Biometric Systems

Nature of Program

Biometric systems are composed of complex hardware and software designed to measure a signature of the human body, compare the signature to a database, and render a decision for a given application based on the identification achieved from this matching process. Uses of biometric systems for positive personal identification are experiencing rapid growth in such areas as law enforcement, access control, banking, and a wide range of business and administrative systems. In an even broader application context, biometric systems are having a revolutionary impact on health care and the enhancement of the human computer interface, including in vivo identification of specific human conditions via implantable devices and the automated administration of life-saving medical therapies. The continued rapid advance of integrated sensor, signal/image processing, computer, and mass storage technology promises to extend these applications further into our daily lives with even the most inanimate objects able to identify, interact with, and assist their users.

Biometric systems for personal identification are based upon fundamental biometric features that are typically unique and time invariant, such as features derived from fingerprints, faces, irises, retinas, and voices. Biometrics for biomedical, human computer interface, and other applications may include these but will necessarily extend to a wide range of physiological signals which possess identifiable patterns that may change in time, albeit predictably. The spectrum of usable biometrics is defined by human physiology, the bioengineering implied by their measurement, and the application. As biometric system capabilities and applications evolve, biometrics will extend to any known measurement of the human body.

Biometric identification is a highly interdisciplinary field mixing traditional engineering with the forensic sciences. As a result, the engineering design and development of biometric systems requires knowledge of the biometric as well as the engineering disciplines. Designers work with the physics of the sensor to obtain measurements of the biometric defined by human physiology. Signal and image processing techniques are applied to the sensor signal to extract features usable for identification. Databases combined with artificial intelligence enable rapid storage, retrieval, and pattern matching while decision theory supports the mechanisms whereby systems can provide the needed identification results. Underlying the entire system is a foundation of statistics and mathematics that provides the language for implementing and evaluating biometric technology and systems.

Program Educational Objectives

The Program Educational Objectives (PEO) of the Biometric Systems (BS) program at West Virginia University is to produce graduates who will apply their knowledge and skills to achieve success in their careers in industry, research, government service or graduate study. It is expected that in the first five years after graduation our graduates will achieve success and proficiency in their profession, be recognized as leaders, and contribute to the well-being of society.

Student Outcomes

Upon graduation, all Bachelor of Science students in Biometric Systems will have:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- An ability to function on multidisciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of the need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Areas of Emphasis

Presently, four specialization paths have been identified for the biometric systems curriculum. Each emphasis area enables students to develop an in-depth technical background in an area of their own choosing which is central to biometric system development. Currently designated areas of emphasis are sensors and circuits, signal processing, statistics, and software systems. Each emphasis area is fulfilled by the successful completion of three courses. Students may obtain at most one emphasis area designation from this four-course set in their degree curriculum. Each emphasis area curriculum is defined by three courses chosen from a set of classes prescribed for that area. At least one of these three courses is a required course. Successful completion of an emphasis area's requirements is designated on the student's transcript.

Click here to view the Suggested Plan of Study (p. 3)

Curriculum in Biometric Systems

GENERAL EDUCATION FOUNDATIONS

Please use this link to view a list of courses that meet each GEF requirement. (http://registrar.wvu.edu/gef)

NOTE: Some major requirements will fulfill specific GEF requirements. Please see the curriculum requirements listed below for details on which GEFs you will need to select.

General Education Foundations		
F1 - Composition & Rhetoric		3-6
ENGL 101 & ENGL 102	Introduction to Composition and Rhetoric and Composition, Rhetoric, and Research	
or ENGL 103	Accelerated Academic Writing	
F2A/F2B - Science & Technology		4-6
F3 - Math & Quantitative Skills		3-4
F4 - Society & Connections		3
F5 - Human Inquiry & the Past		3
F6 - The Arts & Creativity		3
F7 - Global Studies & Diversity		3
F8 - Focus (may be satisfied by completion of a minor, double major, or dual degree)		9
Total Hours		31-37

Please note that not all of the GEF courses are offered at all campuses. Students should consult with their advisor or academic department regarding the GEF course offerings available at their campus.

Curriculum Requirements

To receive a bachelor of science in biometric systems, a student must meet the University's undergraduate degree requirements, take all the courses indicated below, and attain a grade point average of 2.0 or better for all Lane Department of Computer Science and Electrical Engineering courses. If a Lane Department of Computer Science and Electrical Engineering course is repeated, only the last grade received is used to compute the major grade point average, and the course credit hours are counted only once. This requirement assures that the student has demonstrated overall competence in the major.

Freshman Engineering Requirements		
ENGR 101	Engineering Problem Solving 1	2
Engineering Problem Solving:		3
CHE 102	Introduction to Chemical Engineering	
ENGR 102	Engineering Problem-Solving 2	
ENGR 103	Introduction to Nanotechnology Design	
MAE 102	Introduction to Mechanical and Aerospace Engineering Design	
ENGR 199	Orientation to Engineering	1
Non-Biometric Systems Core		
BIOL 115	Principles of Biology (GEF 8)	4
BIOL 324	Molecular Genetics	3
CHEM 115	Fundamentals of Chemistry (GEF 2B)	4
ECON 201	Principles of Microeconomics (GEF 4)	3
ECON 202	Principles of Macroeconomics	3
Calculus I (GEF 3):		4
MATH 155	Calculus 1 (Minimum grade of C- is required)	
MATH 153 & MATH 154	Calculus 1a with Precalculus and Calculus 1b with Precalculus (Minimum grade of C- is required)	
MATH 156	Calculus 2 (GEF 8 - Minimum grade of C- is required)	4
MATH 251	Multivariable Calculus (Minimum grade of C- is required)	4
MATH 261	Elementary Differential Equations	4
MATH 375	Applied Modern Algebra	3
PHYS 111	General Physics	4

PHYS 112	General Physics	4
STAT 215	Introduction to Probability and Statistics	3
STAT 316	Forensic Statistics	3
Biometric Core (Minimum 2.0 GPA is required in all of the following courses.)		
BIOM 426	Biometric Systems	3
BIOM 480	Senior Design Seminar (Fulfills Writing and Communications Skills Requirement)	2
BIOM 481	Senior Design Project	3
CPE 271	Introduction to Digital Logic Design	3
CPE 272	Digital Logic Laboratory	1
CPE 310	Microprocessor Systems	3
CPE 311	Microprocessor Laboratory	1
CS 110	Introduction to Computer Science	4
CS 111	Introduction to Data Structures	4
CS 350	Computer System Concepts	3
CS 465	Introduction to Cybersecurity	3
EE 221	Introduction to Electrical Engineering	3
EE 222	Introduction to Electrical Engineering Laboratory	1
EE 223	Electrical Circuits	3
EE 224	Electrical Circuits Laboratory	1
EE 327	Signals and Systems 1	3
EE 425	Bioengineering	3
EE 465	Introduction to Digital Image Processing	3
Area of Emphasis		9
Free Elective		3
Technical Elective (300 level or higher course in Biometric Systems, Computer Engineering, Computer Science, or Electrical Engineering)		3
GEF Electives 1, 5, 6, 7		15
Total Hours		133

Suggested Plan of Study

It is important for students to take courses in the order specified as much as possible; all prerequisites and concurrent requirements must be observed. A typical B.S.B.S. degree program, which completes degree requirements in four years, is as follows.

First Year

Fall	Hours	Spring	Hours
BIOL 115 (GEF 8)*	4	CHEM 115 (GEF 2)	4
ENGL 101 (GEF 1)	3	CS 110	4
ENGR 101	2	ENGR 102	3
ENGR 199	1	MATH 156 (GEF 8)	4
MATH 155 (GEF 3)	4	PHYS 111 (GEF 8)	4
GEF 5	3		
	17		19

Second Year

Fall	Hours	Spring	Hours
CS 111	4	CPE 271	3
EE 221	3	CPE 272	1
EE 222	1	EE 223	3
MATH 251	4	EE 224	1
PHYS 112	4	ENGL 102 (GEF 1)	3
		MATH 261	4
		STAT 215	3
	16		18

Third Year

Fall	Hours	Spring	Hours
BIOM 426*	3	BIOL 324*	3
CPE 310	3	EE 465*	3
CPE 311	1	MATH 375	3
CS 350	3	GEF 6	3
EE 327*	3	Area of Emphasis Course 1	3
STAT 316*	3	Area of Emphasis Course 2	3
	16		18

Fourth Year

Fall	Hours	Spring	Hours
BIOM 480	2	BIOM 481	3
CS 465*	3	ECON 202	3
ECON 201 (GEF 4)	3	Area of Emphasis Course 3	3
EE 425*	3	GEF 7	3
Free Elecitve	3	Technical Elective	3
	14		15

Total credit hours: 133

* Offered once per year in the semester shown.

Areas of Emphasis

MICROSENSORS AND CIRCUITS AREA OF EMPHASIS REQUIREMENTS

EE 251 & EE 252	Digital Electronics and Digital Electronics Laboratory	4
Choose two of the following:		6
PHYS 314	Introductory Modern Physics	
PHYS 321	Optics	
EE 355 & EE 356	Analog Electronics and Analog Electronics Laboratory	
EE 450	Device Design and Integration	
EE 455	Introduction to Microfabrication	
Total Hours		10

SIGNAL PROCESSING AREA OF EMPHASIS REQUIREMENTS

EE 251 & EE 252	Digital Electronics and Digital Electronics Laboratory	4
EE 329 & EE 328	Signals and Systems 2 and Signals and Systems Laboratory	4
Choose one of the following:		3
CS 453	Data and Computer Communications	
EE 463	Digital Signal Processing Fundamentals	
EE 565	Advanced Image Processing	
Total Hours		11

STATISTICS AREA OF EMPHASIS REQUIREMENTS

Choose either the Applied or Theory Option		9
Applied Option		
STAT 312	Intermediate Statistical Methods	
Choose two of the following:		
STAT 313	Introductory Design and Analysis	
STAT 331	Sampling Methods	

STAT 421	Statistical Analysis System (SAS)	
Theory Option		
STAT 312	Intermediate Statistical Methods	
STAT 461	Theory of Probability	
STAT 462	Theory of Statistics	
Total Hours		9

SOFTWARE SYSTEMS AREA OF EMPHASIS REQUIREMENTS

CS 230	Introduction to Software Engineering	3-4
or CPE 484	Real-Time Systems Development	
Choose two of the following:		6
CPE 442	Introduction to Digital Computer Architecture	
or CS 455	Computer Architecture	
CS 430	Advanced Software Engineering	
CS 450	Operating Systems Structure	
CS 453	Data and Computer Communications	
CS 472	Artificial Intelligence	
Total Hours		9-10

Major Learning Goals

BIOMETRIC SYSTEMS

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