COURSE DESCRIPTION CARD - SYLLABUS

Course name
Biometrics

Course

Field of study
Automation and robotics

Year/Semester
2/4

Area of study (specialization)
Automation and robotics systems

Profile of study
general academic

Level of study
Second-cycle studies

Course offered in
Polish

Form of study
part-time

Requirements
elective

Number of hours

Lecture
12

Laboratory classes
12

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

2

Lecturers

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Responsible for the course/lecturer:
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Prerequisites

Knowledge: The student starting this course should have basic knowledge of linear algebra and digital signal processing.

Skills: Should have the ability to solve basic problems in signal processing with the use of programming in a higher level language and the ability to obtain information from indicated sources. They should also understand the need to expand their competences and be ready to cooperate in a team.

Social competences: Moreover, it should show such qualities as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. Provide students with basic knowledge of biometrics in the field of identifying people using artificial intelligence methods.

2. Developing students' skills in solving data processing problems intended for statistical classification.

Course-related learning outcomes

Knowledge

1. The student possess extended and in-depth knowledge of selected mathematics departments necessary to formulate and solve complex tasks in the field of control theory, optimization, modeling, identification and signal processing - [K2_W1].

2. The student possess detailed knowledge of artificial intelligence methods and their application in automation and robotics systems - [K2_W2].

3. The student possess detailed knowledge of the construction and use of advanced sensory systems - [K2_W6].

4. The student possess extended knowledge within selected areas of robotics - [K2_W10].

5. The student possess detailed knowledge of biometric methods used to identify persons and understands the need to protect privacy when using person monitoring.

Skills

1. The student can use advanced methods of signal processing and analysis, including video signal, and extract information from the analyzed signals - [K2_U11].

2. The student can integrate and program specialized robotic systems - [K2_U12].

3. The student can compare the effectiveness of the classification of the biometric system.

Social competences

1. The student is aware of responsibility for their own work and is ready to submit to the principles of teamwork and responsibility for jointly performed tasks; is able to lead a team, set goals and define priorities leading to the implementation of the task - [K2_K3].

2. The student is aware of the benefits and threats of the automatic identification of people; understands the psychological factors involved in the use of biometric systems - [-].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) in the scope of lectures:

based on answers to questions about the material discussed in previous lectures

b) in the scope of laboratories, assesment of the assumed learning outcomes is based on:

i. assessment of student's preparation for individual sessions of laboratory classes ("entrance" test)and assessment of skills related to the implementation of laboratory exercises,

ii. continuous assessment, during each class (oral answers) -rewarding the increase in the ability to use known principles and methods,

iii. assessment of the laboratory reports prepared partly during the classes and partly at home; this assessment also includes teamwork skills.

Obtaining additional points for activity during classes, in particular for:

i. discuss of additional aspects of the issue,

ii. effectiveness of applying the acquired knowledge while solving a given problem,

iii. ability to work as part of a team that practically performs a specific task in the laboratory,

iv. comments related to the improvement of teaching materials,

v. indicating students' perceptive difficulties enabling ongoing improvement of the didactic process.

Summative assessment:

a) in the scope of lectures the verification of the assumed learning outcomes is carried out by:

i. assessment of the knowledge and skills shown in the exam - written work containing problem questions and written calculation tasks; getting 50% of the number of total points give a positive rating, the questions are a detailed version of the issues made available to students in order to prepare for the exam,

ii. discussion about exam results,

b) in the scope of laboratories , it is a resultant assessment resulting from the formative assessments.

Programme content

The lecture covers the following topics:

1. Traditional methods of identifying people, the beginnings of biometrics and current investment forecasts; physiological and behavioral identifiers; comparison of biometric techniques in terms of cost and accuracy; biometric documents; the problem of scale in biometric applications; multimodal biometrics; diagram of the biometric system; the concept of automatic recognition and basic difficulties, phases of the automatic recognition process, strategies for creating a feature space through selection or extraction, dimensionality "curse", class separability; feature selection methods: supervised, unsupervised, filters, wrappers, frappers and embedded methods; Fisher's coefficient for linear class discrimination.

2. Feature extraction methods: unsupervised (PCA, ICA), supervised (LDA, NDA); projection on eigenvectors, vectors obtained by principal components analysis, by independent components analysis

and by linear discriminant analysis; data classification as the application of the criteria for assigning to a specific category (class); deterministic and probabilistic strategies, generalization of knowledge; minimum-distance classification methods - nearest neighbor, nearest average, k-nearest neighbors; distance measures - distance in metric space, distance of Euclid and Machalonobis; classification by feature space division - neural classifiers; support vector machines (SVN).

3. Probabilistic recognition methods, estimation of probability distributions (parametric and non-parametric); linear discriminant analysis (LDA) and multi-class generalization (MDA) and cluster analysis; Bayes' theorem; linear combination of normal distributions (GMM); event sequence modeling - dynamic programming, implicit Markov models; deterministic and probabilistic modeling, algorithms for calculating the parameters of the implicit Markov model (forward, Viterbi, forward-backward).

4. Assumptions for the biometric system, characteristics of the individual characteristics (universality, uniqueness, durability and measurability), physical and behavioral characteristics; system errors (incorrect compliance, incorrect compliance); stages of operation of the biometric system (training and normal work); ROC and DET curve; specific patterns of fingerprints (works by Francis Galton), difficulties in using fingerprints; acquisition methods - optical, capacitive, thermal, ultrasonic readers; fingerprint basic categories (left loop, right loop, whirlpool, arc and sharpened arc), minutiae types; automatic fingerprint comparison algorithms.

5. Iris recognition - structure of the iris and its properties; iris image acquisition, iris quantification algorithm - iris descriptor, Hamming distance; resistance to fraud, arguments for and against the use of iris; facial recognition - facial properties as biometrics; biometric photo; mainstream algorithms (detailed analysis and full face analysis); face location algorithms, eigenfaces decomposition.

6. Speaker recognition as a biometric method; multilayer information structure of a speech signal; recognition algorithm based on spectral and prosodic features, algorithm for calculating mel-kepstral coefficients MFCC; letter recognition as a biometric method, automatic signature verification, off-line and on-line procedures (registering the dynamics of signing); quantitative description of the signature, global and local features.

Laboratory exercises topics:

1. Criteria for assessing the correctness of biometric analysis: false acceptance rate, false rejection rate, receiver operating characteristics, equal error rate.

2. Biometric systems for identification of people based on fingerprints - the method of identification with using an artificial neural network.

3. Biometric systems for identification of people based on the shape of the ear - PCA (principal component analysis) and CPD (coherent point drift) methods.

4. Biometric systems for identification of people based on the signature - the identification method using an artificial neural network.

5. Biometric systems for identification of people based on the iris of the eye - creating the iris code, Hamming distance.

6. Biometric systems for identification of people based on the hand geometry - segmentation of the hand image from the background and normalization - ICA (independent component analysis) method and distance transformation.

Teaching methods

1. Lecture: multimedia presentation, presentation illustrated with examples given on the board, solving problems

2. Laboratory classes: problem solving, practical exercises, conducting experiments, case studies, teamwork

Bibliography

Basic

1. Biometria, Bolle R., Connell J., Pankanti S., Ratha N. Senior, WNT, Warszawa, 2008

2. Wybrane zagadnienia biometrii, Ślot K., WKŁ, Warszawa, 2008

3. Wstęp do sztucznej inteligencji, Flasiński M., Wydawnictwo Naukowe PWN, Warszawa 2011

Additional

1. Rozpoznawanie obrazów i sygnałów mowy, Kasprzak W., Oficyna Wydawnicza Politechniki Opolskiej, Opole, 2009

2. Rozpoznawanie biometryczne - nowe metody ilościowej reprezentacji obiektów, Ślot K., WKŁ, Warszawa, 2010

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2
Classes requiring direct contact with the teacher	26	1,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	24	1,0

[1] delete or add other activities as appropriate