The aim of the project is to design innovative methods of processing visual data using modern event-based neuromorphic sensors and heterogeneous, reprogrammable MPSoC (Multiprocessor-System-on-Chip) devices. Event cameras are vision sensors that are inspired by the way the human visual organ works. Contrary to traditional cameras, the output is not a stream of frames, but only information about the pixels for which the brightness has changed. The sent data packet contains information about the pixel coordinates, the polarity of the change (change to lighter or darker), and a time stamp. The camera operating in this way has a number of advantages over classical sensors that sequentially send pixels belonging to the entire image frame, e.g., high temporal resolution, low latency (between a change in the scene and the information available about it), no redundant data, high dynamic range and energy efficiency.

However, event cameras bring not only advantages but also challenges. The biggest one is designing innovative data processing methods (both algorithms and hardware) and extracting useful information. These challenges arise from processing visual information in a spatio-temporal representation, analysing brightness changes instead of absolute pixel values, and sensor imperfections, resulting in noise in the event data.

The field of dynamic vision sensors is constantly and dynamically developing. Over the past few years, the resolution of sensors and the number of events that can be sent by the devices have increased significantly. This in turn leads to an increased demand for computing power and greater power dissipation, especially in tasks where it is necessary to process the event stream from the camera in real time.

Nowadays, increasing efforts are made to automate every possible process. Many of them require fast and reliable processing of visual data recorded by the camera system, e.g., ADAS (Advance Driver Assistance System), AVSS (Advance Video Surveillance System), or an automated UAV (Unamanned Aerial Vehicle) control and navigation system. One of the most important elements of such systems is the detection and tracking of objects, as well as determining the location of the camera. The first of them allows to determine the position of the object in subsequent image frames (for traditional cameras, based on frames). This information allows for a more complete analysis of the object's behaviour (e.g., recognition of human actions).

Camera position estimation is an important element of almost any mobile robot, especially when a location signal (such as GPS) cannot be used. This situation is common when the robot is working inside a building or near very tall buildings. The data from the vision sensor is used to calculate the robot's displacement between points in time.

In the aforementioned applications, the key parameters are: execution time (most often real-time processing is preferred), energy efficiency, and the ability to adapt the algorithm to various scenarios. Computing platforms that allow to meet these requirements to a large extent are reconfigurable FPGAs (Field Programmable Gate Arrays), as well as programmable heterogeneous systems, such as Zynq SoC (System on Chip), Zynq UltraScale + MPSoC and ACAP/Versal by Xilinx.

The final result of the research will be a number of configurable hardware modules described in a hardware description language (VHDL/Verilog) and software models of the proposed architectures implemented in the MATLAB computing environment or Python. It is assumed that the proposed methods and hardware platforms will allow the acceleration of data processing from event-based dynamic vision sensors, while improving energy efficiency.

The code created will be open and available for further development by other scientists. The datasets created for evaluation and algorithm development will also be released online.

The results of the project will be presented at international conferences and in scored journals (open access if possible).