S7 - Embedded Vision Design and Machine Learning

General information OWE / course	
Degree programme	Embedded Systems Engineering
Semester	S7
Course Code (OSIRIS)	EMBVIM06
Academic year	2026
Name Course short Dutch	ESE S7 Embedded Vision &Machine Learning
Name Course long Dutch	Embedded Vision Design and Machine Learning
Name Course short English	ESE S7 Embedded Vision &Machine Learning
Name Course long English	Embedded Vision Design and Machine Learning
Coordinating unit	AEA
Course type	OWE
Credits	30
Degree	B (post propaedeutic bachelor)
Grading scale course grades	Whole (without decimal)
Language of communication	English
Study load in hours	840
Instructional modes	OW (Onderwijs/Education)
Starting term education	P1A
Duration of education	Semester
Compensation options	Not applicable
Entry requirements course	Not applicable.
General discription	You get to delve into topics like image recognition, image processing and object classification with the help of artificial intelligence. The minor has a practical approach with different hardware platforms such as PC and embedded system. The student learns to apply vision algorithms and classification methods in order to reach solutions for given assignments and for their own ideas. We use software tools like OpenCV, MATLAB, Qt and an IDE for developing applications for Cortex-M microcontrollers. These software tools are programmed in the programming languages Python and C/C++. You work individually and in a project team with these tools and programming languages. Your aim? To develop and produce a system that can read and process camera images and classify the found objects with the help of artificial intelligence. In this course, mini-tests will be used. The organisation of these mini-tests, such as criteria, possible compensation, obligation to participate, resits, etc. is described on the

	digital learning environment. In this course, mini-tests will be used. The organisation of these mini-tests, such as criteria, possible compensation, obligation to participate, resits, etc. is described on the digital learning environment.
Mandatory participation	No
Examination	
Exam number in OSIRIS	**TOETS-01**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD1-Tentamen
Description (English)	EVD1-Exam
Format (modular)exam	KENN Knowledge exam
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	YEARA
Written exam type	PROD (Professional) Product
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. Uses knowledge of the following image acquisition operators and applies it with OpenCV in new situations: camera, lens, lighting and interfaces. 2. Uses knowledge of the following enhancement operators and applies it in new situations with OpenCV: Image algebra, geometric operators, Synthetic images and contrast manipulation. 3. Uses knowledge of the following segmentation operators and applies it in new situations with OpenCV: thresholding, labelling and blob measurement. 4. Uses knowledge of the following feature extraction operators and applies it in new situations with OpenCV: filters, edge detection, binary morphology and colour image processing. 5. Uses knowledge of the following classification operators and applies it in new situations with OpenCV: blob analysis, neural networks, blob matchers.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-02**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD1-Assessment
Description (English)	EVD1-Assessment
Format (modular)exam	PROD (Professional) product
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	YEARA
Written exam type	Not applicable
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. Implements a set of vision operators in ANSI-C programming language based on a functional description and considers limitations such as performance and memory use.

	2. Uses knowledge of the implemented operators to solve a vision problem using an embedded system: classifying the three figures circle, square and triangle. The student demonstrates the solution. 3. Describes and presents the functional working and technical realisation of a unique vision operator in a brief and concise PowerPoint presentation. 4. Realises a unique vision operator in the ANSI-C programming language and demonstrates its operation.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-03**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD2-Tentamen 1
Description (English)	EVD2-Exam 1
Format (modular)exam	KENN Knowledge exam
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	P1A (1x) P2A (1x)
Written exam type	Written
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. Knows what digital image processing is, knows the backgrounds, frequency bands and is aware of the fundamental digital image processing steps. 2. Knows Digital Image Fundamentals regarding the human eye, light and the electromagnetic spectrum. Knows different sensors for the purpose of Image Acquisition and a simple image formation model. 3. Knows the physical properties of optical instruments and light and can apply them to new situations.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-04**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD2 - Tentamen 2
Description (English)	EVD2 - Exam 2
Format (modular)exam	KENN Knowledge exam
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	P2A (2x)
Written exam type	Written
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. Applies the concepts of image sampling and quantization. Knows basic relationships between pixels. Applies mathematical tools relevant to digital image processing. 2. Applies Intensity Transformations operators (such as Image Negatives, Log Transformations Power_law (Gamma) Transformations and Piecewise-Linear Transformations) in novel situations.

	3. Applies Histogram Processing (such as Histogram Equalisation, Histogram Matching (Specification), Local Histogram Processing and Using Histogram Statistics for Image Enhancement) in new situations. 4. Applies the fundamentals of Spatial Filtering and various filters (such as Smoothing Spatial Filters and Sharpening Spatial Filters) in new situations. 5. Applies Morphologic Image Processing operators (such as Erosion, Dilation, Opening, Closing, etc.) in new situations. 6. Applies Image Segmentation operators (such as Point, Line, and Edge Detection) and various thresholding methods (such as Basic Global Thresholding, Optimum Global Thresholding Using Otsu's Method, etc.) in new situations. 7. Describes the shape and boundaries of a segment using Statistical Moments.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-06**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD3 - Machine Learning
Description (English)	EVD3 - Machine Learning
Format (modular)exam	PORT Portfolio
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	YEARA
Written exam type	Not applicable
Assessment criteria (OWE)/Learning outcomes (EVL)	Regarding image processing, the student: 1. Knows the basic principles of Machine Learning. 2. Knows the properties of Supervised Machine Learning. 3. Knows the Supervised Machine Learning pipeline. Regarding image processing, the student: 1. Explains the basic principles of Machine Learning and reflects on its applications. 2. Applies Supervised Machine Learning by selecting and training an algorithm and preparing data for it. 3. Analyses a Supervised Machine Learning pipeline by validating and testing and by evaluating performance.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-05**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD3 - Deep Learning
Description (English)	EVD3 - Deep Learning
Format (modular)exam	PORT Portfolio
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	YEARA
Written exam type	Not applicable
Assessment criteria (OWE)/Learning outcomes (EVL)	Regarding image processing, the student: 1. Explains the basic principles of Deep Learning and reflects

	on its applications. 2. Applies a Convolutional Neural Network by selecting and training a network. 3. Analyses a Convolutional Neural Network and evaluates its performance. Regarding image processing, the student: 1. Knows the basic principles of Deep Learning. 2. Knows the properties of a Convolutional Neural Network. 3. Knows the evaluation criteria of a Convolutional Neural Network.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-07**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD Project - Research Report
Description (English)	EVD Project - Research Report
Format (modular)exam	PROD (Professional) product
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	YEARA
Written exam type	Not applicable
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. Describes the essence of the study in a summary. 2. Formulates a research question accurately and SMART. 3. Describes the research approach and result separately. 4. Describes which alternatives have been weighed against each other. 5. Specifies sources according to APA standards and refers to the sources in the running text.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-08**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD Project - Functional Requirements Document
Description (English)	EVD Project - Functional Requirements Document
Format (modular)exam	PROD (Professional) product
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	YEARA
Written exam type	Not applicable
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. Describes what the system will do, not how. 2. Proposes a realistic and feasible project. 3. Identifies all stakeholders and their interaction with the system. 4. Describes the functional and technical requirements in a numbered table. 5. Describes a clear and realistic schedule.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-09**

Fulltime/Parttime	Fulltime
Description (Dutch)	EVD Project - Technical Realisation Document
Description (English)	EVD Project - Technical Realisation Document
Format (modular)exam	PROD (Professional) product
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	YEARA
Written exam type	Not applicable
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. Describes system architecture through block diagrams, hierarchical diagrams, architectures or other diagrams. 2. Describes the vision solution using the five steps acquisition, enhancement, segmentation, feature extraction and classification. Sub-steps are illustrated by means of images. 3. Describes software features through state diagrams. 4. Describes which alternatives were weighed against each other. 5. Describes functional test scenarios and the results. 6. Describes realistic and to-the-point conclusions and recommendations. 7. Writes a document suitable for reproduction, maintenance and knowledge transfer.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-10**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD Project - Product
Description (English)	EVD Project - Product
Format (modular)exam	PROD (Professional) product
Weight factor of (modular) exam	1
Minimum result	5,5
Grading scale	Decimal
Exam sittings	YEARA
Written exam type	Not applicable
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. Realises a final product with the right scope and complexity. 2. Realises an end product in which the system architecture as described in the technical realisation document is recognisable. 3. Realises a final product in which the chosen solution for each vision step (acquisition, enhancement, segmentation, feature extraction and classification) is obvious. 4. Demonstrates the operation of the final product according to the functional requirements. 5. Realises the final product with a high degree of independence, but in consultation with the supervisor.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-11**

Fulltime/Parttime	Fulltime
Description (Dutch)	EVD Project - PReSentatie en demonstratie 1
Description (English)	EVD Project - PReSentation and demonstration 1
Format (modular)exam	PRES Presentation
Weight factor of (modular) exam	0
Minimum result	P
Grading scale	P/F
Exam sittings	YEARA
Written exam type	Not applicable
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. prepares his project presentation. 2. makes a presentation together with his team members and has an active role both in the presentation, the demonstration and in answering questions. 3. clearly articulates the point/message of his presentation 4. delivers his presentation convincingly in terms of content. 5. concludes his presentation concisely. 6. demonstrates the operation of the intermediate product.
Educational activities offered	Not applicable
Exam number in OSIRIS	**TOETS-12**
Fulltime/Parttime	Fulltime
Description (Dutch)	EVD Project - PReSentatie en demonstratie 2
Description (English)	EVD Project - PReSentation and demonstration 2
Format (modular)exam	PRES Presentation
Weight factor of (modular) exam	0
Minimum result	P
Grading scale	P/F
Exam sittings	YEARA
Written exam type	Not applicable
Assessment criteria (OWE)/Learning outcomes (EVL)	The student: 1. prepares his project presentation. 2. makes a presentation together with his team members and has an active role both in the presentation, the demonstration and in answering questions. 3. clearly articulates the point/message of his presentation 4. delivers his presentation convincingly in terms of content. 5. concludes his presentation concisely. 6. demonstrates the operation of the intermediate product.
Educational activities offered	Not applicable