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Ravi Ramachandran
Rowan University

Steven Chin
Rowan University

Kevin Dahm
Rowan University

Liang Hong
Tennessee State University

Sachin Shetty
Old Dominion University

See next page for additional authors

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Authors

Ravi Ramachandran, Steven Chin, Kevin Dahm, Liang Hong, Sachin Shetty, Robert Nickel, Richard Kozick, Ying Tang, and Robi Polikar

Planning and Assessment of a Workshop on Undergraduate Education in Biometric Systems

Dr. Ravi P. Ramachandran, Rowan University

Ravi P. Ramachandran received the B. Eng degree (with great distinction) from Concordia University in 1984, the M. Eng degree from McGill University in 1986 and the Ph.D. degree from McGill University in 1990. From October 1990 to December 1992, he worked at the Speech Research Department at AT&T Bell Laboratories. From January 1993 to August 1997, he was a Research Assistant Professor at Rutgers University. He was also a Senior Speech Scientist at T-Netix from July 1996 to August 1997. Since September 1997, he is with the Department of Electrical and Computer Engineering at Rowan University where he has been a Professor since September 2006. He has served as a consultant to T-Netix, Avenir Inc., Motorola and Focalcool. From September 2002 to September 2005, he was an Associate Editor for the IEEE Transactions on Speech and Audio Processing and was on the Speech Technical Committee for the IEEE Signal Processing society. Since September 2000, he has been on the Editorial Board of the IEEE Circuits and Systems Magazine. Since May 2002, he has been on the Digital Signal Processing Technical Committee for the IEEE Circuits and Systems society. His research interests are in digital signal processing, speech processing, biometrics, pattern recognition and filter design.

Dr. Steven H Chin, Rowan University

Steven H. Chin is currently the Associate Dean of Engineering at Rowan University. He has been in this position since 1997, while serving as Interim Dean from 2010-2012. He has a Bachelor of Science in Electrical Engineering and Ph.D. from Rutgers University, and Masters of Science in Electrical Engineering from the Johns Hopkins University. His specialization areas are in signal processing and communication system. His current interests include STEM education, and academic partnerships.

Dr. Kevin D. Dahm, Rowan University

Kevin Dahm is a Professor of Chemical Engineering at Rowan University. He earned his BS from Worcester Polytechnic Institute (92) and his PhD from Massachusetts Institute of Technology (98). He has published two books, "Fundamentals of Chemical Engineering Thermodynamics" and "Interpreting Diffuse Reflectance and Transmittance." He has also published papers on effective use of simulation in engineering, teaching design and engineering economics, and assessment of student learning.

Dr. Liang Hong, Tennessee State University

Dr. Liang Hong received the B.S. and the M.S. degrees in Electrical Engineering from Southeast University, Nanjing, China in 1994 and 1997, respectively, and the Ph.D. degree in Electrical Engineering from University of Missouri, Columbia, Missouri in 2002. Since August 2003, he has been with the Department of Electrical & Computer Engineering at Tennessee State University where he is now Full Professor. His research interests include cognitive radio, security of communication systems, networked control system, wireless sensor networks, wireless multimedia communications and networks, and engineering education.

Dr. Sachin Shetty, Tennessee State University

Sachin Shetty is currently an Assistant Professor in the Department of Electrical and Computer Engineering at Tennessee State University. He received his Ph.D. degree in Modeling and Simulation from Old Dominion University in 2007 under the supervision of Prof. Min Song. His research interests lie at the intersection of computer networking, network security and machine learning. Recently, he has been working on security issues in cloud computing, cognitive radio networks, and wireless sensor networks. Over the years, he has secured funding over \$3 million from NSF, AFOSR, DOE, DHS, TBR and local industry for research and educational innovations. He has authored and coauthored over 30 technical refereed and non-refereed papers in various conferences, international journal articles, book chapters in research and pedagogical techniques. He is the director of the Cyber Defense and Security Visualization Laboratory

Prof. Robert M Nickel, Bucknell University

Robert M. Nickel received a Dipl.-Ing. degree in electrical engineering from the RWTH Aachen University, Germany, in 1994, and a Ph.D. in electrical engineering from the University of Michigan, Ann Arbor, Michigan, in 2001. During the 2001/2002 academic year he was an adjunct faculty in the Department of Electrical Engineering and Computer Science at the University of Michigan. From 2002 until 2007 he was a faculty member at the Pennsylvania State University, University Park, Pennsylvania. Since the fall of 2007 he is a faculty member at the Electrical Engineering Department of Bucknell University, Lewisburg, Pennsylvania. During the 2010/2011 academic year he was a Marie Curie Incoming International Fellow at the Institute of Communication Acoustics, Ruhr-Universität Bochum, Germany. His main research interests include speech signal processing, general signal theory, and time-frequency analysis.

Dr. Richard J. Kozick, Bucknell University

Richard J. Kozick received the B.S. degree from Bucknell University in 1986, the M.S. degree from Stanford University in 1988, and the Ph.D. degree from the University of Pennsylvania in 1992, all in electrical engineering. From 1986 to 1989 and from 1992 to 1993 he was a Member of Technical Staff at AT&T Bell Laboratories. Since 1993, he has been with the Electrical and Computer Engineering Department at Bucknell University, where he is currently Professor. His research interests are in the areas of statistical signal processing and communications.

Dr. Kozick received a "2006 Best Paper Award" from the IEEE Signal Processing Society and the Presidential Award for Teaching Excellence from Bucknell University in 1999. He serves on the editorial board of the EURASIP Journal on Wireless Communications and Networking.

Dr. Ying Tang, Rowan University

Ying Tang received the B.S. and M.S. degrees from the Northeastern University, P. R. China, in 1996 and 1998, respectively, and Ph.D degree from New Jersey Institute of Technology, Newark, NJ, in 2001. She is currently a Professor of Electrical and Computer Engineering (ECE) at Rowan University, Glassboro, NJ. Her research interests include virtual reality and augmented reality, artificial intelligence, and modeling and scheduling of computer-integrated systems. Dr. Tang is very active in adapting and developing pedagogical methods and materials to enhance engineering education. Her most recent educational research includes the collaboration with Tennessee State University and local high schools to infuse cyber-infrastructure learning experience into the pre-engineering and technology-based classrooms, the collaboration with community colleges to develop interactive games in empowering students with engineering literacy and problem-solving, the integration of system-on-chip concepts across two year Engineering Science and four year ECE curricula, and the implementation of an educational innovation that demonstrates science and engineering principles using an aquarium. Her work has resulted in over 100 journal and conference papers and book chapters.

Dr. Robi Polikar, Rowan University

Robi Polikar is a Professor of Electrical and Computer Engineering at Rowan University, in Glassboro, NJ. He has received his B.Sc. degree in electronics and communications engineering from Istanbul Technical University, Istanbul, Turkey in 1993, and his M.Sc and Ph.D. degrees, both co-majors in electrical engineering and biomedical engineering, from Iowa State University, Ames, IA in 1995 and 2000, respectively. His current research interests within computational intelligence include ensemble systems, incremental and nonstationary learning, and various applications of pattern recognition in bioinformatics and biomedical engineering. He is a member of IEEE, ASEE, Tau Beta Pi and Eta Kappa Nu. His recent and current works are funded primarily through NSF's CAREER and Energy, Power and Adaptive Systems (EPAS) programs.

PLANNING AND ASSESSMENT OF A WORKSHOP ON UNDERGRADUATE EDUCATION IN BIOMETRIC SYSTEMS

ABSTRACT

Biometrics is the science of recognizing and authenticating people using their physiological features. The global biometrics market has a compound annual growth rate of 21.3 percent. There is much research interest in different biometric systems, which has led to increasing efforts in ensuring that biometrics is taught at the undergraduate level. The authors are in the final year of an NSF TUES Type 2 grant that is based on the theme of vertically integrating biometrics experiments throughout the undergraduate curriculum. Three universities have joined together in this effort. This paper describes the planning and assessment of a 3 day workshop that is based on the NSF funded effort. Fifteen faculty from across the country participated in this workshop. Undergraduate and graduate students also attended. The key points of the workshop included invited lectures and hands-on laboratory activities. The invited lectures included a tutorial on biometrics, detailed lectures on speaker recognition and a lecture on how to assess an educational intervention. The hands-on activities were presented such that the attending faculty could take them back to their respective universities. The workshop assessment results are very positive with respect to organization, quality of the invited lectures, quality of the hands-on activities and the social program.

INTRODUCTION AND BACKGROUND

Biometrics is the science of recognizing and authenticating people using their physiological features [1]. Border and immigration control, restricted access to facilities and information systems, cybersecurity, crime investigations and forensic analysis are just a few of the primary application areas of biometrics used by commercial, government and law enforcement agencies. The global biometrics market has a compound annual growth rate of 21.3 percent. There is much research interest in different biometric systems and this has led to increasing efforts in ensuring that biometrics is taught at the undergraduate level [2][3][4][5][6][7]. The authors are in the final year of an NSF TUES Type 2 grant that is based on the theme of vertically integrating biometrics experiments throughout the undergraduate curriculum [7]. Three universities have joined together in this effort [8][9][10][11][12].

Biometrics involves signal/image processing in a pattern recognition framework [13][14]. There are two types of biometric systems. Biometric identification (BID) systems identify a person among a set of people whereas biometric verification (BV) systems accept or reject a person's claimed identity. Five biometric systems are considered in this project, namely, face, speech, iris, signature and fingerprint. Although fingerprint recognition forms the largest share of today's market [15], there are practical tradeoffs with other systems as given in Table 1 [15]. This exemplifies the need for further research and educational activities pertaining to a variety of biometric systems. Face-based and speech-based recognition systems are particularly promising as their accuracy is improved.

System	Accuracy	Ease of Use	User Acceptance	Ease of Implementation	Cost
Fingerprint	High	Medium	Low	High	Medium
Face	Low	High	High	Medium	Low
Speech	Medium	High	High	High	Low
Iris	Medium	Medium	Medium	Medium	High
Signature	Medium	Medium	High	Low	Medium

Table 1 Characteristics of Biometric Systems (taken from [15])

The desired characteristics of biometrics systems are [1]:

- Permanence: The unique features of the biometric modality change very little over a person's lifetime.

- Unique: The probability of the physiological/behavioral characteristic of two different people being the same or resulting in the same biometric features is nearly impossible.
- Easy integration: Biometric recognition technology can easily be integrated into existing security systems or operate as a standalone. No special purpose hardware is needed for integration to a personal computer. This is true of iris, speech and face based systems.
- Cannot be spoofed: The biometric data are not susceptible to theft, loss or compromise. They cannot be artificially duplicated.
- Non-Invasive and Quick: No invasive contact with a subject and quick to give a result.
- Very high accuracy making it a method of choice for airport security and other biometrics applications.
- Little memory required for data to be stored.
- Reasonable cost.
- High user acceptance.
- Little performance degradation due to mismatched training and testing conditions. This is a very important research issue.

As part of the NSF-funded project, the team conducted a 3-day workshop intended to disseminate information on the principles of biometrics and on strategies for introducing biometrics into the undergraduate curriculum. The remainder of this paper discusses the workshop itself.

MOTIVATION AND WORKSHOP OBJECTIVES

In planning a workshop, the objectives must be envisioned and the logistical issues must be continuously addressed and resolved. Meticulous planning is highly essential. At the conclusion, an assessment in the form of a survey will provide constructive feedback. A workshop also needs to have a focus topic. For the workshop discussed in this paper, vertical integration of topics in biometrics for an undergraduate ECE curriculum is the focus. Descriptions of several other workshops have been published with focus topics including information assurance and security education [16], systems engineering education [17], teaching pedagogy [18], and mentorship of women and other underrepresented groups in Science, Engineering and Mathematics to help them succeed in obtaining tenure-track faculty positions and in acquiring tenure [19].

The motivation and objectives of the workshop are as follows:

1. To develop a cohort of faculty who are either knowledgeable or want to learn about biometrics and are enthusiastic about integrating this topic into the engineering curriculum.
2. To invite leading researchers/educators in the area to give plenary or tutorial lectures.
3. To involve all faculty attendees in key hand-on activities.
4. To disseminate hands-on educational activities and assessment strategies that have proven effective.
5. To provide networking opportunities for faculty who are interested in biometrics. This will allow for exchange of technical information among people from academia and practitioners in the field.
6. To invite and provide an opportunity for graduate and undergraduate students to attend a technical workshop.
7. To bring higher visibility to Rowan in this important field, and to stimulate more (and larger) workshops and meetings at Rowan.
8. To discuss challenges in the biometrics field and in so doing, potentially form collaborative teams in future research proposals.
9. To help further improve engineering education in biometrics.

ISSUES AND GUIDELINES IN WORKSHOP ORGANIZATION

The basic guidelines in workshop organization are:

1. Start well in advance, ideally one year before the envisioned date.
2. The PI should regularly hold meetings with a subset of the team working on the grant.
3. The PI should designate one of the co-investigators to take the lead role and work with the PI.
4. Get clerical support for making the hotel arrangements and configuring the social program.
5. One of the investigators should work on the assessment survey.

In organizing the workshop, it must be ensured that the budget is exhausted and very little money above the budget is spent. Continuous estimates of the expenses must be made.

The issues involved in workshop organization are:

1. When to hold the workshop and for how many days: A weekend in the summer was chosen (July 31, 2015 to August 2, 2015). The workshop started on Friday morning and ended soon after lunch on Sunday. The attendees arrived on the evening of July 30.

2. Where to hold it: We chose to accommodate all participants at the Marriott hotel, adjacent to the Rowan campus. The facilities at the Marriott allowed us to hold the morning tutorial lectures there. The afternoon laboratory sessions were held at the Rowan engineering building. Transportation between the two venues was provided.
3. How many participants to invite: Given the budget considerations, 10 faculty from outside were invited. Some came by plane and some drove. In addition, up to 15 Rowan (faculty and students) could be accommodated.
4. Facilities at the Marriott: Ten hotel rooms were reserved. A room for the tutorial lectures was needed that could hold 30 people. This room required projection capabilities. Also, a spare laptop was always ready. Meals were served in the adjacent room.
5. Facilities at Rowan: The first floor atrium was reserved to serve meals and coffee. It was extremely important to ensure that two computer laboratories were ready for the hands-on activities. A lab technician was briefed on what was to be ready three months in advance. Twenty Windows based computers at Rowan were ensured to work properly and have MATLAB installed. The responsible lab technician was present during the workshop so that there would be no glitches.
6. Decide where the meals and coffee are to be served. This required particular attention in the workshop described here as there were two venues on opposite ends of campus.
7. Invite participants who can give tutorial lectures. Three of the ten participants from outside gave tutorial lectures. The lecture on project assessment was given by the Rowan faculty on the team who was responsible for project evaluation.
8. Decide which hands-on activities are to be demonstrated:
 - Since a freshman level module in biometrics is highly useful to many universities, a freshman face recognition module was the first hands-on activity [8].
 - A senior level project in speaker recognition was chosen as the second activity [9].

WORKSHOP PROGRAM

The actual workshop agenda as it was presented to attendees is shown below:



BIOMETRICS EDUCATION WORKSHOP
SPONSORED BY NATIONAL SCIENCE FOUNDATION
JULY 31 to AUGUST 2, 2015

FRIDAY, JULY 31

Morning at the Marriott Hotel

8:00 AM to 9:00 AM: Breakfast at the Marriott Hotel

9:00 AM to 9:30 AM: Opening Remarks by Dr. Shreekanth Mandayam, Vice President for Research, Rowan University

9:30 AM to 10:00 AM: Introduction by Ravi P. Ramachandran

10:00 AM to 10:30 AM: Coffee break

10:30 AM to 11:30 AM: Keynote tutorial on biometrics by Dr. Anil K. Jain, Michigan State University

Afternoon at Rowan Hall

11:30 AM to 1:00 PM: Lunch at Rowan Hall

1:00 PM to 3:00 PM: Face identification Lab for Freshman Students, Hands-on using MATLAB

3:00 PM to 3:30 PM: Coffee break

3:30 PM to 5:30 PM: Face identification Lab for Freshman Students, Hands-on using MATLAB (continued)

7:00 PM to 9:30 PM Dinner at Marriott Hotel

SATURDAY, AUGUST 1

Morning at the Marriott Hotel

8:00 AM to 9:00 AM: Breakfast at the Marriott Hotel

9:00 AM to 10:00 AM: Tutorial on Speech Coding by Dr. Tokunbo Ogunfunmi, Santa Clara University

10:00 AM to 10:30 AM: Coffee break

10:30 AM to 11:30 AM: Tutorial on Speaker Recognition by Dr. Brett Smolenski, Assured Information Security Inc. and SUNY Polytechnic Institute.

Afternoon at Rowan Hall

11:30 AM to 1:00 PM: Lunch at Rowan Hall

1:00 PM to 3:00 PM: Speaker identification Lab for Senior Students, Hands-on using MATLAB

3:00 PM to 3:30 PM: Coffee break

3:30 PM to 5:30 PM: Speaker identification Lab for Senior Students, Hands-on using MATLAB (continued)

7:00 PM to 9:30 PM Dinner at Marriott Hotel

SUNDAY, AUGUST 2

Entire program at Marriott Hotel

8:00 AM to 9:00 AM: Breakfast at the Marriott Hotel

9:00 AM to 10:00 AM: Practical Assessment Tools for Engineering Education, Lecture by Dr. Kevin Dahm, Rowan University

10:00 AM to 10:30 AM: Coffee break

10:30 AM to 11:30 AM: General discussion

11:30 AM to 1:00 PM: Lunch at Marriott hotel

ASSESSMENT RESULTS

Nineteen participants filled out the survey of which 14 were faculty with five or more years of experience, two were faculty with less than five years of experience and three were graduate students. Also, three have worked extensively in biometrics, six have some experience working in biometrics, one has significant knowledge of biometrics but has not worked in the area, seven have some familiarity with biometrics but have not worked in the area and two have no significant knowledge of biometrics.

Table 2 gives the results of the assessment survey regarding the tutorial lectures and the hands-on activities. For each question, the ratings are on a scale from 1-5, with 5 indicating “very informative” and 1 indicating “not at all valuable”.

Outcome or Question	Mean, Median
Keynote tutorial on biometryrics by Dr. Anil K. Jain	4.95, 5
Tutorial on speech coding by Dr. Tokunbo Ogunfunmi	4.47, 4
Tutorial on speaker recognition by Dr. Brett Smolenski	4.67, 5
Practical assessment tools for engineering education by Dr. Kevin Dahm	4.80, 5
Face identification lab for freshman students	4.63,5
Speaker identification lab for senior students	4.60,5

Table 2 – Assessment Survey Results for Tutorial Lectures and Hands-on Activities

Table 3 gives the results of the general arrangements. For each question, the ratings are on a scale from 1-5, with 5 indicating “excellent” and 1 indicating “unsatisfactory”.

Outcome or Question	Mean, Median
Networking opportunities	4.80, 5
Meals served at the Marriott hotel	4.50, 4
Meals served at the Rowan engineering building	4.07, 4
Marriott hotel rooms (answered by only those who stayed there)	5, 5

Table 3 – Assessment Survey Results for General Arrangements

The last question on the survey was to consider the statement: “The workshop was a positive and valuable experience”. The ratings are on a scale from 1-5, with 5 indicating “strongly agree” and 1 indicating “strongly disagree”. The mean score is 4.88. The median score is 5.

Participants were also asked to give comments. The complete list of comments is as follows:

1. Faculty: I was very impressed with both labs.
2. Faculty: This workshop is really well organized and provides a lot of useful information. I really appreciate the wonderful experience. Thanks
3. Faculty: The talk by Dr. Jain was a very good overview. Dr. Ogunfunmi’s talk was excellent and comprehensive but lengthy. More details of the speaker identification lab is needed.
4. Faculty: Dr. Jain’s keynote tutorial was excellent.
5. Faculty: Not my field but the attendees were very interactive. It was nice meeting new people outside of my field.
6. Graduate student:
 - Dr. Jain gave an informative introductory talk on biometrics. It was clear and showed the mastery that Dr. Jain commands on the subject of biometrics. He proved to me that the subject area is relevant and important for future research.
 - Dr. Ogunfunmi delved specifically into my research area related to speech coding/speech processing. He gave specific and thorough explanations of the material. It may have been hard to follow if I had no background in speech processing.
 - Dr. Smolenski was able to provide real industry perspective into biometrics specifically regarding speaker recognition. Knowing what is

used in practice in real settings is very informative to those who research speaker recognition under controlled lab settings.

- For people involved in biometrics, the workshop was informative. For people not involved in biometrics, I believe the workshop showed the importance of the subject matter.

SUMMARY AND CONCLUSIONS

This paper discusses the motivation and logistical issues involved in organizing an educational workshop. The purpose of the workshop in this case was to disseminate information about biometrics and to disseminate strategies for integrating this information into the undergraduate curriculum. The assessment results show that the program was highly successful in meeting these goals. This workshop will also serve as a model for similar and larger workshops held at Rowan in the future.

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