COURSE DESCRIPTION CARD - SYLLABUS

Course name
Artificial intelligence and biometrics

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/2

Area of study (specialization)
Vision systems

Profile of study
general academic

Level of study
Second-cycle studies

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
15

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
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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: In addition, in terms of social competences, the student must 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. As a result of the course, the student has a detailed knowledge of artificial intelligence methods and their application in automatic identification systems - [K2_W2].

2. As a result of the course, the student has detailed knowledge of the construction and use of advanced sensory systems used in biometrics - [K2_W6].

3. As a result of the course, the student has detailed knowledge of biometric methods used to identify people and understands the need to protect privacy when using monitoring of people - [-].

Skills

1. As a result of the course, the student should demonstrate the ability to integrate and program specialized biometric identification systems - [K2_U12].

2. As a result of the course, the student should demonstrate the ability to compare the effectiveness of classification of biometric systems - [-].

Social competences

1. As a result of the course, the student will gain awareness of responsibility for their own work and readiness to submit to the principles of teamwork and responsibility for jointly performed tasks; can lead a team, set goals and set priorities leading to the implementation of the task - [K2_K3].

2. As a result of the course, the student will gain awareness of the benefits and threats of 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.

c) in the scope of project activities (design activities), verification of the assumed learning outcomes is carried out by:

i.assessment of knowledge and skills related to the implementation of project tasks through progress reports - twice per semester,

ii. evaluation of the project implementation report.

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 of the results of the test,

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

c) in the scope of projects , 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.

2. The concept of automatic recognition and basic difficulties, phases of the automatic recognition process, strategies of creating a feature space through selection or extraction, large dimensionality, class separability; feature selection methods: supervised, unsupervised, filters, wrappers, frappers and embedded methods; Fisher's coefficient for linear class discrimination.

3. 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.

4. 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; measures of distance - distance in metric space: distance of Euclid and Machalonobis; classification by division of the feature space? neural classifiers; support vector machines (SVN).

5. 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).

6. Modeling of the sequence of events - dynamic programming, implicit Markov models; deterministic and probabilistic modeling, algorithms for calculating the parameters of the implicit Markov model (forward, Viterbi, forward-backward).

7. 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.

8. 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.

9. Iris recognition - structure of the iris and its properties; iris image acquisition, iris quantification algorithm - iris descriptor, Hamming distance; resistance to fraud, arguments in favor and against the use of iris.

10. Face recognition - face properties as biometrics; biometric photo; mainstream algorithms (detailed analysis and full face analysis); face location algorithms, eigenfaces decomposition.

11. Recognition on the basis of DNA - properties of the method from the point of view of biometric applications; risk of error in classification based on DNA.

12. 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.

13. Handwriting 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.

14. Recognizing the rhythm of walking and typing rhythm on a computer keyboard.

15. Recognition of gender, age and emotions based on face analysis and voice analysis.Laboratory classes are conducted in the form of 2-hour exercises in the laboratory.

Exercises are carried out by teams of 2/3 people.

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.

The program of project classes covers the following issues, from which one task is chosen:

1. Analysis of selected artificial intelligence algorithms in biometric applications.

2. Development of the implementation of selected artificial intelligence algorithms in biometric applications.

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

3. Design classes: multimedia presentations, discussion, team work

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	100	4,0
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	40	1,5

[1] delete or add other activities as appropriate