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Insect detection using event cameras

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Introduction

Understanding insect behavior, population dynamics, and interactions is essential for ecological research, agriculture, pest control and biodiversity conservation. Traditional methods for insect detection, such as manual observation, are time-consuming and limited. This master project explores the potential of the Davis346 event camera for accurate and efficient insect detection, presenting experimental findings and results. The Dynamic Vision Sensor's (DVS) are different from conventional cameras, they record changes in their brightness from a different threshhold, the spatial position, precise timestamp triggering and indicator for direction of change.

Description

Event Camera Technology
Since the output of the sensor is driven by changes, thus significantly less amount of redundant information would be transmitted. The very high time resolution in the continous sensor output,which reaches the microsecond change, supports the detection of fast moving objects such as insects[1].Figure below shows a DAVIS436 and its specs. (source:https://inivation.com)

Specifications
Frame Resolution – 346x260pixels, Grayscale, simultaneous output with DVS
Bandwidth – 12 MEvents / second
Dimensions – H 40 x W60 x D25 [mm]
Software – DV Platform
Pixel Size – 18.5 x 18.5 [um]
Array size – 6.4x 4.8 [mm]

Insect Detection Approach
Several own captured datasets are to be used for the concept study, these having a length between 30 seconds to two minutes are to be used for the processing pipeline. All of the data sets were recorded by DAVIS360 . To evaluate methods for differentiating between insects, additional event data are to be simulated from slow motion videos by using methods from the Metavision SDK. The next step would be to prefilter data for the labelling, that would reduce the manual effort to separate events caused by noise and environmental influences., subesqeuntly the detection of flight are to be approximated by spline functions [1].
For pre-filtering , inorder to reduce the noise statistical outline removal is initially applied, it calculates average distance of each point to ist 15 nearest neighbours. Events more distant than it, plus 0.5 (Standrad Deviation) are removed., then we would have to filter out all events linearity value less than 0.1. Fig 1 shows the results [1].
After filtering DBSCAN algorithm is used to cluster data (Fig2). And for detection of flight trajectories segmented events streams are to be converted to 2D images and classic encoder decoder strcutures are to be used (U-Net).

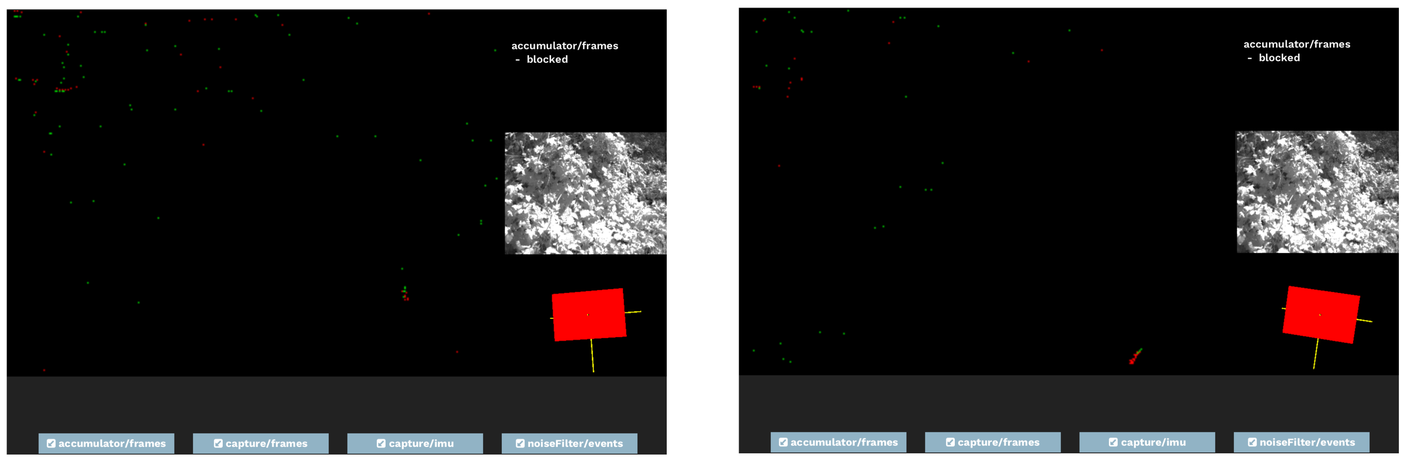

Fig. 1:The recorded events using DAVIS346,change in the pixels(black screen) denote the insect movements. The grey image is the corresponding output while recording and the red box shows the cameras position according to axis.

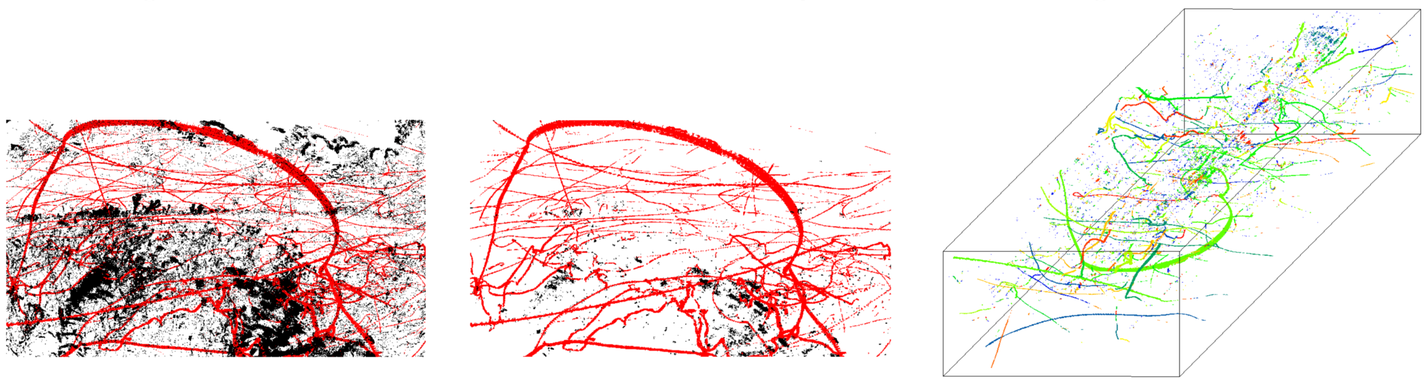

Fig.2: projected 3Devent space time point cloud of a wildflower meadow with insects, colored using manual class mapping for events from insects(red) and events from the environment and noise(black).
3D event space-time point cloud after clustering, clusters are highlighted by random colors
source: https://www.hs-niederrhein.de/elektrotechnikinformatik/personen/pohle-froehlich/

Data Set Collection
The events are captured in daylight using DAVIS360 and very less movements of the insects are captured till now. Bees were predominantly captured in our experiment till now.

Experimental Results

Collection of Data Sets
Several events were captured using DAVIS360 event camera and the prefiltering of data sets are being carried out.

Labelling
After the filtering , the events should have to be labelled using the DBSCAN algorithm .

Experiments yet to be done
1. Detection of flight trajectoties
2. Diffferentiation between Insect species.

Conclusion

In this study we have initiated the collection of events using DAVIS346 for insect detection. Our preliminary results show the potential of this technology in capturing and analysing the insects, by extracting clusters from the dataset, we aim to gain insights into the spatial and temporal patterns of insect activities. The high temporal resolution and sensitivity to motion offered by DAVIS346 provide a promising foundation for further research in this area.

References

[1] Regina Pohle-Fröhlich and Tobias Bolten, "Concept study for dynamic vision sensor based insect monitoring".

[2]Computer Vision and Mixed Reality Lab
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