd.mil

Multivariate Statistical Analysis Techniques For Automatic Speech Identification

SBIR Topic Num: AF04-062
SBIR Title: Expanded Speech Recognition to Include Foreign Accents
SBIR Research & Technical Areas: Human Systems
SBIR Topic Author: Mr. David Williamson
Phone: (937) 255-7593
Email: david.williamson@wpafb.af.mil

12. COMPANY COMMERCIALIZATION REPORT (SEE ADDITIONAL ELECTRONIC SUBMITTAL)

13. COST PROPOSAL (SEE ADDITIONAL ELECTRONIC SUBMITTAL) (Also See Last Page)

14. REFERENCES and FOOTNOTES

Michael C. McDermott (2003)
"History of Voice ID" pg 2 by K&R's All Media Productions Inc.Email: recordav@knr.net

Tom Owen, and Frank M. McDermott, Ltd. Owl Investigations, Inc. (2003)
"VOICE IDENTIFICATION: The Aural/Spectrographic Method" mike@mcdltd.com

Aldenderfer, M.S., and Blashenfield, R.K. (1984)

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Multidimensional scaling. Malabar, Fl, CA: Krieger Publishing.

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Kim, J., and Mueller, Charles W. (1978)
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Romesburg, H.C. (1984)
Cluster analysis for researchers. Belmont, CA: Lifetime Learning Publications.

Rummel, R.J. (1984)
Applied factor analysis. Evanston, IL: Northwestern University Press.
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RBI Cost Proposal

RBI 9511 W.Waneta Lake Rd, Hammondsport NY 14840 Date:
01-Jan-04

Phone: **(607) 292-6639** CAGE Code: _____

Title: **Multivariate Statistical Analysis Techniques For Automatic Speech Identification**

Topic: **AF04-062** Expanded Speech Recognition to Include Foreign Accents

Total Proposal Amount **$87,021.58**

Direct Material	EA	PER COST	EST COST	TOTAL
a. PURCHASED PARTS	NA		0	
b. SUBCONTRACTED ITEMS	NA		0	
c. OTHER	NA		0	
TOTAL DIRECT MATERIAL			.	0
	9	MO		
Direct Labor	EST MM	RATE/HR	EST COST	TOTAL
(1728 MH/MY)	20	hr/wk		
Principle Engineer	800	45	36,000	
Jr Engineer	0	24	0	
Programmer	0	24	0	
Publications	0	13	0	
TOTAL DIRECT LABOR	5.56	0.62	ENGRS	36,000
LABOR OVERHEAD	OH RATE	XBASE	EST COST	
a. IN PLANT	0.7	36,000	25,200	
b. ON SITE	0.55	0	0	
TOTAL LABOR OVERHEAD	.	.	.	25,200
SPECIAL TESTING	.	.	.	0
SPECIAL EQUIPMENT	.	.	.	0
TRAVEL	EA	RATE	EST COST	
a. TRANSPORTATION	3	979	2,937	
b. PERDIEM	10	85	850	
c. LOCAL TRANSPORTATION	10	32	320	
TOTAL TRAVEL	.	.	.	4,107
CONSULTANT	Hrs	Rate	Cost	
	0	75	0	
TOTAL CONSULTANT	.	.	.	0
OTHER DIRECT COST	.	.	.	0
TOTAL DIRECT COST AND OVERHEAD		.	.	65,307
GENERAL ADMIN EXPENCE	0.25	OF COST	.	16,327
COST OF MONEY	0	OF COST	.	0
TOTAL ESTIMATED COST	.	.	.	81,634
FEE OR PROFIT	0.07	OF COST	.	5,388
TOTAL ESTIMATE AND FEE OR PROFIT		.	.	87,021.58