Graphical user interface, text

Description automatically generatedProfessional Internship Plan

*This is the plan for a professional internship, meaning at a company. For research internships there is a separate form.*

# Personal Details

Name: *(Student’s family name and first names)*    
Mario Real Enrique

Student number: *(Student’s ID number as provided by the university)*   
6376763

Program: *(Choose the master program that applies to this internship)* Master Artificial Intelligence  
 Master Data Science for Decision Making

Intended start date of the internship (In compliance with UM policy, internships that are not approved in advance by the Board of Examiners of the programme will be excluded from receiving credits and guidance by Maastricht University, hence this date must be at least six weeks in the future.)  
03-02-2025

Intended end date of internship  
4-07-2025  
*Note that you cannot start before having received approval. You will not receive credit points for the period before receiving approval.*

Number of European credits (ECTS) for the internship. At minimum 10 ECTS (280 hours)  
30

Total number of working hours of the internship  
840

# Supervision details

*The internship advisors are DACS staff members that give process-based and content-based supervision. At least one of the internship supervisors acts as an examiner. For the assessment at least two DACS staff members are required, but the additional assessor(s) can be decided later; please see the Rules and Regulations for details. External advisors are listed in the next section and cannot be examiners.*

Name DACS internship supervisor 1: Enrique Hortal Quesada  
Name DACS internship supervisor 2: Guangzhi Tang  
Name DACS internship supervisor 3: optional

Frequency of contact between DACS internship supervisor(s) and student:  
20 minute meeting once every three weeks

*.*

Name company: Sioux Technologies B.V.

Location company: Esp 130 5633 AA Eindhoven

Name daily supervisor: Oksana Manyuhina  
*These supervisors cannot be a student of FSE, nor a family member. In case the daily supervisor is an alumnus of FSE, she/he/they should have graduated more than two years ago. By listing the supervisors, one attests that these supervisors meet these conditions.*

Frequency of contact between the external supervisor(s) and student:  
Weekly

Frequency of contact between the external supervisor(s) and DACS internship advisor(s):  
20 minutes once every six weeks in combination with supervision meetings

The work times of the student are as follows: 8 hours each workday and the student will be present at the internship organization for at least 75% of the time of the internship.

All internship reports must be sent to the DACS Student Affairs Office for storing, where they can be labelled “confidential”, but DACS committees and assessment committees (visitatie commissies) will always have (confidential) access for auditing purposes.

*The UM internship agreement template must be used for the contract, or dispensation must be granted by the DACS internship office, and the contract must be approved by UM legal affairs. Indicate which of the two options will be used:*  
 The UM internship agreement will be used  
 Special permission will be requested to deviate, and the contract will get prior approval by   
 UM legal affairs. *(Start this procedure long before your internship since it may take time)*

The student will receive from the external institute:  
 No financial compensation  
 An internship fee  
 Salary  
 Travel costs reimbursement

On behalf of the company, Oksana Manyuhina consents with this internship plan and commits to its content

Signature: ………………………………….

# Assessment

The assessment will be based on:   
*(Specify the terms of assessment that at least should contain the report)*  
 The internship report  
 A (software) product  
 The presentation  
 The process  
 (optional)  
 (optional)

# Internship details

Background of the internship *(Describe the setting of the problem and the internship organization)*  
Problem statement: Current artificial neural network (ANN)-based systems for processing spatio-temporal and asynchronous data face significant challenges, particularly in latency and energy efficiency [1]. For instance, conventional frame-based cameras operating at standard frame rates introduce considerable delays in capturing and processing fast-moving objects, such as a ball traveling at high speeds. This delay results in prediction inaccuracies that hinder real-time applications like robotic goalkeeping. There is a need for a biologically inspired solution, such as Spiking Neural Networks (SNNs), that can leverage event-driven data for faster and more accurate processing while reducing computational overhead.

These networks are particularly suitable for spatio-temporal, sparse, and asynchronous data processing and promise to be faster and more energy efficient, compared to their ANN counterparts. Moreover, SNNs are particularly suitable for processing of events from neuromorphic camera, also known as silicon retina, which detects only changes of the logarithm of intensity. Since we do not completely understand how our retina and brain work, there are still challenges related to the design and the use of these biologically inspired technologies. With this assignment we plan:

- to advance our understanding on SNN network architectures and direct training, while introducing relevant time-encoding of event data with positive and negative polarities.

- to contribute to the RoboCup competition by creating the solution for robotic goalie with shortest possible reaction time (on CPU or edge devices, see Refs. below).

Sioux Technologies is a strategic high-tech solutions partner that develops, innovates and assembles complex high-tech systems with advanced Software, Mathware, Electronics and Mechatronics.

Reference: [1] Ottati, F. (2024). Efficient Deep Learning Inference: A Digital Hardware Perspective-Evaluating and Improving Performance and Efficiency of Artificial and Spiking Neural Networks.

Description of the assignment: *(A single page, describing the assignment and indications of the techniques that will be explored, such that it can be assessed to what extend this elective contributes to the learning outcomes)*

A ball traveling at a speed of 10 m/s and captured by a conventional frame-based camera operating at 30 frames per second, processed using a standard artificial neural network (ANN), would result in a prediction with a minimum uncertainty of 0.33 m due to the latencies introduced by the framerate. To address this unacceptable latency and to improve the accuracy of the ball trajectory, we will develop a framework, naturally combining an event camera with spiking neural network (SNN). The event camera generates continuous spikes at microsecond time resolution, with the number sensitive to the ball speed. SNN is described as a collection of neurons, which are activated if and only if the sum of spikes reaches a certain (membrane) potential, similar to actual neural dynamics. How to go from a collection of events and active neurons with local (summation only!) rules to extracting the information and global properties of the system, like moving contours, velocity, object shape, location etc., is the goal of this internship

Inspired by biological neurons, design Spiking Neural Network (SNN) architecture(s) capable of detecting, tracking, and predicting the position and velocity of a ball over time, using event camera data and following a setup similar to [1]. Compare the performance with existing event cluster tracker(s).

Reference: [1] Polykretis, I., Tang, G., Balachandar, P., & Michmizos, K. P. (2022). A Spiking Neural Network Mimics the Oculomotor System to Control a Biomimetic Robotic Head Without Learning on Neuromorphic Hardware. IEEE Transactions on Robotics.

Planning: *(Provide a complete planning for the internship period with a reasonable time path for completion. The preferred format is a Gantt chart that you can attach separately or add as an image. If your internship activities will be parallel to other educational elements at DACS (e.g., the project) please state clearly how you will incorporate this in your internship planning.)*The planning is defined in the Gantt chart. The task descriptions and the research questions can be found hereunder:

Task descriptions:

• Literature Review:

Conduct a literature review to identify the most suitable Spiking Neural Network (SNN) architecture. This review will inform the subsequent development phases.

• Ball Throws Simulator:

Develop a simulator to model ball trajectories. The simulated trajectories will be used as the expected output for the SNN.

• Event Camera Simulator:

Create a simulator that generates event camera data corresponding to the different ball throws. This simulated data will serve as input to the SNN.

• Dataset Generation:

Assemble a comprehensive dataset containing both the simulated ball throws (input) and their expected trajectories (output) for training and testing the SNN.

• Initial SNN Development:

Build and evaluate the first iteration of the selected SNN architecture using the generated dataset. This will establish a baseline performance.

• SNN Refinement:

Based on evaluation results, refine the SNN. Potential adjustments may include changes in the architecture, dataset composition, or event camera configurations.

• Hardware Integration:

Integrate the refined SNN with a physical event camera and assess its real-world performance in detecting and predicting fast-moving objects.

• Writing the report

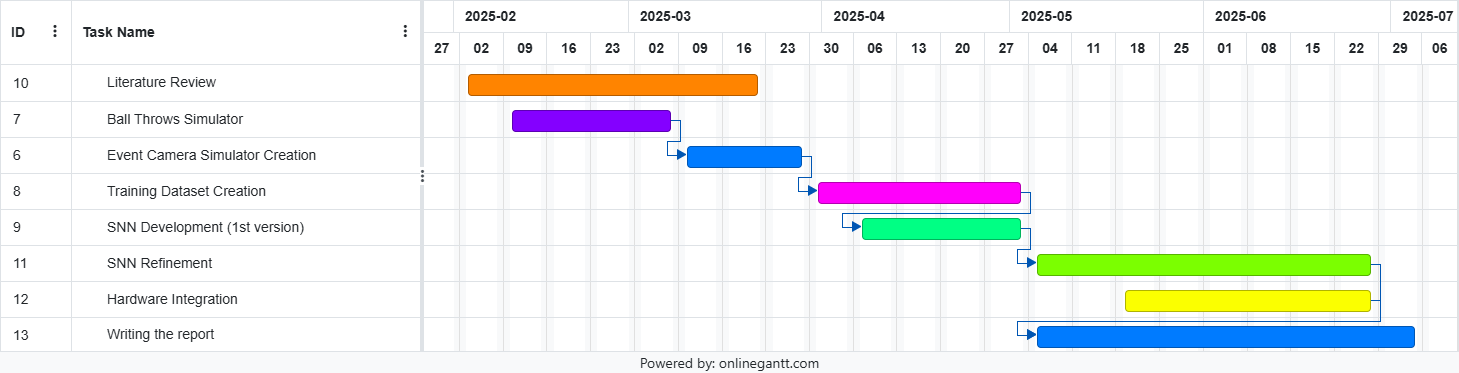
Research questions:

1. How can we accurately simulate ball throw readings in an event camera?

2. What architecture of SNN works best for transforming event camera readings into ball trajectory predictions in a simulated environment?

3. How well does this approach translate into real-world hardware implementation?

4. How well does this approach compare to existing event cluster trackers?

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# Student’s signature

The student would like to make the following additional statements to the board of examiners regarding this internship plan:  
(optional)

Ensure that you: *(Ensure that you check all)*

are familiar with the Education and Examination Regulations (EER) that are published on   
 student portal, as is expected of each student  
 are familiar with the Rules and Regulations that are published on student portal, as is   
 expected of each student  
 are familiar with the concept of plagiarism and fraud and will refrain from committing it  
 are aware of academic standards, in particular relating to proper citing  
 understand that an approval of the internship plan does not mean checking nor   
 approving the curriculum thus far  
 understand that it is not facilitated taking other components alongside the   
 internship remotely, and that any study delay is at the risk of the student  
 have at least 40 ECTS consisting of year 1 components   
 have a total of ECTS for the electives in elective semester amounts to 30 ECTS and no more   
 than 30 ECTS (unless with prior approval to take extracurricular electives)  
 ensure that this is the sole internship you undertake  
 have filled out the complete form  
 have included a planning and/or attached a Gantt chart with a planning for your internship  
 have collected the signature of your examiner and if applicable, the external institute

Date: 23/01/2025

Student’s signature ………………………………………………..

Submit this form through intranet at least six weeks before the intended start of the internship. In case of a non-UM contract, start earlier. UM internship contracts are in principle only signed after approval of the internship. In case it is signed earlier, this does not constitute automatic approval.

# Examiner

*As a prospective examiner, please check the following:*

* you adhere to the requirement so be an examiner as specified in the Rules and Regulations and the EER
* the technical content of the internship plan and that this internship contributes to the learning goals of the programme
* the intended duration is feasible for the content
* the level of the internship is appropriate as a year 2 component of the programme
* the number of ECTS credits is appropriate for the size of the internship. (1 ECTS = 28 hours)
* the internship will be an in-depth analysis of specific problems related to the programme
* the internship is planned to start sufficiently far in the future such that the formalities can still be arranged.
* the students are warned that they should submit the plan at least 6 weeks before the start and even more if the standard UM internship agreement is not used
* it is appropriate to warn the student not to make commitments until approval has been obtained

*The requirements to be an examiner can be found in the Rules and Regulations*

Name proposed internship examiner: Signature: Date:

Enrique Hortal Quesada ……………………………………………… …………………………………………